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Boosting DR through increased communIty-level consumer engaGement by combining Data-driven and blockcHain technology Tools with social science approaches and multi-value service design

Deliverable D2.1 User group needs, req. & advanced DR engagement scenarios

Authors: Andrej Čampa, Andrej Simončič, Špela Lunar, Denis Sodin

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Authors:	Špela Lunar (SONCE), Andrej Simončič (SONCE), Andrej Čampa (COM), Denis Sodin (COM)
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Consortium - List of partners

Table 1. Consortium partner list

Partner no.	Short name	Name	Country
1	ENG	ENGINEERING - INGEGNERIA INFORMATICA SPA	Italy
2	TUC	UNIVERSITATEA TEHNICA CLUJ-NAPOCA	Romania
3	IMEC	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM	Belgium
4	COM	COMSENSUS, KOMUNIKACIJE IN SENZORIKA, DOO	Slovenia
5	SONCE	SONCE energija d. o. o.	Slovenia
6	ISKRA	ISKRAEMECO, MERJENJE IN UPRAVLJANJE ENERGIJE, D.D.	Slovenia
7	EMOT	EMOTION SRL	Italy
8	TNO	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK	Netherlands
9	CENTRICA	CENTRICA BUSINESS SOLUTIONS BELGIUM	Belgium
10	ASM	ASM TERNI SPA	Italy
11	DuCoop	DUCOOP	Belgium
12	CEL	CYBERETHICS LAB SRLS	Italy
13	DOMX	DOMX IDIOTIKI KEFALAIOUCHIKI ETAIREIA	Greece
14	APC	Asociatia Pro Consumatori	Romania
15	WVT	WATT AND VOLT ANONIMI ETAIRIA EKMETALLEYSIS ENALLAKTIKON MORFON ENERGEIAS	Greece
16	SUN	SunContract OÜ	Estonia

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List of Acronyms and Abbreviations

Table 2. List of Acronyms and Abbreviations

AAL	Ambient Assisted Living
AI	Artificial intelligence
AMI	Automatic Metering Infrastructure
B-BRIGHT	BRIGHT Business Ecosystem
B-DLT	BRIGHT Distributed Ledger Technology
B-DT	BRIGHT Digital Twins
B-EMHC	BRIGHT Edge Monitoring and Home Automation
B-FLEX	BRIGHT AI Driven Flexibility Valorisation
BRIGHT	Boosting DR through increased community-level consumer engagement by combining Data-driven and blockchain technology Tools with social science approaches and multi-value service design
BRP	Balancing Responsible Partners
BUC	Business Use Case
CEC	Citizen Energy Community
CO2	Carbon dioxide
COM	Community-On-the-Move
DER	Distributed Energy Resource
DHW	Domestic Hot Water
DoW	Description of Work
DR	Demand Response
DSO	Distribution System Operators
DT	Digital Twin
EC	European Commission
EMS	Energy Management System
ESCO	Energy Service Company
ESP	Energy Service Provider
EU	European Union
EV	Electric Vehicle
HVAC	Heating, Ventilation, and Air Conditioning
ICT	Information and Communications Technology
IoT	Internet of Things
KPI	Key Performed Indicator
LEC	Local Energy Community
LLUC	Low-Level Use Case
LV	Low Voltage
MV	Medium Voltage
NGIN	Next Generation Intelligent Network
NILM	Nonintrusive Load Monitoring
P2P	Peer to Peer
PV	Photovoltaic
RES	Renewable Energy Sources
S-BRIGHT	Social BRIGHT
SCADA	Supervisory Control And Data Acquisition

T-BRIGHT	BRIGHT Technological Enablers
TSO	Transmission System Operator
UML	Unified Modelling Language
VEC	Virtual Energy Community
VPP	Virtual Power Plant
Wi-Fi	Wireless Fidelity
WP	Work Package

Executive Summary

The objective of this deliverable is to present the user needs and requirements for the proposed technical infrastructure of the BRIGHT project. The following deliverable is part of the WP2 task T2.1: *End-users and business requirements and advanced DR scenarios definitions*. This work's results are a collection of commonly agreed and methodologically aligned business and low-level use cases. This collection of use cases serves as the basic input for future work on the project on different levels.

The deliverable has been divided into the following two stages:

a) collecting and defining high-level use cases or business use cases that served as input for the second stage
b) collecting the low-level use cases.

During the following task, the pilots' actors' needs will be considered and, with the identification of the specific technical characteristics, the analysis will be created. Task 2.1 collects the needs and requirements of BRIGHT target customers/groups and other relevant energy market players, such as DSO, Aggregators, etc.

Figure 1 shows a relation of task T2.1 to other tasks in WP2 that are closely related, namely:

- T2.2: Functional Specification & Technology/Tools Design
- T2.3: Data Models & Service and Platform Interoperability Specifications
- T2.5: Novel multi-value service design
- T2.6: Analysis of obstacles to innovations on consumer engagement

In the first stage, T2.1 was closely correlated with T3.1 (Citizens engagement strategies), with a common definition of BUC and collecting requirements from two different aspects technical (T2.1) and socio-economical (T3.1).

This document provides a basis for developing tools and services (WP4, WP5 and WP6) by providing technical and social requirements together with the input developed at other tasks of WP2. Furthermore, T2.1 provides the necessary input in terms of goals and KPIs to prepare BRIGHT's pilots' demonstration and validation (WP7).

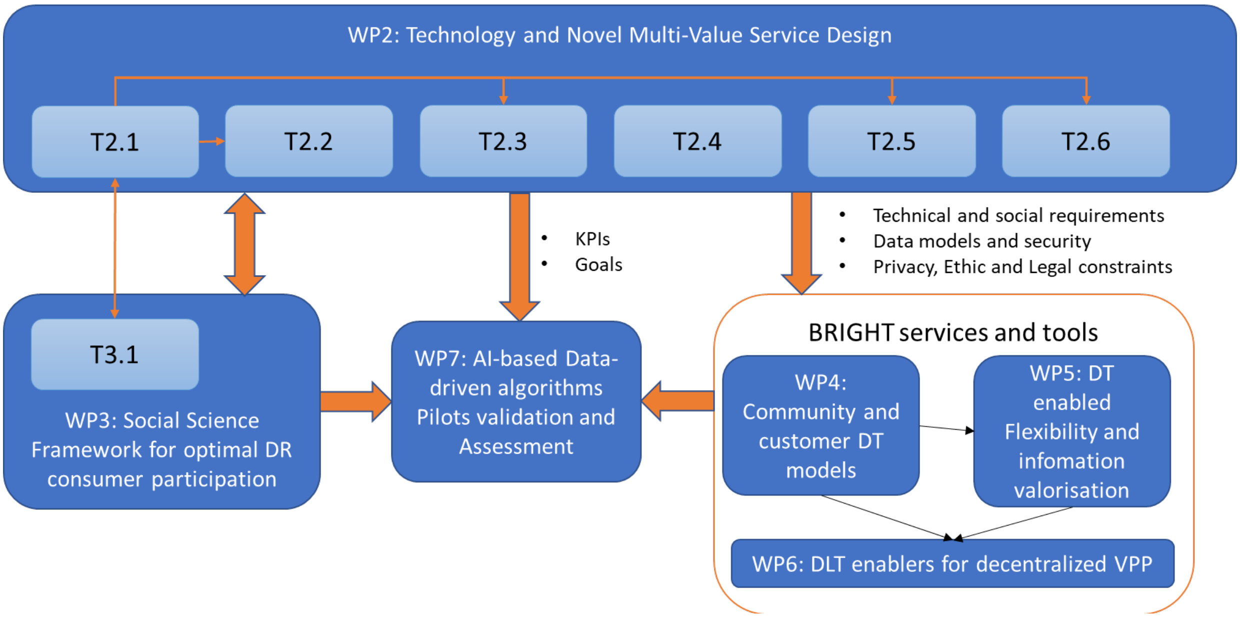

Figure 1. Main interactions of T2.1 and WP2 with other tasks and work packages

The combination of project and partner's objectives in interactive workshops resulted in a final list of LLUCs classified according to three domains - Personal care (e.g., AAL, safety/security, wellness), DR/flexibility and e-mobility - and 4 different communities:

- Virtual Energy Community (VEC);
- Local Energy Communities (LEC);
- Citizen Energy Community (CEC);
- Community-On-the-Move (COM).

The output of the two-stage work done by project partners, as described in Section 2.4, resulted in 12 LLUCs as shown in Figure 2. The LLUCs were derived from the pilot and relevant business use case, represented by the different colour. The use cases were described following the template defined by IEC 62559-2 standard. Since this methodology is helpful for a technical description of the use cases, it was slightly modified in the case of BUCs to also cover the social aspect in the template.

The full description of 4 BUCs is presented in Annex 2 and 12 LLUCs in Annex 3.

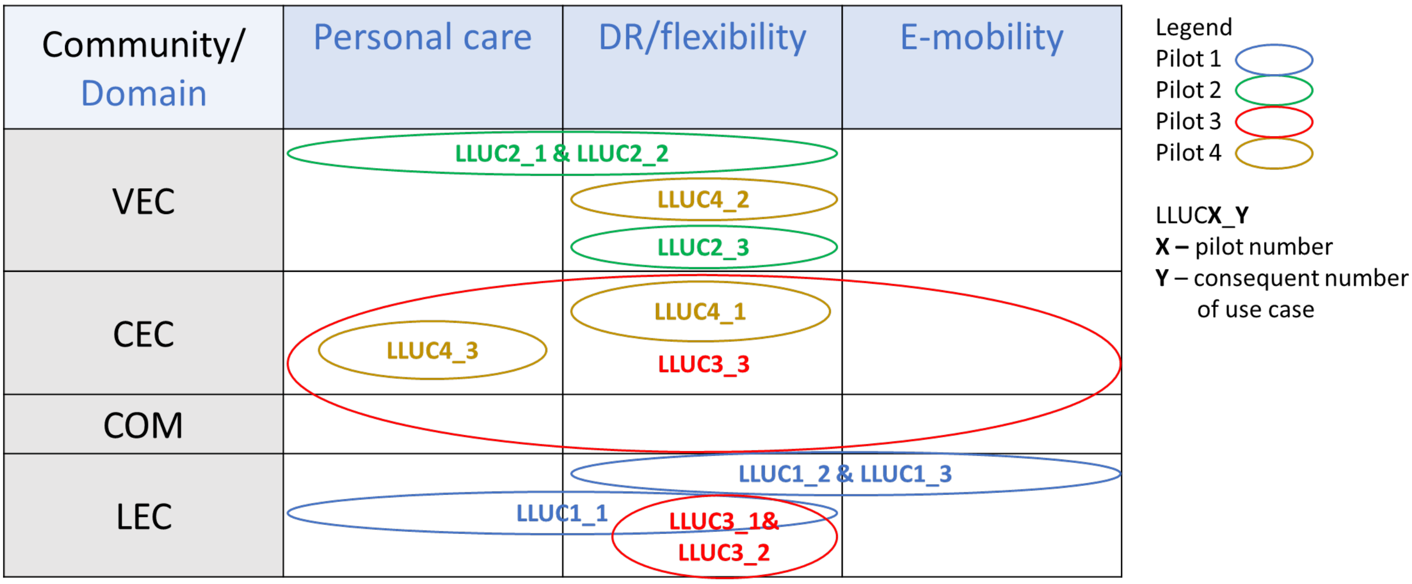

Figure 2. BRIGHT's LLUC classification according to identified BRIGHT communities and domains

1 Introduction

The BRIGHT project aims to design, develop, and deploy an energy market exploiting new opportunities for demand response (DR). In this new approach, the citizen, consumer, or prosumer (end-users) are the heart of the energy market. Decentralised renewable energy production and digitalisation offer new ways to engage consumers in the energy transition. From the end-user perspective and holistic approach used in BRIGHT, three main aspects are essential: a) the social aspect, b) the technological aspect, and c) the business aspect.

1.1 Scope of the document

The presented deliverable describes the methodology and accomplished work on use cases by the BRIGHT consortium. Using the proposed method, we have systematically described a specific system's requirements for identifying the use cases. Simultaneous analysis of the requirements from both technical and social-economic perspective resulted in a comprehensive description of BRIGHT use cases. For the latter, we have identified different actors (mainly devices, system and human actors) and their position on the market in the energy value chain. Lastly, use cases were aligned with the project's main goals.

Two types of use cases were used in the BRIGHT procedure to address functionalities at different levels efficiently: a) business level (high-level/business use cases - BUCs) and b) more detailed technical level (low-level use cases - LLUCs).

Different scenarios were identified in DoW for each of the four pilots in the BRIGHT project. These scenarios were the starting point for determining the LLUCs. The word scenario is directly related to the term LLUC and can be equated with it in all subsequent occurrences in this document.

Common BUCs were jointly produced from a technical (WP2) and social (WP3) perspective. These BUCs will be the basis for the co-design of DR technology and services (T2.4, T2.5, T2.6, T3.1 and T3.2). All use cases provide valuable input for further defining functional specification (T2.2), data models and interoperability (T2.3). LLUCs have identified services to be developed in WP4, WP5 and WP6. In addition, the LLUC defined in this document will serve as a starting point for creating the validation and assessment plan in WP7.

1.2 Structure of the document

The remaining part of this deliverable is organised in sections presenting:

- Section 1 continues with the BRIGHT project vision and objectives. It contains a description of different communities that are part of the whole project and a description of every pilot and its geographical location;
- In Section 2, the methodology of the use case is described. It consists of eight main sections and definitions of different levels of use cases based on the IEC 62559-2 standard. This section also includes a description of the use case writing process. Use case template is presented in Annex 1;
- Section 3 consists of business use case descriptions of pilot communities that are a part of the BRIGHT project. A complete description of BUC can be found in Annex 2;
- Section 4 summarises the pilots' low-level use cases. A complete description of LLUC can be found in Annex 3.

The document ends with a conclusion, references, and annexes.

1.3 Project vision and objectives

The vision of the project is a multi-layered community-centred cross-domain adaptable implicit and explicit multi-timescale (a day-ahead to real-time) DR supporting ecosystem that combines:

- **social-science-drive use experience design and social acceptance facilitation for end-user behaviour and motivation** categorisation and monetary/non-monetary incentive magnitude design for the end user's engagement in DR within a community;
- **individual and community-level DTs'** models and tools where user experience and social incentive design for end-user motivations and relevant categorisation dimensions may be alternatively combined with
    - coupled data-driven end-users and flexibility assets models to provide improved consumer predictability within a centralised VPP governance model;
    - P2P DLT/blockchain/smart contracts enablers for capturing intra-community interaction dynamics within a decentralised VPP configuration supporting community aggregation mechanisms;
    - Hybrid intermediate partially decentralised VPP configurations where some preliminary prosumers aggregations will be defined by leveraging on DTs model, complemented by a decentralised intra-community P2P privacy-preserving information sharing and reciprocal negotiation among the pre-selected prosumers to combine the top-down aggregation governance with the bottom-up community-level internal dynamics cross-flexibility markets and cross-commodity value stacking flexibility management algorithms;

The terms implicit and explicit demand response are explained below:

Implicit demand response is the consumer's reaction to price signals. That means consumers choose to be exposed to time-varying electricity prices that reflect the value and cost of electricity in different time periods. Time-varying prices are offered by electricity suppliers. With such information in advance, consumers can decide for themselves or even automate the decision – to shift their electricity consumption away from times of high prices and reduce their energy bill. A consumer uses power when it's cheapest, thus saving money on the energy bill and supports the energy system. This type of demand response is sometimes referred to as “price-based” demand response.

Explicit demand response is committed, dispatchable flexibility that can be traded on the different energy markets (wholesale, balancing, system support and reserves markets). Explicit DR is usually facilitated and managed by an aggregator that can be an independent service provider or a supplier. Consumers change their consumption upon request, triggered by high electricity prices, flexibility needs of balance responsible parties or a constraint on the network. It gains an income/reward on committed flexibility and supports the energy system. This type of demand response is often referred to as “incentive-driven” or “volume-based” [1], [2].

Both implicit and explicit types of demand response are complementary and should coexist to allow for consumer choices and enable efficient usage of the energy system. It is important to note that enabling both types is necessary to accommodate different consumer preferences and exploit the full spectrum of consumer- and system benefits from demand response [2].

The addressed project visions are divided into the following objectives:

1. To leverage actual regulatory bottlenecks and DR services for designing novel attractive consumer-centred multi-value hybrid energy services, which intelligently combine and hybridise aggregators, ESCOs, and other non-energy service providers, including personal safety, care, and AAL value chains;
2. To leverage social sciences methodologies and frameworks to understand energy consumer behaviour, identify principal "social" enablers such as community-level incentive design and P2P trading/sharing mechanisms enablers for making attractive their participation in DR programs;
3. To upscale technologies, tools, and standards for DR optimal programs design for improved centralised VPP governance, including DR forecast, individual and community end-user profiling, segmentation, and asset flexibility forecasting, to combine and integrate them within a consumer DT model for improved big data-enabled consumption predictability;
4. To leverage End User DTs modelling to develop the necessary adaptation of electricity consumption data-driven algorithms for value stacking multi-market multi-commodity flexibility valorisation for aggregators, optimal energy management and increased energy efficiency for ESCOs/suppliers and other non-energy e-mobility and smart home services;
5. To deploy and validate on a large scale the proposed BRIGHT social, technological and business environment and its co-creation approach;
6. To develop and validate innovative open, cooperative sharing-economy local business models, which leverage on the design of innovative electricity-enabled cross-domain services;
7. To draw on best practices, blueprints and guidelines, prepare the ground for EU-wide replication of the BRIGHT approach aimed to enable the EU-wide support to LEC creation and DR increased participation through a vibrant public outreach campaign, which directly liaises with citizens and consumers as facilitated by consumers associations and respective EU network.

1.4 Addressed business domains

The project considers a comprehensive and more bottom-up approach, where communities can take complete control of the local energy system and capture all the benefits of different integration options. The project addresses three different domains: (i) **S-BRIGHT**: community-centred social domain, (ii) **T-BRIGHT**: technological domain and (iii) **B-BRIGHT**: business ecosystem. The domains mentioned above combine different aspects such as:

- Social science user experience design for end-user behaviour understanding and community-level beyond-economic incentive;
- Consumer and community DTs by integrating data-driven consumer preferences and behaviour modelling with flexibility assets modelling to enable centralised VPP governance;
- DLT/blockchain/smart contracts technology enablers aimed to implement P2P trading/sharing mechanisms for supporting decentralised P2P VPP where self-organising prosumers may exchange information reciprocally and spontaneously aggregate within dynamic coalitions while taking explicit control of their flexibility assets, hence better trading off their preferences against grid stakeholders' requirements;
- Cross-domain value stacking service design and innovative business modelling at the interplay among different energy carriers, different energy stakeholders, different domains.

S-BRIGHT: a social science framework for soft modelling of end-user behaviour as a "beyond-financial social animal", especially when considered as a member of a community-centric organisational configuration. It combines insights from social science and behavioural economics to understand the electricity consumer social beyond-economical motivations for participating in DR programs and appropriate incentive design. It also supports the co-creation approach, which systematically combines and integrate social science-driven user studies for user experience design, consumer motivation understanding and continuous engagement methodologies through appropriate incentive design with technology enablers for the data-driven end-user and flexibility assets modelling and business dimension for new service design.

T-BRIGHT: leverages on latest advancements in IoT, AI, Blockchain and Big Data technologies to build DTs for individual consumers and communities aimed to improve consumer behaviour predictability and support the implementation of novel community-oriented services for increased flexibility mobilisation. It includes the following technological tools:

- **B-DT** for customers and community and Big Data-enabled accurate prediction;
- **B-EMHC** an edge grid stack for electricity metering infrastructure and smart home automated control, which will deploy advanced scalable and interoperable edge-level stack for behind-the-meter electricity near real-time consumption;
- **B-FLEX** will consider the DT models and prediction outcomes to deliver optimal flexibility services at the level of end-user, community, and system;
- **B-DLT** blockchain and smart contract technology enable a decentralised P2P virtual power plant, a self-organised VPP. Thus, without a central operator's need, where P2P information sharing and broadcasting is allowed in a decentralised way.

B-BRIGHT: allows hybridising DR/flexibility provisioning with multi-commodity energy services, energy efficiency services, e-mobility management, and personal care services. It features integrated service offering that may enable win-win reciprocal synergies and reinforcing business opportunities for both DR operators and energy-efficiency/ESCOs/mobility managers/personal care/security operators, and in particular, opens up additional opportunities for aggregators to design and deploy multi-value chain stacking services allowing individual consumers (or organised groups of consumers) to get additional revenues from flexibility provisioning stacking (e.g., stacking the value of flexibility on different energy services such as combining ancillary services with self-consumption) or cost savings for their wellness/AAL/energy efficiency/personal safety needs.

1.5 Narratives of the communities

Central to the project's vision is the energy communities as a group of energy consumers, which share some common interest and/or attitudes, and are, in some cases, supported by an existing legal framework. These communities may be engaged to unlock their additional and unique flexibility and accordingly contribute effectively to increase the share of activated DR. The communities identified by the BRIGHT project with the most significant potential are: Local energy communities, Virtual energy communities and Hybrid communities. The following communities were chosen due to their diversity, which is seen in the whole picture of the EU social sphere. Each community represents their own advantages and specialities and are most common on the EU floor.

1.5.1 Local Energy Community

Local Energy Communities (LEC) are non-commercial entities that integrate energy generation systems, loads, storage systems and other services present in the same geographical area. The area that the local energy community covers may be more than one dwelling and includes nearby consumers located in other buildings or consumers on the same electrical grid. [3] Local energy communities described and planned in the BRIGHT project will be under a hundred participants in each pilot. The main purpose of a LEC is to develop the territory, provide better environmental conditions, and guarantee the members' economic and social advantages, sharing costs and benefits.

The European Union has promoted energy communities' development through the Clean Energy Package, with two different directives: The Renewable Energy Directive 2018/2001 that regulates mainly renewable energy communities, and the Internal Electricity Market Directive 2019/944 that establishes roles and responsibilities for citizen energy communities. Organisational and legal structures of LEC can vary significantly (energy cooperatives, limited partnership, foundations, non-profit customer-owned enterprises…), but they all have in common some fundamental characteristics: the participation is voluntary and open for all local members potentially interested, so it's an essential representation of consumer engagement; the control is carried out democratically and directly by citizens, local authorities and other entities involved; the aim is to produce social and environmental benefits, such as guaranteeing economic savings and reducing greenhouse gas emissions by rationalising energy consumption. LECs are made up of all or some of the following components: generation units, most often from renewable sources, electricity distribution systems, storage systems, energy services such as consumption monitoring, energy management systems, building heating and electric mobility systems.

The presence of LECs favours the self-consumption of the energy produced within the community, constitutes a source of flexibility for the electricity grid, and increases its resilience, reducing losses and enabling better management.

1.5.2 Virtual Energy Community

First of all, a virtual community is a social entity, which means that a group of people are connected by specific criteria for the community and can be uniquely exploited in DR programs. A virtual energy community is an energy network of energy consumers and prosumers who connect through specific energy platforms, crossing geographical boundaries [4]. The basic concept of the word "Virtual" proclaims that some other traditional meanings of a community are no longer part of the “real” world. In comparison to that, the property is only virtual, which means that the sound, the look and the feeling is "as if" it is real but is not. That kind of community is taking part in our society [5]. The platform offers huge opportunities to current and future users in the field of energy and non-energy services. In energy services, users can sell and buy electricity produced exclusively by renewable energy sources and improve the self-consumption from RES. In this way, users can lease energy at a lower price than their electricity contract price. As far as non-energy services and products are concerned, users can offer or buy projects and services from the P2P project marketplace platform.

1.5.3 Community on the move

BRIGHT considers the community on the move as the whole of EV owners. EV owners are a group of energy consumers that have recently formed and could become one of the most energy-intensive groups in the near future. This entails an ambitious challenge for the management of the electricity grid, which will have to host a greater quantity of energy, mainly coming from renewable power plants; in this context, the involvement of EV owners in DR campaigns is a powerful solution to limit the investments necessary to upgrade the power grid, coordinating the scheduling of charging sessions with the intermittent renewable plants' operation. The transition to electric mobility is an important issue for the European Commission (EC), as demonstrated through "Europe on the move", a wide-ranging set of initiatives related to transport and mobility [2]. During his State of the Union address of September 2017 [1], former EC President Juncker set out a goal for the EU and its industries to become a world leader in innovation, digitisation and decarbonisation, considering actions for a fundamental modernisation of European mobility and transport, such as:

- The first-ever CO2 standards for heavy-duty vehicles;
- A strategic Action Plan for the development and manufacturing of batteries in Europe;
- A forward-looking strategy on connected and automated mobility;
- An integrated policy to ensure EV charging infrastructure safety.

1.6 Mapping to pilots

The BRIGHT co-creation approach and the underlying business in the domains mentioned above will be demonstrated and validated in actual conditions across four demo-sites across four EU countries as shown in Figure 3 (Belgium, Greece, Italy and Slovenia). As part of the pilots, the partners will introduce, validate, and evaluate different aspects and dimensions, ranging from community type, VPP aggregation mechanisms, other energy and non-energy services to varying types of DR, DER resources, and small consumers.

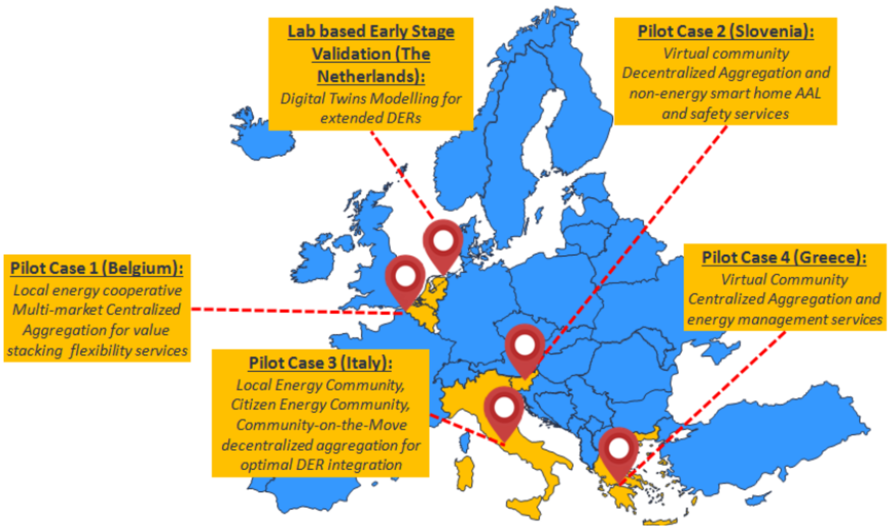

Figure 3. BRIGHT pilot locations across Europe

The pilots were mapped to different communities as identified in Section 1.5, Figure 4. However, the citizen energy community (CEC) is a specific community that can be linked either to LEC or VEC, but the main idea is, it is a much larger community and therefore also more diverse. For instance, the CEC is on the scale of the city. Hence, CEC represents a statistically very large community. Some specifics related to local community, building or behaviour associated with the district of some city may already be lost in the statistical average. Thus, this kind of community needs a different approach in addressing the social and technical challenges related to smart grid improvements.

Since the basis for each pilot is a completely different community, the overall objective of the use cases is to identify services and strive for a common solution.

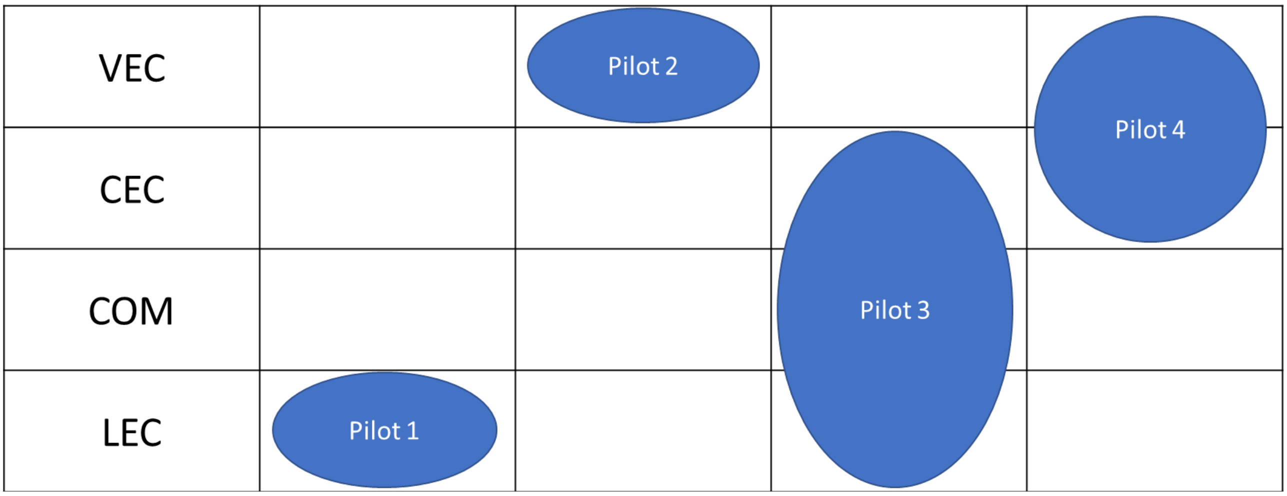

Figure 4. Mapping of pilots to different communities

1.6.1 Pilot 1: Local Energy Cooperative multi-market centralised aggregation for value stacking flexibility services

The objective of pilot 1 (De Nieuwe Dokken, Ghent, Belgium) is to demonstrate the combined usage of social incentive design with end-users' digital twins for the end consumer characterisation to allow optimal exploitation of the available flexibility. Both financial and non-financial incentives will be assessed. DuCoop ESCO will deploy the pilot and manage the energy-related assets on-site, including the district heating network, the EV charging stations, the solar panel installation and battery storage capacity, as the most relevant assets to the BRIGHT use cases. The LEC (see Section 1.5.1) that will help in achieving the BRIGHT objective is already in place, managed by DuCoop.

On the technical side, an overarching intelligent monitoring system (SCADA) was set up (2019-2020) in collaboration with the utility company Farys to manage and control collective (industrial) energy consumption (water treatment plant, vacuum system, EV charging stations, district heating, battery storage, etc.). As an additional control layer, an Energy Management System (EMS) is being developed by partner OpenMotics. The main objective is to optimise further and align the use of the different technologies leading to an increased self-consumption of renewable energy. On this level, the BRIGHT objectives for this pilot will be implemented.

In the context of user engagement, it is worth mentioning that DuCoop also enables a digital communication platform to inform end-users of their energy consumption profile, made possible by the use of digital meters and real-time data communication.

