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Orchestrating an interoperable sovereign federated Multi-vector Energy data space built on open standards and ready for GAia-X

Handbook for User Engagement in OMEGA-X Use Case Families

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List of Abbreviations

Abbreviation / Acronym	Description
AI	Artificial Intelligence
DoA	Description of Action
CPO	Charging Point Operators
DSO	Distribution System Operators
EC	European Commission
EDIH	European Digital Innovation Hub
EMSP	Electric Mobility Service Providers
EU	European Union
GDPR	General Data Protection Regulation
HVAC	Heating, Ventilation and Air Conditioning
ICT	Information and Communication Technology
KPI	Key Performance Indicator
LEC	Local Energy Community
MPO	Metering Point Operator
OEM	Original Equipment Manufacturer
PV	Photovoltaic
RID	Research, Innovation and Deployment
SME	Small and Medium-sized Enterprises
SSH	Social Science and Humanities
TSO	Transmission System Operators

Foreword

This document, a handbook for user engagement, is a first outline for an integrated human-centred approach to OMEGA-X. The handbook is particularly targeted at the Use Case Family and Pilot level of the OMEGA-X project but strives for transferability. Therefore, it will

- build on the learnings from the BRIDGE initiative, OMEGA-X sister projects, as well as other relevant projects and initiatives.
- outline principles and practices for stakeholder engagement and empowerment of users in the energy transition.
- identify potential sociocultural barriers for both data sharing across sectors and actors, and for the implementation of solutions and services in and across the various pilot sites.
- assist the Use Case Families/pilots in developing and implementing pathways to achieve societal impact.

OMEGA-X recognizes the importance of the active role of citizens in the energy transition, which we currently see in dramatic forms emerging as a global challenge. The current state of affairs only stresses that there is a huge need for a societal and human-centred approach when developing data driven services and business cases in the energy domain and for empowering citizens in the green energy transition.

OMEGA-X aims to provide interoperability with the other four projects that are funded under the same call: ENERSHARE, DATA CELLAR, SYNERGIES and EDDIE. The iterative methodology for alignment is built on five pillars: Interoperability, deployment of cutting-edge technologies, marketplace and innovative business models, user involvement and co-creation, and use case family operation.

As the OMEGA-X pilots have not yet started, this handbook should be seen as flexible and dynamic guidelines which will be continued, iterated, adjusted, and implemented on an ongoing basis. The handbook is written in collaboration with the Use Case Family leaders and based on interviews with the leaders and their written contributions.

1. Introduction

Human-centred approach to energy systems

Why a human-centered perspective to energy dataspace?

The urgency of a human-centred approach to energy systems is driven by several factors and movements: In the first place - as the global geopolitical situation currently shows in dramatic ways - energy is a critical infrastructure that influences people's everyday lives and life quality in a highly direct way. Secondly, due to a need and political push for a climate-neutral Europe in 2050, the urge for European sovereignty, as well as technology advances, European citizens have become more dependent on electricity, as for examples for transportation and heating. Thirdly, renewable energy production (as we also see with emerging new technologies, such as Edge computing, Edge AI, digital twins, etc,) provide a more distributed and decentralized landscape. Solar and wind energy can be produced locally, near citizens, and rely partly on an active role of citizens and communities. Fourthly, the green energy transition demands an optimization through integration of the energy system and of data flows. The creation of a dataspace for energy requires interoperability between sectors, and challenges existing value chains. New forms for collaboration and governance, changing roles of stakeholders, the increasing importance of ecosystems, all indicate that the energy transition should be understood in both sociotechnical and political terms. Energy systems are deeply intertwined with human affairs, from the daily lived practices and experiences of individuals, households, businesses and national cultural formations and imaginaries to global political economies, international security, and the deep structures of capitalism and democracy [1].

The adoption of a human-centred approach will help OMEGA-X and the Use Case Families to enhance understanding of possible barriers for adoption and implementation of data driven services and solutions, as well as for data sharing across sectors.

- increase quality of services and solutions, as they are adjusted to citizens and communities' needs.
- increase awareness of diversity amongst users (gender, age, etc) and their (diverse) needs.
- awareness of the various roles and changing roles of stakeholders and users: e.g. consumers can be public sector, citizens and SMEs, but the public sector can also act as regulator, and plays an important role for the alignment of services and solutions with local policies and strategies (societal impact).
- enhance our understanding of incentives and pathways for behavioural change of individuals and communities.
- identify barriers for data sharing that are related to values, local practices, geographical conditions, etc.
- raise awareness of the local context and the value OMEGA-X will bring to local communities.
- raise awareness that data sharing across private and public sector needs to be GDPR compliant and can lead to ethical, privacy and security issues
- raise awareness of governance and organisational structures that needs to be in place for achieving societal impact

- raise awareness of the importance of empowerment of citizens and communities in the energy transition

Working with an energy sector in transformation

Users and stakeholders not only act on inner motivation but are embedded in sociocultural, technological, and regulatory structures. Hence, their interests and concerns, as well as ability to engage and take action, is not only influenced by single technologies but also shaped in a context of technological systems and regulations.

As contextual background for a European energy data space, it is therefore important to be aware of the structural change happening in the energy technological systems in parallel with the digital transformation. Figure 1 below illustrates traditional energy systems, where each energy vector is a more or less closed system with a linear, top-down flow from supply through distribution to demand. Further, each energy sector has traditionally been organised and regulated as closed systems.

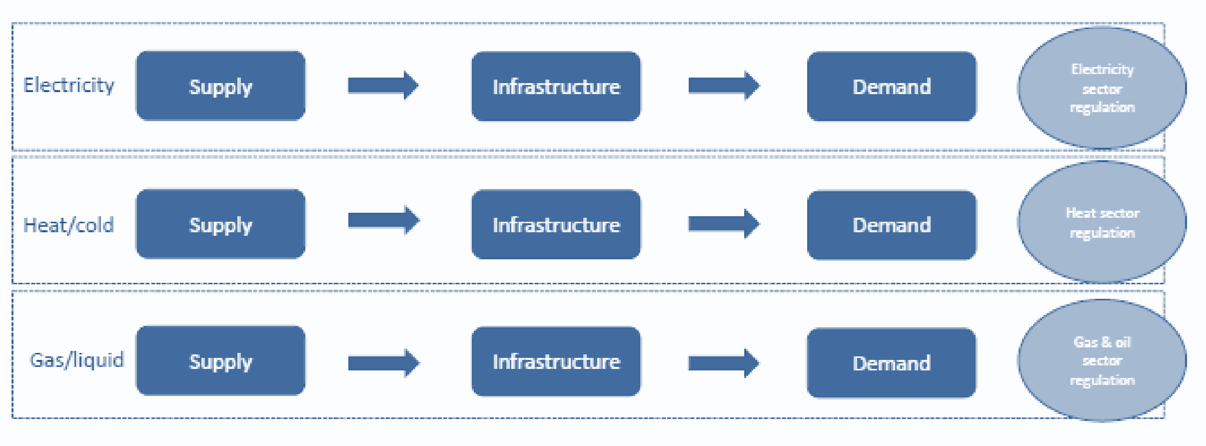

Figure 1. The traditional energy system.

As consequence of changing supply systems – primarily from storable fossil fuels to variable renewable energy – the energy system is foreseen to become more integrated across energy vectors. This is reflected in the EU Strategy of Energy System Integration [2] published by the European Commission in 2020, where this sectoral integration is foreseen and encouraged. Likewise, it points out barriers in the existing sector regulation which is designed for closed and linear energy sub-sectors. Indeed, also the fundamental OMEGA-X concept is aimed for a data space across energy vectors. Thus, the data architecture for energy data spaces should reflect and facilitate this increased energy system integration. And the same time, the fact this change in energy systems is only underway can potentially also be a source of challenges for the use cases. In figure 2, the integrated energy system is illustrated.

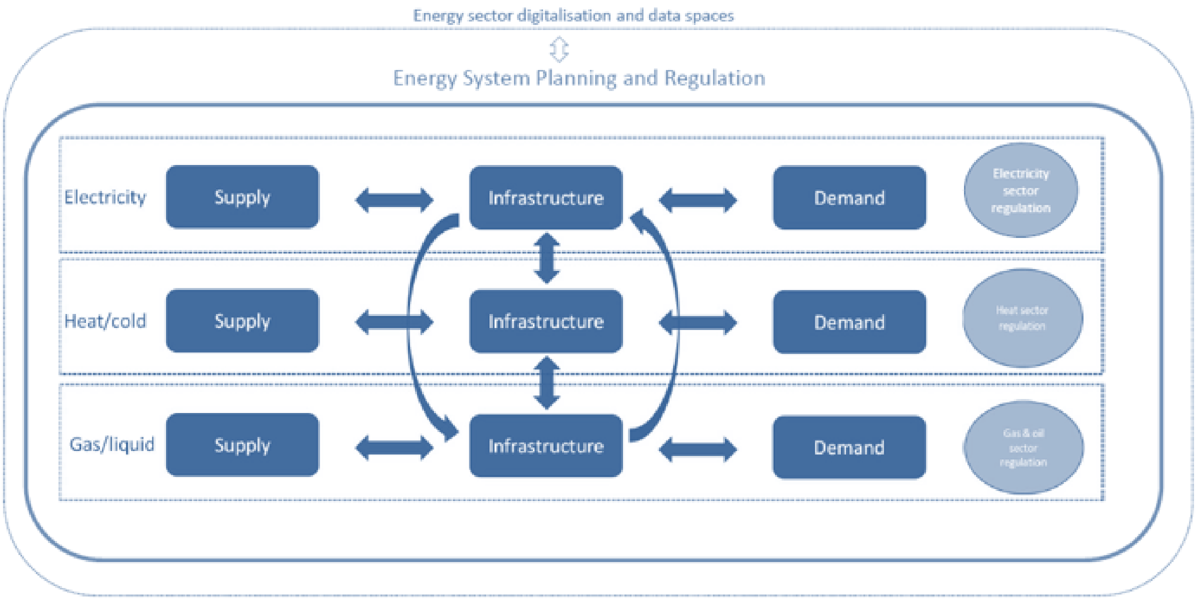

Figure 2. The integrated energy system.

The ongoing energy system transformation implies that stakeholders may confront a two-dimensional change; both digitalisation and energy vector integration.

New collaborations and changing roles of actors in the energy transition

Perspectives and methods from the Social Sciences and Humanities (SSH) are thus not only integrated in OMEGA-X to enhance understanding of the importance of user and citizen perspectives and needs in the pilots, but also on a higher project level to shed light on barriers for data sharing, interoperability and collaboration that might be related to practices and cultures that vary across the different energy sectors, for example the solar industry has a different tradition and practice for data sharing than OEMs in wind energy. These different traditions and practices influence business models, as well as initiatives for integration, collaboration and data sharing across sectors. In the energy sector, as well as in the context of data marketplaces, a transition can be identified towards a more open, but also increasingly complex ecosystem. For example, traditionally, data marketplaces are large, but rather closed constellations led by a few established key players. This has limited the data offered and, at the same time, creates barriers for smaller players to access. The creation of an energy dataspace helps growing a competitive data economy, where all stakeholders can freely participate under fair conditions [3] but will also mean an increase of complexity on many levels. In collaboration with the sister projects OMEGA-X will provide a few recommendations for how to address these complexities.

Energy communities: empowering citizens in the energy transition

The energy transition asks for a more active role for citizens and communities. While energy prosumerism and communal energy are not new concepts in Europe (for example wind power communities in Denmark), energy communities has, as political instrument, only recently been introduced in EU legislation[1], where it appeared in 2018 in the Clean Energy Act. Benefits of introducing energy communities in the energy transition are described as follows:

"*[t]he participation of local citizens and local authorities in renewable energy projects through renewable energy communities has resulted in substantial added value in terms of local acceptance of renewable energy and access to additional private capital which results in local investment, more choice for consumers and greater participation by citizens in the energy transition. Such local involvement is all the more crucial in a context of increasing renewable energy capacity* [4]

A point for attention is how Energy Communities are embedded in society and relate to already existing initiatives and communities. Working with the relationships between energy communities and existing communities can shed light on potential barriers for the energy transition, as well as on possible pathways for societal impact of energy related initiatives. Energy Communities will especially be present in OMEGA-X Use Case Family: Local Energy Communities.

Figure 3. Energy communities [5]

[1] Article 21 obliges Member States to ensure that consumers are entitled to become renewables' self-consumers, who may generate renewable energy, including for their own consumption, as well as store and sell their excess renewable generation. Moreover, an enabling framework for the promotion of renewables self consumption is to be established in every Member State, in which the potential and incentives, as well as the financial and regulatory barriers for the concept's development, are to be assessed.