1.6.2 Pilot 2: Virtual Community Decentralized Aggregation and non-energy smart home AAL & safety services

The objective of the pilot is to demonstrate VEC decentralised and participatory orchestration of flexibility for implicit and explicit DR programs with energy and non-energy services based on the availability of electricity fingerprinting data. Technology- and business-wise, the Slovenian pilot aims to provide one-stop-shop solutions for active consumers, which combine and integrate an edge-secure gateway component (provided by COM) with the metering infrastructure and the P2P

DLT/Blockchain platform. The above-resulting stack will be duly complemented by BRIGHT social and technological enablers adoption, the social incentive design for understanding consumer behaviour and motivations, to define a multi-criteria segmentation, and the edge smart Home automation layer. The P2P/Blockchain platform will support and operate the P2P virtual community orchestration of flexibility. Simultaneously, the BRIGHT DLT enabler will be utilised to support the P2P tokenised asset trading for token sharing within a cross-domain scenario (energy versus non-energy services). The pilot will also be deployed by the consortium partner SUN, which is also a P2P Blockchain platform provider. The Slovenian pilot is mostly related to the project objective focusing on upscaling technologies, tools and standards for DR optimal programs design for improved centralised VPP governance, including DR forecast, individual and community end-user profiling, segmentation, and asset flexibility forecasting.

The Slovenian pilot is divided into three scenarios, which connects the pilot processes into the whole picture.

- The first pilot scenario: Virtual community decentralised flexibility orchestration for implicit and explicit DR. The first pilot scenario addresses the possibilities for the integration and orchestration of virtualised behind-the-meter assets by means of a decentralised consensus scheme operating on top of the P2P energy marketplace.
- The second pilot scenario: Building optimal flexibility management traded off with comfort management.
- The third scenario: Analytics and automation supported aggregation of behind-the-meter assets. This scenario addresses the challenge of providing a hierarchical control architecture that tightly integrates heterogeneous assets and systems.

1.6.3 Pilot 3: LEC, CEC and COM Aggregation for optimal Flexibility Management

Pilot 3 will consist of three scenarios aiming to demonstrate flexibility management services for decentralised and semi-decentralised VPP. The VVP will be realised at three main levels: Building-level LEC semi-decentralized VPP, LEC decentralized VPP Marketplace for Local MV/LV Network Congestion Management and CEC semi-decentralized VPP. The P2P trading will be fundamental to extract flexibility from heterogenous customers.

The utilities available for carrying out the demonstrative analyses are a residential building, the ASM headquarters, a school building and a fleet of 10 electric vehicles. A total of about 200 consumers are involved in the Pilot. The system includes over 250 kW of photovoltaic generation peak, a storage system (72 kW, 66 kWh), three electric vehicle charging stations (22 kW), and water network control. Users are equipped with smart meters and controllable loads.

The three study scenarios are made up as follows.

- In Scenario 1, an LEC demonstration for flexibility services will be carried out to demonstrate how to optimise loads and manage flexibility through a multi-market approach involving the BRP, the DSO and the aggregator. Smart contracts will be used for near-real-time verification of the flexibility provided.
- In Scenario 2, the demonstration aims to use the sources of the LEC's flexibility for the management of network congestion and reverse power flow that occurs in the ASM headquarters due to the excess of renewable production at certain times of the day. The contractual tools include smart contracts and P2P B-DLTs.

- In Scenario 3, a CEC will be demonstrated in which user consumption prediction will be integrated with the exchange of flexibility from decentralised users via P2P; in particular, the flexibility sources will be variable loads, batteries, and electric vehicles. Furthermore, the aggregation of the flexibility provided by electric vehicles through intelligent charging will be demonstrated.

1.6.4 Pilot 4: Virtual Communities Centralized Aggregation and energy management services

The pilot objective is to demonstrate VEC centralised for implicit DR programs together with energy management services based on electricity and gas fingerprinting data availability. The Greek pilot will showcase how IoT-assisted energy and comfort management can be combined with cross-energy services for decentralised communities of consumers towards promoting their participation in DR schemes while offering reduced consumption for end-consumers and improved flexibility for suppliers. Business-wise the Greek pilot is an ideal benchmark for implicit price-based DR since the supplier may coordinate and combine load demand shifting with a dynamic price for the energy, which is directly set by the supplier and is directly connected to the energy purchasing in the wholesale market.

The Greek pilot involves 100 residential consumers, half of which are electricity consumers and the other half, gas consumers. Overall, three study scenarios are implemented in pilot 4.

- Scenario 1 envisages participation in DR schemes for both electricity and natural gas and energy management for Smart home individual households, employing both smart relays and smart plugs to control heavy consuming appliances and other electric white goods using the B-EMHC tool.
- In Scenario 2, the demonstration aims to implement virtual community optimal thermal comfort management with cross-energy services while trading off with energy flexibility provisioning. Optimal control of legacy heating and DHW preparation boilers is performed by integrating smart automation controllers (B-EMHC) and cloud IoT platform.
- Pilot scenario 3 of advanced user profiling intends to improve the predictability of consumption and consumer behaviour based on the different types of identified customer segments, usage patterns, building and device characteristics. B-DT models will be used for making energy data consumption available and understandable through visualisation.

2 Use case methodology

Several organisations and projects over the world have used and developed the use case methodology from IEC PAS 62559. The most crucial thing in describing the use cases and their functionalities is the bone structure and organisational path. The organisational path could be described in different approaches and viewpoints; top-down and bottom-up approach. The whole process is known as Use Case Methodology and is specified as a template in the standard IEC 62559-2 by IECTC8 [6]. The complete standard template has eight main sections, which titles are defined below:

1. Description of the use case;
2. Diagrams of a use case;
3. Technical details;
4. Step by step analysis of use case;
5. Information exchanged;
6. Requirements;
7. Common terms and definitions;
8. Custom information.

In general, a use case is a list of actions and steps, which defines the actor's interactions and system to achieve specific goals. We're using the UML diagram to capture the explanations of the actions and steps [7]. The focus of the use case description is to capture the designed system's general functionalities and environment. Well defined use cases are functional for later usage and for sharing with the general community in the form of reports [6]. The iterative process of entering the data and descriptions in the use-case questionnaires by the domain experts of the system delivered the detailed technical specification.

2.1 Definitions

We used the IEC 62559-2 as the baseline document for the use case and report definitions.

The actor is an individual that communicates and makes interactions with the subject. In use case modelling, the actor specifies a user's role, individual, external hardware, or any other system[8] [9].

The use case describes and represents the function list of tasks that actors can perform in a system in a technology-neutral way and is directly related to the business process's requirements. According to ISO/IEC 19505-2:2012, a Use Case is defined as *"a specification of a set of actions performed by a system that yields an observable result of value for one or more actors or other stakeholders of the system".* It represents a list of specific actions defining the interactions between an actor and a system to reach an objective. It can be specified on different levels, such as the Business Use case (BUC) and/or Low-level Use case (LLUC). The use case document defines the requirements and, at the same time, provide the introduction of the different actors or roles for a given scenario [10] [7].

The business use case describes the relationship between the use case and the actors' objectives and ensures that objectives are met. All objectives need to be measurable by the KPI specified in the Use case.

A low-level use case defines a use case according to an end-user/system objective and achieving these objectives through the implementation. The use case implementation is normally automated. Concerning the business use cases, the low-level use case can implement the business use case as a whole or part of it.

The sequence diagram defines the interaction on low-level use cases that takes place between a user of the system and the system.

2.2 Preconditions, functional and non-functional requirements

The use case writing process enables identifying and documenting the preconditions and requirements efficiently. Since this is an initial process of identifying the relations and steps, it has to be noted use cases are generic, and they cannot identify all preconditions and requirements. Therefore, the requirements and preconditions related to the development of algorithms and tools are not captured by use cases methodology.

A **precondition** is requirements that need to be met so the basis scenario use case can be successfully initiated.

A functional requirement describes a system's functions that need to be performed. A system functions are inputs and outputs [11]. The functional requirements correspond to each sentence of the step-by-step description of the use case, for example, what the use case's associated actors must do.

Non-Functional requirement describes the quality attribute of a software system. It also allows user to impose restrictions on the system [11]. It is a requirement that defines criteria that can be used to determine a system's operation rather than specific actions [12].

2.3 Key performance indicators (KPI) and expected impacts

The KPIs are defined in each of the BUCs and LLUCs. Partners were encouraged to use the KPIs specified in DoW, update them and identify new ones if needed. For the LLUC, the focus was on defining KPIs related to BRIGHT functions linked to the development of services and tools in WP4-WP6. The author had to identify the technical as well as social KPIs. With KPIs' help, we will evaluate the general success of a use case and a project and measure their performance in the field test as defined in the WP7. In addition to all above, the KPI identify the room for improvement and weaknesses of the proposed innovative functionalities [13].

2.4 Use case writing process

The writing of the Bright use cases was divided into two parts. The top-down approach was used in describing and identifying the Use Cases as shown in Figure 5.

In the first step, each pilot identified the pilot's overall scope, the objectives, roles of the actors, functionalities needed to realise the use cases and consumer/citizen engagement strategies.

The outcome of the first step is the set of high-level business use cases. Since the high-level business goals are common from a technical and social perspective, a common template for WP2 (T2.1) and WP3 (T3.1) was created in step 1. This way, we were able to efficiently identify social and technical requirements. The iterative process was used to write the BUC until the use case's satisfactory specification was achieved.

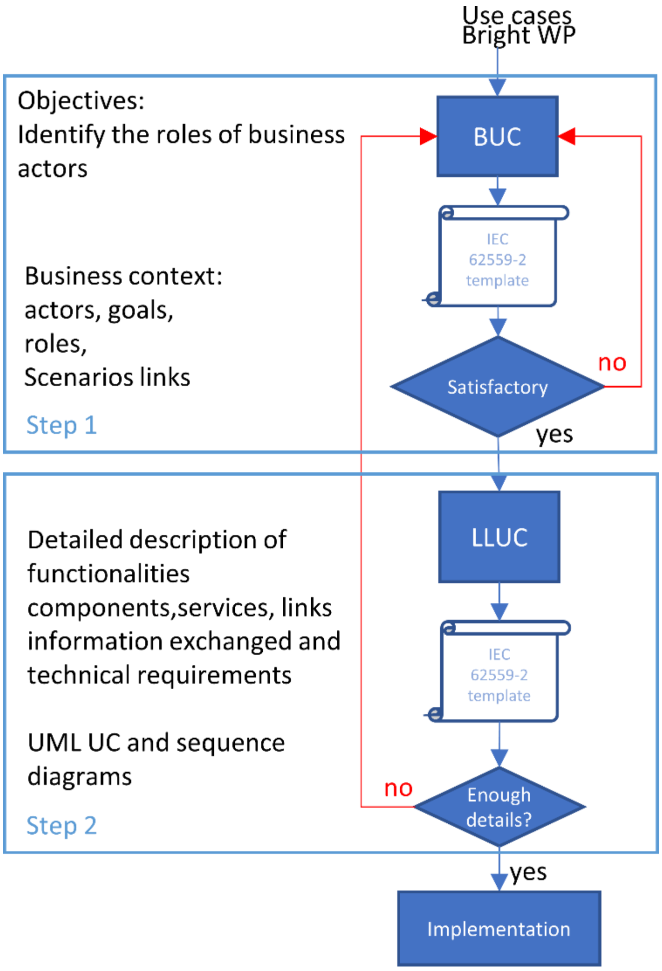

Figure 5. BRIGHT Use Case methodology

In the second step, the low-level use cases were derived from each BUC. LLUCs were described in detail using the IEC 62559-2 methodology. This step was focused on providing a technical solution to the problems that the BUCs had identified. Therefore, more detailed descriptions and relations among actors are presented by use case diagrams and step by step analysis. The LLUCs enable us to identify some new relations and solutions that might be interesting also from the business perspective. Again, the iterative process was used until a comprehensive description of BUCs and LLUCs was achieved.

3 Business use cases

This section describes the business goals associated with social, environmental, and economic factors. The business use cases were mapped one to one with the BRIGHT pilots and the communities related to each BRIGHT pilot. The business use cases' main goal is to describe general social and technical enablers in various communities, therefore striving to cover the project's common goal from variety of different aspects. The model describes what is generally called "processes" [14]. BUCs relate to all domains, also mentioned in Section 1.4. The S-BRIGHT combines the social aspects of users within the DR program and puts the user and his needs at the forefront. The T-BRIGHT domain is involved in developing technology that adds value to the social framework and encourages the development of new guidelines. The B-BRIGHT represents a combination of both previously mentioned domains in terms of adding value to companies and individuals within technological progress and the development of new technologies.

BUCs describe only general requirements, ideas, or concepts as architectural solutions and are the basis for LLUCs. As shown in Annex 2 – Business Use Cases, BUCs were systematically described following these steps:

1) **Identify the actors**: with this step, we identify the actors for more precise information on who will interact with the system and how.
2) **Identify the scope and objectives**: with this step, we place the aims and boundaries of the use case and the objectives goals the use case is expected to achieve.
3) **Define the assumptions and prerequisites**: in this step, we define which requirements must be met to accomplish the basic scenario use case.
4) **Describe the short and complete description of the use case**: in this step, we describe the use case from the actor's point of view, describing what happens when, how, why, where and under what conditions.
5) **Define the KPIs**: description of the KPIs and their relations to use case objectives.

3.1 BUC 1: Local Energy Cooperative multi-market centralised aggregation for value stacking flexibility services

BUC 1 falls under LEC. DuCoop, in its role as responsible for pilot 1, has the main goal to develop and evaluate new business use cases, in particular relating to consumer (and in this case also customer) engagement and demand response. In the context of BRIGHT, three cases applying demand response to heating, electricity and EV charging will be considered. As a first step, methods to engage and inform customers will have to be developed. Because DuCoop is a consumer cooperative, all customers also own a part of the company and have a say in the decisions made about their energy. Moreover, since this LEC is centralised, all customers live close to each other geographically speaking (at most 500m apart). This opens up especially interesting perspectives since the threshold to gather customer preferences is assumed to be lower than for traditional energy providers, and there is the possibility to get more direct feedback on what customers find engaging or not. On the other hand, this also requires DuCoop to put significant effort into informing customers about possible business cases.

On the business case level, the end-goals can be listed as follows:

- Assess the different ways of creating engagement among customers;
- Assess the willingness of customers, possibly incentivised financially, to approve and use suggested demand response schemes;
- Assess the financial results of the applied demand response schemes.

On a more general level, DuCoop intends to provide insights into how customer engagement is approached throughout the project and the final engagement level, thereby providing a valuable starting point for other ESCOs, LECs, etc., their customer engagement.

Conversely, the Italian pilot scope demonstrates decentralised and semi-decentralised VPPs for geographically bounded communities. The available local flexibility is combined and optimally managed to be delivered to the wholesale and/or local congestion management market. In relation to the local energy communities, the following objectives will be reached:

- Building-level LEC Semi-decentralized VPP for flexibility multi-value stacking services, capable of allowing residential customers to participate in the energy transition actively;
- LEC decentralised VPP Marketplace for Flexibility Trading for Local MV/LV Network Congestion Management, capable of increasing the interactions between heterogenous customers and increasing energy performances.

The Italian Pilot covers different geographic areas at the building, district and city level; different levels will be orchestrated by ASM, the Distribution System Operator (DSO) of Terni. At the building level, the engaged citizens are interested in a deeper knowledge of their consumptions in order to minimise their electric bill. Some of them want to be aware and active on energy transition. The ASM headquarters needs to identify and exploit the flexibility from different energy clusters at the district level, such as building facilities, photovoltaic plant, battery energy systems, and electric vehicle supply equipment. The city-level corresponds to an energy community that wants to increase its energy efficiency and identify its flexibility capability. This level includes, beyond the residential consumers above mentioned, additional end consumers, such as public schools equipped with local photovoltaic (PV) generation, residential household consumers equipped with PV, and smart home individual household consumers with local generation, storage and adding on EV renting and driving integration.

3.2 BUC 2: Virtual Community Decentralized Aggregation and non-energy smart home AAL & safety services

BUC 2 falls under VEC. The Slovenian pilot's scope is to provide one-stop-shop solutions for active consumers and citizens, who will engage in innovation and co-create the added value together with other actors (all together forming a virtual community). The DR programs solution will not be based only on energy services but also non-energy services such as detecting unreasonable or sudden deviations in the consumption of devices or detection of ambient sensors outside the normal range in living areas. The alarm will alert caregivers on a sudden deviation to normal behaviour and try to prevent potentially dangerous situations or behaviour of citizens.

In relation to the virtual energy communities, the business use case has the following objectives:

1. To design social incentives for optimal user engagement in DR programs.
2. To collect data on consumer behaviour and motivation.
3. To create and demonstrate VEC.

The Slovenian pilot's speciality is not having strict geographical boundaries since it takes place in the virtual community. A virtual community is formed by platform users: consumers, prosumers and indirectly involved citizens. The awareness of the variable energy price differs from one group of users to another, reflected in a different understanding of comfort management. By providing peer-to-peer exchanging tokens between platform users on the B-DLT platform, we can utilise the new energy services and non-energy services for personal safety and AAL on the market.

The business use case's main goal is to characterise the virtual community users well; get a typical consumer consumption profile throughout the different seasons (repetitive patterns or hourly consumption profiles). By using advanced analytics, the virtual community's typical consumer profile can be extracted and used to optimise the schedule of the heating and energy consumption profile on the level of the virtual community. Furthermore, by estimating the difference between the consumption and PV production, we can manage these flexibilities to a) provide improved self-consumption, b) lower the energy cost and c) enable other non-energy related services such as detection of deviations in consumption patterns and triggering the alarm in case of abnormal behaviour. These alarms can be used to build auxiliary services related to AAL.

The pilot connects several different actors: P2P energy marketplace operator, Service user, Service provider, AMI, Aggregator and EMS.

Figure 6. Pilot location, Dom sv. Lenart, Slovenia

3.3 BUC 3: LEC, CEC and COM Aggregation for optimal Flexibility Management

BUC 3 falls under LEC, CEC and COM. Community on the move (COM) will be considered a further energy community for providing flexibility to the DSO; EV owners will be involved in the DR campaign through economic incentives and leveraging on a 100% green energy charging session. During the DR campaigns, the electric vehicles will be redirected to specific charging stations at specific times of the day in order to reduce reverse power flows due to local renewable energy surplus.

Figure 7. SpotLink EVO charging station in Terni pilot site

On the business case level, the objective will be to create and demonstrate COM by efficiently coordinating e-Mobility consumption and renewable energy production in order to avoid grid instability. The coordination will involve developing optimal EV user incentives, whose effectiveness will be evaluated based on the results of the COM DR campaign as measured by the KPI regarding the reduction of reverse power flows.

Furthermore, intelligent centralised flexibility aggregation by the EV fleet operator will be validated by smart recharging to match the flexibility profile request.

3.4 BUC 4: Virtual Communities Centralized Aggregation and energy management services

BUC 4 falls under VEC and CEC. The Greek pilot aims to provide a central solution that combines automated electricity and natural gas management by maintaining indoor comfort (temperature, humidity) and reducing energy consumption and costs for end consumers while delivering improved flexibility for energy suppliers by applying implicit DR solutions (load shifting). The pilot's objective is to implement:

- IoT-assisted energy management for Smart home individual households, employing smart relays to control heavy consuming appliances, such as electric water heaters/space heaters/heat pumps, etc. and smart plugs to control other white goods (dehumidifiers, dryers, etc.);
- Optimal control of legacy heating and DHW preparation boilers for residential gas consumers;
- Advanced user profiling improves consumer behaviour predictability based on the different types of identified customer segments, usage patterns, building, and device characteristics.

The pilot will involve 3 clusters of consumers, forming three virtual energy communities (Thessaloniki, Volos, Chalkidiki). The pilot will involve diverse customer profiles (age, financial, etc.) and cities with various climatic data (temperature, humidity, air etc., of northern and central Greece), allowing the evaluation of different scenarios based on different occupation patterns. Its main goal is to enhance the participation in implicit Demand Response schemes through the development and implementation of energy (energy statistics and information, energy analysis and advice) and non-energy services (comfort monitoring, home automation, security), for decentralised communities of consumers, by using the infrastructure that has been established from other EU projects with the installation of new technologies(sensors).

4 Low-Level use cases

This section presents an overview of the LLUCs identified in the BUCs as described in Section 2.4. The identified BUCs served as a basis for identifying functionalities and domains. The functionalities are more precisely defined in the low-level use cases (LLUCs). The goal of the LLUCs was to identify and describe functions of the tools that need to be developed, improved and demonstrated within the BRIGHT project. 12 LLUCs were identified as a result of the process. As shown in Figure 8, the LLUCs were mapped according to the community they address and different BRIGHT projects' main technical and social domains. In other words, use cases describe the conversation between a system and its users, also known as actors. Even though the system is usually automated, use cases also apply to equipment, devices, or business processes [15]. As it turns out, described use cases in the BRIGHT project mainly interact with devices and their systems with the persons or companies on the low-level use cases.

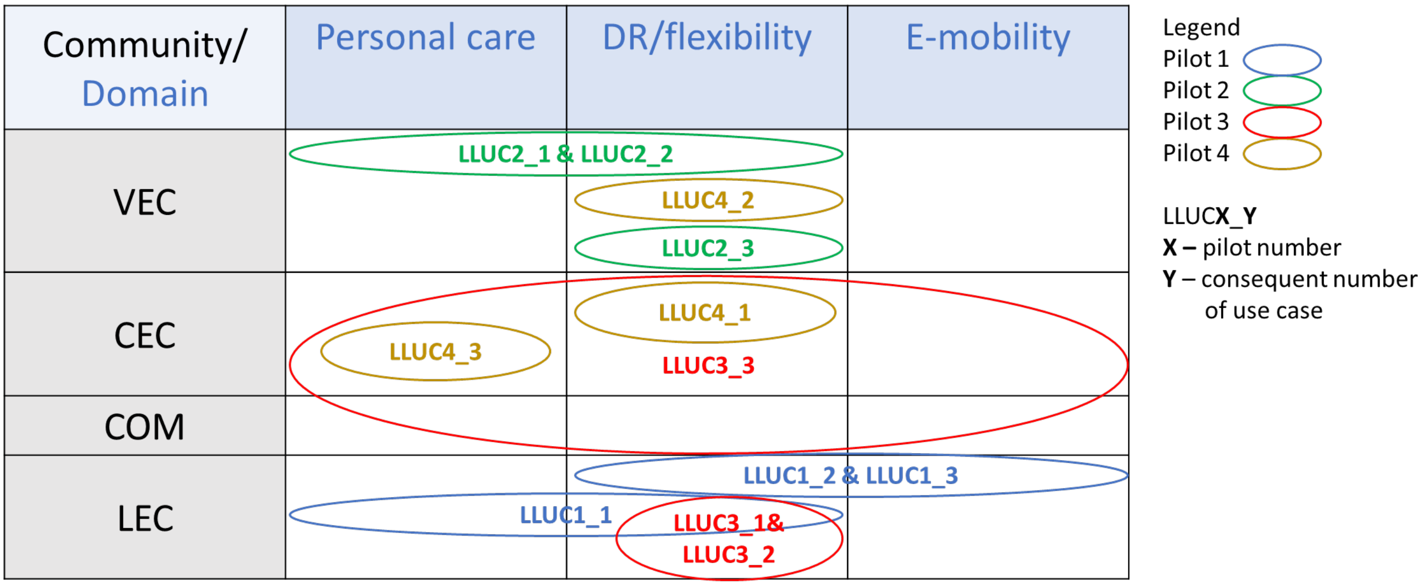

Figure 8. Mapping of LLUC cases to communities and three main domains.

The figure above represents which communities and domains are addressed by a single low-level use case from BRIGHT's pilots:

- The first pilot consists of three low-level use cases and represents all parts of the LEC Community; the first one addresses the Personal care and DR/flexibility domain. The first pilot consists of three low-level use cases and represents all part of the LEC Community; the first one addresses the Personal care and DR/flexibility domain. The second and the third address the DR/flexibility and e-mobility domain.
- The activities in the second pilot are described in three low-level use cases. The first and the second LLUC is dedicated to VEC Community and touches the personal care and DR/flexibility domain. The third LLUC addresses the VEC Community and DR/flexibility domain.
- The third pilot activities are divided into three LLUC. The first and the second LLUC is dedicated to LEC Community and is explicitly devoted to DR/flexibility domain. The third LLUC touches two Communities – CEC and COM – and addresses all listed domains – personal care, DR/flexibility and e-mobility.

- The last pilot (Pilot four) is also divided into three LLUC. The first LLUC addresses the DR/flexibility domain in CEC Community. The second LLUC addresses the DR/flexibility domain as well as the first LLUC but also addresses the VEC domain. The last, third LLUC addresses the Personal care domain inside CEC Community.

4.1 LLUC1_1: Modelling of electrical and thermal community- and individual-level flexibility

The objective of the first LLUC of pilot 1 is to optimally use the flexibility inherent to the district heating network of the pilot. This concerns flexibility on both the individual user level as well as on the district level (e.g., storage of heat in the network). To accomplish such optimal use of flexibility, different high-level elements are required:

- A forecast for the heat demand to assess what amount of energy need to be present in the district heating network in the coming hours;
- Customer comfort preferences (e.g., what deviation from thermostat temperature would they be comfortable with, how much control over their home temperature are they willing to hand over in exchange for certain benefits, etc.);
- Customer agreement to apply a certain control to their heat delivery (e.g., only provide sanitary hot water, no heat, during morning heat demand peak).

An additional nice-to-have is the forecast for heat production, as this increases the potential to foresee the cheapest and most environmentally friendly heat.

The technologies available and relevant to this use case include the low-temperature district heating network itself, the individual heat exchanger station in each living unit, and the heat pump providing additional heat to the network when possible. On the control level, particularly the SCADA system and the EMS implemented on top (serviced in the cloud) are relevant. Specific technical requirements for this use case include the communication (including control) with the individual heat exchangers and the district-level assets and a functioning stand-alone operation of the district heating network if the advanced control of the EMS fails would harm the network in any way. DuCoop will collaborate with BRIGHT partner Centrica to develop control algorithms.

4.2 LLUC1_2: Local energy cooperative grid support

As an interesting option to extend its business model, DuCoop wants to investigate the possibility to offer grid services as its second use case within the BRIGHT project. The option to offer grid services is interesting to DuCoop on two levels. Firstly, the cooperative owns a large range of energy-producing and consuming assets, some flexible, some not. Secondly, the owners of future apartments themselves will have the option to buy smart and therefore flexible appliances, that can potentially be accessed for demand response schemes.

A first and crucial step to make the offering of grid services work is to set up communication with the grid operator (TSO or DSO) and assess not only their interest but also the technical possibilities within the range of appliances that DuCoop controls. Once an agreement is reached, the more technical communication aspects will be addressed, and both a business and technical plan will be made.

Evaluation of this second use case will be done on a technical level (i.e., is it working) and on an economic level (i.e., is it economically useful). Based on this evaluation, recommendations for future approaches will be given.

4.3 LLUC1_3: EV charging infrastructure flexibility optimization for local community and grid improved operation

In a third use case, DuCoop intends to make use of the fact that it operates a large number of EV charging stations (currently 16, to be increased to 34 during the BRIGHT project duration (already confirmed investment)). This inherently brings with it a specific kind of flexibility, again strongly related to consumer/customer preferences. A combination of vehicles that need to be charged with a certain amount of energy by a certain time allows for the application of time-scheduled loads with different possible premises (e.g., decrease peak load, increase local renewable energy consumption…)

Similar to low level use case 1, also here, customer interaction will be central, although possibly more difficult to obtain, since the users of the charging infrastructure are not necessarily inhabitants of the pilot buildings. Once again, comfort will have to take an important space and will inform on what boundary conditions apply for a possible control strategy.

For the modelling of the charging station load and the development of the control algorithms, DuCoop will collaborate with BRIGHT partner IMEC. Some technical aspects, such as data communication with the charging stations, are in place; others, such as the integration of the IMEC control algorithm with the DuCoop EMS, still need to be established during the execution of the project.

4.4 LLUC2_1: Virtual community decentralized flexibility orchestration for implicit and explicit DR

The scope of the low-level use case number 1 is integrating and orchestrating of virtualised behind-the-meter assets by means of decentralised consensus scheme operating on top of a P2P energy marketplace.

The main objectives of this use case are on the following topics:

- Supporting of data analytics services in demand/supply forecasting, assets fingerprinting, and flexibility potential estimation;
- Social incentive design for optimal consumer engagement in explicit and implicit DR;
- Demonstration and validation of decentralised VPP for flexibility aggregation from VEC;
- Utilisation of B-EMHC infrastructure for services dispatch and remuneration.

This use case aims to offer flexibility services on the P2P energy marketplace. The virtual behind-the-meter asset will be utilised in providing the decentralised consensus schemes. The Virtual Energy Community will be created to demonstrate decentralised and participatory orchestration of flexibility for implicit and explicit DR programs.

The shift towards a decentralised, distributed electric grid and requirements for lower carbon emissions affect the electrical grid by introducing new decentralised energy resources and new, more efficient loads, especially HVAC and EV. The power quality issue is no longer the parameter of one variable, but it is becoming a multidimensional problem. The new decentralised flexibility orchestration plays a crucial role in addressing issues mainly related to excess decentralised production and congestion on the LV grid. Since the new loads are daily introduced to the LV grid creating a reliable, long-lived solution is a must. The use case will:

1. Disaggregate loads. By using the nonintrusive load monitoring method (NILM) [16], the asset behind-the-meter will be determined. The NILM will label the loads and care for the detection of future loads.
2. A decentralised consensus scheme will be used for the orchestration of the virtualised behind the meter asset.
3. Explicit and implicit DR programs. The implicit (price-based) programs and explicit (incentive-based) programs will be upgraded with social incentives for optimal consumer and citizen engagement.
4. A VPP will be created from the VEC to create and trade the aggregated flexibility.
5. The flexibility will be offered on the P2P energy marketplace based on blockchain technology.

4.5 LLUC2_2: Building optimal flexibility management traded off with comfort management

This low-level use case is finding the optimal way to engage the consumer or citizen in flexibility programs. Consumer/citizen's main drawback to participating in the programs is they are usually not willing to give up too much of their comfort. We have to encourage them to do something for the environment as well as for the community. The objectives are:

- To define the "comfort spectrum" of participants;
- To determine the manoeuvring area of controlled assets.

Based on the B-DT modelling of preferences within citizens, care management will be demonstrated, where citizen's comfort management will be traded off and considered. The definition of how to engage the consumers without the inclusion of monetary motivation and finding the balance between comfort and environmental benefits will be clarified during the analytics.

This use case will be focused on the modelling of energy consumption and creating the B-DT of citizens/consumer or prosumer and community. This data-driven model of citizen or community (retirement house community) behaviour will be exploited to determine the limits of citizens' comfort zone that will still get them on board for participating in DR programs. With citizen getting on board, the B-DT of the citizen will be combined with incentives to determine optimal control of flexible devices (e.g. HVAC or white goods) together with decentralised PV generation.

4.6 LLUC2_3: Analytics and automation supported aggregation of behind-the-meter assets

The aim of this use case is to support the ambition of BRIGHT to realise a multi-time scale DR ecosystem. The challenge of providing a hierarchical control architecture that tightly integrates heterogeneous assets (loads) and systems will be addressed.

We have determined the following main objectives:

- Analysis of time-series measurement data using historical usage patterns and other contextual signals (weather);
- Providing a hierarchical control architecture of assets and system;
- Obtaining information on the behaviour of various types of devices based on aggregate measurements.