2. Learnings from BRIDGE, sister projects & other relevant EC funded projects & initiatives

The BRIDGE initiative

The BRIDGE initiative is a Cooperation between Horizon 2020 Projects in the fields of Smart Grid, Energy Storage, Islands, and Digitalisation. BRIDGE is organised in different working groups. For the stakeholder engagement activities in OMEGA-X, this document will build on the work carried out in the BRIDGE Working Group "Consumer and Citizen Engagement (WG CCE)". The role of this Working Group is to develop a framework to guide R&I projects toward better understanding, triggering and leveraging the action of consumers in the energy market. The Working Group addresses the transformation of the role of consumers into prosumers, the community level and other active forms of participation and empowerment in the energy sector, as well as the increasing importance of ecosystems [6]. WG CCE has four main objectives:

1. Build methodologies to engage consumers in the energy sector
2. Build methodologies to support the constructions of organisations to involve consumers in the energy system
3. Build objective assessment criteria to consumer engagement
4. Build models for collective action of citizens [6]

As the report "Exploration of citizen engagement methodologies in European R&I project" by the WG CCE group states: "There is a heavy bias around the notion of individual benefit in the tools gathered by the subgroup, vs an idea of collective benefits or community benefits [6]." This approach has implications for methodologies in technology driven projects that, for example, are focused on incentives that benefit individuals, and on individual behavioural change. There is a lack of a more systematic approach with a long-term vision where more comprehensive KPIs to increase Quality of life, and the community /ecosystem/ society level are in focus [6].

In addition to the community level, the working group states that, in energy projects, often the local context of the pilot sites is not sufficiently taken into account [6]. Here we observe in particular that technology-driven projects often lack an understanding for the barriers for technology implementation that are related to cultural values, social practices, governance issues, mindsets and worldviews that can be barriers for data sharing across sectors and for the implementation of services and solutions. Bridge WG CCE states that many of the energy projects the working group has analysed only have provided broad notions of engagement of users and other stakeholders [6].

BRIDGE Principles and recommendations that OMEGA-X will address at the Use Case Family level [6]:

- Work with existing collective actions, where citizens have shown interest in supporting research and innovation and where the social fabric underpinning collective action has already been established.
- Activities should be guided by basic principles of democratic governance to sustain the engagement of their members through time: transparency, fair representation and education.
- Need for social and society related KPIs (see Section 4.3)

- Need for a more competence-based approach to community building and citizen engagement.
- Need to shift our focus away from market integration to community value as a key success factor to promote the development of energy communities

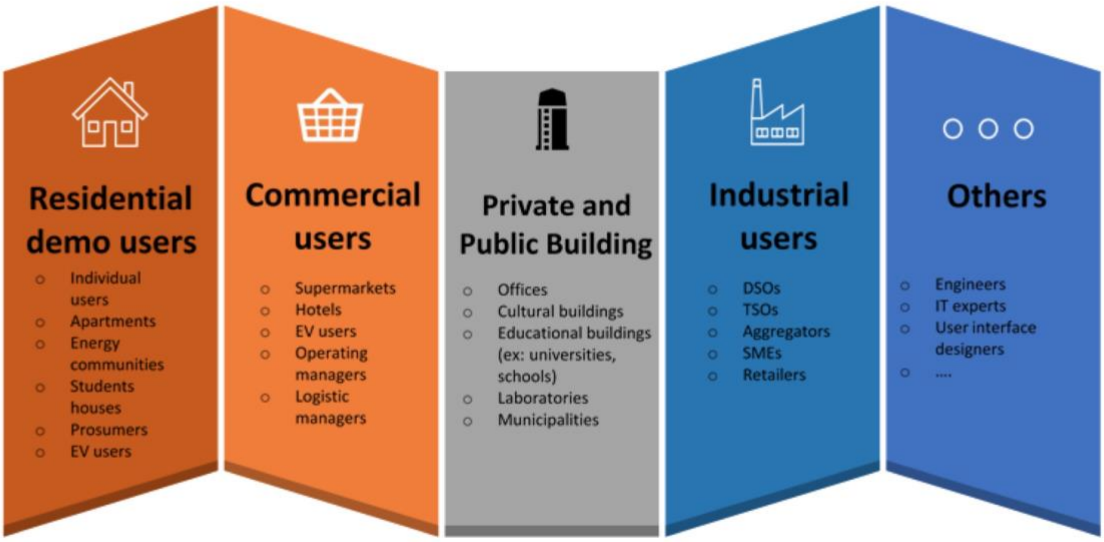

Figure 4. Main user types in Energy projects, Bridge [6]

Table 1. Success strategies for engagement from BRIDGE documents [6]

Success strategies	Description
Identify end users	There are diverse types of users, it is crucial to know who you want to target.
Understand context	Even in small communities the context might differ per user type, these contexts should be understood.
Build trust	Involve local stakeholders to understand the local context and users. Create workshops and forums to get to know them, together with the end users.
Need based approach	Users have different needs even in the same communities, getting to know them will be helpful in the adaptation process.
Custom communication	Asking users how they prefer to communicate with stakeholders and setting up the proper channels will lead to a better involvement and less misunderstandings.
Understand barriers	To tackle barriers and challenges, it is key to understand them.

Human-centred approach & user engagement in OMEGA-X sister projects

The envisaged iterative methodology to be implemented in OMEGA-X has as purpose to take advantage of synergies among project partners to maximize the overall impact of project outcomes and achievements. This is translated into five main pillars of actuation, including user involvement and co-creation. Through coordinated activities and alignment, OMEGA-X will engage with activities and approaches that support a human-centred approach and included user engagement activities in the projects that are funded under the same call for the purpose of exchanging learnings, best practices and recommendations.

ENERSHARE

ENERSHARE (European Common Energy Dataspace framework enabling data sharing driven across and beyond energy services) aims at facilitating the transition of the energy systems towards more smart and decentralized paradigms thanks to the secure data exchange and sharing among all the energy value chain stakeholders.

One of the tasks foreseen is to co-design SSH based consumer-centric business models for energy data sharing enabling data beyond-financial value creation and spreading along value chain [7].

SYNERGIES

Short description of the project

Synergies "Shaping consumer-inclusive data pathwaYs towards the eNERGy transItion, through a reference Energy data Space implementation" aims at establishing a reference Energy Data Space through sharing innovation in value chains in the energy field, which is fragmented due to the growing number of distributed energy resources connected to the network. Synergies promotes the creation of a data-driven intelligence ecosystem that not only supports energy operators in improving efficiency in supply operations but also enables prosumer inclusiveness in market transactions [8].

Vision for a human-centred approach

- User-Driven Innovation Approach towards addressing emerging end-user and market needs, involving both prosumers and energy value chain stakeholders throughout all stages of the project life-cycle, as key enablers of the SYNERGIES innovation process
- Agile ICT implementation methodologies in conjunction with Continuous Validation and Verification processes to manage cross-functional and interdisciplinary teams and ensure the establishment of an effective framework that will facilitate the establishment of an inclusive pathway and collective intelligence framework towards the digital energy transition.
- Living Lab that provides an excellent network for experience and knowledge exchange and integration towards user and business-driven open innovation

Methods and actions to support stakeholder/user engagement

- Concept Screening, User Requirements Definition and Technical Design: The SYNERGIES concept will be screened, and requirements will be elicited based on the actual needs of end-users and considering regulations, social perceptions, business practices and economic factors
- SYNERGIES Technology Prototyping and Development: definition of a variety of mature and proven components, integrate them and further enhance their features to enable the delivery of functional, integrated prototypes which will be continuously validated to elicit user feedback
- Demonstration/ Piloting and Marketability Tests: Validation will involve a vast number of stakeholders and end-users involved in the demonstrators and overall energy data value chain (7)

DATA CELLAR (Rina-C)

Vision for human-centred approach

Local Energy Communities (LECs) play a key role in driving the European Union's energy transition according to the European Commission. It is important to foster the exchange of best practices and the creation of a knowledge community to tackle one of the most urgent global crises of our society: climate change. The digitisation of the EU energy system is fundamental to achieve that goal, as well as the best exchange of data between different energy actors.

Actors/stakeholders involved

LEC stakeholders, researchers, and tenants.

Methods and actions to support stakeholder/user engagement

It is important to study the ethical, regulatory, cybersecurity, and governance aspects of data handling, and marketplace. DATA CELLAR devotes specific effort to establish mutual benefit interaction and collaboration with other Data Space sisters' projects (and other relevant Energy Community project like LocalRES, MUSE GRIDS etc.). Many dissemination activities will be planned to engage them to share their data to populate the data hub, fostering common stakeholders' engagement and knowledge exchange among relevant outcomes of the project WPs and results.

Societal impact foreseen

To maximize its impacts DATA CELLAR focuses on being user-friendly and easy-to-access for non-ICT experts thanks to the availability of a data marketplace. It will also impact on cities decarbonization through the creation of energy communities and new user-centric designed and data driven energy services.

EDDIE

EDDIE is the last of OMEGA-X sister projects that will be funded at a later stage.

3. Use Case Families & Pilots

Human-centred approach to OMEGA-X Use Cases

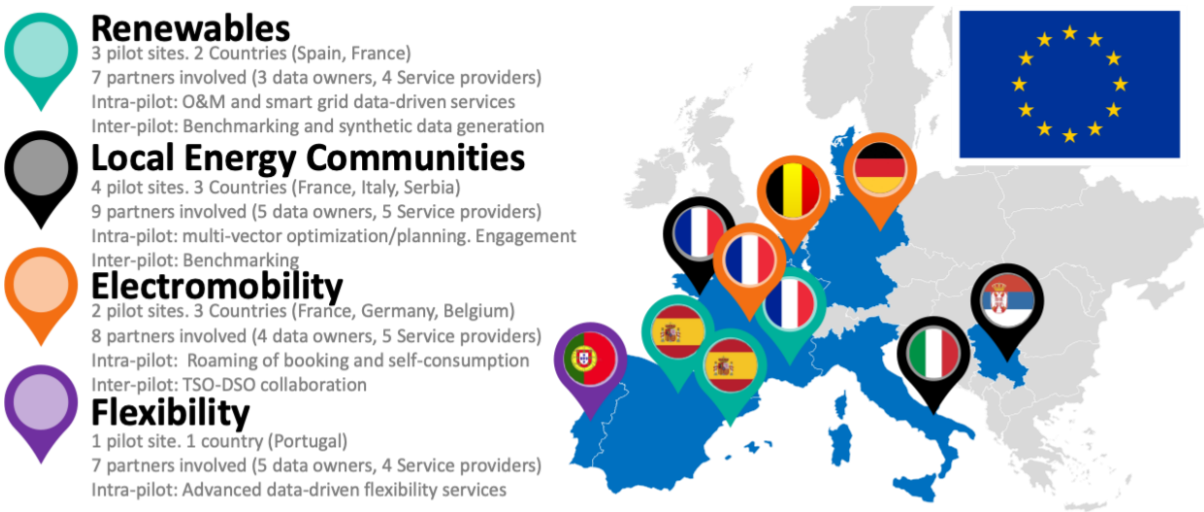

Figure 5. OMEGA-X' Four Use Case Families

Renewables

Description

The Use Case Renewables has as objectives to develop, implement and validate data services for renewable energy assets, specifically for solar PV. The developed services will benefit from data sharing thanks to the implemented Data Space. The sustainable compensation/ monetization for sharing data and services to foster the European market for the data economy will be analysed. The Use Case consists of three pilots based on data from multiple solar parks in Europe:

1. **ENGIE** 175 PV Plants with different power levels/locations **across EU**
2. **EyPESA** smart grid, solar photovoltaic and hydroelectric. **Spain**
3. **EDF:** 3,000 MW of PV Plants from different power levels/locations across the world (focus on EU).

Actors, stakeholders, and wider ecosystems

The actors involved in the pilots are data providers (Engie, Large Utility; EDF, Large Utility; Estebanell, Medium-sized Utility/DSO) and service providers (Sener, Large EPC and maintenance service provider, Meteo for Energy, SME, UPC, University, Tecnalia, RTO). Equipment Manufacturers. The wider ecosystem consists of TSO, LEC managers, Prosumers and Aggregators (flexibility).

Barriers and challenges for collaboration and implementation

The following barriers are foreseen for the pilot implementation

- Difficulty to share operational data
- Data Quality
- Data Standardisation
- Service Generalisation

Societal impact foreseen

Reduction in energy bill

- More efficient operation of Renewable Energy Generation Assets
- More efficient operation of the grid

Reduction of C02

- Clean, sustainable energy

Local Energy Communities

Description

The Use Case Family (UCF) "Local Energy Communities" (LEC), led by RINA-C, consists of four different pilot sites, located in Spain, Italy and Serbia. Energy Communities (ECs) is an initiative that emerges from the increasingly concrete need amongst citizens to manage their own energy supply chain. In particular, this kind of local approach to a clean energy society supports the engagement of local citizens in becoming active contributors/prosumers and to influence other consumers to adopt similar active behaviour. In that sense, Local Energy Communities have as primary objective to provide environmental, economic, and social community benefits. Energy Communities can foster citizens' participation and control over decision-making in renewable energy initiatives, support the energy transition, and reinforce positive social norms. Energy Community initiatives are offering new opportunities for citizens to increase the share of renewables in local areas with limited impact on the public grid and an enhancement of energy efficiency as bottom-up actions. It is fundamental for the green energy transition that citizens become more proactive in the energy production–consumption process and in the achievement of sustainability targets.