The data analytics engine must therefore enable efficient complex queries of large data, and the reports emerging from the queries should support the operation infrastructure, respond to market signals and aid the maximisation of stakeholders' yield.

The aim of the use case is to create novel advanced analytics and automation solutions. With the decentralisation of the grid, distributed renewable resources, and emerging new loads, providing stable and quality power to the end-user is becoming a bigger and bigger issue. Furthermore, the role of the end-user is becoming increasingly important for providing more efficient management of the LV grid.

To address the challenges, we will apply a non-intrusive load monitoring method on the measured data to determine the fingerprint of the flexible asset at each individual location. The local EMS system will be able to evaluate flexible holistic potential. Fingerprinting represents the first step in realising DR orchestration, which will allow us to realise higher service and efficiency levels on a system level. The goal is to obtain the information on the behaviour of an individual type of devices based on aggregate measurements needs, deduce from those the customised aggregates and feed triggers of the analytic system to rules engines and schedulers.

Non-energy services for personal safety and AAL will be demonstrated and validated on the electricity fingerprinting based models. During the project, we will also develop citizens behaviour profiling in order to develop behavioural monitoring services, which will detect abnormal behavioural patterns as inferred by abnormal electricity fingerprinting.

4.7 LLUC3_1: Building-level LEC semi-decentralized VPP for flexibility multi-value stacking services

The LLUC 3.1 scope is to demonstrate how small-scale demand and flexibility may be leveraged and optimised within a multi-market scenario, combining a wholesale market and a local market. The main objectives are the following:

- Implementation of a wholesale and local market to exploit flexibility from the assets.
- Validation of semi-decentralised VPP community-level aggregation flexibility trading.
- Implementation of a smart contract-based near real time verification and settlement.

The use case involves a multi-apartments residential building, equipped with IoT smart meters and capable of providing flexibility for the DSO requests. Community members will be provided with a dedicated app that allows them to take full control of the flexibility of their assets and of being notified with the performed action in case of automated control action. The community members are characterised by very different personal and social conditions, such as age, gender, income, education level, employment status. They can be considered as a local energy community with traditional home loads.

The residential community consisted of a multi-apartments residential building with 50 consumers equipped with IoT smart meters, characterised by flexible and controllable home loads. The flexibility exploitation from the community may be leveraged and optimised within a multi-market scenario, which combines a wholesale market where BRP procures flexibility in near real time with a local market where DSO procure flexibility for local congestion management in advance. The combination of top-down initial B-DT-based clustering of suitable flexible assets with P2P B-DLT and smart contract-based negotiation within such cluster will allow the trading feasibility.

4.8 LLUC3_2: LEC decentralized VPP marketplace for flexibility trading for local MV/LV network congestion management

The Use Case scope is to demonstrate the feasibility of decentralised VPP Marketplace for Flexibility Trading as a solution for Local MV/LV Network congestions. The main objectives are the following:

- Implementation of P2P B-DLT and smart contract-based negotiation for flexibility trading along heterogeneous customers.
- Validation decentralised VPP community-level aggregation.
- Validation of local flexibility trading.

The LLUC 3.2 is implemented at ASM headquarter district, characterised by heterogenous energy units. The headquarter load patterns are typical of a company building and the main consumers are the employees. The district flexibility will be fundamental to avoid congestions in near electrical districts. Therefore, a hybrid community will be created.

High shares of intermittent RES in the ASM headquarters area and the need for reducing the reverse power flow are the most relevant aspects to be considered for the local congestion management. The LLUC 3.2 energy units are the following:

- Industrial customers
- Commercial customers
- Residential customers
- Decentralised RES generation
- Second life batteries

About 20 consumers will be engaged. DSO will be undertaking the role of the aggregator within a multiple flexibility provider and the flexibility marketplace will be operated from intraday to near real time mode.

4.9 LLUC3_3: Virtual community semi-decentralized aggregation for optimal flexibility management

The LLUC 3.3 will be demonstrated in the Italian pilot, consisting of:

- 170 smart meters;
- 240 kW peak power PVs;
- 66 kWh/72 kW storage system;
- Controllable loads: HVAC (around 100-120 kW) and lighting;
- 3 charging stations;
- 10 electric vehicles.

The LLUC 3.3 scope is to guarantee the stability and efficiency of the power grid in a high penetration condition of distributed not-programmable renewable energy plants. The main objective is to aggregate city-level energy community controllable devices, such as EVs, flexible loads and storage system, for flexibility provisioning in order to balance the power grid. IoT-NGIN will provide day-ahead forecasting of the grid, based on real-time energy data collected from smart meters, supporting DSO in DR campaign creation. Furthermore, a flexibility marketplace based on blockchain technology will be developed to enable P2P energy trading between DSO and CEC aggregator using smart contracts.

4.10 LLUC4_1: IoT-assisted participation in DR schemes for both electricity and natural gas and energy management for communities of Smart homes residents

The LLUC 4.1 scope is to provide a central IoT service with which end-users will be able to monitor their indoor conditions and energy consumption (electricity, natural gas) and control their legacy and heavy consuming appliances. The main objectives are:

- Installation of IoT devices for monitoring indoor conditions and energy consumption (electricity, gas).
- Enabling home automation through IoT devices to provide end-user control of heavy consuming electricity and gas appliances.
- Enabling implicit DR through the adoption of IoT devices and controllers.

IoT technologies will support the profiling and prediction of consumption through monitoring the indoor environment and energy consumption (electricity and natural gas). Furthermore, end-users will be able to control their indoor environment through home-IoT equipment. IoT will support information retrieval through smart sensors (temperature, humidity, light, etc.) metres (smart meters and plugs) and controllers (relays, heating controllers) that will be installed in the three pilot sites. After data analysis and data processing, IoT devices will offer remote control of end-user appliances through end user interfaces (smartphone applications).

4.11 LLUC4_2: Virtual community optimal thermal comfort management and cross-energy services, while trading off with energy flexibility provisioning

The global use case scope is to optimally control the operation of legacy heating appliances towards maintaining a pleasant environment for the end-user and delivering advanced cross-energy services to the supplier. The aim is to strike a balance for the end user, by jointly achieving the following objectives:

- Maintaining indoor climate comfort
- Reducing natural gas consumption through improved boiler efficiency
- Participating in flexibility provisioning services

The proposed concept focuses on the Management of Natural Gas consumption in buildings, by actively controlling and optimising the indoor environment, with the aim of (a) improving their energy efficiency through load reduction and (b) contributing to energy system flexibility providing real-time energy balancing services.

The low use case 4.2 describes how users of legacy natural gas boilers can upgrade their heating systems through a cost-effective IoT controller, while enabling their participation in flexibility provision services to the natural gas supplier. The core innovation of the proposed concept builds on the interconnection of major consuming heating devices (boilers, DHW preparation, radiators, etc.) with the gas network, through the seamless integration of the domX heating controller with legacy boilers, towards upgrading existing and long life-cycle building equipment to higher levels of smartness. Targeted devices include residential and commercial heating devices operating on natural gas, supporting different types of control modes (ON/OFF, power modulation, etc.). The system is interconnected with a cloud-based energy management system that constantly collects, stores and analyses the detailed data collected from connected heating devices.

The heating controllers are attached with the boilers of pilot users to enable smart and remote heating control, gas consumption estimation and communication with cloud energy management services over Wi-Fi. The user can interact with the upgraded boiler, both through the existing thermostat and the smartphone application, providing climate comfort limits and collecting real-time feedback on the boiler operation. The proposed concept focuses on the Management of Natural Gas consumption in buildings, by actively controlling and optimising the indoor environment, with the aim of (a) improving energy efficiency through load reduction and (b) contributing to energy system flexibility providing real-time gas balancing services. Energy services for natural gas will be combined with non-energy such as (home automation, security, indoor comfort) to achieve the most efficient solution balancing the end-user needs with the recommendations of the system.

4.12 LLUC4_3: Advanced user profiling to improve predictability of consumption and consumer behaviour based on the different types of identified customer segment, usage patterns, building and device characteristics

The use case scope provides individual services based on consumers' profile by trying to increase either their comfort level or savings. The main objectives are the following:

- Use of historical consumer behaviour and device usage data for making energy data consumption available and understandable through visualisation.
- Empowering users to achieve energy savings and manage their energy consumption, being energy-efficient and cost-effective, without sacrificing their comfort feeling.

Into LLUC 4.3, submeter infrastructure will be exploited, and diverse energy consumption, as well as user behaviour profiles will be classified into clusters. Furthermore, data analytics will be used for visualisation tools and to enhance implicit DR services.

More particularly, data collected from real-time submeters, sensors and heating controllers will be used to create a historical database per pilot household. The inputs from the sensors will be analysed, configuring an individual profile based on its user characteristics. The pilot aims to reduce operational cost on the client-side by providing real-time energy consumption and analytics dashboards to enable end-users to document their decisions in real-time and creating scope for more comprehensive energy efficiency actions. Consumers will be able to watch the consumption of their connected appliances through their mobile phones and remotely and efficiently managing them (time scheduling, modulated control, etc.). In parallel, it respects end-users preferences by giving them the ability to configure their needs in terms of their required climate comfort. Through their participation in DR schemes, they will gain house control and increase their comfort feeling while saving energy and money.

5 Conclusions

The business and low-level use cases will be used in almost all tasks of the project. The common collection of BUCs between T2.1 and T3.1 will be the basis for creating and modelling citizen engagement strategies and social acceptances strategies of DR programs from WP3 and T2.6. In WP2, the BUCs and LLUCs will be used to define the technical and functional specifications of BRIGHT technology and tools with an in-depth definition of the new tools and functionalities functional specification T2.2, T2.3 and T2.5.

The bright tools and service development is concentrated in the three main work packages WP4, WP5 and WP6. The main benefit of the work presented here is it defines well the functional and non-functional requirements for developing tools and services and measuring the BRIGHT project goals by defined and system performance through defined KPIs, WP7.

Non-technical work packages (WP8 and WP9) will indirectly benefit from the use cases. Especially the BUC will give them a clear idea about expected BRIGHT project results to properly present them to involved stakeholders and build upon BUCs business models and plans.

The collection of use cases provided in Annex 2 and Annex 3 indicates the BRIGHT project scope and the amount of work invested into use cases. The bright main idea to engage citizen to participate more actively in the DR programs; therefore, BUCs were analyzed around four main communities:

- Virtual Energy Community
- Local Energy Communities
- Citizen Energy Community
- Community-On-the-Move

Each of the four identified BUCs were defined not only geographically but also around different communities they address. From the collected BUCs, actors and their roles in social engagement in respect to DR programs were well defined. This was also the basis for defining and deriving 12 LLUCs. For these LLUCs, additional important domains were identified:

- Personal care
- DR and flexibility
- E-mobility

Defining different communities and domains covered by different approaches represented by the LLUCs, we have obtained very well structured scenarios to tackle energy efficiency design activities more efficiently.

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7 Annex 1

7.1 Use Case template

1 Description of the use case

Part of the template describing the use case with all general information about the designated goals.

1.1 Name of use case

Unique ID of the use case identifying the use case scope of the use case according to the domain, use case name.

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*

ID: unique project identification number of the use case. It will be used for the administration of use cases. Can be a mixture of letters and numbers.
Area/Domain(s)/Zone(s): Specify the placement of the use case in the BRIGHT area, domains and zones.
Name of use case: A short name to precisely refer to the activity of the use case.

1.2 Version management

Tracking changes to the template.

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*

Version No.: The number that identifies the version of the document.
Date: Date of the creation of the version.
Name of author(s): The name of the person or organisation, who has provided the current version.
Changes: If any changes have been made in this version, they should have been documented shortly in this column.

1.3 Scope and objectives of use case

The scope describes the aims and boundaries of the use case and the objectives goals the use case is expected to achieve.

Scope and objectives of use case	
Scope	
Objective(s)	
Related business case(s)	

Scope: This field will describe the aim and boundaries of the use case.
Objective(s): This field will list the goals, that the use case is expected to achieve.
Related business case(s): This field will list the possible business use case.

1.4 Narrative of Use Case

Short and long description.

Narrative of use case
Short description
Complete description

Short description: In the field, "Short Description" is summarised as the main idea as a service by providing the steps of the use case. It should not be longer than ten lines.
Complete description: It is the description of the use case from the user's point of view, describing what happens when, how, why, where and under what conditions. It should be written in simple language.

1.5 Key performance indicators (KPI)

KPIs related to the objectives of the use case.

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*

Key performance indicators (KPI): List of most important KPIs for the described use case. Should specify KPIs per use case objectives.

1.6 Use case conditions

Assumptions and Prerequisites of the use case.

Use case conditions
Assumptions
Prerequisites

Assumption(s): General presumptions about conditions or system configurations
The precondition(s): Preconditions specify which requirements must be met so that the basic scenario use case can be accomplished. They often contain properties and states of actors or the condition of a triggering event.

1.7 Further information to the use case for classification/mapping

Relation to other use cases, prioritisation, nature of the use case.

Classification information
Relation to other use cases
Level of depth
Prioritisation
Generic, regional or national relation
Nature of the use case
Further keywords for classification

Relation to other use cases: The relation to other use cases in the same project.

Level of Depth: The level of depth reflects the degree of specialisation of the use case.
Prioritisation: Prioritisation helps to rate the use cases in a project from very important to nice-to-have with labels like obligatory/mandatory or optional which have to be agreed upon beforehand.
Generic, regional or national relation: Often use cases are applied to areas where restrictions by law or similar issues occur, so for purpose of generalisation the generic, regional or national relation has to be specified.
Nature of the use case: The nature of the use case describes the viewpoint and field of attention like technical, political, business etc.
Further keywords for classification: Further keywords for classification can be entered at will in the last field of this part. They should follow a pre-described manner of notation so that sorting and grouping use cases on behalf of these keywords is possible.

1.8 General remarks

Other remarks, that do not fit in other sections.

General remarks

General Remarks: Any additional information that does not fit in any other category will be mentioned here.

2 Diagrams of use case

Use case diagrams, activity diagrams, sequence diagrams illustrating the narrative

Diagram(s) of use case

Diagram(s) of use case: UML use case, activity, and sequence diagrams are presented in this section to provide a good understanding of the procedures of the use case.

3 Technical details

3.1 Actors

Use case actors, types, description and further information specific to the use case; use case actors should be present in the narrative of the use case

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*

Actor name: The name of the Actor
Actor type: It can be described as a role, person, company, system, application etc.
Actor description: A short description of the actor.
Further information specific to this use case: Documents actor information specific to this use case.

3.2 References

Any references the use case is based on

References						
No.	*References Type*	*Reference*	*Status*	*Impact on the use case*	*Originator / organization*	*Link*

4. Step by step analysis of use case

Scenarios related to the description of the use case

4.1 Overview of scenarios

Identification of the scenario with the short description

Scenario conditions						
No.	*Scenario name*	*Scenario description*	*Primary actor*	*Triggering event*	*Pre-condition*	*Postcondition*

No.: A following number of the scenario
Scenario name: A unique name of the scenario.
Scenario description: A short description of the scenario
The primary actor: The primary actor is the one who causes the scenario to begin.
Triggering event: It is the event that causes the beginning of the scenario.
The Pre-condition: The pre-condition specify the term that needs to be fulfilled for the execution of the scenario.
The Post-condition: The post-condition specifies the term that should be valid after the scenario.

4.2 Steps – Scenarios

Identification of the scenario.

Scenario

Scenario name:	***No. 1 - …***							
Step No.	*Event*	*Name of process / activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*

Steps-Scenario: This section will provide a detailed description of the scenarios. The description is listed in the execution order with their step number and the triggering event. Every step presents the process or activity with a unique name and short description.
The Service: this field specifies the nature of the information flow. (GET, CREATE, CHANGE, DELETE, CANCEL/CLOSE, EXECUTE, REPORT, TIMER, REPEAT)

5 Information exchanged

Information exchanged in the steps, an indication of the requirement ID

Information exchanged			
Information exchanged, ID	*Name of Infor-mation*	*Description of information ex-changed*	*Requirement, R-IDs*

Information exchanged: This section will provide a detailed description of the information exchanged in the scenario steps. It is plain text information with a unique ID and name.

6 Requirements

Requirements specifications per different categories.

Requirements(optional)		
Categories ID	*Category name for requirements*	*Category description*

Requirements: Unique category with ID, name of the category and short and precise description of the category.

7 Common terms and definitions

Glossary.

Common Terms and Definitions	
Term	*Definition*

Common terms and definitions: It specifies the common terms and definition in the glossary.

8 Custom information (optional)

Information for the sections of the use case.

Custom information (optional)		
Key	*Value*	*Refers to section*

8 Annex 2 – Business Use Cases

8.1 BUC 1

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Do- main(s)/ Zone(s)*	*Name of use case*
BUC1	Area: District level Domains: Bulk generation, DER, Customer premises Zones: Market, Enterprise, Operation, Station, Field, Process	Local Energy Communities - Demand response optimisation

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
v1	18/1/2021	Chaïm De Mulder, Lieven Demolder	Initial draft	
v2	11/2/2021	Chaïm De Mulder	- Additions/ adjustments based on feedback TNO	
v3	18/3/2021	Chaïm De Mulder	- Additions/adjustments based on feedback Comsensus - Add objectives - Update list of KPIs; add references to UC objectives - Update actor list	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	Use both community-level and individual demand response flexibilities to provide grid services
Objective(s)	1. Develop social incentive design 2. Construct end user digital twins for end consumer characterization with respect to financial and non-financial incentives 3. Make optimal use of common asset energy flexibility (electricity and heat) 4. Make optimal use of individual user energy flexibility (electricity and heat) 5. Incentivize customers to allow centralized VPP exploitation of the available flexibility
Related business case(s)	

1.4 Narrative of Use Case

Narrative of use case
Short description *Describe the technical, socio-economic, geographic, and institutional conditions of the use case. You may use criteria's such as age, gender, income, education level, employment status to describe your user base. Categorize your use case among local energy communities, virtual energy communities, hybrid communities or communities on the move and cross vector communities.*
Location: De Nieuwe Dokken (Ghent, Belgium) Type: local energy community Technical: a wide range of electricity and heat-related energy assets are available, providing the complete district with energy. Socio-economic: the city development company SoGent aimed at obtaining a mix of residents in a socio-economic distribution that is representative for the city of Ghent Institutional: Sustainability barometer: integration of sustainability goals in the project development proposals that were selected by the city development company SoGent. Those are put in line with the climate ambitions (2030/2050 carbon emission targets) of the city council.
Complete description *Here provide detailed description of the use case.*
This use case is geographically placed at the site of De Nieuwe Dokken (Ghent, Belgium), where the local energy community, as well as all the energy assets managed by DuCoop are located. The available assets include a solar panel installation (80kW peak (Central field), 100kWp (exp. By 2022 Northfield), >120 kWp (exp. 2024 South field)), a battery storage unit (240kWh storage capacity), EV charging stations (16 currently installed, exp. 34 by 2022), a 120kWth heat pump, a district heating network, a vacuum network for black water collection and a waste water treatment installation producing biogas, clean water, waste heat and fertilizer. The living units on site include co-housing units, luxury apartments, public housing and variety in size from 60m² to 145m² (1-3 bedrooms). 50% of the apartments bought so far were bought by investors that intend to rent out the apartment. In addition to the living units, also a kindergarten, a sports facility, city administration offices and business spaces are also part of the district. The large amount of energy-related assets and inhabitants offers interesting possibilities to investigate demand response on several levels.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Engagement level	Engage min. 10% of the community (+20 residents) actively in the Bright project	1, 5
2	Engagement representativeness	Ensure the engaged participants are representative for owners/renters of newly built homes	1
3	Engagement drivers and barriers	Identify user's drivers and barriers to engage in demand-response mechanism and their underlying reasons/motivations	1

4	Technology development (end-user electricity)	Integrate end-users in the energy management system logic	2, 4, 5
5	Technology Development (charging stations)	Integrate charging stations as flexibility providers in the energy management system logic	3
6	Technology development (end-user heat)	Integrate end-user heat demand profiles in the energy management system logic, leading to flattening of demand peaks (at least 10% lower)	2, 4, 5
7	Technology development (district heating)	Integrate district heating heat sources in the energy management system logic, leading to an increased use of renewable heat thanks to demand response	3
8	Sustainability (user level)	Add min. 5% of the final energy consumption to the flexibility pool	3, 4, 5

1.6 Use case conditions

Use case conditions
Assumptions Describe the local socio-economic and techno-institutional condition (living situation, energy prices, rules and regulation) specific to the use case. Does an energy regulator that has established the lawfulness of different types of energy provision contracts exist? Do the use case users consume energy exclusively in their place of residence? Are users' consumption patterns comparable? In other words, do they have similar lifestyles? Are the age and condition of the electrical system an important variable? What is the maturity/enagement level with respect to demand response in the use case? How confident are your users with smart home technologies? If applicable, how often they have changed their energy providers? Is your average user aware of the existence of different price ranges for energy depending on the hour at which it is consumed? If so, what is their degree of awareness?
Since inhabitation of De Nieuwe Dokken has only been going on since the spring of 2020 and no extensive data analysis was executed yet, no profiling of user consumption patterns was done so far. Due to the spread-out nature of the district's living units, variable patterns are expected. Energy prices of the electricity that DuCoop buys are dynamic (and also dynamically paid for by DuCoop) and have in the latest months varied between approximately -10€/MWh and 120€/MWh. The energy that DuCoop sells to its residents is priced at 300€/MWhe (only EV-charging), the heat at 51,3€/MWh. DuCoop is in close contact with the residents by means of, amongst others, newsletters and presence on site (the DuCoop office is located in the district). No specific communication on demand-response has been already started. We have found that many of our inhabitants are very enthusiastic about their local energy community, although we have not assessed what their awareness is of different aspects of energy in daily life (dynamic energy prices, different energy provider options...). Almost all living units are equipped with smart home technologies. At this moment, we have not established yet how often residents have made use of the different options this gives them.
Prerequisites Is it a prerequisite that the user be the owner of the accountholder of the energy contract? Is it a prerequisite that all users be located in the same area? In other words is location specificity important? Should the consumer be equipped with smart meter and devices? What means of engagement for demand response are foreseen?

Since the users are already gathered in a local energy community and for a large part foreseen of similar measuring equipment, any prerequisites regarding location or conformity of installation will likely be fulfilled. DuCoop itself manages a large part of the electricity load and has a perfect overview of the loads of the individual units, so also in that case, any demand response options can be managed quite centrally. Still, also individual-level participation in demand response is aimed, with the prerequisite that such participation is welcomed by individual residents and they allow DuCoop to take control over the flexibility of their appliances. Also in terms of heat-related demand response, resident participation in terms of allowing control of the individual heating stations is a prerequisite.

1.7 Consumer/citizen engagement strategies

Engagement strategies: In consumer/ citizen engagement in demand response four phases are foreseen: concept development and design, participation/getting on board, response and persistence. These different phases are expected to have different barriers and drivers for demand response programs.
Concept development and design: *How do you establish collaboration with the citizens/energy communities? What needs, wishes, behavior and social priorities with respect to demand response programs are identified? How do you ensure that project creates values for consumers/citizens and address their needs?* Are there intermediate actors with more connection to the local level or you have strong base in the local communities? How complex are your demand response product and services? How these technical complexity are handled with consumers?
We intend to approach customers through our newsletter, the DuCoop platform (under development*) and the yearly general assembly of the cooperative. When communicating, information will be given on the purpose of any questionnaires we might ask our customers to fill in, i.e. it will be stated they are participating in research aimed at gathering their needs, desires, behaviours, preferences, experiences, motivations in relation to demand-response mechanisms. The added value of participation for the customers, e.g. through an actual implementation of demand-response schemes, can be stressed during the communication itself; other incentives for participation could also be provided. Once customer engagement is established, more detailed explanations, e.g. on the concept of demand-response will be provided in either written of verbal format (e.g. an information evening). **Together with the Ghent home-automation start-up OpenMotics, DuCoop implemented an interactive digital monitoring platform, where every end-user in the smart district can obtain historic and actual consumption data for water, district heating and electricity from digital metering devices that are installed throughout the buildings. More information and applications can be shared through-out the development of this community engagement platform.*
Participation/Getting on board: How do you approach consumers? What influences citizen's decision to engage in demand response?How do you get (or planning) other user groups on board? *Which consumer segments are onboard?*
(see above) Since the consumer group can be considered quite diverse (see 1.4: Narrative of use case), there can be several factors influencing citizen's decision to engage in (research on) demand response. Based on the amount of responses from each predefined user group (e.g. age class, apartment size...), a first estimation can be made on the interest in demand-response (or energy services in

general) for a specific group. During continued engagement of a particular citizen, inquiries can be made as to what motivated him/her to engage in the research and in demand-response.
Response: What influences the level of response provided by a consumer? What are the current engagement strategies (incentives, co-benefits such as possibility to see energy consumption in real time) in place, which works and which does not?
Because DuCoop is a cooperative (see above), all residents own a part of the company and have a say in the decisions made about their energy. This in itself can be considered a very effective engagement strategy, because it empowers and incentivizes involvement in local energy production. Moreover, this increases the chance for a successful co-creation process, since participants have the chance to be very close to the persons that will be actually providing demand-response services to them. This is expected to create the trust that is required in a co-creation process. From a more technical side, residents are able to track their own energy use (as described above), providing another level of involvement.
Persistence: What influences the decision to stay engaged in demand response? How do you avoid overburdening the consumers? How do you inform consumers regularly on project developments? What communication challenges are foreseen? Are there proper communication channels in place?How do you communicate with your consumers as a continuous give and take, back and forth? How do you ensure long-term engagement of consumer? How do you co-create new business models and co-develop community services?
Initial communication will be done as mentioned above. Once a group of people that commit to the co-creation process has been formed, more specific communication channels can be set up, depending on the group preferences and ensuring inclusive communication. This more specific channel will allow more frequent communication and is expected to keep long-term engagement high. The additional fact that citizens active in the research have a high chance of meeting each other during daily activities because they live in close proximity to each other can also increase the long-term engagement. Because energy in general and demand-response in particular can be a quite technical topics, sufficient efforts will have to be put in clear and understandable communication to ensure an inclusive co-creation process. In terms of monitoring, minutes will be kept of the co-creation meetings, including an attendance list to be able to track attendance over time. If attendance should decrease, inquiries can be made to assess what could be possible factors.

1.8 Actors

Actors Actors information is important to understand the socio-institutional conditions of the use case. Who are the actors, what roles and responsibilities they have and what changes in these roles and responsibilities have been foreseen? What are the relation between the actors?			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Energy user	Business actor	User of electricity and heat energy; pays energy bills to the energy service provider.	Pilot residents and other building users
Energy service provider	Business actor	Responsible for: - Providing energy services to the district residents - Communication with residents on	DuCoop

		their energy use	
Technology provider	Business actor	Depending on the specific role this actor fulfills, he can be responsible for: - Providing energy-related assets - Providing hardware for asset control - Providing software for asset control	Farys, OpenMotics, providers of the specific assets
Local energy supplier	Business actor	If available, possibly responsible for providing additional local renewable energy to the LEC energy service provider	e.g. EnerGent
DSO/TSO	Business actor	Responsible for providing energy to the LEC energy service provider when needed (i.e. shortage of local renewable energy). Benefits from the provided flexibility (both private and community-owned loads) to increase grid efficiency	Elia
Producers of smart appliances	Business actor	End-user appliances that could increase flexibility at the energy user level	e.g. Whirlpool
Asset	Logical actor	Any energy-related asset	e.g. solar panel installation, battery storage, EV charger, district heating network, heat pump...
Device	Logical actor	Hardware device involved in the communication between assets and the control algorithms, i.e. SCADA system, gateways...	SCADA system, private gateways, building gateways
Control algorithm	Logical actor	Responsible for calculating and sending control signals to the assets for their optimal operation	Located in the cloud

1.9 Further information to the use case for classification / mapping

Classification information
Relation to other use cases
LLUC1, LLUC2, LLUC3
Level of depth
High level
Prioritization
High priority
Generic, regional or national relation
Impacted by national and regional regulatory framework (grid tarification, energy exchange, etc.)
Nature of the use case

Technical, market
Further keywords for classification
Local energy community, demand response, user modelling, user engagement, flexibility, district heating, self-consumption,

1.10 General remarks

General remarks
Interaction with other research projects: • Regional cooperative research project 'ROLECS' • H2020 Interconnect • H2020 Renergetic

8.2 BUC 2

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
BUC2	Smart grid/DER-customer Premises/	Virtual Energy Community (VEC)

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V1	15.12.2020	Špela Lunar, Andrej Simončič	Initial draft	
V2	22.12.2020	Špela Lunar, Andrej Simončič	Additions to initial draft	
V3	07.01.2021	Andrej Čampa	Revision	
V4	10.02.2021	Andrej Simončič, Špela Lunar	Additions according to TNO comments	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	This BUC's scope is to provide one-stop-shop solutions for active consumers and citizens, who will engage in innovation and co-create the added value together with other actors (all together forming a virtual community). The DR programs solution will not only be based on energy services but also on non-energy services.
Objective(s)	This BUC has the following objectives 1. To design social incentives for optimal user engagement in DR programs. 2. To collect data on the consumer behaviour and their motivation. 3. To create and to demonstrate VEC.
Related business case(s)	-

1.4 Narrative of Use Case

Narrative of use case
Short description *Describe the technical, socio-economic, geographic, and institutional conditions of the use case. You may use criteria's such as age, gender, income, education level, employment status to describe your user base.*

Categorize your use case among local energy communities, virtual energy communities, hybrid communities or communities on the move and cross vector communities.
Slovenian pilot does not have strict geographical boundaries since it takes place in the virtual community. A virtual community is formed by platform users, namely consumers, prosumers and indirectly involved citizens. The awareness of the variable energy price differs from one group of users to another, reflected in a different understanding of comfort management. By providing peer-to-peer exchanging tokens between platform users on the B-DLT platform, we can utilize the new energy services and non-energy services for personal safety and ambient assisted living (AAL) on the market. Targeted users are: Informed Citizens are Citizens who care about the environment. They are neither aware nor interested to know the processes and understand how things work. However, they are willing to adjust their behaviour and sacrifice some of their comforts to achieve noble goals. Sensitive Citizens are Citizens who have a hard time adjusting to new things or accepting new technologies and solutions. They are hard to reach as they will refuse to cooperate in most cases and will not adapt their behaviour or trade their comfort for noble goals. However, they might be convinced to cooperate with the money-saving aspect of the DR program. The consumer knows a lot about the technical aspect of the DR program. They are well-informed users who have a relatively well-defined goal. Their main goals are to reach significant energy and money savings. A prosumer is a consumer with the capability of producing electrical energy. In most cases, they have a high awareness of the sustainability aspect and creating a greener image of their property. They are mostly interested in improving self-consumption to reduce the bills.
Complete description • *Here provide detailed description of the use case.*
The main goal of the business use case is to characterize the virtual community users well; get a typical consumer consumption profile throughout the different seasons (repetitive patterns or hourly consumption profiles). By using advanced analytics, the typical consumer profile of the virtual community can be extracted and used to optimize schedule of the heating and energy consumption profile on the level of the virtual community. Furthermore, with estimating the difference between the consumption and PV production we can manage these flexibilities to provide a) improved self-consumption, b) lower the energy cost and c) enable other non-energy related services, such as detecting derogation and triggering the alarm.