Actors, stakeholders, and wider ecosystems

The Use Case Family Local Energy Communities has a Use Case Family Leader which is RINA-C, and four energy managers: IMPULSA, ASTEA, EDP and PUPIN as LEC operators and data providers; one SME (Revolt as data user and service provider; one energy consultancy, RINA-C as data user and service provider; two Universities/RTOs, Tecnalia and UPC, as data users and service providers; and a cross-demo actor (EDF) in charge of developing a methodology for analysing compliance of proposed services with regulatory frameworks existing and envisaged in various countries in Europe.

The Table 2 presents the four Pilots, with the location and the addressed pilot leader.

Table 2. Four Pilots in the LEC Use Case Family

Pilot	UC family	Country	Pilot Leader
1	LEC	Spain	IMPULSA
2	LEC	Italy	ASTEA
3	LEC	Serbia	PUPIN
4	LEC	Spain	EDP

Below a short description of each Pilot is provided.

EDP: ZARAGOZA LEC

EDP Solar Espana activities are related with Inclusive Solar Communities, that intend not only to share energy produced by solar panels with several neighbours in the same neighbourhood, but also to do so in an inclusive manner, granting access to solar energy to vulnerable families.

These solidarity neighbourhoods are being created in Portugal and Spain, and a community was already created in Zaragoza that is positively impacting 200 families and businesses, including 20 vulnerable families. The production of solar energy for self-consumption enables customers to reduce their energy dependency and, consequently, their energy bills.

To overcome the lack of space available for installation, EDP launched Bairros Solares, renewable energy communities in which the energy produced by one photovoltaic installation benefits not only the producers, who make their space available, but also the community members.

IMPULSA: Granollers LEC (SPAIN)

IMPULSA as LEC operator provides data regarding the LEC in its headquarters of EyPESA located in Granollers, Spain. The LEC consists of buildings including PV units with 40 kW of generation capacity (expected to increase the PV capacity up to 70 kW in two years) and an energy storage system with 200 kWh of capacity with a maximum power of 100 kW. The headquarters have several supply points. This LEC is provided with smart meters, that can measure the following: Hourly active power, hourly reactive power, hourly consumed and injected power, transformer active and reactive power (specific cases), topology including line impedances. Other important parameters that are measured are: Detected frauds (one year of data), Asset Costs and age, GIS Data of DSO grid (never clients).

PUPIN: BELGRADE PUPIN CAMPUS LEC

BELGRADE PUPIN CAMPUS has a size of 14,500 sq. meters indoor (office buildings, laboratories, workshops, storage space), 17,500 sq. meters outdoor (parking, exhibition area);

The community is composed by a Total of > 600 occupants within seven separate legal business in IMP and > 6 external SMEs. The total energy consumption measures are the following: Electricity 890,300 kWh/yr, 133,700 kVArh/yr; Heat 550,000 kWth. The Local energy assets parts are: Substation for electricity supply from power grid, roof-top PV power plant (50kWp), Heat supply from local thermal plant with two fuel-oil powered steam boilers (2x1MWt) and from electric boilers (3x24kW), Heat exchanger (1MW) to transfer heat from steam to water, Cooling supply from split air-conditioning units (in each office), Remotely controlled heat source switch unit; Fuel oil (mazut) storage (main 110 tons, aux 2.5 tons).

ASTEA: OSIMO LEC

Astea is a local utility which operates in the main following public sectors: Distribution of natural gas, Distribution of water, District Heating, Power Plants management.

ASTEA as LEC operator provides data regarding the multi vector municipal LEC in Osimo in Italy (only one point of common coupling with national TSO) with a high share of distributed generation (37 MW; yearly electricity production>30% if CHP is considered; 26% only by RES).

ASTEA as LEC Operator as well as demo site partner will provide data to test and validate innovative services.

Expected barriers and challenges for collaboration and implementation

It can be hard to properly support community energy action helping energy customers to engage in the generation and management of sustainable energy. We should also investigate the barriers preventing people and communities from participating in energy projects.

The most effective strategies to be implemented in energy communities must be investigated together with a qualitative analysis on the most innovative and interesting instruments (digital or not) for enabling communities in the creation of those experiences and in their contribution to the creation of wide energy citizenships, this is a challenge in the implementation on OMEGA-X project.

The main barriers for EC are related to their involvement at a social level, as well as to a lack of trust in the new energy solutions. People may be afraid of the recording and use of data, because of security issues. Also, problems can be related to missing parts in the energy infrastructure or missing technologies such as smart meters, that can impact on the possibility to apply innovative services to LECs. It is also fundamental to have technicians and engineers that are able to implement the energy related services or to build the infrastructure needed for the implementation.

About the social part, there may be barriers and challenges for collaboration and implementation that prevent socially vulnerable groups from participating in distributed generation and communities. It could be difficult for LEC participants to access funds even if innovative financing schemes have been implemented to overcome barriers to investments. The potential of Energy Communities relies in reducing energy poverty, including using new opportunities to overcome barriers for participation of socially vulnerable and energy poor households in energy communities. Also, assessing the impact of community-based initiatives on individual and collective behaviours can provide useful evidence for future policy initiatives on sustainable energy behaviours. Barriers impact strongly on LEC possibilities to strengthen their capacity building to replicate successful practices. We should also focus on addressing barriers for citizens' participation, including for the lower income, vulnerable customers and local authorities.

User oriented activities planned

An example of the involvement in user-oriented activities is the participation of citizens and communities as partners in energy projects. Its social innovation potential also resides in the ability to integrate consumers independently of their income and access to capital, ensuring that the benefits of decentralization are also shared with those that cannot participate.

Interoperability among data driven platforms is also fundamental in this respect as it improves coordination between various actors, as energy communities. In addition to achieve the ambitious objectives of carbon neutrality and collective self-consumption, it is crucial that data and associated representations are shared/used in a secure way.

Energy Communities can bring a lot of benefits to the energy systems. For example, they can support system operations by providing services locally and alleviating the need for traditional network upgrades. On that purpose, different services will be developed, implemented and validated, leveraging data from different community actors. Furthermore, some of the services will also be shared amongst communities and even with other actors such as RES and flexibility families

Societal impact foreseen

Thanks to the data space in OMEGA-X, it will be possible to develop the following services that also have a societal impact:

- Services for optimum LEC operation including water losses detection, thermal losses detection and benchmarking services across communities to compare operation in similar operating conditions, identify potential inefficiencies and help in decision making process for future investment planning.
- Grid services (frequency and voltage control) by aggregation of several LEC.
- Gamification services to foster customer participation and influence end users' consumption patterns (load shifting) for increased energy saving and decarbonization.

- Services for thermal comfort in buildings supplied by DHC including thermal energy generators models that translate the LEC thermal demand to the needed energy (electricity, gas).
- Forecasting services to predict electricity production by RES, specifically PV at LEC level.
- Service for optimizing self-consumption of renewable energy at LEC level. For instance, by optimizing the charging/discharging schedules of a lithium-ion battery but also switching to other energy carriers as boosters.
- Service for optimal flexibility offer at LEC level, in order to schedule loads, generators and storage systems, allowing LEC participation in flexibility markets.
- Planning services for evaluating different decarbonization scenarios (from 2020 until 2050) based on the combination of alternative strategies and actions and evaluate the impact of energy storage in alternative scenarios (electric vehicle batteries, hydrogen, etc).

Electromobility

Description

The purpose of the electric mobility use cases is to set up services that facilitate the development of the use of electric vehicles, by simplifying the customer experience while roaming or even by proposing an innovative mode of consumption for people with home production. The first use case must make it technically and functionally possible for users of electric vehicles to reserve charge points throughout Europe: standardisation of exchanges between mobility service providers and charge infrastructure operators will facilitate interoperability and give everyone access to European charge points in a transparent manner (price, actual availability, reservation, etc.). The second use case, which is more innovative (and prospective), details the data and certification exchanges necessary to enable the implementation of a service in which a user of an electric vehicle would see the billing of his charge take into account the energy that will have been produced at his home by solar panels at the same time.

Actors, stakeholders and wider ecosystems

- Service user: electric vehicle users, prosumers.
- Service and data providers: electric mobility service providers (EMSP), charging point operators (CPO), interoperability service providers, distribution/transmission system operators (DSO/TSO), metering point operator (MPO) if this responsibility is not held by a DSO/DTO.
- Other parties involved: Granular Certificate of Origin Registry, Granular Certificate of Origin Platform

Roles and interactions

In a nutshell, the main role put forward in the use cases of electric mobility is the mobility service provider (which can also take on other responsibilities, if it has its own charge points for example). The end-user is in direct relation with the EMSP and the latter, through data exchanges with the other actors implemented in the use cases, renders the service to the end-user in a transparent way.

Expected barriers and challenges for collaboration and implementation

The main problems or barriers that are seen in this electromobility use case domain are technical, functional, or economic.

Technically it is necessary to standardise the exchange of data handled by the various infrastructure operators (both for static and dynamic data). There is already a set of standards covering different parts of the ecosystem but it is clear that interoperability is not easy to achieve.

Functionally, it is necessary to ensure that the data provided are valid (i.e., close to the observable reality, in almost real time from the user's perspective). Thus, the latencies of updates must be reasonable and the possible problems of coherence (reservation finally impossible, charging point having a new status, …) transmitted to the end user in a fluid and fair way. This requires finding a good balance (neither too slow, nor too complex or expensive).

Finally, from an economic point of view, it will be necessary to look at how the remuneration of the service is shared between actors and to ensure that the transparency for the end user is compatible with the business secrecy for the commercial parties involved.

User oriented activities planned

The work planned in the electromobility family does not currently contain activities in which end-users (users of electric vehicles) would be consulted or targeted by dedicated communication. There is a potential for working with end users in the use case to capture possible sociocultural barriers for implementation and to increase the quality of the services offered through integrating feedback from end-users.

Societal impact foreseen

We expect several societal impacts:

In general, anything that can make life easier for electric vehicle users (finding available charge points while roaming; buying at the best price by being able to take advantage of surplus production at home) will have a positive impact on society and will allow us to move forward in the direction of decarbonizing our economies.

The services associated with the reservation of charge points will also accompany the rationalization of the deployment of charging infrastructures and their use: Drivers will be able to more easily find free infrastructures nearby or at their destination, which they would not have seen without these services; infrastructure operators will see their charge points more often solicited and will have more visibility on the demand for charging.

Finally, for the energy market players, the deployment of the two use cases of our Mobility family should also have positive impacts: better estimation of network demands in the first case (use case reservation), making it possible to exploit flexibilities; incentives to synchronize consumption with production in the second case, or even encouragement to deploy solar production means at home (roaming of consumption)

Electric mobility, which can be seen as a source of difficulties for the electricity network, will thus show that it is more of a solution than a problem.

Flexibility

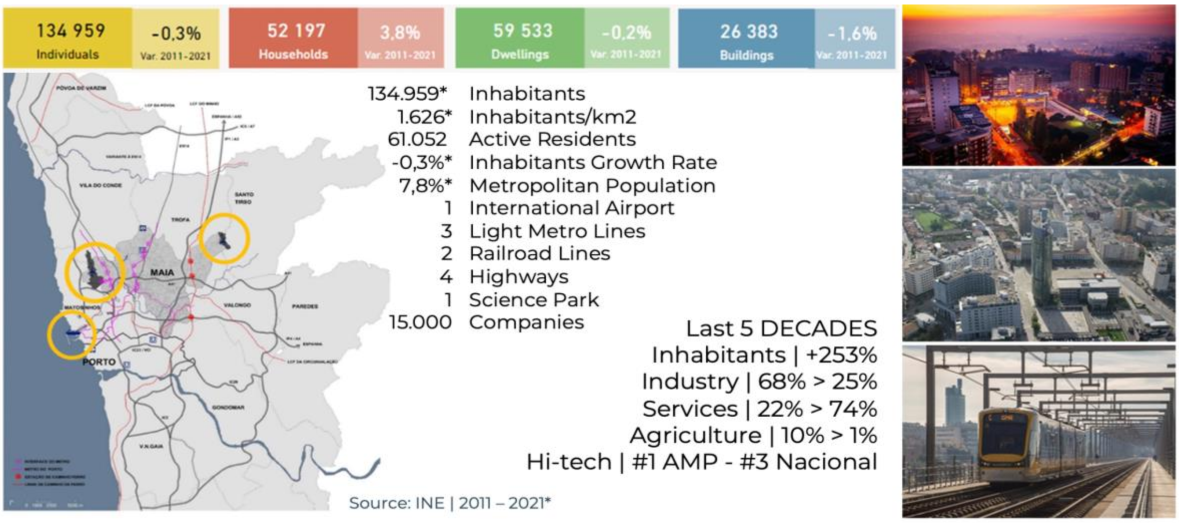

Figure 6. Flexibility pilot site. Maia Municipality

Description

In energy systems, flexibility is linked to the ability a power system has in adjusting its consumption and production to a varying electricity demand both anticipated and unanticipated. Currently electricity produced from renewables cannot be stored efficiently, therefore we can, for instance, shave peak hours and smoothen the energy demand by moving some of the consumption to off-peak hours. The end goal is therefore to provide flexibility while optimizing some cost function, such as by minimizing the cost of production through renewable usage.