Dom sv. Lenart, Slovenia

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Consumer behavior and consumption patterns	Obtain better predictability of customers energy consumption	1,2,
2	Number of consumers engaged	Engage consumers to actively participate in Bright project	2
3	Cost reduction	Lower the consumers' energy bill by DR services	1,3

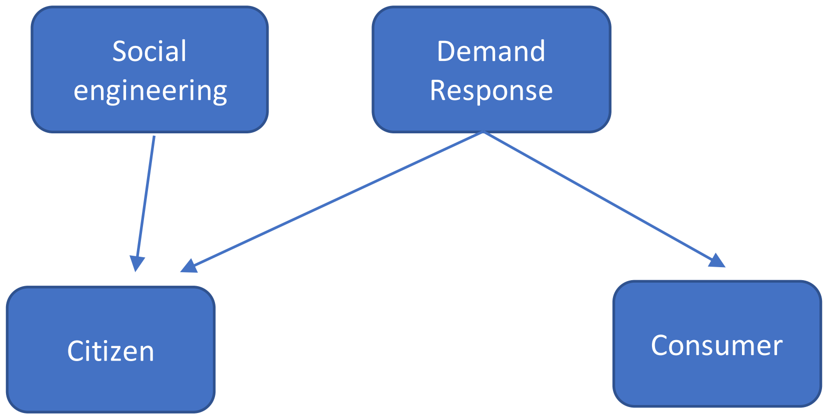
1.6 Use case conditions

Use case conditions
Assumptions Describe the local socio-economic and techno-institutional condition (living situation, energy prices, rules and regulation) specific to the use case. Does an energy regulator that has established the lawfulness of different types of energy provision contracts exist? Do the use case users consume energy exclusively in their place of residence?

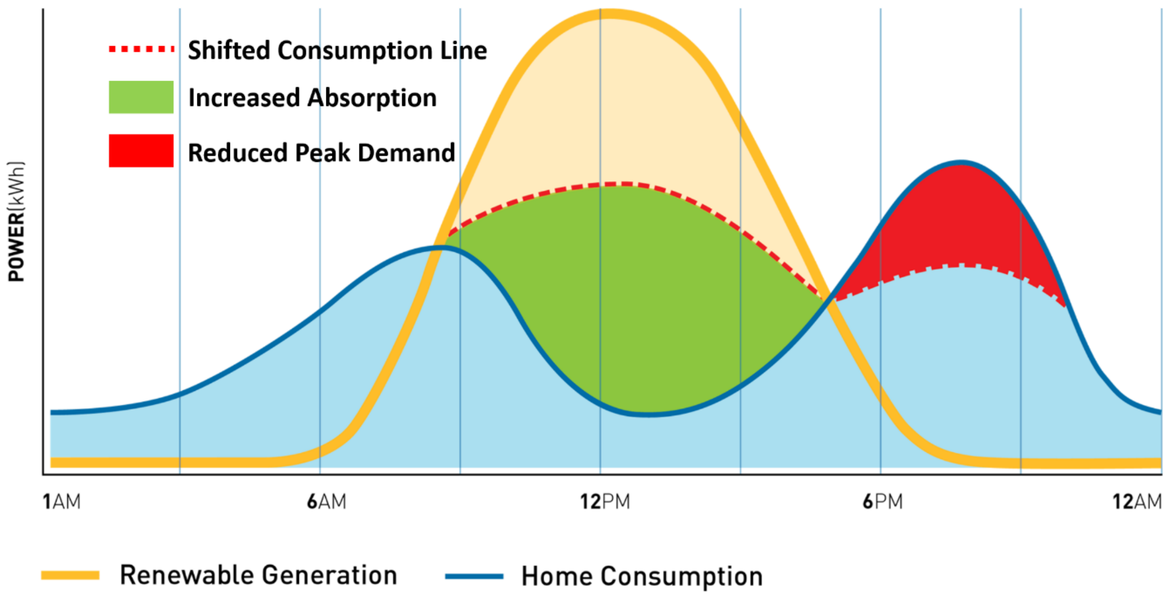
Are users' consumption patterns comparable? In other words, do they have similar lifestyles? Are the age and condition of the electrical system an important variable? What is the maturity/enagement level with respect to demand response in the use case? How confident are your users with smart home technologies? If applicable, how often they have changed their energy providers? Is your average user aware of the existence of different price ranges for energy depending on the hour at which it is consumed? If so, what is their degree of awareness?
All necessary data, provided by the energy and heating meters and sensors, needs to be available.
Cooperation among Pilot partners on specific tasks.
The use case users will consume energy exclusively in place of residence.
The assumption is that the user's consumption profile patterns are similar to each other.
The average user's degree of awareness of the existence of different price ranges for energy (depending on the hour at which it is consumed) is low or none.
Prerequisites Is it a prerequisite that the user be the owner of the accountholder of the energy contract? Is it a prerequisite that all users be located in the same area? In other words is location specificity importnant? Should the consumer be equipped with smart meter and devices? What means of engagement for demand response are foreseen?
The certain number of consumers is needed to make analytics credible.
Consensus for using personal and/or sensitive data (the GDPR) needs to be signed by all participants.
Assets such as heat pump with heat storage, EV charging point, PV power plant etc., included in use case needs to be available for using, managing and monitoring.
Consumers should be equipped with a smart meter, which requires space for equipment.

1.7 Consumer/citizen engagement strategies

Engagement strategies: In consumer/ citizen engagement in demand response four phases are foreseen: concept development and design, participation/getting on board, response and persistence. These different phases are expected to have different barriers and drivers for demand response programs.
Concept development and design: How do you establish collaboration with the citizens/energy communities? What needs, wishes, behavior and social priorities with respect to demand response programs are identified? How do you ensure that project creates values for consumers/citizens and address their needs? Are there intermediate actors with more connection to the local level or you have strong base in the local communities? How complex are your demand response product and services? How are these technical complexities handled with consumers?
Some involved BUC participants (citizens and consumers) are already involved in some other projects and are willing to extend participation in further projects, including BRIGHT Slovenian Pilot BUC. BUC will provide the following: a) improved self-consumption, b) lower energy cost, c) enablement of other non-energy related services and d) consumption planning (schedules). Demand Response services' backend is complex and hard to understand, whereas the products for end-user will be user friendly. The end-user does not need to be aware of the DR and services; the technical complexity will be addressed as preference input from the end-user (or estimated from sensors), whereas the output can be a simple customized schedule (e.g., shorter period of activity in schedule

or having several periods instead of one throughout the day…). In the light of the price range of the energy a customized schedule for the citizens daily activity will be created. In the context of personal security, social engineering will be applied as action of ambient assisted living only on citizens, while demand response is going to be applied on citizens as well on consumers. In the view of social engineering any act that influences a citizen that may or may not be in their best interest is necessary to fulfill the demand response actions. Such as the change in the power consumption of an electric utility consumer to match the demand for power with the supply. 
Participation/Getting on board: How do you approach consumers? What influences citizen's decision to engage in demand response? How do you get (or plan to get) other user groups on board? Which consumer segments are onboard?
Establishing collaboration with the consumers and prosumers will be based on pre-cooperation. The planning to get other user groups on board is to offer them the opportunity to lower their costs and engage the smart technologies in their home environment. However, a different approach will be used in the home for elderly, since building the trust among participants will be first needed, by introducing the program to improve their wellbeing. Targeted user groups are: **Citizens** are mostly represented by the residents of the Home for the elderly and others directly involved DR program, who do not know a lot about the technical aspect of the DR program. They are not aware of the energy prices and technology and do not have an interest in smart home technology. Around 30% of the residents of the Home for elderly are going to participate in the project research. **Consumers/Prosumers** are well educated on energy consumption and well informed on differences in energy prices. They are mainly represented by consumers and prosumers included in the peer-to-peer energy trading platform. The representatives of the consumers and prosumers community are households and SME.
Response*:* What influences the level of response provided by a consumer? What are the current engagement strategies (incentives, co-benefits such as possibility to see energy consumption in real time) in place, which works and which does not?
Demand Responds services and products are expected to reduce the congestion of the energy network.

The vision is to offer energy consumers the opportunity to lower their costs and engage the smart technologies, personal safety and AAL in their home environment. However, a different approach will be used in the different target groups. The approach in Home for the elderly will be based on different schedules, depending on our needs through demand response. However, changing or delaying citizens activities during the day and week, based on Demand response, will help us to lower the costs of the energy consumption.



Persistence: What influences the decision to stay engaged in demand response? How do you avoid overburdening the consumers? How do you inform consumers regularly on project developments? What communication challenges are foreseen? Are there proper communication channels in place? How do you communicate with your consumers as a continuous give and take, back and forth? How do you ensure long-term engagement of consumer? How do you co-create new business models and co-develop community services?

Communication will be through the communication channels of the platform. Ensuring long-term engagement of consumer on energy service level will be based on several benefits including lowering the costs and encouraging the sustainability and self-sufficiency with the energy from PV of the consumers and prosumers. Engagement of the users at the elderly home will be built on the citizens trust and minimization of interactions they will have with DR programs. Additionally, the citizens will be informed that by participating in the program they are co-creating greener image of the property.

1.8 Actors

Actors

Actors information is important to understand the socio-instituional conditions of the use case. Who are the actors, what roles and responsibilities they have and what changes in these roles and responsibilities have been foreseen? What are the relation between the actors?

Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Consumer	Person or company	Entity connected to the distribution grid that consumes electric energy	
Prosumer	Person or company	Entity connected to the distribution grid that can either consume or produce electric energy	
Citizen	Person	Entity indirectly involved in DR programs	Mainly residents of the home for the elderly
Utility	Company	Electrical energy provider.	SONCE energija
Service provider	Role	Entity that creates and offers new services	Creates DR based services
AMI	System	Automatic metering infrastructure	
Aggregator	Role	Aggregates and manages flexible assets	
Service user	Role	User of the services	
Data provider	Role	Provides the data that can be shared for developing services	
EMS	System	Energy management system	

1.9 Further information to the use case for classification / mapping

Classification information
Relation to other use cases
• LLUC1: Virtual Community Decentralized flexibility orchestration for implicit and explicit DR • LLUC2: Building Optimal Flexibility Management trade off with Comfort Management • LLUC3: Analytics and automation supported aggregation of behind-the-meter assets.
Level of depth
High level
Prioritization
Mandatory
Generic, regional or national relation
Generic
Nature of the use case
Business use case

Further keywords for classification
DR, VPP, VEC, B-DLT, B-EMHC, AAL, P2P

1.10 General remarks

General remarks

8.3 BUC 3

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
BUC3	Smart Grid / Distribution / Operation	LEC, CEC and COM Aggregation for optimal Flexibility Management

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V1	19/01/2021	Tommaso Bragatto, Federico Carere	Initial draft	
V2	26/02/2021	Federico Carere		

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	The pilot scope is to demonstrate decentralized and semi-decentralized VPPs for geographically bounded communities in which the available local flexibility is combined and optimal managed to be delivered to wholesale and/or local congestion management market
Objective(s)	1. Building-level LEC Semi-decentralized VPP for flexibility multi-value stacking services, capable to allow residential customers to actively participate to the energy transition 2. LEC decentralized VPP Marketplace for Flexibility Trading for Local MV/LV Network Congestion Management, capable to increase the interactions between heterogenous customers, increasing the energy performances. 3. Virtual Community Semi-Decentralized Aggregation for Optimal Flexibility Management, capable to exploit the EV charging sessions integration benefits.
Related business case(s)	

1.4 Narrative of Use Case

Narrative of use case
Short description *Describe the technical, socio-economic, geographic, and institutional conditions of the use case. You may use criteria's such as age, gender, income, education level, employment status to describe your user base.*

Categorize your use case among local energy communities, virtual energy communities, hybrid communities or communities on the move and cross vector communities.
Italian Pilot covers different geographic areas, at building, district and city level; different levels will be orchestrated by ASM which is the Distribution System Operator (DSO) of the city of Terni. At building level, the engaged citizens therefore they are interested in a deeper knowledge of their consumptions in order to minimize the electric bill. Some of them want to be aware and active on energy transition, At district level, the ASM headquarters need to identify and exploit the flexibility from different energy clusters, such as building facilities, photovoltaic plant, battery energy systems, electric vehicle supply equipment. The city level corresponds to an energy community that wants to increase its energy efficiency and identify its flexibility capability. This level includes, beyond the residential consumers above mentioned, additional end consumers, with public schools equipped with PV local generation, household residential consumers equipped with PV, and smart home individual households consumer with local generation, storage and adding on EV renting and driving integration.
Complete description *Here provide detailed description of the use case.*
The Use Case will be demonstrated leveraging four different clusters of users of the distribution grid, notably: • A multi-apartments residential building, with 50 consumers equipped with IoT smart meters and that will be characterised by flexible and controllable home loads. • ASM headquarters district, with 20 consumers including industrial, commercial, residential customers, water pumping stations, decentralized RES generation, second life batteries, etc. • A Citizen Energy Community, with 120 end consumers, including public schools, household residential consumers, smart home individual households consumer. • A fleet of 10 EVs, with the Intelligent Recharging Stations. At building level, a multi-market scenario will exploit small scale flexibility. A semi-decentralized VPP community-level aggregation flexibility trading will be validated, with a mix of top-down initial B-DT-based clustering of suitable flexible assets with P2P B-DLT and smart contract-based negotiation. At district level, a decentralized VPP community-level aggregation will be validated. The local flexibility trading will leverage on P2P B-DLT and smart contract-based negotiation along heterogeneous customers, including industrial, commercial, residential customers, water pumping stations, decentralized RES generation, second life batteries. At city level, the main challenge consists of the top-down selection of the prosumers intelligent clustering, in particular the intelligent centralized flexibility aggregation by EV fleet operator (EMOT).

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
KPI_1	Real-Time Monitoring	Time granularity for monitoring about seconds	Grid observability and flexibility forecasting
KPI_2	Big Data Collection	Interaction capability: about thousands of measurements per minute	Grid observability and flexibility forecasting
KPI_3	Flexibility Provision	Reduction of reverse power flows	Grid stability and efficient renewable energy integration

1.6 Use case conditions

Use case conditions
Assumptions Describe the local socio-economic and techno-institutional condition (living situation, energy prices, rules and regulation) specific to the use case. Does an energy regulator that has established the lawfulness of different types of energy provision contracts exist? Do the use case users consume energy exclusively in their place of residence? Are users' consumption patterns comparable? In other words, do they have similar lifestyles? Are the age and condition of the electrical system an important variable? What is the maturity/enagement level with respect to demand response in the use case? How confident are your users with smart home technologies? If applicable, how often they have changed their energy providers? Is your average user aware of the existence of different price ranges for energy depending on the hour at which it is consumed? If so, what is their degree of awareness?
With respect to the socio-economic condition, the Italian Pilot will engage a heterogenous set of customers who have different goals as well as various levers for participating and being engaged in the demonstration activities. The main needs and drivers are related to the economic benefits derived by energy efficiency and an increased consumption knowledge. The main barriers consist of the uncertainties in investing in new technologies and the necessity to have a full automatic control. With respect to consumption patterns, some groups can be identified by means a proper analysis (e.g., Residential all-day, Residential evening, Smart houses, industrial customers). In addition, the regulatory framework should be taken into account as external condition; in particular, it is worth mentioning that in Italy Demand Response programs are very limited and they are not accessible by most of the customers; moreover, they are only managed by the Transmission System Operator, which acts at National level. This also implies that the majority of the customers have not experience with DR programs and they are not aware about energy prices hourly based.
Prerequisites Is it a prerequisite that the user be the owner of the accountholder of the energy contract? Is it a prerequisite that all users be located in the same area? In other words is location specificity importnant? Should the consumer be equipped with smart meter and devices? What means of engagement for demand response are foreseen?
• A Web Application is crucial for engaging users • User has to be equipped with an IoT smart meter • Users have to be involved by means of proper meetings

1.7 Consumer/citizen engagement strategies

Engagement strategies: In consumer/ citizen engagement in demand response four phases are foreseen: concept development and design, participation/getting on board, response and persistence. These different phases are expected to have different barriers and drivers for demand response programs.
Concept development and design: *How do you establish collaboration with the citizens/energy communities? What needs, wishes, behavior and social priorities with respect to demand response programs are identified? How do you ensure that project creates values for consumers/citizens and address their needs?* Are there intermediate actors with more connection to the local level or you

have strong base in the local communities? How complex are your demand response product and services? How these technical complexity are handled with consumers?
Many customers were involved in 2018 and 2019 when the IoT Smart Meter was installed and presented; at the same time, an agreement compliant with GDPR was signed. Therefore, based on previous experience, preliminary meetings could not be useful for these reasons: • Promising deadline could not be violated in the subsequent months • Meetings may appear as a duplicate of the introductory meetings that the company made in the past. It would be preferable to engage the final users only when the project tools are already deployed in the pilot and they can be instantiated immediately for the customers. This is especially referred to the Web Application. After the tool presentation, the users can be smoothly engaged in some DR campaigns identifying some keywords and targets (e.g., saving energy because of green energy production or scheduling loads during the most convenient time periods). Moreover, their participation can be further encouraged by means of periodical meetings and social advertising. Finally, the social network could help the dissemination and wide communication of the project activities to the citizens during all the phases.
Participation/Getting on board: *How do you approach consumers? What influences citizen's decision to engage in demand response? How do you get (or planning) other user groups on board? Which consumer segments are onboard?*
We will have meeting to present the tools developed by the project (i.e., App, Smart Appliances). The citizens' decision can be influenced by their typical behaviour (as a precondition), because of their possible reluctance in modifying their habits. In addition, customer can be engaged if the proposed system will smoothly work and the information about DR is communicated in a simple and straightforward way. The selected customers are not only residential users, therefore, ASM will try to involve other users that have an IoT smart meter at their premises, this additional cluster is quite heterogenous since it comprises industrial factories, offices, shops, PV plant and schools.
Response: What influences the level of response provided by a consumer? What are the current engagement strategies (incentives, co-benefits such as possibility to see energy consumption in real time) in place, which works and which does not?
Customer response can be got by means of a proper set of tools that can enable different services (e.g., App, Smart Appliance). The possibility to easily control and change the smart home loads is fundamental to receive a good response from the customers.
Persistence: What influences the decision to stay engaged in demand response? How do you avoid overburdening the consumers? How do you inform consumers regularly on project developments? What communication challenges are foreseen? Are there proper communication channels in place?How do you communicate with your consumers as a continuous give and take,

back and forth? How do you ensure long-term engagement of consumer? How do you co-create new business models and co-develop community services?
We have no previous experience about persistence on DR campaign, nevertheless, customer involvement is strictly related to the smooth usage of the tools as well as to a continuous flow of information. In this respect, several ways of communication will be adopted for engaging citizens; in particular, customer can be reached by phone call, individual meetings, assembly and public workshop. In addition, communication through social networks will be investigated, especially for keeping a continuous focus on project activities and the related involvement into DR campaign.

1.8 Actors

Actors Actors information is important to understand the socio-instituional conditions of the use case. Who are the actors, what roles and responsibilities they have and what changes in these roles and responsibilities have been foreseen? What are the relation between the actors?			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Distribution System Operator	Company	Owner and manager of the Distribution Network Responsible for engaging the users.	
Domestic Consumer	Person	Domestic user to be engaged by DSO and to be involved in DR campaigns.	
Prosumer	Person or Company	User of the electrical network able to self-produce energy	
Not Domestic Consumer	Person or Company	In comparison with domestic user, this actor can have a wide range of flexibility to be offered. In addition, the main contact point is an Energy Manager which could be aware about the general topics of the project.	
Utility	Company	This company carries out billing operation and it sells energy to the customers.	
Citizen	Person	The citizen is not actually the owner of the energy contract, nevertheless he/she wants/needs to be involved in DR campaign (e.g., a member of a family, a user of a public building).	

1.9 Further information to the use case for classification / mapping

Classification information

Relation to other use cases
All UC envisioned for Pilot 3
Level of depth
High
Prioritization
Mandatory
Generic, regional or national relation
City
Nature of the use case
Technical/ Social
Further keywords for classification
DR, VPP, LEC, CEC, COM, B-DT, B-DLT, B-FLEX, P2P

1.10 General remarks

General remarks

8.4 BUC 4

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Do- main(s)/ Zone(s)*	*Name of use case*
BUC 4	Grid-Interactive Efficient Buildings/DR costumer Premises/	Virtual Community Centralized Aggregation and energy management services

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V1	15.02.2021	Iordanis Tourpeslis	Initial Draft	
V2	26.02.2021	Kanela Karatzia, Iordanis Tourpeslis, Dimitris Sidiropoulos	Revision	
V3	03.03.2021	Kanela Karatzia, Iordanis Tourpeslis, Dimitris Sidiropoulos	Revision	
V4	17.03.2021	Stratos Keranidis, Ellie Efstathiou	Revision	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	Providing a central solution that combines automated electricity and natural gas management by maintaining indoor comfort (temperature, humidity) and reducing energy consumption and costs for end consumers, while delivering improved flexibility for energy suppliers through the application of implicit DR solutions (load shifting)
Objective(s)	1. IoT-assisted energy management for Smart home individual households, employing smart relays to control heavy consuming appliances, such as electric water heaters/space heaters/heat pumps, etc. and smart plugs to control other white goods (dehumidifiers, dryers, etc.) 2. Optimal control of legacy heating and DHW preparation boilers for residential gas consumers 3. Advanced user profiling to improve predictability of consumption and consumer behavior, based on the different types of identified customer segments, usage patterns, building and device characteristics
Related business case(s)	

1.4 Narrative of Use Case

Narrative of use case
Short description *Describe the technical, socio-economic, geographic, and institutional conditions of the use case. You may use criteria's such as age, gender, income, education level, employment status to describe your user base. Categorize your use case among local energy communities, virtual energy communities, hybrid communities or communities on the move and cross vector communities.*
The Greek pilot will take place in 3 clusters of consumers forming three virtual energy communities (Thessaloniki, Volos, Chalkidiki). The pilot will involve diverse customer profiles (age, financial, etc.) and cities with different climatic data (temperature, humidity, air etc. of northern and central Greece) The pilot will showcase how IoT-assisted energy and thermal management can be combined with non-energy services (comfort monitoring, home automation) for decentralized communities of consumers, towards promoting their participation in implicit DR schemes, while offering reduced consumption for end-consumers and improved flexibility for suppliers.
Complete description *Here provide detailed description of the use case.*
The main goal of the pilot is to enhance the participation in implicit Demand Response schemes through the development and implementation of energy (energy statistics and information, energy analysis and advice) and non-energy services (comfort, security) by using the infrastructure that has been established from other EU projects together with the installation of new technologies (sensors). • 50 households equipped with real-time electricity submeters • These homes will also be equipped with Smart-home Gateways and various home-IoT sensors able to characterize climate conditions (temperature, humidity, light) and home usage patterns (door contacts, human presence) in real-time. • 50 households equipped with smart automation controllers (edge) attached with legacy natural gas boilers for space heating and DHW preparation • Central and remote control of legacy appliances (electrical water heaters, natural gas boilers) • Accurate consumption estimation without the need of installing dedicated and expensive metering equipment • Optimal and efficient tuning of legacy device preparation, by exposing previously unused control capabilities for legacy devices (e.g. time-scheduling, modulation control, weather compensation) • Cloud IoT platform enabling the application of AI algorithms to identify home (insulation level) and user characteristics (usage patterns) and optimally adapt heating operation • Smartphone application supporting remote control and monitoring The users tend to be interested in their energy usage in relation to paying bills especially for the use of heating and cooling appliances which are high consuming. They also show significant interest in comfort and safety issues and relevant services. In comparison, they don't show the same willingness for improving the energy efficiency of old appliances, such as by not using or turning off legacy appliances (instead of setting them in stand-by mode).

1.5 Key performance indicators (KPI)

Key performance indicators

ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Cost reduction	Lower the consumers energy/natural gas bill by implicit DR services.	1, 2, 3
2	Consumer behavior and consumption patterns	Obtain better predictability of customers energy consumption.	2, 3

1.6 Use case conditions

Use case conditions
Assumptions Describe the local socio-economic and techno-institutional condition (living situation, energy prices, rules and regulation) specific to the use case. Does an energy regulator that has established the lawfulness of different types of energy provision contracts exist? Do the use case users consume energy exclusively in their place of residence? Are users' consumption patterns comparable? In other words, do they have similar lifestyles? Are the age and condition of the electrical system an important variable? What is the maturity/engagement level with respect to demand response in the use case? How confident are your users with smart home technologies? If applicable, how often they have changed their energy providers? Is your average user aware of the existence of different price ranges for energy depending on the hour at which it is consumed? If so, what is their degree of awareness?
The Greek pilot will engage mostly residential users with diverse social/energy profiles (in three different cities with different climate and sub/urban conditions), the users vary from families to single person flats. Comparison of consumption patterns is feasible because the users are mainly households sharing facsimile lifestyles but only within each cluster since the three cities do not share same climatic characteristics. The maturity of the electrical system plays a vital role in DR schemes, but because the installations and infrastructure that are going to be used are in the premises of the users it will not affect the efficiency of the solution. All data that are monitored (electricity, gas, indoor conditions) will be analyzed and usage patterns will be conducted to enforce implicit DR solutions, such as load shifting techniques, by providing feedback and recommendations through the smartphone app to help consumers decrease their energy expenses by controlling remotely their appliances. The consumers that will get involved in the project have participated in the past in other EU projects. With that approach the consumers are acquainted with smart home technologies. Generally, in Greece the average consumer does not know the different price ranges depending on the hour at which it is consumed. However, as already mentioned the majority of the users have been participating in the past in other EU projects and therefore some of them are informed that in congestion hours the price of the energy is higher compared to hours when the majority of the people is sleeping and the demand is low.
Prerequisites Is it a prerequisite that the user be the owner of the accountholder of the energy contract? Is it a prerequisite that all users be located in the same area? In other words is location specificity

importnant? Should the consumer be equipped with smart meter and devices? What means of engagement for demand response are foreseen?
The most important prerequisite is that all the users must have access to the internet over Wi-Fi, so that the Wi-Fi sensors and meters to be installed at consumer premises will be able to offload data to the respective servers.

1.7 Consumer/citizen engagement strategies

Engagement strategies: In consumer/ citizen engagement in demand response four phases are foreseen: concept development and design, participation/getting on board, response and persistence. These different phases are expected to have different barriers and drivers for demand response programs.
Concept development and design: *How do you establish collaboration with the citizens/energy communities? What needs, wishes, behavior and social priorities with respect to demand response programs are identified? How do you ensure that project creates values for consumers/citizens and address their needs?* Are there intermediate actors with more connection to the local level or you have strong base in the local communities? How complex are your demand response product and services? How these technical complexity are handled with consumers?
Effective communication is crucial to succeed and facilitate consumer engagement. At first stage, it is important to raise awareness about the project and make clear to potential consumers its overall approach. In this term, WVT has developed several communication channels. Social networks, company's website, press releases, newsletters and individual emails would be used to provide basic information inducing them to participate. Some of the participants have been involved in the past in other relevant projects and are willing to extend their participation to Bright project. The wide Retail Stores Network all over Greece (already existing Stores in Thessaloniki, Volos and Chalkidiki) as well as the feedback/preferences from Swartwatt app allow continuous interaction with customers so that our products meet their demands and facilitate our collaboration. The technical complexity will be addressed as preference input or estimated by sensors by respecting users' needs in an easy/understandable way.
Participation/Getting on board: How do you approach consumers? What influences citizen's decision to engage in demand response? How do you get (or planning) other user groups on board? Which consumer segments are onboard?
In this phase we intend to stimulate and increase costumers' interest who already are aware of the project. It is important to realize the benefits which will be gained from their engagement. WVT retail stores network will offer full costumer support demonstrating to the visitors our home automation and energy services in the most understandable way making the DR products applicable/attractive. Also, conferences, workshops and videos with more specific content would be produced to gain participation of consumers.

The most vital influence that affect the decision of consumers is the ability to manage their energy in order to achieve energy savings and operate their households in the most efficient manner. The residential consumers are indeed keen of managing the energy services.
Response: What influences the level of response provided by a consumer? What are the current engagement strategies (incentives, co-benefits such as possibility to see energy consumption in real time) in place, which works and which does not?
The current engagement strategy is to provide consumers with real time consumption data for electricity and gas, but also historical baseline data through visualization tools. The ability to significantly reduce gas consumption for heating and hot water preparation and to understand the amount of personal savings have a great impact on engaging users to employ automated control of legacy boilers. Furthermore, offering the consumers with the automation possibilities is an asset for further engagement.
Persistence: What influences the decision to stay engaged in demand response? How do you avoid overburdening the consumers? How do you inform consumers regularly on project developments? What communication challenges are foreseen? Are there proper communication channels in place?How do you communicate with your consumers as a continuous give and take, back and forth? How do you ensure long-term engagement of consumer? How do you co-create new business models and co-develop community services?
Our primary objective is to engage energy users to understand more about energy consumption, change their consumption habits and the way they act, live and behave towards energy, by adopting a sustainable way of life. We aim to promote their participation in DR programs, by offering them cost reduction and comfort services. Once consumers are engaged, it is important to provide the necessary services support and maintenance for keeping the customer on board with the BRIGHT approach. This stage may include upscaling and replication of Bright products/services through workshops and development of an effective network of external partners. In parallel the Retail Stores network all over Greece provide energy sales, full customer support, and of course demonstrating to the visitors our home automation and energy services approach. In this way we ensure effective customer communication and long-term engagement.

1.8 Actors

Actors Actors information is important to understand the socio-instituional conditions of the use case. Who are the actors, what roles and responsibilities they have and what changes in these roles and responsibilities have been foreseen? What are the relation between the actors?			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Consumers	Person	Entity that is connected to distribution greed and consumes electricity and natural gas	

DSO	Company	Responsible for the connection of the consumers to the distribution greed.	
Technolo gy provider	Company	Intermediate entity providing the IoT hardware, user interfaces and energy services.	domX, WVT
AMI	System	Real-time electricity submeter network.	WVT
Utility	Company	Electric energy provider.	WVT

1.9 Further information to the use case for classification / mapping

Classification information
Relation to other use cases
• LLUC_4_1: IoT-assisted participation in DR schemes for both electricity and natural gas and energy management for communities of Smart homes residents. • LLUC_4_2: Virtual Community optimal thermal comfort management and cross-energy services, while trading off with energy flexibility provisioning for smart home households. • LLUC_4_3: Advanced user profiling to improve predictability of consumption and consumer behavior, based on the different types of identified customer segments, usage patterns, building and device characteristics.
Level of depth
High Level Use Case
Prioritization
High
Generic, regional or national relation
Generic
Nature of the use case
Business
Further keywords for classification
VEC, DR, B-DT, B-EMHC, B-FLEX, B-DLT

1.10 General remarks

General remarks

9 Annex 3 – Low-Level Use Cases

9.1 LLUC1_1

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Do- main(s)/ Zone(s)*	*Name of use case*
LLUC_1_1	Area: district level Domain: Customer premises Zone: Enterprise, Operation, Station, Field, Process	Heat energy flexibility on district heating and individual user level

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
1.0	2021/3/18	Chaïm De Mulder	Initial draft	
2.0	2021/03/22	Chaïm De Mulder	- Add sequence diagram. - Update sections 3-4-5-6-7	
3.0	2021/03/23	Chaïm De Mulder	Add requirements	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	District-level local heat energy optimisation
Objective(s)	1. Optimally use the flexibility of the district heating network to lower operational costs 2. Optimally use demand-response flexibility in heating from the individual user side to lower operational costs
Related business case(s)	BUC1

1.4 Narrative of Use Case

Narrative of use case
Short description
To optimize its business model, an ESCO wants to make use of the flexibility that comes with the range of heat-generating and –consuming assets it operates.
Complete description

Operating a number of heat-related assets (e.g. heat pump, industrial waste heat heat exchanger, community-level and individual-level heat sinks...) connected with a district heating network, an ESCO has the potential to incorporate the flexibility this brings into its business plan. Consider for example the possibility to 'charge' the district heating network with heat that will only be required within a few hours, by using the heat pump with currently low electricity prices. These kinds of flexibilities require a functional analysis of each asset (e.g. what control parameters can be used), as well as an analysis of how the assets interact. On an individual user level, citizens first need to agree with the use of their home as a flexibility asset. Especially comfort considerations will be important here. If a citizen agrees, it is especially the time-lag and the heat saved in the individual floor heating/rooms/walls that will provide flexibility to e.g. postpone part of the morning heat delivery.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Forecasting services for heat demand	Statistics-based predictors for estimating expected heat demand with a maximum error of 20% for the coming 10 hours	1, 2
2	Shift in peak heat load	The heat peak load(s) is (are) shaved by at least 10% and load is shifted to other points in time (earlier or later).	1, 2
3	Decrease in heat production requirements	Heat production requirements are 10% lower when compared to non-optimised situation	1, 2

1.6 Use case conditions

Use case conditions
Assumptions
- All energy assets have a stand-alone operation that guarantees heat energy provision - There is communication (both data acquisition and control levels) with relevant controllable assets
Prerequisites
- Information on the stand-alone operation of the assets, as well as the available degrees of freedom for control algorithms that would come on top of and supersede the stand-alone operation.

1.7 Further information to the use case for classification / mapping

Classification information

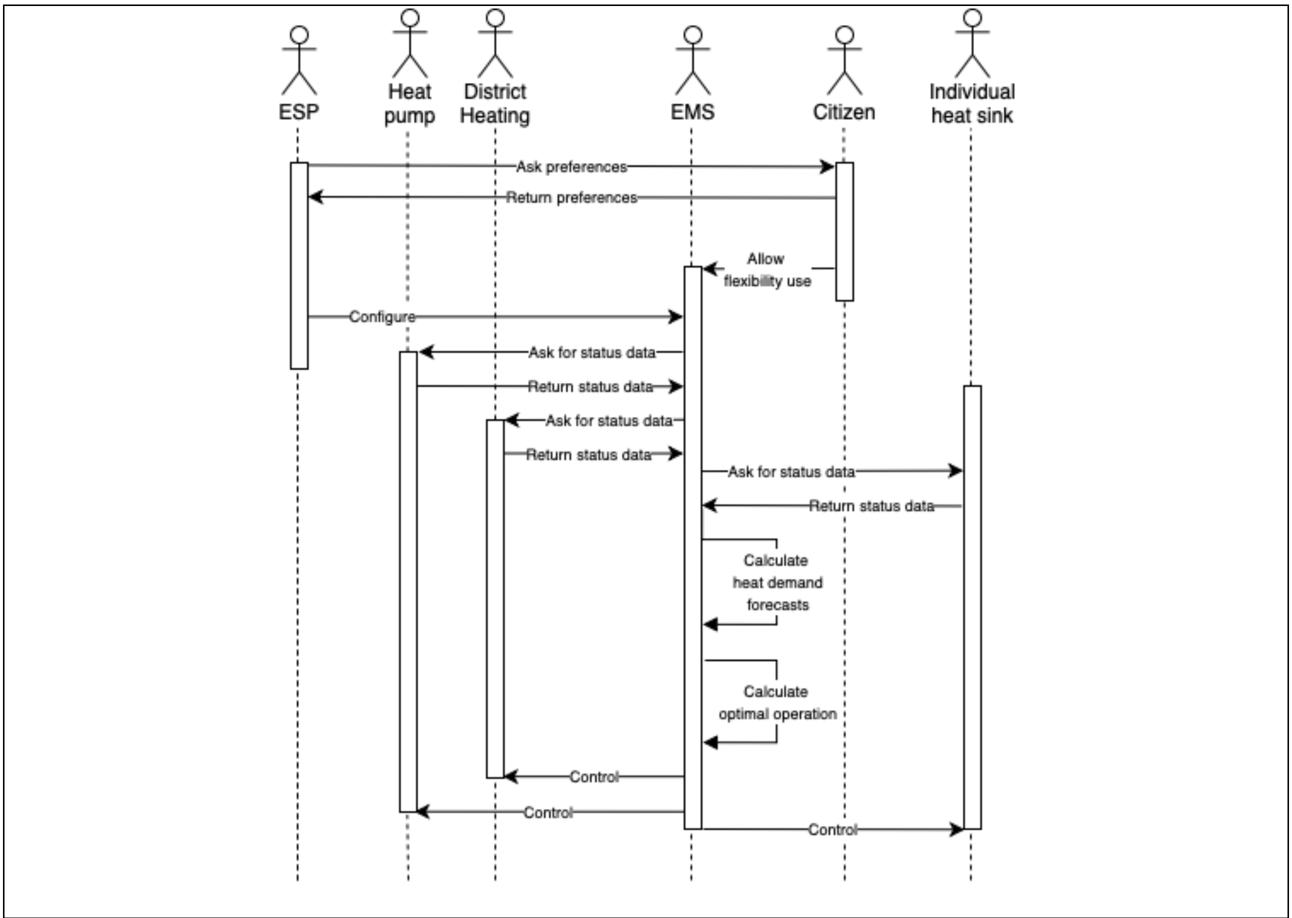
Relation to other use cases
BUC1, LLUC2
Level of depth
Low level
Prioritization
High priority
Generic, regional or national relation
Impacted to some extent by electricity pricing (through use of heat pump), and possibly other policy-level decisions impacting investment costs in energy assets
Nature of the use case
Technical
Further keywords for classification
Local energy community, ESCO, smart building, district heating

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Energy service provider	Business actor	Energy Service Company	DuCoop cooperative manages all energy-related assets at the pilot 1 site
Technology provider	Technical actor		OpenMotics provides hard- and software to align the different assets. It does not vouch for stand-alone operation, but for the interactional optimization of the assets.
Asset	Logical actor	Heat energy-related assets	District heating pumps, heat pump
Device	Logical actor	Data acquisition and control devices	SCADA system, building-level gateways, private gateways
EMS	Logical actor	Energy management system, calculate and send optimal control actions to assets	

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
1	Optimal control	Optimal control of the flexible heat-related assets	EMS	Scheduled EMS run	Heat-related assets are operational and controllable	Optimal control action sent every 15 minutes

4.2 Steps – Scenarios

Scenario								
Scenario name:		***No. 1 – Optimal control***						
Step No.	*Event*	*Name of process/ activity*	*Description of process/ activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Require ment, R-IDs*
	Ask preferences	Ask preferences	Ask citizen preferences regarding heat-related demand response	GET	ESP	Citizen	-	-
	Return preferences	Return preferences	Share preferences regarding heat-related demand response	REPORT	Citizen	ESP	1	-
	Allow flexibility use	Allow flexibility use	Citizen/user allows the use of his/her heat demand for flexibility	REPORT	Citizen	EMS	1	-
	Configure	Configure	Energy Service Provider	CREATE	ESP	EMS	2	1

			configures EMS					
	Ask for status data	Ask for status data	EMS asks for status data of heat pump, district heating, individual heat sinks (in case it is allowed by the user)	GET	EMS	Heat pump, district heating, citizen heating system	-	6
	Return status data	Return status data	Return status data	REPORT	Heat pump, district heating, citizen heating system	EMS	3	2, 3, 4, 5
	Calculate forecast	Calculate forecast	Calculate heat demand forecast	CREATE	EMS	EMS	-	-
	Calculate optimal operation	Calculate optimal operation	Calculate optimal operational states for the different heat-related assets	CREATE	EMS	EMS	-	-
	Control	Control	Control the different heat-related assets	EXECUTE	EMS	Heat pump, district heating, citizen heating system	4	6

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information ex- changed*	*Requirement, R-IDs*
1	User preferences	Personal preferences as defined by the user (e.g. temperature, allowed flexibility...)	-
2	Configuration information	Information required for the configuration of the EMS (e.g. heat pump compression stages and power)	1

3	Status data	Data describing the current and possibly past status of heat-related assets (heat pump, district heating, individual heat demand...)	2, 3, 4, 5
4	Control signal	Control signal sent to the different controlled assets	6

6 Requirements

Requirements(optional)		
Categories ID	*Category name for requirements*	*Category description*
1	Configuration interface	A configuration interface is available for the EPS to configure the EMS
2	Recent data available	Recent (defined in configuration) data is available
3	Historical data available	Historical data (as defined in configuration) is available
4	Data sufficiently accurate	Data is sufficiently accurate for representing the real situation
5	Data with sufficiently high frequency	Data has a sufficiently high frequency to allow accurate calculations/control
6	Communication with asset	Communication with the relevant asset is online (I.e. data is flowing from asset to database and from EMS to asset)

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*
EMS	Energy Management System
ESP	Energy Service Provider

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.2 LLUC1_2

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_1_2		Local Energy cooperative Grid support

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
1.0	2021/2/25	Chaïm De Mulder	Initial draft	
2.0	2021/3/22	Chaïm De Mulder	- Add sequence diagram - Update sections 3-4-5-6-7	
3.0	2021/03/23	Chaïm De Mulder	Add requirements	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	Use both community-level and individual demand response flexibilities to provide grid services
Objective(s)	1. Successfully deliver grid support services 2. Verify the business model for providing grid support services
Related business case(s)	BUC1

1.4 Narrative of Use Case

Narrative of use case
Short description
DuCoop, owning both energy-producing and energy-consuming assets representing a significant power, is interested in providing grid services to extend the potential of its business model.
Complete description

Electricity infrastructure operators are meant to provide secure access to electricity. With an increased penetration of renewable energies on the grid, this becomes more challenging. In order to keep the grid balanced, electricity sources and sinks that can be made available on short notice are valuable assets. It is exactly in that context that the Local Energy Community at De Nieuwe Dokken, managed by DuCooop, is interested in providing such sources and sinks, in order to add an additional level to its business case.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Live communication with grid operator	Establish a live communication with the grid operator, including the required signals such as: amount of flexibility available (uptake/provision), expected flexibility, expected required flexibility	1
2	Flexibility provision	Flexibility is available for at least a minimum amount of time (suggested 5%), and the DSO/TSO is indeed able to make use of it	1
3	Financial assessment - pre	Before the actual implementation, a financial assessment is made to verify business model	2
4	Financial assessment – post	Once the flexibility service is in place, verify the business case and initial financial assessment	2
5	Flexibility control algorithm for electricity	Control algorithm that leverages the available electricity asset flexibility	1

1.6 Use case conditions

Use case conditions
Assumptions
- Live communication with DSO/TSO is possible - The amount of flexibility that can be provided is large enough to be interesting for DSO/TSO partners
Prerequisites
- Legislation allows for exchange of energy services

1.7 Further information to the use case for classification / mapping

Classification information
Relation to other use cases

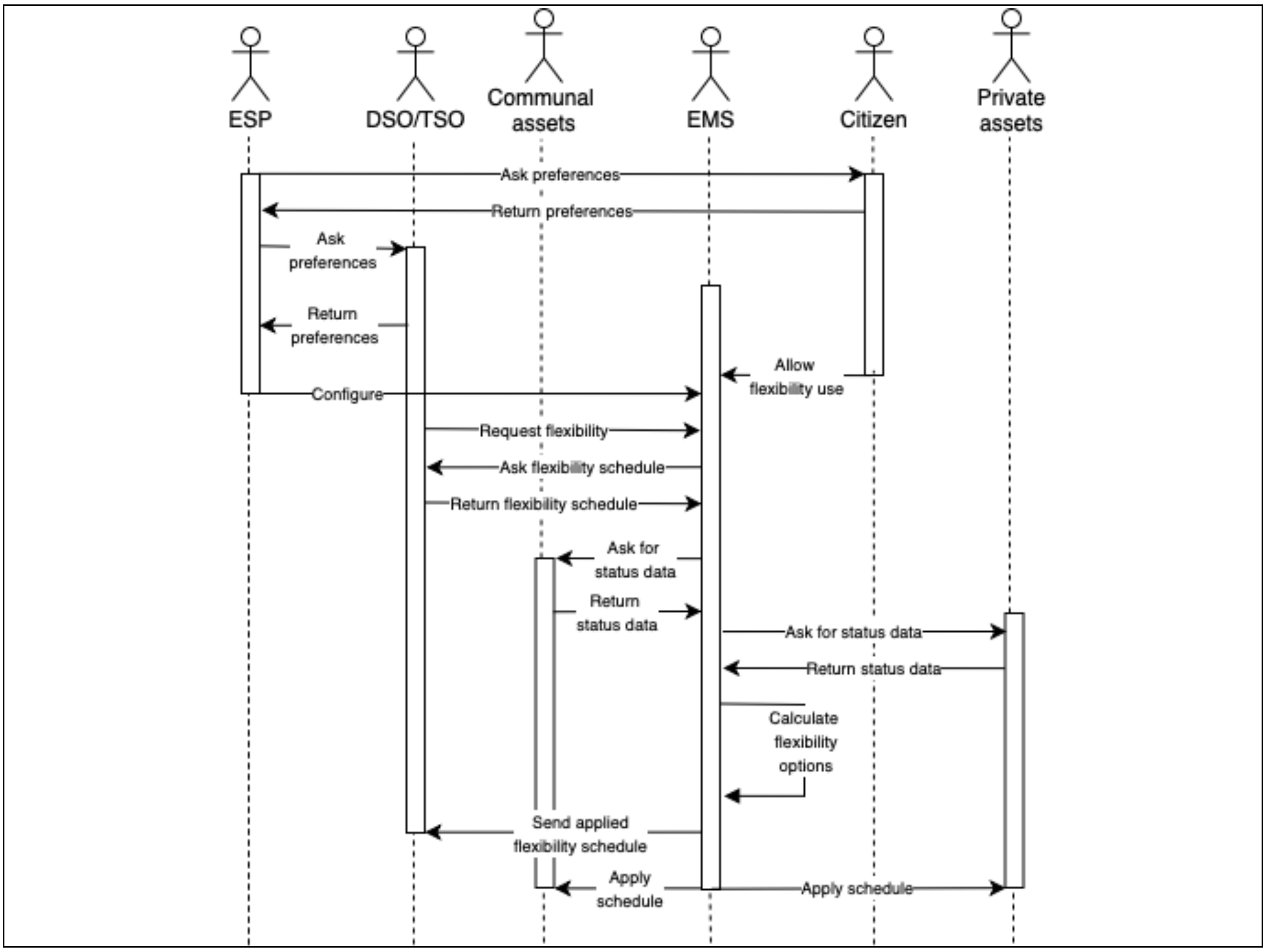
BUC1
Level of depth
Low level
Prioritization
Medium prioritization
Generic, regional or national relation
Impacted by national and regional regulatory framework (grid tarification, energy exchange, etc.)
Nature of the use case
Technical, electricity market
Further keywords for classification
Local Energy Community, grid services

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Citizen	Business actor	Citizen that is part of a local energy community	
Energy service provider	Business actor	Energy Service Company	DuCoop cooperative manages all energy-related assets at the pilot 1 site
Technology provider	Technical actor		OpenMotics and Farys provide hard- and software that will allow to communicate with the grid operator
DSO/TSO	Technical actor		Elia
Communal asset	Logical actor	Electricity-related assets on the communal level	
Private asset	Logical actor	Private electricity-related asset that allows flexibility	

EMS	Logical actor	Energy management system, calculate and send optimal control actions to assets	

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
	Flexibility provided	The local ESP is able to provide flexibility to the DSO/TSO	DSO/TSO	Flexibility required	Flexibility providing assets are operational and controllable and/or private flexibility is accessible	Flexibility (schedule) is provided

4.2 Steps – Scenarios

Scenario								
Scenario name:	***No. 1 – Flexibility provided***							
Step No.	*Event*	*Name of process/ activity*	*Description of process/ a ctivity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Ask preferences	Ask preferences	The energy service provider asks citizens and DSO/TSO about their preferences for a flexibility service	GET	ESP	Citizen/DSO/ TSO	-	-
2	Return preferences	Return preferences	Citizens/DSO/ TSO return their	REPORT	Citizen/ DSO/ TSO	ESP	1	-

			preferences					
3	Allow flexibility use	Allow flexibility use	Citizen allows (or not) use of the flexibility (s)he has to offer	REPORT	citizen	EMS	-	-
4	Configure	configure	EMS is configured based on preferences	REPORT	ESP	EMS	2	1
5	Request flexibility	Request flexibility	DSO/TSO requests flexibility to balance the grid	GET	DSO/TSO	EMS	-	-
6	Ask flexibility required	Ask flexibility required	EMS asks for the estimated flexibility schedule required by the DSO/TSO	GET	EMS	DSO/TSO	-	-
7	Return flexibility required	Return flexibility required	DSO/TSO provides the EMS with estimated flexibility required	REPORT	DSO/TSO	EMS	3	2, 4, 5
8	Ask for status data	Ask for status data	EMS asks for status data about communal and private assets that can deliver flexibility	GET	EMS	Communal and private assets	-	-
9	Return status data	Return status data	Assets provide their current status	REPORT	Communal and private assets	EMS	4	2, 3, 4, 5
10	Calculate flexibility options	Calculate flexibility options	EMS Calculates options for flexibility, now and in	CREATE	EMS	EMS	-	-

			the coming hours					
11	Send applied flexibility schedule	Send applied flexibility schedule	EMS sends applied flexibility schedule to DSO/TSO	REPORT	EMS	DSO/TSO	5	6
12	Apply schedule	Apply schedule	EMS applies calculated schedule to communal and private assets	EXECUTE	EMS	Communal and private assets	5	6

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information ex- changed*	*Requirement, R-IDs*
1	Preferences	Preferences as defined by the user (e.g. allowed flexibility...) and by the TSO/DSO	-
2	Configuration information	Information required for the configuration of the EMS (e.g. heat pump compression stages and power)	1
3	Required flexibility estimation	An estimation of the flexibility that will be required in the coming hours to keep the grid balanced	2, 4, 5
4	Status data	Data describing the current and possibly past status of heat-related assets (heat pump, district heating, individual heat demand...)	2, 3, 4, 5
5	Flexibility schedule	The flexibility schedule to be applied to the flexible assets for the coming hours	6

6 Requirements

Requirements(optional)		
Categories ID	*Category name for requirements*	*Category description*
1	Configuration interface	A configuration interface is available for the EPS to configure the EMS
2	Recent data available	Recent (defined in configuration) data is available
3	Historical data available	Historical data (as defined in configuration) is available
4	Data sufficiently accurate	Data is sufficiently accurate for representing the real situation
5	Data with sufficiently high frequency	Data has a sufficiently high frequency to allow accurate calculations/control

6	Communication with asset	Communication with the relevant asset is online (I.e. data is flowing from asset to database and from EMS to asset)

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*
EMS	Energy Management System
ESP	Energy Service Provider
DSO	Distribution System Operator
TSO	Transmission System Operator

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.3 LLUC1_3

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_1_3		EV charging infrastructure flexibility optimization for local community and grid improved operation

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
1.0	2021/2/25	Chaïm De Mulder	Initial draft	
2.0	2021/3/22	Chaïm De Mulder	- Add sequence diagram - Update sections 3-4-5-6-7	
3.0	2021/3/23	Chaïm De Mulder	Add requirements	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	Optimize the intrinsic flexibility of charging stations with a large number of charging points
Objective(s)	1. Provide quality services for EV charging 2. Use the flexibility inherent to the charging of multiple EVs under different user requirements to obtain a more even load
Related business case(s)	BUC1

1.4 Narrative of Use Case

Narrative of use case
Short description
To avoid the large peak loads associated with the simultaneous charging of a large number of EVs, DuCoop wants to smartly spread this load.
Complete description
A large number of charging EVs, each with different requirements (e.g. amount to charge, time by which charging needs to be completed...) allows to spread out the corresponding charging load, avoiding an

increased pressure on the electricity grid but also increased fees for DuCoop (in this case the buyer of grid electricity), because of high peak demand. Control algorithm will be developed to manage this flexibility.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Non-affected service quality	No significant increase in complaints (on a monthly basis) about the charging station operation is being filed	1
2	Load evening	Load of the EV charging stations is effectively spread out as much as possible (maximum and minimum load within a certain maximum range from each other, corrected for number of cars charging)	2

1.6 Use case conditions

Use case conditions
Assumptions
- Communication with charging stations is possible - There is enough flexibility in the amount of charging points available at the pilot site (16, to be extended with another 18)
Prerequisites
- Charging stations allow external control to the required level of detail (e.g. what load to which car)

1.7 Further information to the use case for classification / mapping

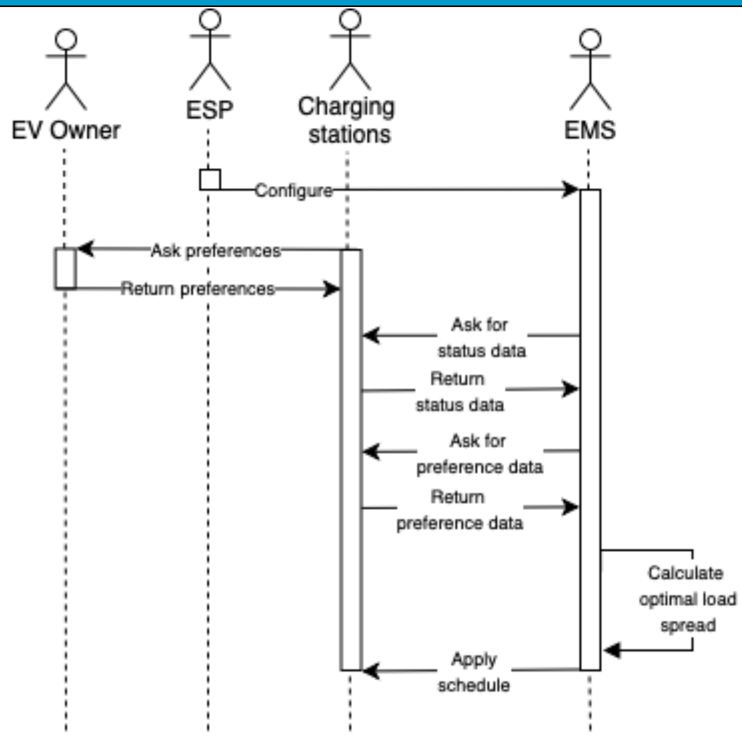
Classification information
Relation to other use cases
BUC1
Level of depth
Low level
Prioritization
High priority
Generic, regional or national relation
This use case is not directly dependent on external regional or national factors
Nature of the use case

Technical, control
Further keywords for classification
Local Energy Community, electric vehicles, EV charging forecasting

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case


3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
EV owner	Business actor	Owner of an electric vehicle that is being charged	
Energy service provider	Business actor	Energy Service Company, providing energy to local energy community citizens	DuCoop cooperative manages all energy-related assets at the pilot 1 site
Charging station	Logical actor	Charging stations	Powerdale

EMS	Logical actor	Energy management system, forward optimal control actions from model provider actor to assets	In this use case, the control algorithms developed by partners within the Bright project are taken to fall under EMS as well, although they might be provided from another platform than the one of the EMS

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario description*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
	Charging station load spread	Load of the charging stations is effectively spread out in time	EMS	Scheduled EMS run	Charging stations are online and operable	Charging station load is efficiently spread out in time, without service quality loss

4.2 Steps – Scenarios

Scenario								
Scenario name:		***No. 1 – Charging station load spread***						
Step No.	*Event*	*Name of process/ activity*	*Description of process/ activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information exchanged (IDs)*	*Requirement, R-IDs*
	Configure	configure	EMS is configured with charging station parameters	REPORT	ESP	EMS	1	1
	Ask preferences	Ask preferences	The charging station interface asks the	GET	Charging stations	EV owner	-	-

			EV owner to enter his/her preferences for the charging session					
	Return preferences	Return preferences	EV owner enters preferences for the charging sessions	REPORT	EV owner	Charging stations	2	-
	Ask for status data	Ask for status data	Ask for data describing current state of charging station(s)	GET	EMS	Charging station	-	-
	Return status data	Return status data	Provide data describing their current state	REPORT	Charging stations	EMS	3	2, 3, 4
	Ask for preference data	Ask for preference data	Ask for EV owner preference data	GET	EMS	Charging stations	-	-
	Return preference data	Return preference data	Provide data describing EV owner preferences for the ongoing charging sessions	REPORT	Charging stations	EMS	2	2, 3, 4
	Calculate optimal load spread	Calculate optimal load spread	Calculate the optimal way to spread out the current (and expected) load and avoid pekas	CREATE	EMS	EMS	-	-

	Apply schedule	Apply schedule	Apply the calculated load spread schedule	EXECUTE	EMS	Charging stations	4	5

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information ex- changed*	*Requirement, R-IDs*
1	Configuration information	Information required for the configuration of the EMS for the charging stations (e.g. number of spots)	1
2	Preferences	Preferences as defined by the EV owner (e.g. time to charge, expected number of kilometers to drive...)	-
3	Status data	Data describing the current and possibly past status of heat-related assets (heat pump, district heating, individual heat demand...)	2, 3, 4
4	Load schedule	The load schedule to be applied to the charging stations for the coming hours	5

6 Requirements

Requirements(optional)		
Categories ID	*Category name for requirements*	*Category description*
1	Configuration interface	A configuration interface is available for the EPS to configure the EMS
2	Recent data available	Recent (defined in configuration) data is available
3	Data sufficiently accurate	Data is sufficiently accurate for representing the real situation
4	Data with sufficiently high frequency	Data has a sufficiently high frequency to allow accurate calculations/control
5	Communication with asset	Communication with the relevant asset is online (I.e. data is flowing from asset to database and from EMS to asset)

7 Common terms and definitions

Common Terms and Definitions

Term	*Definition*
EMS	Energy Management System
ESP	Energy Service Provider
DSO	Distribution System Operator
TSO	Transmission System Operator

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.4 LLUC2_1

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_2_1		Virtual Community Decentralized flexibility orchestration for implicit and explicit DR.

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
v0.1	17.02.2021	Andrej Simončič, Špela Lunar	First draft	
v0.2	16.3.2021	Andrej Čampa, Andrej Simončič, Špela Lunar, Denis Sodin	Sequence diagram, scenarios, steps, information exchanged, requirements	
v0.3	25.3.2021	Andrej Čampa	KPIs, review	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	Integrating and orchestrating of virtualized behind-the-meter assets by means of decentralized consensus scheme operating on top of a P2P energy marketplace.
Objective(s)	1. Supporting of data analytics services in demand/supply forecasting, assets fingerprinting, and flexibility potential estimation. 2. Social incentive design for optimal consumer engagement in explicit and implicit DR. 3. Demonstration and validation of decentralized VPP for flexibility aggregation from VEC. 4. Utilization of B-EMHC infrastructure for services dispatch and remuneration.
Related business case(s)	BUC_2 Virtual Community Decentralized Aggregation and non-energy smart home AAL & safety services

1.4 Narrative of Use Case

Narrative of use case
Short description
This use case aims to offer flexibility services on the P2P energy marketplace. The virtual behind-the-meter asset will be utilized in providing the decentralized consensus schemes. The Virtual Energy Community will

be created to demonstrate decentralized and participatory orchestration of flexibility for implicit and explicit DR programs.
Complete description
The shift towards a decentralized, distributed electric grid and requirements to lower carbon emission affects the electrical grid by introducing new decentralized energy resources and new, more efficient loads, especially HVAC and EV. The power quality issue is not anymore the parameter of one variable, but it is becoming a multidimensional problem. The new decentralized flexibility orchestration plays a crucial role in addressing issues mainly related to excess decentralized production and congestion on the LV grid. Since the new loads are daily introduced to the LV grid creating a reliable, long-lived solution is a must. The use case will: 1. Disaggregate loads. By using the nonintrusive load monitoring method (NILM), the asset behind-the-meter will be determined. The NILM will label the loads and care for the detection of future loads. 2. A decentralized consensus scheme will be used for the orchestration of the virtualized behind the meter asset. 3. Explicit and implicit DR programs. The implicit (price-based) programs and explicit (incentive-based) programs will be upgraded with social incentives for optimal consumer and citizen engagement. 4. A virtual power plant (VPP) will be created from the VEC to create and trade the aggregated flexibility. 5. The flexibility will be offered on the P2P energy marketplace based on blockchain technology.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Number of controllable loads	Number of controllable devices	1, 2
2	Number of accepted schedules	Number of the schedules that the citizen accepted	3
3	Amount of provided flexibility	Calculate the amount of provided aggregated flexibility	4, 5

1.6 Use case conditions

Use case conditions
Assumptions
The possibility to gather the data from assets fingerprinting.
Cooperation among pilot partners on specific tasks.
Prerequisites

Availability of the B-EMHC.
Consensus for using personal and/or sensitive data needs to be signed by all participants.
Permission to operate with assets needs to be signed.