Flexibility benefits from data spaces in the sense that it requires a high-level of information integration between different partners, which will be highly accelerated through a common data space simplifying and reducing the burden of many managerial, bureaucratic, and technological aspects of the data exchange. Examples of information exchanged include consumption and production of all network nodes periodically, information from weather stations, information from advanced analytics and predictive services, models already trained, energy consumption/production profiles, information on how to activate and deactivate consumption and production remotely of specific resources, among others.

Actors, stakeholders and wider ecosystem

This Use Case Family will be led by EDP and will have one pilot site located in Portugal, in the municipality of Maia, in Porto region. The University of Maia, ISMAI, will be helping Maia throughout the project. Tecnalia and Odit-e will be the service developers and most of the data with be provided either by the municipality of Maia or E-Redes (EDP).

Maia municipality is within the metropolitan area of Porto and has 135.000 inhabitants. Maia is one of the most industrialized municipalities of Portugal and an important transportation hub. Maia began seriously paving the way to be a sustainable city in 2012, first by tackling energy issues and in 2014 by creating the Sustainable Energy Action Plan addressing the RES penetration, energy efficiency, CO_2 emissions, mobility, citizen’s engagement, among others. In Maia municipality there are a few production and consumption endpoints that can be used as a source of flexibility that will be the basis for our pilot. These are briefly listed next:

Production sources:

- PV generator of municipal pool.

Consumption sources:

- Maia Forum (public building): HVAC, pumps, and rest of consumption appliances;
- Municipality EVs (Electric Vehicles) car fleet;
- Other public buildings.

Roles and interactions

In terms of partners and their interactions, the roles will be:

- Maia will be the prosumer, providing and using data;
- ISMAI (University/RTO) will be a facilitator and a data provider;
- EDP will be the energy supplier, a facilitator, and is also the owner of E-REDES;
- E-REDES is the DSO and the flexibility market operator, providing and using data;
- Tecnalia will be the flexibility service provider;
- Odit-e will be the analytic service provider.

Barriers and challenges for collaboration and implementation

Possible barriers and challenges foreseen for implementation, especially those related to culture, user behaviour and mindset, society, governance, and ethics:

- No user perception of the consumption profile of resources (consumption over time);
- No user perception of what resources can be used as a source of flexibility;
- Maybe the customer not satisfying his/hers needs immediately will translate into a perception of the decrease of living standards;
- Perceived lack of control over certain types of consumption resources (from the user perspective: when will the consumption occur? for example: What if I need my electric car sooner than expected?)
- Possible disputes over the limited renewable resources available between the customers. Who has priority over cheaper energy?
- (Maybe Technical barrier) Lack of data points in the grid (for example, smart meters); lack of periodic data from these points; lack of certain types of data;
- What type of security problems will these systems create?

User oriented activities planned

On user and stakeholder perspectives, including key stakeholders and wider ecosystem, also thinking of the household, community, and policy level, some actions include:

- Maia began seriously paving the way to be a sustainable city in 2012, first by tackling energy issues and in 2014 by creating the Sustainable Energy Action Plan addressing the RES penetration, energy efficiency, CO2 emissions, mobility (including soft mobility, promotion of public transport, e-mobility, among others), citizen's engagement, among others;
- Empower, educate, and promote participation of consumers on their role in the energy transition.

Societal impact foreseen

Activities in the Use Case Family have the following social and cultural elements expected to lead to societal impact:

- Citizens empowerment and active participation in the green and energy transition;

- Improved climatization of public building and schools;
- Thermal management and climatization of social housing;
- Reducing the public energy bill.

Other expected societal impacts of the pilot:

- This use case will enhance new market roles, market participants and energy communities leveraged by the stakeholder's participation and enable the appearance of innovative business models (increased acceptance and participation of consumers on data sharing for energy services), triggering economic and social value from it.
- It is expected, as well, to achieve territorial planning objectives through a pooled process and structured sharing of information between producers, local communities, and network managers.

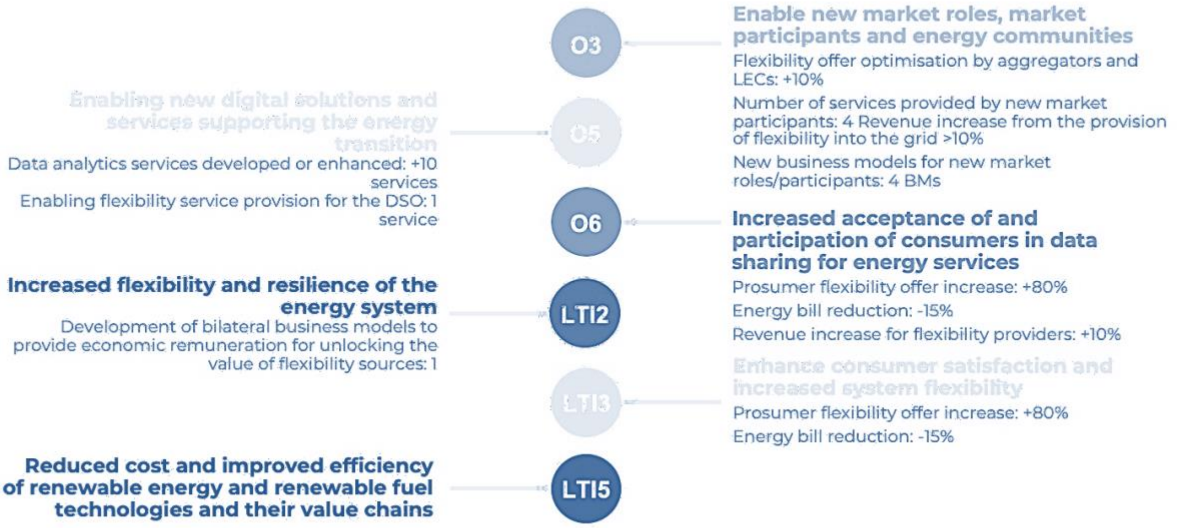

Figure 7. Flexibility Use Case Expected outcomes and long-term impact

4. Principles & Methods for User Engagement

Principles for user engagement

The Consumer and Citizen Engagement Working Group under the BRIDGE initiative has collected and analysed experiences from previous European R&I projects in the publication "Exploration of citizen engagement methodologies in European R&I projects" from April 2021.