1.7 Further information to the use case for classification / mapping

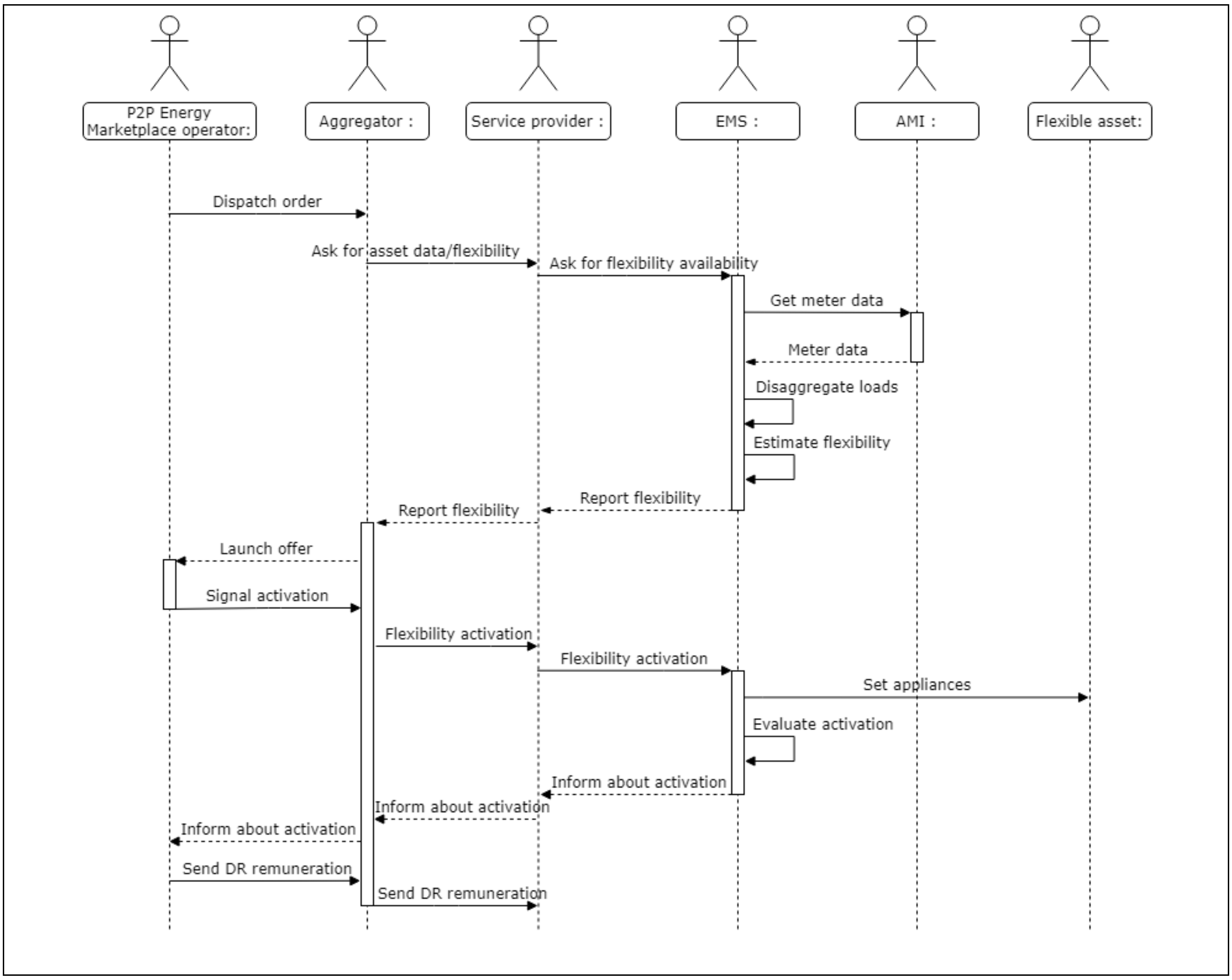
Classification information
Relation to other use cases
• BUC2: Virtual Energy Community (VEC) • LLUC_2_2: Building Optimal Flexibility Management trade-off with Comfort Management • LLUC_2_3: Analytics and automation supported aggregation of behind-the-meter assets.
Level of depth
Low level
Prioritization
Mandatory
Generic, regional or national relation
Generic
Nature of the use case
Low level use case
Further keywords for classification
DR, VPP, VEC, B-DLT, B-EMHC, AAL, P2P

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Aggregator	Role	Aggregates and manages flexible assets	
AMI	System	Automatic metering infrastructure	
EMS	System	Energy management system	
Flexible asset	Device	Controlled device	e.g. HVAC, boiler, EV, …
P2P energy marketplace operator	Role	The operator of the P2P energy marketplace	
Service provider	Role	Provides the data that can be shared for developing services	Creates DR based services

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
1	Flexibility potential estimation	Flexibility potential estimation of DR	Aggregator	Estimation of flexibility	Aggregation of assets	A flexibility estimation is calculated.

4.2 Steps – Scenarios

Scenario								
Scenario name:		**No. 1 - Flexibility potential estimation**						
Step No.	*Event*	*Name of process/ acivity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Dispatch order	Dispatch order	P2P energy marketplace operator dispatches order to aggregator	CREATE	P2P energy marketplace operator	Aggregator		2-data
2	Ask for asset data/flexibility	Ask for asset data/flexibility	Aggregator ask service provider for asset data	GET	Aggregator	Service provider		
3	Ask for flexibility availability	Ask for flexibility availability	Service provider ask EMS for flexibility availability	GET	Service provider	EMS		
4	Get meter data	Get meter data	EMS request meter data from AMI	GET	EMS	AMI		1-config
5	Meter data	Meter data	AMI reports meter data	REPORT	AMI	EMS	LLID-1	1-data

6	Disaggregate load	Disaggregate load	EMS calculates disaggregated loads	EXECUTE	EMS	EMS	LLID-2	
7	Estimate flexibility	Estimate flexibility	EMS estimates flexibility potential	EXECUTE	EMS	EMS		1-data
8	Report flexibility	Report flexibility	EMS reports flexibility to service provider	REPORT	EMS	Service provider	LLID-3	1-data
9	Report flexibility	Report flexibility	Service provider reports flexibility to Aggregator	REPORT	Service provider	Aggregator	LLID-3	1-data
10	Launch offer	Launch offer	Aggregator launches the offer to P2P energy marketplace operator	CREATE	Aggregator	P2P energy marketplace operator		
11	Signal activation	Signal activation	P2P energy marketplace operator sends signal to aggregator	EXECUTE	P2P energy marketplace operator	Aggregator		1-config
12	Flexibility activation	Flexibility activation	Aggregator activates the flexibility to service provider	EXECUTE	Aggregator	Service provider		1-data
13	Flexibility activation	Flexibility activation	Service provider activates the flexibility to EMS	EXECUTE	Service provider	EMS		1-data
14	Set appliance	Set appliance	EMS sets appliance state	CHANGE	EMS		LLID-4	2-data
15	Evaluate activation	Evaluate activation	EMS evaluates activation of appliance	EXECUTE	EMS	EMS		
16	Inform about activation	Inform about activation	EMS informs service provider about activation of appliance	REPORT	EMS	Service provider	LLID-5	

17	Inform about activation	Inform about activation	Service provider informs aggregator about activation of appliance	REPORT	Service provider	Aggregator	LLID-5	
18	Inform about activation	Inform about activation	Aggregator informs P2P energy marketplace operator about activation of appliance	REPORT	Aggregator	P2P energy marketplace operator	LLID-5	
19	Send DR remuneration	Send DR remuneration	P2P energy marketplace operator sends DR remuneration to aggregator	REPORT	P2P energy marketplace operator	Aggregator	LLID-6	
20	Send DR remuneration	Send DR remuneration	Aggregator sends DR remuneration to service provider	REPORT	Aggregator	Service provider	LLID-6	

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of infor- mation*	*Description of information ex- changed*	*Requirement, R-IDs*
LLID-1	Meter data	Power, time, direction	
LLID-2	Disaggregated loads	time, label, event characteristics	
LLID-3	Flexibility report	Forecast of flexibility: time, power, direction	
LLID-4	Set appliances	List of appliances to be changed, profiles	
LLID-5	Information about activation	Sending the information about the activation of the appliance	
LLID-6	DR remuneration	Remuneration information of DR event	

6 Requirements

Requirements(optional)

Categories ID	*Category name for require-ments*	*Category description*
config	Configuration	Reflect the typical, probable, or envisioned communication configurations that are relevant to the use case step. The mentioned configuration issues
R-ID	*Requirement name*	*Requirement description*
1-config	Communication access:	

Requirements(optional)		
Categories ID	*Category name for require-ments*	*Category description*
Data	Data Management	Covers both the management of the data exchanges in each Use Case step and if management of data is impacted by data exchanges.
R-ID	*Requirement name*	*Requirement description*
1-data	Data format requirements: Flexibility	
2-data	Has right to process the data	Consent given by citizen to use a EMS controller

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*
ALL	Ambient Assisted Living
AMI	Advance Metering Infrastructure
B-DLT	BRIGHT Distributed Ledger Technology
B-EMHC	BRIGHT Edge Monitoring and Home Automation
DR	Demand Response
EMS	Energy Management System
P2P	Peer-to-Peer
VEC	Virtual Energy Community
VPP	Virtual Power Plant

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.5 LLUC2_2

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_2_2		Building Optimal Flexibility Management traded off with Comfort Management

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
v0.1	17.02.2021	Andrej Simončič, Špela Lunar	First draft	
v0.2	16.3.2021	Andrej Čampa, Andrej Simončič, Špela Lunar, Denis Sodin	review	
v0.3	25.3.2021	Andrej Čampa	KPIs, review	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	The scope of this low-level use case is finding the optimal way to engage the consumer or citizen in flexibility programs. Consumer/citizen's main drawback to participating in the programs is they are usually not willing to give up the comfort too much. We have to encourage him/her to do something for the environment as well as for the community.
Objective(s)	1. To define the word "comfort" of participants 2. To determine maneuver area of controlled assets
Related business case(s)	BUC_2 Virtual Community Decentralized Aggregation and non-energy smart home AAL & safety services

1.4 Narrative of Use Case

Narrative of use case
Short description

Based on the B-DT modelling of preferences within citizens, care management will be demonstrated, where citizen's comfort management will be traded off and considered. The definition of how to engage the consumers without the inclusion of monetary motivation and finding the balance between comfort and environmental benefits will be clarified during the analytics.
Complete description
This use case will be focused on the modelling of energy consumption and creating the B-DT of citizens/consumer or prosumer and community. This data drive model of citizen or community (retirement house community) behaviour will be exploited to determine the limits of citizens' comfort zone that will still get them on-board for participating in DR programs. With citizen getting on-board, the B-DT of the citizen will be combined with incentives to determine optimal control of flexible devices (e.g. HVAC or white goods) together with decentralized PV generation.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Number of controllable loads	Number of controllable devices	2
2	Number of accepted schedules	Number of the schedules that the citizen accepted	1

1.6 Use case conditions

Use case conditions
Assumptions
Cooperation among pilot partners on specific tasks.
Prerequisites
Consensus for using personal and/or sensitive data needs to be signed by all participants.
Permission to operate with assets needs to be signed.

1.7 Further information to the use case for classification / mapping

Classification information
Relation to other use cases
• BUC2: Virtual Energy Community (VEC) • LLUC_2_1: Virtual Community Decentralized flexibility orchestration for implicit and explicit DR • LLUC_2_3: Analytics and automation supported aggregation of behind-the-meter assets.

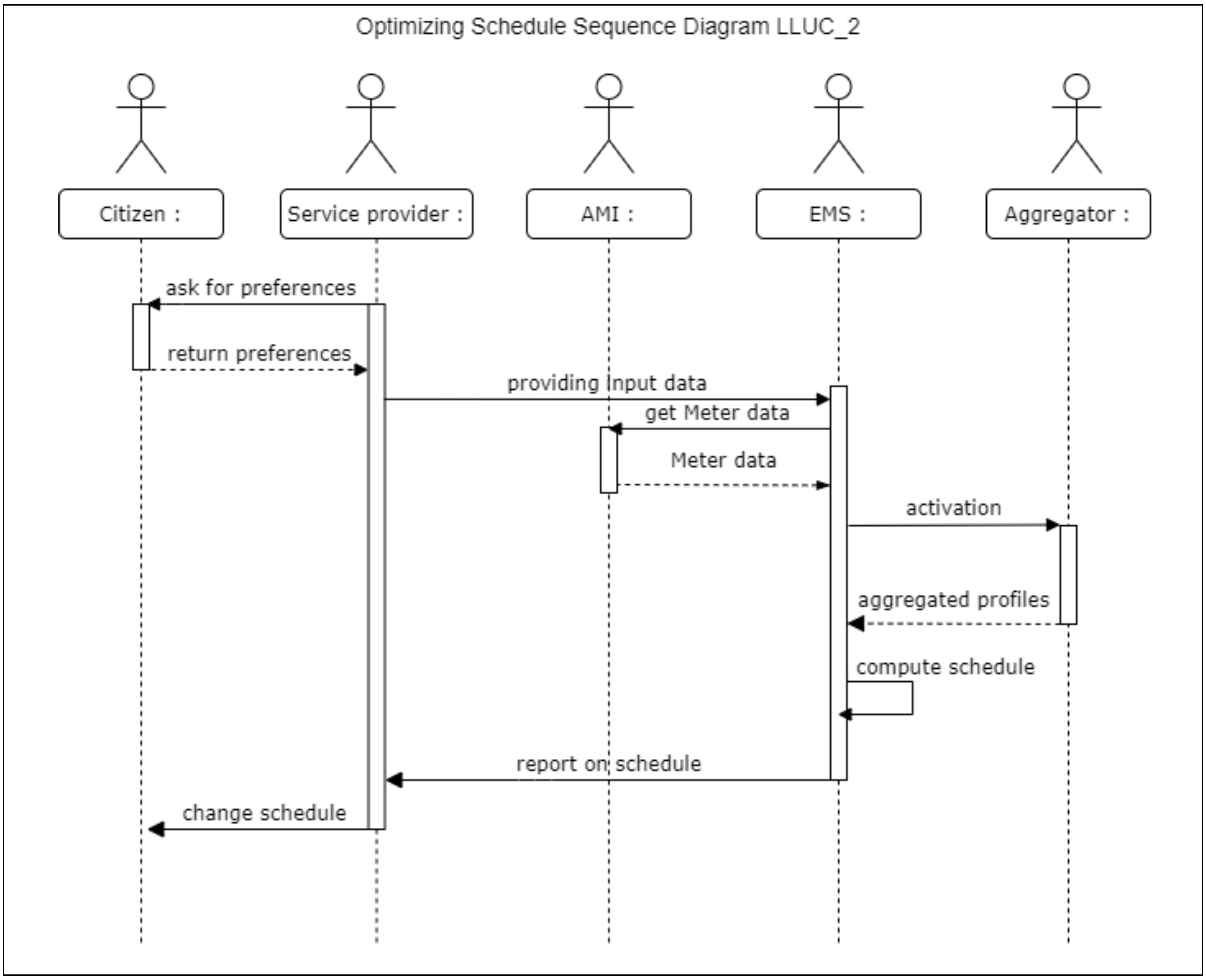
Level of depth
Low level
Prioritization
Mandatory
Generic, regional or national relation
Generic
Nature of the use case
Low level use case
Further keywords for classification
DR, VPP, VEC, B-DLT, B-EMHC, AAL, P2P

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Aggregator	Role	Aggregates and manages flexible assets	
AMI	System	Automatic metering infrastructure	
Citizen	Person	Residents of the home for the elderly	Indirectly involved in the programs
EMS	System	Energy management system	
Service provider	Role	Entity that creates and offers new services	Creates DR based services

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
1	Optimized schedule	Optimized schedule for citizens in home for elderly	EMS	Data gathering	All data is available	Analytic data is ready for Marketplace and optimized schedule

4.2 Steps – Scenarios

Scenario								
Scenario name:		***No. 1 - Optimized schedule***						
Ste p No.	*Event*	*Name of process/ acivity*	*Description of process/activit y*	*Service*	*Informati on producer (actor)*	*Informa tion receiver (actor)*	*Informat ion ex-changed (IDs)*	*Requireme nt, R-IDs*
1	Ask for preferen ces	Ask for prefere nces	Service provider ask for personal preferences of the citizen	GET	Service provider	Citizen		Cit-1
2	Return	Return	Citizen provide the personal preferences to the service provider	REPORT	Citizen	Service provider	LLID-1	
3	Providin g input data	Providin g input data	Service provider provides data to AMI	REPORT	Service provider	EMS	LLID-1	
4	Get meter data	Get meter data	EMS sends data to AMI	GET	EMS	AMI		
5	Meterin g data from assets	Meterin g data	AMI sends data to EMS from metering assets	REPORT	AMI	EMS	LLID-2	
6	Activatio n	Activati on	EMS activates Aggregator	SET	EMS	Aggrega tor		

7	Returned aggregated profiles	Aggregated profiles	Aggregator returns aggregated profiles back to EMS	REPORT	Aggregator	EMS	LLID-3	
8	Creating schedule	Compute schedule	EMS creates optimized schedules	EXECUTE	EMS	EMS		
9	Reporting schedule to Service provider	Report on schedule	EMS sends optimized schedules to Service provider	REPORT	EMS	Service provider	LLID-4	
10	Reporting the changed schedules	Changed schedules	Service provider inform citizen with changed schedule	REPORT	Service provider	Citizen	LLID-4	

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information ex- changed*	*Requirement, R-IDs*
LLID-1	User preferences	Citizens(user) provides personal preferences (temperature…)	
LLID-2	Meter data	Power, time and type of assets	
LLID-3	Consumption (aggregated profile)	Flexibility profiles	
LLID-5	Schedule	Optimized schedule of citizen's daily activity according to EMS results	

6 Requirements

Requirements(optional)		
Categories ID	*Category name for requirements*	*Category description*
Cit-1	Citizen	Anonymization, Signed consent

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*

AAL	Ambient assisted living
AMI	Automatic metering infrastructure
B-DT	BRIGHT Digital twins
DR	Demand response
EMS	Energy Management System
VEC	Virtual energy community

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.6 LLUC2_3

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_2_3		Analytics and automation supported aggregation of behind-the-meter assets.

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
v0.1	17.02.2021	Andrej Simončič, Špela Lunar	First draft	
v0.2	16.03.2021	Andrej Čampa, Andrej Simončič, Špela Lunar, Denis Sodin	review	
v0.3	25.3.2021	Andrej Čampa	KPIs, review	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	The aim of this use case is to support the ambition of BRIGHT to realize a multi-time scale DR ecosystem. The challenge of providing a hierarchical control architecture that tightly integrates heterogeneous assets and systems will be addressed.
Objective(s)	3. Analysis of time-series measurement data using historical usage patterns and other contextual signals (weather) 4. Providing a hierarchical control architecture of assets and system 5. Obtaining information on the behavior of various types of devices based on aggregate measurements
Related business case(s)	BUC_2 Virtual Community Decentralized Aggregation and non-energy smart home AAL & safety services

1.4 Narrative of Use Case

Narrative of use case
Short description
During the project, we will deal with complex multimodal data, such as analysing time-series measurement data in conjunction with historical usage patterns and other contextual signals. The data

analytics engine must therefore enable efficient complex queries of large data, and the reports emerging from the queries should support the operation infrastructure, respond to market signals and aid the maximization of stakeholders' yield.
Complete description
The aim of the use case is to create novel advanced analytics and automation solutions. With the decentralization of the grid, distributed renewable resources, and emerging new loads, providing stable and quality power to the end user is becoming a bigger and bigger issue. Furthermore, the role of the end-user is becoming increasingly important for providing more efficient management of the LV grid. To address the challenges, we will apply a non-intrusive load monitoring method on the measured data to determine the fingerprint of the flexible asset at each individual location. The local EMS system will be able to evaluate holistic flexible potential. Fingerprinting represents the first step in realizing DR orchestration, which will allow us to realize higher service and efficiency levels on a system level. The goal is to obtain the information on the behaviour of an individual type of devices based on aggregate measurements needs, deduce from those the customized aggregates and feed triggers of the analytic system to rules engines and schedulers. Non-energy services for personal safety and AAL will be demonstrated and validated on the electricity fingerprinting based models. During the project, we will also develop citizens behaviour profiling in order to develop behavioural monitoring services, which will detect abnormal behavioural patterns as inferred by abnormal electricity fingerprinting.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Number of controllable loads	Number of controllable devices	1, 2, 3
2	Number of characterized profiles	Number of characterized profiles of controllable devices	1, 3

1.6 Use case conditions

Use case conditions
Assumptions
Cooperation among pilot partners on specific tasks.
Prerequisites
Consensus for using personal and/or sensitive data needs to be signed by all participants.
Permission to operate with assets needs to be signed.

1.7 Further information to the use case for classification / mapping

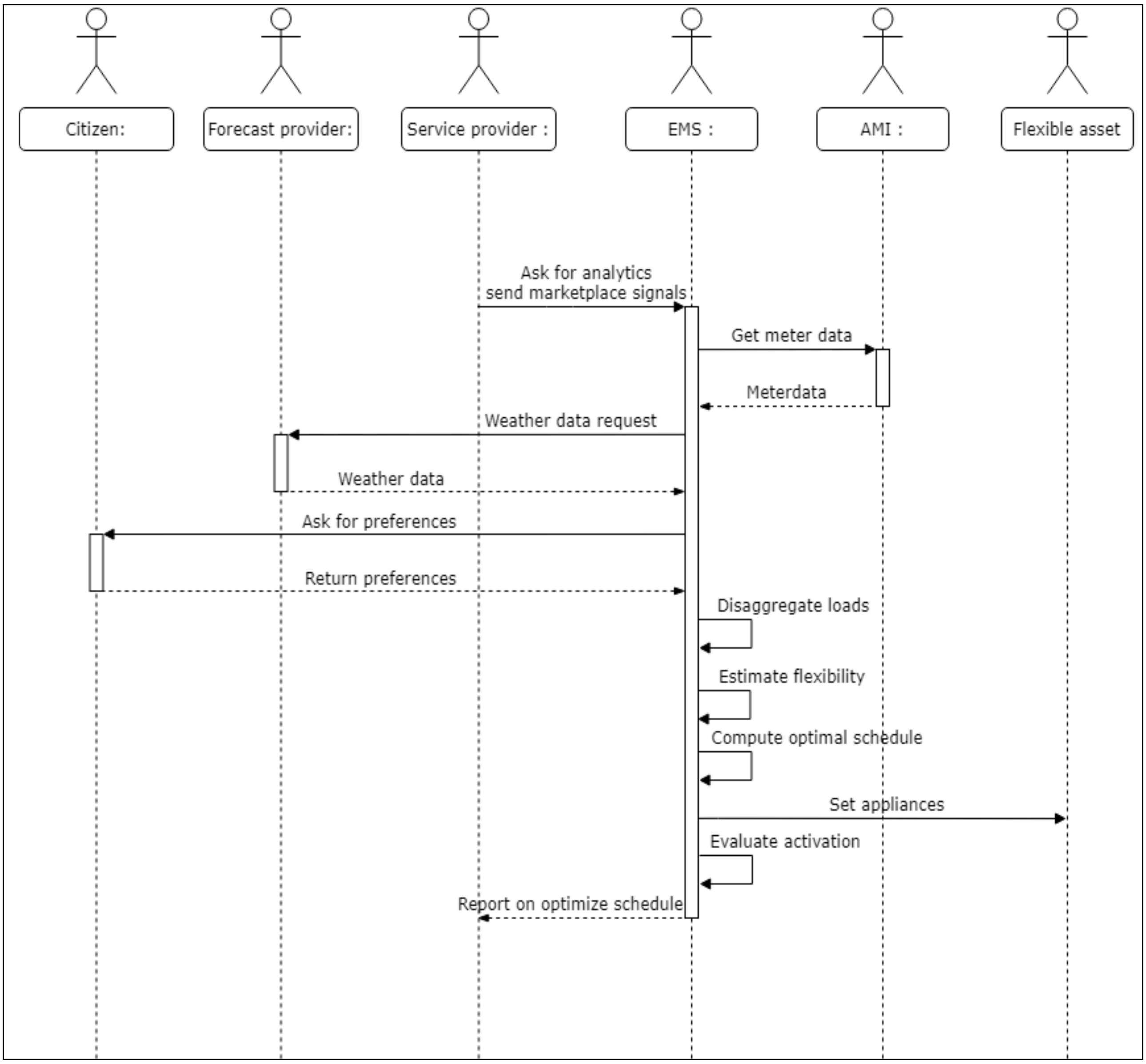
Classification information
Relation to other use cases
• BUC2: Virtual Energy Community (VEC) • LLUC_2_1: Virtual Community Decentralized flexibility orchestration for implicit and explicit DR • LLUC_2_2: Building Optimal Flexibility Management traded off with Comfort Management.
Level of depth
Low level
Prioritization
Mandatory
Generic, regional or national relation
Generic
Nature of the use case
Low level use case
Further keywords for classification
DR, VPP, VEC, B-DLT, B-EMHC, AAL, P2P

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
AMI	System	Automatic metering infrastructure	
Citizen	Person	Residents of the home of the elderly	
EMS	System	Energy management system	
Flexible asset	System	Devices actively involved in DR schemes	
Forecast provider	Role	Entity that provides weather-forecast related data	

Service provider	Role	Entity that creates and offers new services	Creates DR based services

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
1	Fingerprinting of consumer behaviour	Analytics and automation supported aggregation of behind the meter assets	EMS	Data gathering	All the data is available	Fingerprint of various assets

4.2 Steps – Scenarios

Scenario								
Scenario name:	*No. 1 – Fingerprinting of consumer behaviour*							
Step No.	*Event*	*Name of process/ acivity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Ask for analytics/ send marketplace signals	Ask for analytics/ send marketplace signals	Service provider asks EMS for analytics availability	GET	Service provider	EMS		
2	Get meter data	Get meter data	EMS requests meter data from AMI	GET	EMS	AMI		
3	Meter data	Meter data	AMI reports meter data to EMS	REPORT	AMI	EMS	LLID-1	

4	Weather data request	Weather data request	EMS requests weather data from forecast provider	GET	EMS	Forecast provider		
5	Weather data	Weather data	Forecast provider reports weather data	REPORT	Forecast provider	EMS	LLID-2	
6	Ask for preferences	Ask for preferences	EMS ask for personal preferences of the citizen	GET	EMS	Citizen		
7	Return preferences	Return preferences	Citizen provides the personal preferences to the EMS	REPORT	Citizen	EMS	LLID-3	
8	Disaggregate loads	Disaggregate loads	EMS calculates disaggregated loads	EXECUTE	EMS	EMS		
9	Estimate flexibility	Estimate flexibility	EMS estimates flexibility potential	EXECUTE	EMS	EMS		
10	Compute optimal schedule	Compute optimal schedule	EMS determines optimal schedule	EXECUTE	EMS	EMS		
11	Set appliances	Set appliances	EMS sends optimized schedule to flexible assets	CHANGE	EMS	Flexible asset		
12	Evaluate activation	Evaluate activation	EMS evaluates performance of optimized schedule activation	EXECUTE	EMS	EMS		
13	Report on optimize schedule	Report on optimize schedule	EMS reports on performance of optimized schedule to	REPORT	EMS	Service provider	LLID-4	

			service provider					

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information ex-changed*	*Requirement, R-IDs*
LLID-1	Meter data of assets	Power, operating time and type of assets	
LLID-2	Weather forecast	Forecast of weather	
LLID-3	User preferences	Citizen's personal preference about the temperature, operating time of an asset etc.	
LLID-4	Optimized schedule report	Report on optimized schedule performance	

6 Requirements

Requirements(optional)		
Categories ID	*Category name for require- ments*	*Category description*

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*
AAL	Ambient assisted living
AMI	Automatic metering infrastructure
DR	Demand response
EMS	Energy management system
VEC	Virtual energy community

8 Custom information (optional)

Custom information (optional)

Key	*Value*	*Refers to section*

9.7 LLUC3_1

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_3_1		Building-level LEC Semi-decentralized VPP for flexibility multi-value stacking services

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V1	25/02/2021	Federico Carere	Initial draft	
V2	14/04/2021	Federico Carere	Final draft	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	The pilot scope is to demonstrate how small-scale demand and flexibility may be leveraged and optimized within a multi-market scenario, combining a wholesale market and a local market.
Objective(s)	• Implementation of a wholesale and local market to exploit flexibility from the assets. • Validation of semi-decentralized VPP community-level aggregation flexibility trading. • Implementation of a smart contract-based near real time verification and settlement
Related business case(s)	BUC3

1.4 Narrative of Use Case

Narrative of use case
Short description
The use case involves a multi-apartments residential building, equipped with IoT smart meters and capable of providing flexibility for the DSO requests. Community members will be provided by a dedicated apps for allowing them to take full control of the flexibility of their assets and being notified with the performed action in case of automated control action. The community members are characterized by very different

personal and social conditions, such as age, gender, income, education level, employment status. They can be considered as a local energy community with traditional home loads.
Complete description
The residential community consisted of a multi-apartments residential building with 50 consumers equipped with IoT smart meters, characterized by flexible and controllable home loads. The flexibility exploitation from the community may be leveraged and optimized within a multi-market scenario, which combines a wholesale market where BRP procures flexibility in near real time with a local market where DSO procure flexibility for local congestion management in advance. The combination of top-down initial B-DT-based clustering of suitable flexible assets with P2P B-DLT and smart contract-based negotiation within such cluster will allow the trading feasibility.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
KPI_1	Increase amount of flexibility (MWh) transacted in the energy market	Percentage of energy exchanged to exploit flexibility services.	Implementation of a wholesale and local market to exploit flexibility from the assets.
KPI_2	Improved accessibility to energy services	Percentage of energy services exploitation after BRIGHT solutions implementation.	Implementation of a smart contract-based near real time verification and settlement.
KPI_3	Energy savings	The difference between measured and reference consumption data, evaluated within a predefined period of time.	Validation of semi-decentralized VPP community-level aggregation flexibility trading.
KPI_4	Consumers energy-efficient behavior increase	Variation on consumers consumption before and after the pilot implementation.	Validation of semi-decentralized VPP community-level aggregation flexibility trading.

1.6 Use case conditions

Use case conditions
Assumptions
The community presents consumption patterns which can be described as Residential all-day, Residential evening or Smart houses. In addition, the regulatory framework should be taken into account as external condition; in particular, it is worth mentioning that in Italy Demand Response programs are very limited and they are not accessible by most of the customers; moreover, they are only managed by the Transmission System Operator, which acts at National level. This also implies that the majority of the customers have not experience with DR programs and they are not aware about energy prices hourly based.

Prerequisites
• A Web Application is crucial for engaging users • IoT Smart Meters are fundamental to allow the DR campaign. • Interaction with the organizer of resident's meetings.

1.7 Further information to the use case for classification / mapping

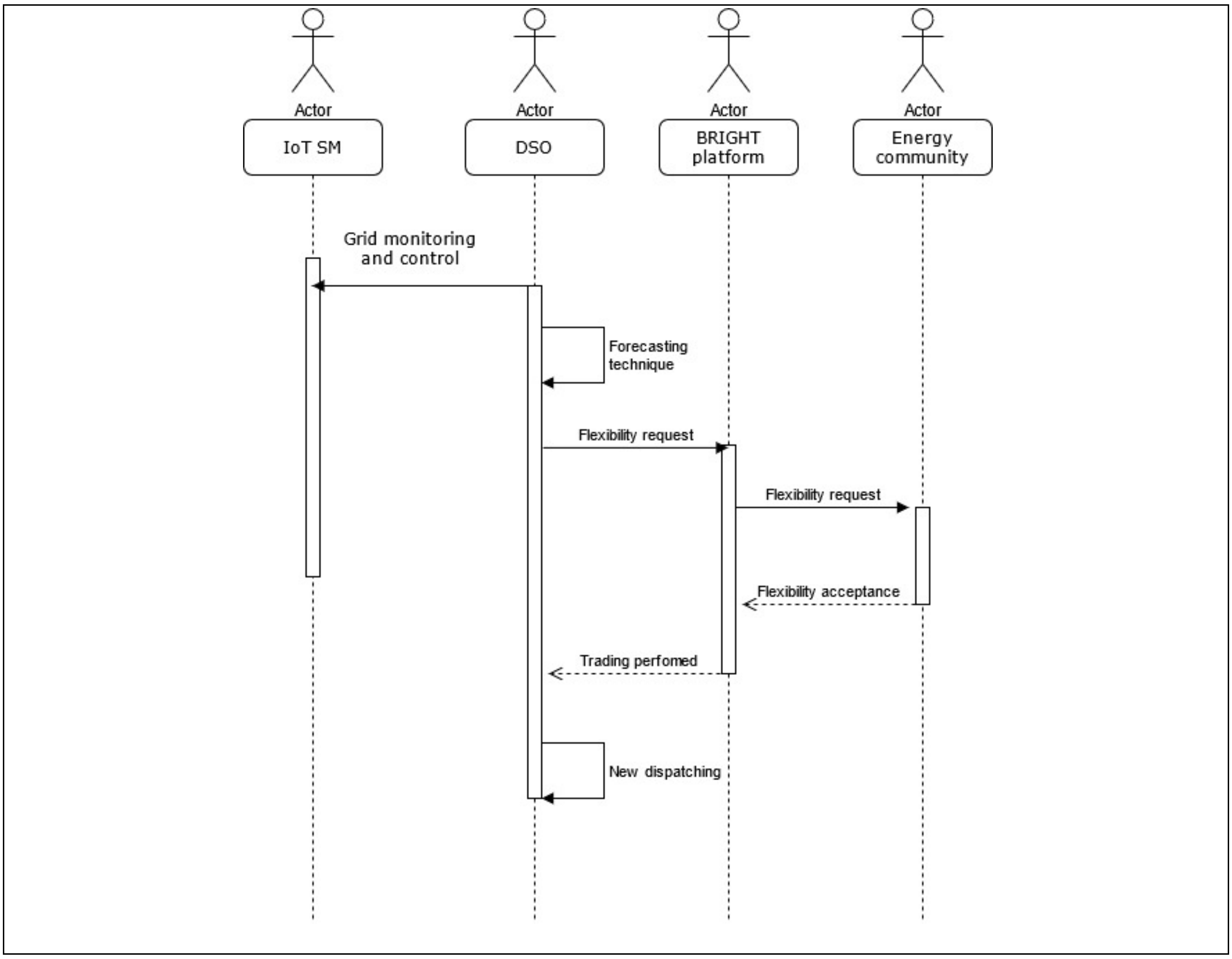
Classification information
Relation to other use cases
All LLUCs envisioned for Pilot 3
Level of depth
Low level
Prioritization
Mandatory
Generic, regional or national relation
City
Nature of the use case
Technical/Social
Further keywords for classification
DR, DSO, VPP, BRP, B-DT, B-DLT, B-FLEX, P2P

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Distribution System Operator	Company	Owner and manager of the Distribution Network Responsible for engaging the users.	
Energy community	Person	Energy community to be engaged by DSO and to be involved in DR campaigns.	

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
	Request of flexibility	The DSO requires a variation of consumption from a member of the community in order to face grid congestion.	DSO	Grid congestion	A local congestion is forecasted.	The DR request allows to face the congestion.

4.2 Steps – Scenarios

Scenario								
Scenario name:		***No. 1 - Request of flexibility***						
Step No.	*Event*	*Name of process/ activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Data collection from the grid	Grid monitoring and control	The distribution network is constantly monitored.	GET	DSO	IoT SM	LLUC3_DATA_1	
2	Congestion forecasted	Forecasting technique	Voltage and current limits violation individuation.	EXECUTE	DSO	DSO		
3	Flexibility need	Flexibility request	The DSO makes a request of flexibility through the BRIGHT platform.	CREATE	DSO	BRIGHT platform	LLUC3_DATA_2	
4	Flexibility need	Flexibility request	The Energy community receives a request of	CHANGE	BRIGHT platform	Energy Community		

			flexibility through the BRIGHT platform.					
5	Decision making	Flexibility acceptance	The Energy Community accepts the flexibility request through the BRIGHT platform.	CHANGE	Energy Community	BRIGHT platform		
6	Economic transaction	Trading performed	The flexibility request is accepted and the trading is finalized.	EXECUTE	BRIGHT platform	DSO	LLUC3_DATA_3	
7	Flexibility exploitation	New dispatching	DSO modifies the DR campaign.	CHANGE	DSO	DSO		

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
LLUC3_DATA_1	Grid data	Data related to the grid congestions.	
LLUC3_DATA_2	Consumers data	Data related to the power and energy consumptions of the energy community.	
LLUC3_DATA_3	BRIGHT platform data	Data related to the flexibility trading.	

6 Requirements

Requirements(optional)		
Categories ID	*Category name for requirements*	*Category description*

7 Common terms and definitions

Common Terms and Definitions

Term	*Definition*
DSO	Distribution System Operator
VPP	Virtual Power Plant
DR	Demand-Response
EC	Energy Community
P2P	Peer-to-Peer
LEC	Local Energy Communities
B-DLT	BRIGHT- Distributed Ledger Technology
BRP	Balancing Responsible Partners
B-DT	BRIGHT-Digital Twin

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.8 LLUC3_2

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_3_2		LEC decentralized VPP Marketplace for Flexibility Trading for Local MV/LV Network Congestion Management

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V1	25/02/2021	Federico Carere	Initial draft	
V2	14/04/2021	Federico Carere	Final draft	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	The Use Case scope is to demonstrate the feasibility of decentralized VPP Marketplace for Flexibility Trading as a solution for Local MV/LV Network congestions.
Objective(s)	• Implementation of P2P B-DLT and smart contract-based negotiation for flexibility trading along heterogeneous customers • Validation decentralized VPP community-level aggregation • Validation of local flexibility trading
Related business case(s)	BUC3

1.4 Narrative of Use Case

Narrative of use case
Short description
The Use Case is implemented at ASM headquarter district, characterized by heterogenous energy units. The headquarter loads patterns are typical of a company building and the main consumers are the employees. The district flexibility will be fundamental to avoid congestions in electrical near districts. Therefore a hybrid community will be created.
Complete description

High shares of intermittent RES in the ASM headquarters area and the need for reducing the reverse power flow are the most relevant aspects to be considered for the local congestion management. The Use Case energy units are the following;

- industrial customers
- Commercial customers
- residential customers
- decentralized RES generation
- second life batteries

About 20 consumers will be engaged in this Use Case.
DSO will be undertaking the role of the aggregator within a multiple flexibility providers and the flexibility marketplace will be operated from intraday to near real time mode.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
KPI_1	Increase amount of flexibility (MWh) transacted in the energy market	Percentage of energy exchanged to exploit flexibility services.	Implementation of P2P B-DLT and smart contract-based negotiation for flexibility trading along heterogeneous customers
KPI_2	Number of consumers engaged in DR across Europe	Number of end users engaged for pilot participation and for user research public awareness campaigns.	Validation decentralized VPP community-level aggregation
KPI_3	Type of consumers engaged in DR across EU	Number of different consumer types engaged.	Validation of local flexibility trading
KPI_4	Improved accessibility to energy services	Percentage of energy services exploitation after BRIGHT solutions implementation.	Validation decentralized VPP community-level aggregation

1.6 Use case conditions

Use case conditions
Assumptions
With respect to the socio-economic condition, the Italian Pilot will engage a heterogenous set of customers who have different goals as well as various levers for participating and being engaged in the demonstration activities. With respect to consumption patterns, some groups can be identified by means a proper analysis (e.g., Residential all-day, Residential evening, Smart houses, industrial customers).In addition, the regulatory framework should be taken into account as external condition; in particular, it is worth mentioning that in Italy Demand Response programs are very limited and they are not accessible by most of the customers; moreover, they are only managed by the Transmission System Operator, which acts at

National level. This also implies that the majority of the customers have not experience with DR programs and they are not aware about energy prices hourly based.
Prerequisites
• A Web Application is crucial for engaging users • User has to be equipped with an IoT smart meter • Users have to be involved by means of proper meetings

1.7 Further information to the use case for classification / mapping

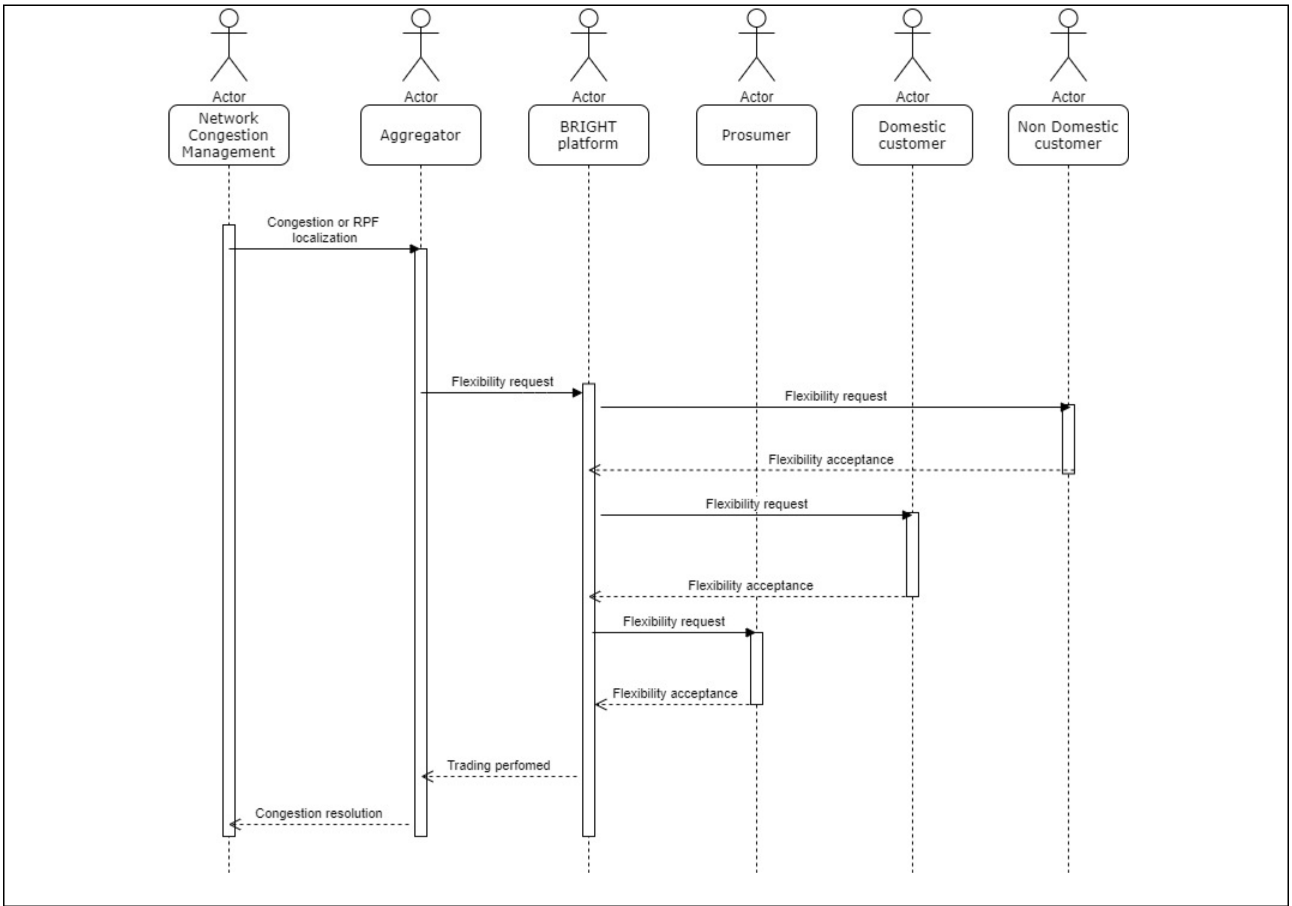
Classification information
Relation to other use cases
All LLUCs envisioned for Pilot 3
Level of depth
Low level
Prioritization
Mandatory
Generic, regional or national relation
District
Nature of the use case
Technical/Social
Further keywords for classification
DR, VPP, RES, B-DT, B-DLT, B-FLEX, P2P

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Distribution System Operator	Company	Owner and manager of the Distribution Network Responsible for engaging the users.	
Prosumer	Person or Company	User of the electrical network able to self-produce energy	
Domestic Consumer	Person	Domestic user to be engaged by DSO and to be involved in DR campaigns.	
Not Domestic Consumer	Person or Company	In comparison with domestic user, this actor can have a wide range of flexibility to be offered. In addition, the main contact point is an Energy Manager which could be aware about the general topics of the project.	

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
1	Congestion management	At MV/LV level, a congestion is forecasted and flexibility from heterogenous customers can solve the grid issue.	DSO	Congestion revelation.	Congestion at MV/LV level and available flexibility from members of hybrid community.	The congestion is removed through the flexibility exploitation.

4.2 Steps – Scenarios

Scenario								
Scenario name:		**No. 1 – Congestion management**						
Step No.	*Event*	*Name of process/ activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Congestion forecasted	Congestion or RPF localization	Through the forecasting technique, a congestion at MV/LV level is detected.	GET	Network Congestion Management	Aggregator	LLUC3_DATA_1	
2	Flexibility need	Flexibility request	The BRIGHT platform allows to make the flexibility request from the	CREATE	Aggregator	BRIGHT platform	LLUC3_DATA_2	

			DSO to the hybrid energy community .					
3	Flexibility availability	Flexibilit y request	The Aggregator makes a request of flexibility to the Non Domestic Customer through the platform.	CREAT E	BRIGHT platform	Non Domestic Customer		
4	Flexibility campaign participatio n	Flexibilit y accepta nce	The Non Domestic Customer accepts the request of flexibility.	CHAN GE	Non Domestic Custome r	BRIGHT platform		
5	Flexibility availability	Flexibilit y request	The Aggregator makes a request of flexibility to the Domestic Customer through the platform.	CREAT E	BRIGHT platform	Domestic Customer		
6	Flexibility campaign participatio n	Flexibilit y accepta nce	The Domestic Customer accepts the request of flexibility.	CHAN GE	Domestic Custome r	BRIGHT platform		
7	Flexibility availability	Flexibilit y request	The Aggregator makes a request of flexibility to the Prosumer through the platform.	CREAT E	BRIGHT platform	Prosumer		
8	Flexibility campaign	Flexibilit y	The Prosumer accepts the	CHAN GE	Prosume r	BRIGHT platform		

	participation	acceptance	request of flexibility.					
9	Market exploitation	Trading performed	The smart contract-based negotiation permits to carry out the flexibility exchange.	EXECUTE	BRIGHT platform	Aggregator	LLUC3_DATA_3	
10	Countermeasure execution	Congestion resolution	The congestion is solved through the flexibility exploitation.	EXECUTE	Aggregator	Network Congestion Management		

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
LLUC3_DATA_1	MV/LV data	Electrical quantities necessary to evaluate the state of the MV/LV grid.	
LLUC3_DATA_2	Hybrid community data	Data related to the power and energy of hybrid community members.	
LLUC3_DATA_3	Flexibility trading	Economic information about the flexibility negotiation.	

6 Requirements

Requirements(optional)		
Categories ID	*Category name for requirements*	*Category description*

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*

DSO	Distribution Service Operator
DR	Demand-Response
EV	Electric Vehicle
VPP	Virtual Power Plant
P2P	Peer-to-peer
RES	Renewable energy sources

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.9 LLUC3_3

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_3_3		Virtual Community Semi-Decentralized Aggregation for Optimal Flexibility Management

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V0.1	23/02/2021	Francesco Bellesini, Gianluca Tribbolati (EMOT)	Initial draft	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	To guarantee the stability and efficiency of the power grid in a high penetration condition of distributed not-programmable renewable energy plants
Objective(s)	1. IoT devices deployment for monitoring energy power flows and estimate grid conditions; 2. Aggregate city-level energy communities (CEC) for DR involvement; 3. Enabling IoT devices remote management for smart flexibility provision in order to reduce reverse power flows.
Related business case(s)	BUC3

1.4 Narrative of Use Case

Narrative of use case
Short description
DSO identifies flexibility need and through demand-response (DR) campaigns avoids power grid instability
Complete description
Electricity grid was designed when the main energy production plants were based on fossil fuel, a resource that guarantees generation programmability; these plants supplied GWh of energy and electricity grid was sized to manage these power flows which unidirectionally went from energy plants to end users. With the

advent of renewable energy plants, the paradigm has totally changed, passing from a system with very few distributed GWp programmable plants to a system with many distributed kWp not-programmable plants. This change, necessary to tackle the global warming problem, has led to the birth of a different approach to grid management, based on two main functionalities: real-time monitoring and remote management. For this reason, in recent years the electricity grid has undergone a strong digitization through the deployment of smart meters and smart devices; this made it possible to obtain increasingly precise forecasts of power grid status, which enabled the DR mechanism. DR consists in changing users energy profile by offering flexibility, i.e. rescheduling energy consumption based on the power grid forecasted needs. In LLUC3 city-level energy communities will be aggregated and involved in DR campaigns to provide flexibility according to DSO requests. Furthermore, EMOT will play the role of EV fleet manager, aggregating EV users for DR campaigns involvement.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
KPI_1	Real-Time Monitoring	Time granularity for monitoring about seconds	1
KPI_2	Big Data Collection	Interaction capability: about thousands of measurements per minute	1, 2
KPI_3	Flexibility Provision	Reduction of reverse power flows	2, 3

1.6 Use case conditions

Use case conditions
Assumptions
A virtual community of citizen end users, owners of flexible loads, battery storage or EVs, will be aggregated for flexibility purposes; the community presents consumption patterns which can be described as residential all-day, residential evening or smart houses. The virtual community goal will be reduce energy cost and increase renewable energy consumption. The regulatory framework should be taken into account as external condition; in particular, it is worth mentioning that in Italy Demand Response programs are very limited and they are not accessible by most of the customers; moreover, they are only managed by the Transmission System Operator, which acts at National level. This also implies that the majority of the residential customers have not experience with DR programs and they are not aware about energy prices hourly based. Nevertheless, EV owners are used to interfacing with a digital platform to carry out charging sessions; this should facilitate their involvement in DR campaigns.
Prerequisites
• A Web Application is crucial for engaging consumers • An e-Mobility platform is needed for engaging EV users • Consumers have to be equipped with an IoT smart meter • EV users have to be equipped with an OBD device

1.7 Further information to the use case for classification / mapping

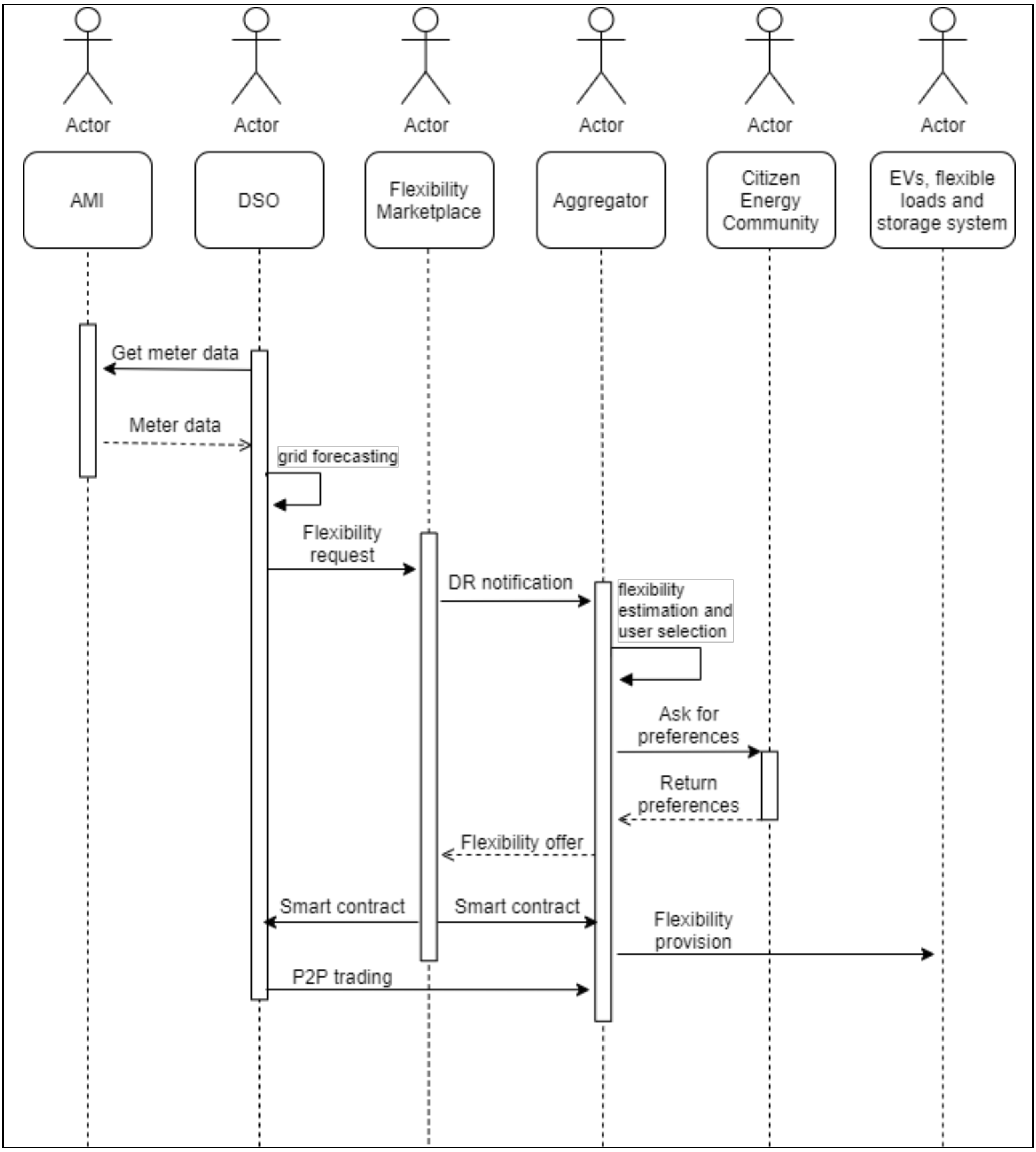
Classification information
Relation to other use cases
All LLUCs envisioned for Pilot 3
Level of depth
High level
Prioritization
Mandatory
Generic, regional or national relation
City
Nature of the use case
Technical/social
Further keywords for classification
DR, VPP, COM, B-DT, B-DLT, B-FLEX, P2P

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Advanced metering infrastructure (AMI)	System	System that measure, collect, and analyse energy usage, and communicate with metering	

		devices (smart meters) either on request or on a schedule	
Distribution system operator (DSO)	Company	Owner and manager of the energy distribution network	
Flexibility marketplace	System	Marketplace designed to enable P2P energy trading	
Aggregator	Company	Responsible for engage energy users in the city and coordinate them to act as a single entity for providing flexibility services to the DSO	
Citizen energy communities (CEC)	Person	Energy users to be involved in DR campaigns	
EVs, flexible loads and storage system	Device	Deployed devices suitable for DR campaign involvement	

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
1	Grid monitoring	DSO collects smart meter data and identifies flexibility need	DSO	Forecast will be calculated every day	Smart meter data should be constantly collected	DR campaign is planned
2	DR campaign creation	Based on forecast data, DSO creates a DR campaign	DSO	The forecast system indicates a potential reverse power flow to be mitigated	The DSO system is connected with the flexibility marketplace	A flexibility request is created in the marketplace

3	Flexibility provider nomination	Based on flexibility offers provided by aggregators to the marketplace, a flexibility provider is nominated	Aggregator CEC	Best offer wins DR campaign involvement	Aggregator system is connected with the flexibility marketplace	Smart contracts between DSO and aggregator is signed and DR campaign is ready to be executed
4	DR campaign execution	Aggregator provides flexibility to DSO	Aggregator CEC	Aggregator remotely manages its citizen energy community devices according to DR campaign needs	Citizen energy community devices are remotely controllable by aggregator	Flexibility is provided and P2P micro payments are executed

4.2 Steps - Scenarios

Scenario								
Scenario name:		***No. 1 – Grid monitoring***						
Step No.	*Event*	*Name of process/ acivity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Get meter data	Get meter data	In order to keep the energy distribution service running, DSO monitors power grid, collecting meter data	GET	DSO	AMI	LLUC3_ID-1	
2	Meter data	Meter data	AMI provides smart meter energy data	REPORT	AMI	DSO	LLUC3_ID-1	
3	Grid forecasting	Grid forecasting	DSO executes grid forecasting in order to identify flexibility needs	EXECUTE	DSO	DSO	LLUC3_ID-1, LLUC3_ID-4	

Scenario								
Scenario name:		**No. 2 – DR campaign creation**						
Step No.	*Event*	*Name of process/ acivity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Flexibility request	Flexibility request	DSO creates a flexibility request on the flexibility marketplace	CREATE	DSO	Flexibility Marketplace	LLUC3_ID-5	
2	DR notification	DR notification	Flexibility marketplace shares to subscribed aggregators notification about new DR campaign creation	CHANGE	Flexibility marketplace	Aggregator		

Scenario								
Scenario name:		**No. 3 – Flexibility Provider nomination**						
Step No.	*Event*	*Name of process/ acivity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Flexibility estimation and user selection	Flexibility estimation and user selection	Aggregator consults the monitoring and forecasting system and identifies suitable users to participate in the DR campaign	EXECUTE	Aggregator	Aggregator	LLUC3_ID-1, LLUC3_ID-2, LLUC3_ID-3, LLUC3_ID-4	
2	Ask for preferences	Ask for preferences	Aggregator contacts identified	GET	Aggregator	Citizen Energy		

			users to ask for preferences/ availability related to DR campaign involvement			Community		
3	Return preferences	Return preferences	Users provide their preferences/ availability related to DR campaign involvement	REPORT	Citizen Energy Community	Aggregator		
4	Flexibility offer	Flexibility offer	Aggregator submits its flexibility offer in the marketplace	REPORT	Aggregator	Flexibility marketplace	LLUC3_ID-6	
5	Smart contract	Smart contract	Marketplace establishes the winner of the flexibility provision based on the most advantageous offer for the DSO and the smart contract is executed between the DSO and the aggregator	EXECUTE	Flexibility marketplace	DSO, Aggregator		

Scenario								
Scenario name:	***No. 4 – DR campaign execution***							
Step No.	*Event*	*Name of process / acivity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Flexibility provision	Flexibility provision	Aggregator manages CEC IoT devices according to	EXECUTE	Aggregator	EVs, flexible loads and storage system	LLUC3_ID-1, LLUC3_ID-2	

			DR campaign needs					
2	P2P trading	P2P trading	DSO remunerates aggregator for flexibility provided	EXECUTE	DSO	Aggregator		

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information ex- changed*	*Requirement, R-IDs*
LLUC3_ID-1	Smart meter data	Smart meter ID Energy Timestamp	
LLUC3_ID-2	Charging station data	Charging Station ID Power Output Socket ID Socket Status Charging Session ID Start Time End Time Energy Cost	
LLUC3_ID-3	Electric vehicle data	Electric Vehicle ID Electric Vehicle Model Connector Type Battery Capacity Battery Power Timestamp SoC Speed Kilometers Autonomy Odometer	
LLUC3_ID-4	Forecasting data	Energy Time	
LLUC3_ID-5	Flexibility request data	Energy Time	
LLUC3_ID-6	Flexibility offer data	Cost	

6 Requirements

Requirements(optional)		
Categories ID	*Category name for requirements*	*Category description*

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*
AMI	Advanced Metering Infrastructure
DSO	Distribution Service Operator
CEC	Citizen Energy Community
EV	Electric Vehicle
DR	Demand-Response
VPP	Virtual Power Plant
P2P	Peer-to-peer

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.10 LLUC4_1

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Do- main(s)/ Zone(s)*	*Name of use case*
LLUC_4_1	Grid-Interactive Efficient Buildings/DR customer Premises supported by IoT services	IoT-assisted participation in DR schemes for both electricity and natural gas and energy management for communities of Smart homes residents.

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V1	26.02.2021	Kanela Karatzia, Iordanis Tourpeslis, Dimitris Sidiropoulos	Initial Draft	
V2	05.03.2021	Kanela Karatzia, Iordanis Tourpeslis, Dimitris Sidiropoulos	Revision	
V3	17.03.21	Stratos Keranidis, Ellie Efstathiou	Revision	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	Providing a central IoT service which end-users will be able to monitor their indoor conditions and energy consumption (electricity, natural gas) and control their legacy and heavy consuming appliances.
Objective(s)	1. Installation of IoT devices for monitoring indoor conditions and energy consumption (electricity, gas). 2. Enabling home automation through IoT devices to provide end-user control of heavy consuming electricity and gas appliances. 3. Enabling implicit DR through the adoption of IoT devices and controllers.
Related business case(s)	BUC4

1.4 Narrative of Use Case

Narrative of use case
Short description
The Greek pilot will take place in 3 clusters of consumers forming three virtual energy communities (Thessaloniki, Volos, Chalkidiki). The pilot will involve diverse customer profiles (age, financial, etc.) as well as different climatic zones. IoT technologies will support the profiling and prediction of consumption

through monitoring the indoor environment and energy consumption (electricity and natural gas). Furthermore, end-users will be able to control their indoor environment through home-IoT equipment.
Complete description
IoT will support information retrieval through smart sensors (temperature, humidity, light, etc.) meters (smart meters and plugs) and controllers (relays, heating controllers) that will be installed to the three pilot sites. After data analysis and data processing IoT devices will offer remote control of end-user appliances through end user interfaces (smartphone applications).

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	Indoor climate (temperature, humidity, light) conditions	Quantify the indoor climate conditions. as captured by the installed IoT sensors.	1
2	Electricity and Natural Gas consumption (kWh)	Quantify the electricity and natural gas consumed during everyday use scenarios.	2
3	Home automation	Quantify the level of automation the end-users have after the implementation of the project solutions.	2
4	Cost reduction	Lower the consumers energy bill through implicit DR services.	2, 3

1.6 Use case conditions

Use case conditions
Assumptions
The selected users participating in the project are familiar with new technologies due to the fact that in the past, they have participated in various EU projects. In Greece however, the energy market does not have any regulatory framework or rule, which is implemented by the DSO, that supports DR through IoT technologies. Citizens cannot exploit the benefits of such services due to the fact that they are not offered from the energy market.
Prerequisites
• Installation of devices to the end-users • Stable internet connection • The user feels comfortable to use smartphone applications

1.7 Further information to the use case for classification / mapping

Classification information
Relation to other use cases

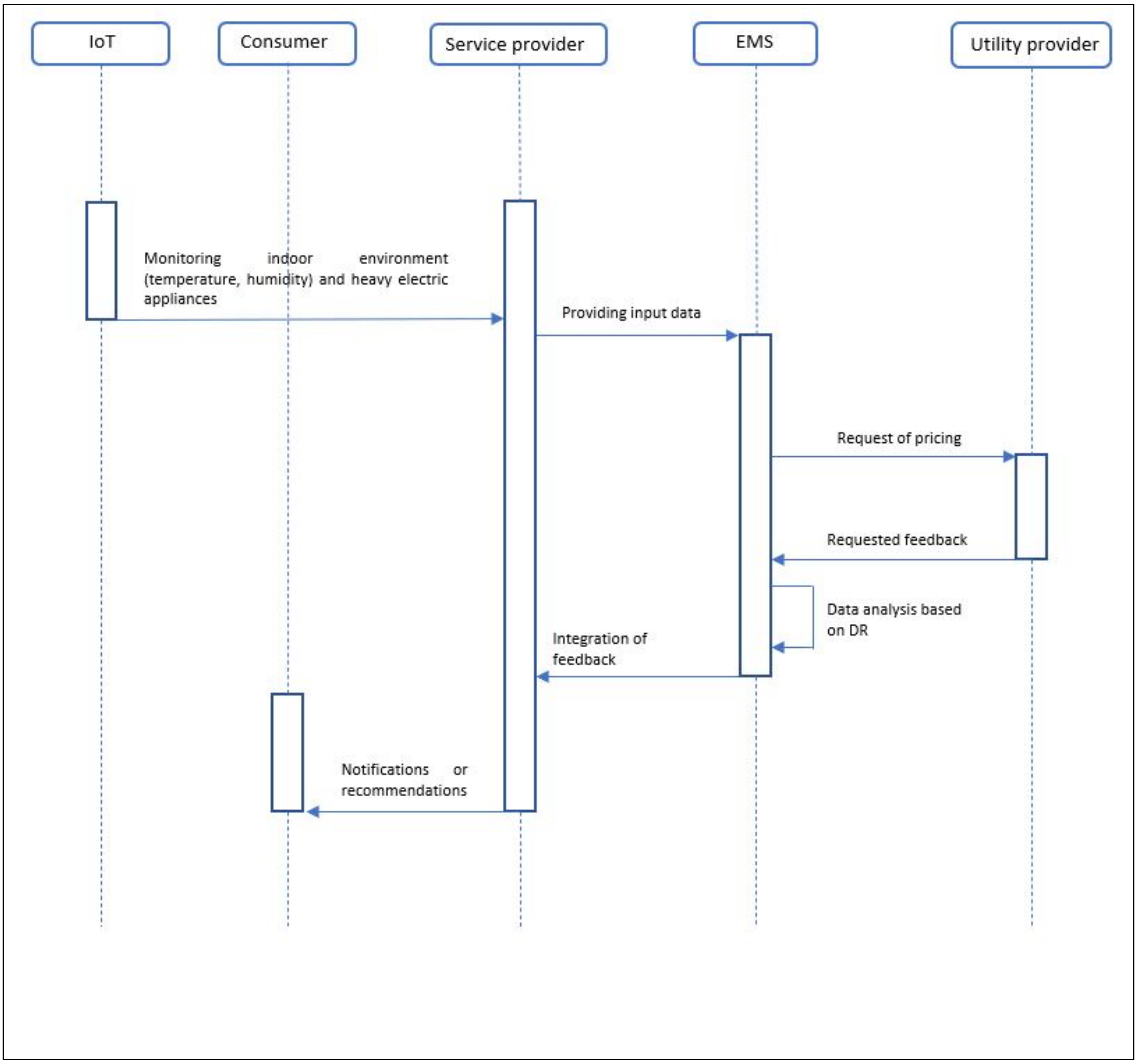
• BUC 4: Virtual Community Centralized Aggregation and energy management services. • LLUC_4_2: Virtual Community optimal thermal comfort management and cross-energy services, while trading off with energy flexibility provisioning for smart home households. • LLUC_4_3: Advanced user profiling to improve predictability of consumption and consumer behavior, based on the different types of identified customer segments, usage patterns, building and device characteristics.
Level of depth
Low level
Prioritization
Mandatory
Generic, regional or national relation
Generic
Nature of the use case
Low level
Further keywords for classification
DR, IoT, DSO, EU

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Consumer	Person	Get engaged to DR schemes	
IoT devices	System	IoT devices provided by the service provider	
Service provider	Company	Intermediate entity providing the IoT hardware, user interfaces and energy services.	WVT
EMS	System	Energy management system	
Utility	Company	Electric energy provider.	WVT

3.2 References

References						
No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
	Information retrieval	Information retrieved by the smart sensors, smart meter and heating controller for supporting data analysis and prediction of consumption	EMS	Peak energy price	IoT device monitoring	DR feedback to the end-user

4.2 Overview of scenarios

Scenario								
Scenario name:		**No. 1 - …**						
Step No.	*Event*	*Name of process/ acivity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	IoT device monitoring	House data collection	Real time monitoring of energy and indoor parameters.	REPORT	IoT devices	Service provider	LLID-1	
2	Providing input data	Providing input data	Service provider gives data to EMS	REPORT	Service provider	EMS	LLID-1	
3	Electricity pricing	Data request	Request of pricing	GET	EMS	Utility provider		

4	Returned feedback	Feedback	Utility provides feedback to EMS based on DR actions	REPORT	Utility	EMS	LLID-2	
5	Data Analysis	Data analysis based on DR	Data gathered from Utility will be analysed based on DR schemes	CREATE	EMS	EMS		
6	Reporting feedback to Service provider	Integrated feedback	EMS sends integrated feedback to Service provider	REPORT	EMS	Service provider	LLID-3	
7	Response to users	Recommendations for optimal energy utilization	After data analysis, feedback will be provided to the end-user with respect to energy consumption mitigation opportunities	REPORT	Service provider	Consumers	LLID-3	

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
LLID-1	Indoor parameters and consumption	Indoor micro-climate (temperature, humidity, light, etc.) and electricity and natural gas consumption.	
LLID-2	Pricing data	Electricity pricing rate	
LLID-3	Recommendations or Notifications	Recommendations or Notifications to citizens according to EMS results	

6 Requirements

Requirements(optional)		
Categories ID	*Category name for require-ments*	*Category description*

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*
DR	Demand Response
IoT	Internet of Things
EMS	Energy Management System
DSO	Distribution System Operators

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.11 LLUC4_2

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Do- main(s)/ Zone(s)*	*Name of use case*
LLUC_ 4_2	Grid-Interactive Efficient Buildings/Heat management costumer Premises/	Virtual Community optimal thermal comfort management and cross-energy services, while trading off with energy flexibility provisioning for smart home households.

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V1	26.02.2021	Kanela Karatzia, Iordanis Tourpeslis, Dimitris Sidiropoulos	Initial Draft	
V2	26.02.2021	Stratos Keranidis, Ellie Efstathiou	Second draft	
V3	17.03.2021	Stratos Keranidis, Ellie Efstathiou	Third draft	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	The global use case scope is to optimally control the operation of legacy heating appliances towards maintaining a pleasant environment for the end-user and delivering advanced cross-energy services to the supplier.
Objective(s)	The aim is to strike a balance for the end user, by jointly achieving the following objectives: 1. maintaining indoor climate comfort 2. reducing natural gas consumption through improved boiler efficiency 3. participating in flexibility provisioning services
Related business case(s)	BUC4

1.4 Narrative of Use Case

Narrative of use case
Short description
The proposed concept focuses on the Management of Natural Gas consumption in buildings, by actively controlling and optimizing the indoor environment, with the aim of (a) improving their energy efficiency

through load reduction and (b) contributing to energy system flexibility providing real-time energy balancing services.
Complete description
The use case describes how users of legacy natural gas boilers can upgrade their heating systems through a cost-effective IoT controller, while enabling their participation in flexibility provision services to the natural gas supplier. The core innovation of the proposed concept builds on the interconnection of major consuming heating devices (boilers, DHW preparation, radiators, etc.) with the gas network, through the seamless integration of the domX heating controller with legacy boilers, towards upgrading existing and long life-cycle building equipment to higher levels of smartness. Targeted devices include residential and commercial heating devices operating on natural gas, supporting different types of control modes (ON/OFF, power modulation, etc.). The system is interconnected with a cloud-based energy management system that constantly collects, stores and analyzes the detailed data collected from connected heating devices. The heating controllers are attached with the boilers of pilot users to enable smart and remote heating control, gas consumption estimation and communication with cloud energy management services over Wi-Fi. The user can interact with the upgraded boiler, both through the existing thermostat and the smartphone application, providing climate comfort limits and collecting real-time feedback on the boiler operation. The proposed concept focuses on the Management of Natural Gas consumption in buildings, by actively controlling and optimizing the indoor environment, with the aim of (a) improving energy efficiency through load reduction and (b) contributing to energy system flexibility providing real-time gas balancing services. Energy services for natural gas will be combined with non-energy such as (home automation, security, indoor comfort) to achieve the most efficient solution balancing the end-user needs with the recommendations of the system.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	User climate comfort deviation (°C)	Quantify the difference between target and actual room temperature over specific monitoring intervals	1
2	Gas consumption (kWh)	Quantify the gas consumed for space heating and hot water preparation	2
3	Boiler efficiency improvement (%)	Quantify the efficiency improvement achieved for legacy boilers	2
4	Revenues from DR participation (€)	Quantify the financial revenues achieved by consumers through DR participation	3

1.6 Use case conditions

Use case conditions
Assumptions

The end users have familiarized with the smart control of their legacy boiler through the smartphone application, have a basic understanding of their comfort needs and are interested to participate in flexibility services.
Prerequisites
• Installation of the required heating controllers • Installation of the smartphone application for interacting with the boiler • Internet support over Wi-Fi at consumer premises • User will comply with the system recommendations

1.7 Further information to the use case for classification / mapping

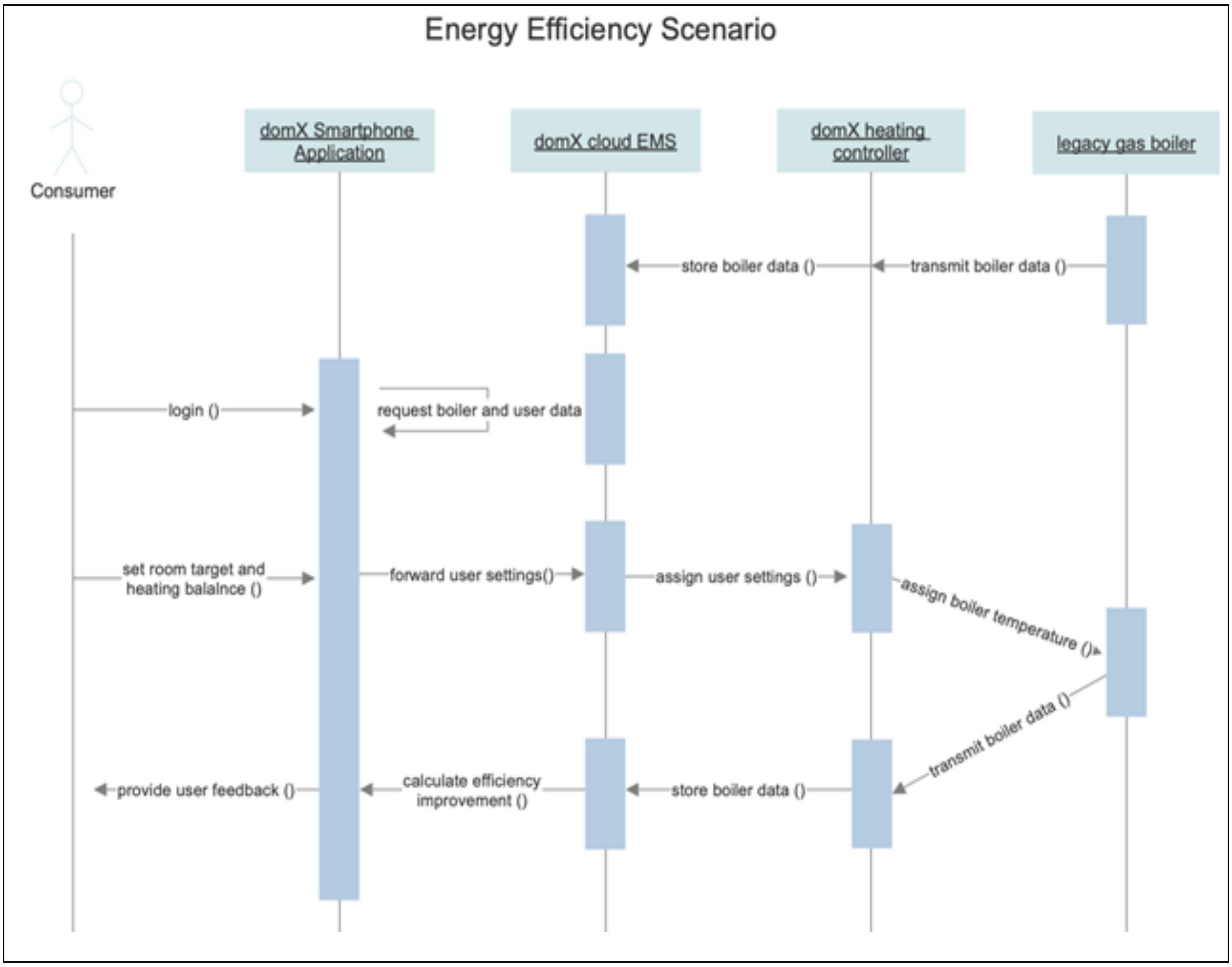
Classification information
Relation to other use cases
• BUC 4: Virtual Community Centralized Aggregation and energy management services. • LLUC_4_1: IoT-assisted participation in DR schemes for both electricity and natural gas and energy management for communities of Smart homes residents. • LLUC_4_3: Advanced user profiling to improve predictability of consumption and consumer behaviour, based on the different types of identified customer segments, usage patterns, building and device characteristics.
Level of depth
Low level
Prioritization
Mandatory
Generic, regional or national relation
Generic
Nature of the use case
Low level
Further keywords for classification
IoT

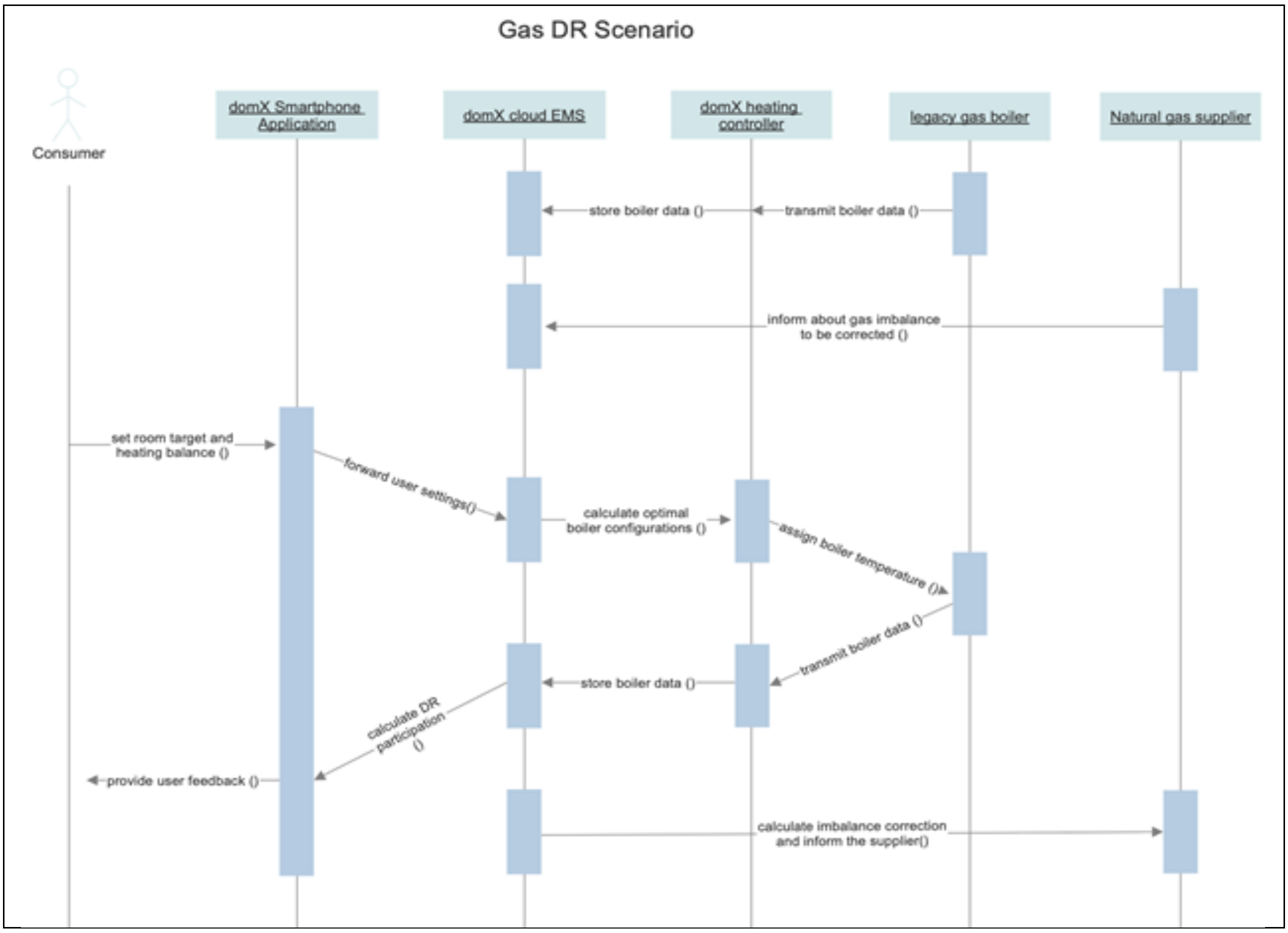
1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case


Energy Efficiency Scenario
Consumer
domX Smartphone Application
domX cloud EMS
domX heating controller
legacy gas boiler
store boiler data ()
transmit boiler data ()
login ()
request boiler and user data
set room target and heating balalnce ()
forward user settings()
assign user settings ()
assign boiler temperature ()
transmit boiler data ()
provide user feedback ()
calculate efficiency improvement ()
store boiler data ()



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Consumer	Person	End user having an energy supply contract with the utility.	
Technology provider	Company	Entity providing the IoT hardware, user interfaces and energy management services for enabling energy efficiency and consumer participation to flexibility services. Responsible also for user engagement.	domX
Legacy Gas Boiler	System	Legacy heating and DHW gas boiler	domX
Utility	Company	Electricity and natural gas supplier.	WVT

3.2 References

References

No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
1	Energy efficiency improvement for legacy gas boilers	Boiler data collected from the heating controller and user settings collected from the smartphone app. Optimal configurations are calculated from the cloud EMS and assigned to each boiler.	Technology provider	User	Heating controller connected to the boiler and the Internet.	Improved energy efficiency of connected boilers while respecting user comfort limits.
2	Natural Gas DR	Boiler data collected from the Information retrieved by the smart sensors and heating controller and user settings collected from the smartphone app. The supplier informs the technology provider about the imbalance to be corrected and optimal	Technology provider	Utility	Heating controller connected to the boiler and the Internet.	Flexibility services delivered to the utility while respecting the user comfort limits.

		configurations are assigned to participating boilers.				

4.2 Steps – Scenarios

Scenario								
Scenario name:		***Energy efficiency improvement for legacy gas boilers***						
Step No.	*Event*	*Name of process/ activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Heating monitoring the boiler	Boiler data collection	Real time monitoring of boiler data and indoor parameters.	GET	Boiler	Technology provider	LLID-1	
2	User using the smartphone app	User data collection	User comfort limits collected through the smartphone app	GET	Consumer	Technology provider	LLID-2	
3	Optimal boiler settings are calculated and assigned	Boiler configuration	Optimal boiler temperature levels are calculated and assigned per device	SET	Technology provider	Boiler	LLID-3	
4	Response to users	Energy efficiency improvement	Inform the consumer about the energy efficiency improvement and cost benefits	REPORT	Technology provider	Consumer	LLID-4	

Scenario								
Scenario name:		Natural Gas DR						
Step No.	Event	Name of process/ activity	Description of	Service	Information	Information	Information ex-	Requirement, R-IDs

			process/activity		producer (actor)	receiver (actor)	changed (IDs)	
1	Heating controller monitoring the boiler	Boiler data collection	Real time monitoring of boiler data and indoor parameters.	GET	Boiler	Technology provider	LLID-1	
2	User using the smartphone app	User data collection	User comfort limits collected through the smartphone app	GET	Consumer	Technology provider	LLID-2	
3	Utility informs about imbalance to be corrected	Imbalance amount communicated	Utility informs the technology provider about the imbalance to be corrected	REPORT	Utility	Technology provi	LLID-5	
4	Optimal boiler settings are calculated and assigned	Boiler configuration	Optimal boiler temperature levels are calculated and assigned per device	SET	Technology provider	Boiler	LLID-3	
5	Response to users	Energy efficiency improvment	Inform the consumer about his DR participation and revenues	REPORT	Technology provider	Consumer	LLID-4	
6	Response to Utility	Corrected imbalance report	Inform the utility about the corrected imbalance	REPORT	Technology provider	Utility	LLID-6	

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
LLID-1	Boiler data	All data collected from the boiler through the heating controller (temperature, consumption, etc.)	

LLID-2	User settings	All data collected from the smartphone app characterizing user comfort limits	
LLID-3	Boiler settings	Optimal boiler temperature to be assigned to the boiler	
LLID-4	Energy efficiency improvement	Calculated energy efficiency improvement to be reported back to the consumer	
LLID-5	Gas Imbalance	Utility informs about imbalance to be corrected	
LLID-6	Corrected Gas Imbalance	Utility is informed about the corrected imbalance	

6 Requirements

Requirements(optional)		
Categories ID	*Category name for require-ments*	*Category description*

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*
DR	Demand Response
IoT	Internet of Things
DHW	Domestic Hot Water
EMS	Energy Management System

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*

9.12 LLUC4_3

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	*Area / Domain(s)/ Zone(s)*	*Name of use case*
LLUC_4_3		Advanced user profiling to improve predictability of consumption and consumer behaviour, based on the different types of identified customer segments, usage patterns, building and device characteristics.

1.2 Version management

Version management				
Version No.	*Date*	*Name of author(s)*	*Changes*	*Approval status*
V1	26.02.2021	Kanela Karatzia, Iordanis Tourpeslis, Dimitris Sidiropoulos	Initial Draft	
V2	05.03.2021	Kanela Karatzia, Iordanis Tourpeslis, Dimitris Sidiropoulos	Second Draft	
V3	17.03.21	Stratos Keranidis, Ellie Efstathiou	Revision	

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	Provide individual services based on consumers' profile to increase their comfort level and savings.
Objective(s)	1. Use of historical consumer behavior and device usage data for making energy data consumption available and understandable through visualization. 2. Empowering users to achieve energy savings and manage their energy consumption, being energy efficient and cost effective, without sacrificing their comfort feeling.
Related business case(s)	BUC4

1.4 Narrative of Use Case

Narrative of use case
Short description
Submeter infrastructure will be exploited and diverse energy consumption and user behavior profiles will be classified into clusters. Furthermore, data analytics will be used for visualization tools and to enhance implicit DR services.

Complete description
Data collected from real time submeters, sensors and the heating controllers will be used to create a historical database per pilot household. The inputs from the sensors will be analyzed, configurating an individual profile based on its user characteristics. Pilot aims to reduce operational cost on the client side by providing real time energy consumption and analytics dashboards to enable end-users to document their decisions in real time and creating scope for wider energy efficiency actions. Consumers will be able to watch the consumption of their connected appliances through their mobile phones and remotely and efficiently managing them (time scheduling, modulated control, etc.). In parallel, it respects end-users' preferences, by giving them the ability to configure their needs in terms of their required climate comfort. Through their participation in DR schemes, they will gain house control and increase their comfort feeling while saving energy and money.

1.5 Key performance indicators (KPI)

Key performance indicators			
ID	*Name*	*Description*	*Reference to mentioned use case objectives*
1	User engagement	Number of consumers using the advanced analytics and visualization tools.	1
2	Energy consumption reduction	Lower the consumers energy consumption by implicit DR services.	2
3	User climate comfort deviation (°C)	Quantify the difference between target and actual room temperature over specific monitoring intervals	2

1.6 Use case conditions

Use case conditions
Assumptions
Visualization tools will be presented in a manner that the end-user can easily understand them.
Prerequisites
• Installation of devices (sensors, meters, relays, controllers) to the end-users • Stable internet connection • A web application for data visualization is needed

1.7 Further information to the use case for classification / mapping

Classification information
Relation to other use cases
• BUC 4: Virtual Community Centralized Aggregation and energy management services. • LLUC_4_1: IoT-assisted participation in DR schemes for both electricity and natural gas and energy management for communities of Smart homes residents. • LLUC_4_2: Virtual Community optimal thermal comfort management and cross-energy services, while trading off with energy flexibility provisioning for smart home households.

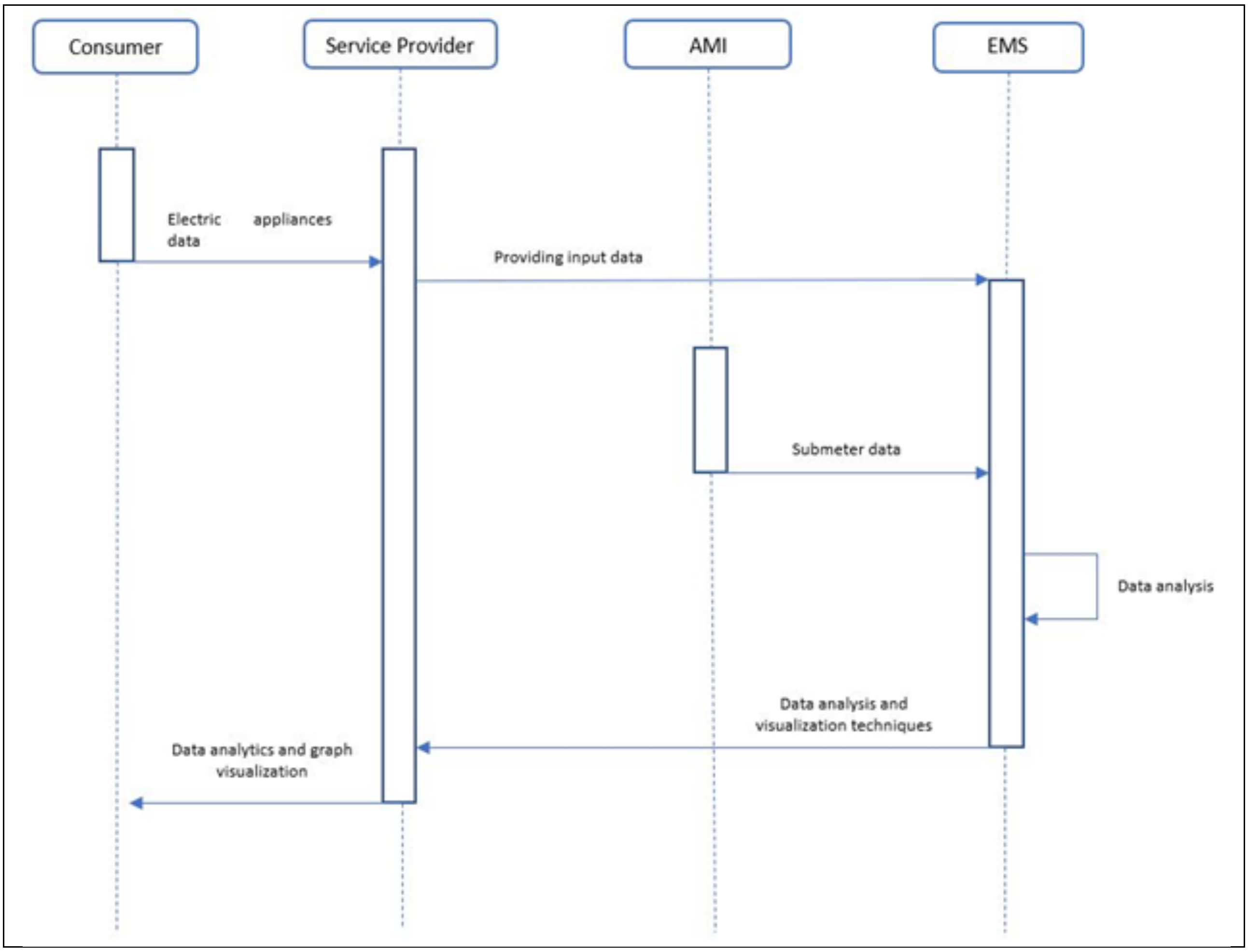
Level of depth
Low level
Prioritization
Mandatory
Generic, regional or national relation
Generic
Nature of the use case
Low level
Further keywords for classification
DR, IoT

1.8 General remarks

General remarks

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors			
Actor name	*Actor type*	*Actor description*	*Further information specific to the use case*
Consumer	Person	Get engaged to DR schemes	
Technology provider	Company	Intermediate entity providing the IoT hardware, user interfaces and energy services.	
AMI	System	Real-time electricity submeter network.	
EMS	System	Energy management system	
Service Provider	Company	Energy service provider.	

3.2 References

References

No.	*References Type*	*Reference*	*Status*	*Impact on use case*	*Originator / organization*	*Link*

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	*Scenario name*	*Scenario de-scription*	*Primary actor*	*Triggering event*	*Pre-condition*	*Post- condition*
	Information provision	Information retrieved by the submeter infrastructure, is analysed, and visualized for better understanding of energy consumption.	AMI	Data gathering	All data is available	Energy profile and data are visualized.

4.2 Steps – Scenarios

Scenario								
Scenario name:		***No. 1 - …***						
Step No.	*Event*	*Name of process/ activity*	*Description of process/activity*	*Service*	*Information producer (actor)*	*Information receiver (actor)*	*Information ex-changed (IDs)*	*Requirement, R-IDs*
1	Information retrieval	Smart plugs monitoring	Data monitoring from electric appliances will be gathered into a central database.	REPORT	Consumer	Service provider	LLID-1	
2	Data propagetion	Data propagetion	All data gathered from the IoT devices will be accoumul	REPORT	Service provider	EMS		

			ated to EMS.					
3	Information retrieval	Submeter monitoring	Data monitored from submeters will be accumulated to EMS.	REPORT	AMI	EMS	LLID-1	
4	Data analytics	Data preprocessing	Data analysis	CREATE	EMS	EMS	LLID-2	
5	Data visualization	Data visualization	Data will be provided to the end-user through different graph methods.	REPORT	EMS	Service Provider		
6	Reporting results	Reporting results	Service provider offers final visualized options to the end-user.	REPORT	Service Provider	Consumer	LLID-3	

5 Information exchanged

Information exchanged			
Information exchanged, ID	*Name of information*	*Description of information exchanged*	*Requirement, R-IDs*
LLID-1	Indoor parameters and consumption	Indoor micro-climate (temperature, humidity) and electricity and natural gas	
LLID-2	Data analysis	Data analysis gathered from meter infrastructure, smart appliances and indoor conditions.	
LLID-3	EMS results	Optimal feedback.	

6 Requirements

Requirements(optional)

Categories ID	*Category name for requirements*	*Category description*

7 Common terms and definitions

Common Terms and Definitions	
Term	*Definition*
DR	Demand Response
IoT	Internet of Things
AMI	Advance Metering Infrastructure
EMS	Energy Management System

8 Custom information (optional)

Custom information (optional)		
Key	*Value*	*Refers to section*