First, the report recommends working with existing collective actions where there may already exist interests among citizens towards supporting research and innovation projects. An important advantage of this is also that such groups already have existing social bonds and habits which support collective action.

Second, it is noted that the consumer and stakeholder engagement often benefits from established legal forms that can sustain the citizen engagement over time – especially allowing activities and collective actions to be concrete. These legal forms often build on democratic governance which provide a community leader with legitimacy through transparency and representation. Further, democratic processes are also fruitful for involving and educating the members of the community.

There has been quite limited exploration of different types of legal forms for organising the user engagement. Often different variations of cooperative legal forms or institutional models and participatory governance models inspired by cooperative principles are used.

Third, use case leaders should be aware that citizens' collective governance system and limited technical knowledge implies that the needs of citizens organisations are different from typical businesses. It is therefore important to emphasise the need of R&I projects to systematically map and understand the needs of citizens and their communities.

When it comes to the various citizen groups, these will have different characteristics, capabilities and needs dependent on the specific context. Therefore, the appropriate indicators may vary between use cases. The BRIDGE report highlights a focus on social indicators related to group formation and decision rules and not only traditional financial and technological indicators which often have been the primary focus of European R&I projects.

This is related to the point that **community value** should be a key focus point as opposed to a narrower market-oriented focus.

Toolkit for user engagement & empowerment of citizens in energy projects

We can structure the citizen engagement process intro into four phases:

1. Defining successful outcome of the use case
2. Identify, map and develop an initial understanding of stakeholders
3. Engage with stakeholders
4. Monitoring the effects of stakeholder engagement and feeding back of the project's results to the involved communities

PHASE 1 – Creating awareness of how stakeholders will contribute to success

The first task is to define what is the successful outcome of the use case? In this definition, identify how the use case concept contribute to achieve the overall OMEGA-X aims, especially Objective 9: OMEGA-X has as objective to integrate a user centric and collaborative approach throughout the project's lifetime.

This first phase of definition may to some appear trivial, but this is not necessarily the case. It is important because it forces use case leaders to be explicit about the aim of the use case and its relation to the project objectives and KPIs. This awareness lays the foundation for understanding the role of citizens/users/stakeholders in achieving success. It is important to be explicit about that the stakeholder engagement and influence is not a nice-to-have add-on to a successful technical outcome, but an integrated part of a successful outcome. Without technology adoptions, there is no technology. And without happy adopters there are no technology successes. Understanding how use cases contribute to OMEGA-X objectives is the first step towards understanding how citizen involvement can contribute to a successful use case.

PHASE 2 – Identify and categorize stakeholders

When the successful outcome of the use case is clarified, the second step is to map stakeholders and identify their role in context of the aim of the use case. Who is important to a successful outcome? Why are they important? In mapping the stakeholders, it is important to recognise that OMEGA-X operates across two physical levels; data and energy. Each of those level have their own systems with producers/providers, distributors, users, regulators, traders, etc. The two systems have already existing technical integration and overlaps of actors.

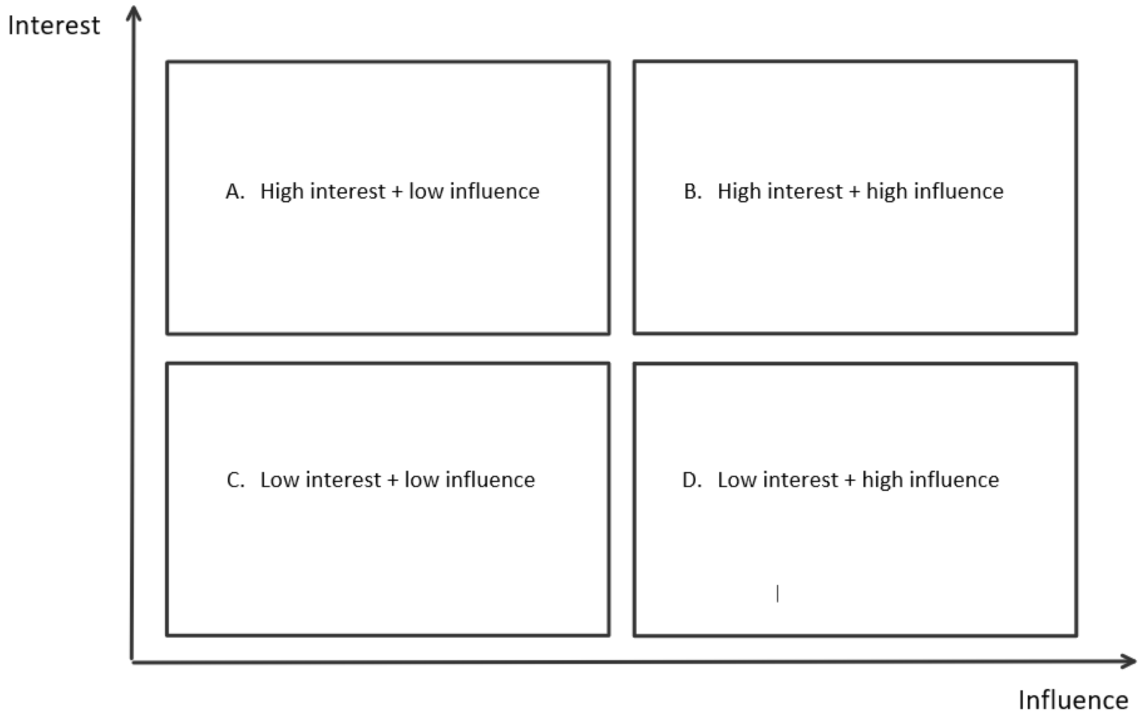

Figure 8. Framework for categorising stakeholders (adapted from Gardner 1988)

The presented mapping tool is a traditional tool in the sense that it has been widely used. A potential pitfall of the approach is that it may implicitly make the use case leader treat each stakeholder or stakeholder groups as individual or isolated entities. Depending on contextual factors, there may be strong social links between different stakeholders meaning that your pool of stakeholders should also be understood as a social ecosystem where relations between them often are important for the social dynamics. Explicit considerations on these relations should be ongoing throughout the project. Note that these relations will often be informal but also can shaped formally in legal forms of communities as highlighted in BRIDGE experiences.

Once categorizing the initial mapping of stakeholders has been initiated, a wider description of the stakeholders and their roles in relation to the project can be approached in a structured way. This mapping of stakeholders should range from who they are, their relation and role for the project, their expectations and interests, considerations on how they can be engaged, when to engage them and in what form of engagement. 3 lists these themes and related questions to help reflection on these issues.

Table 3. Approach for describing stakeholders

Theme	Questions for reflection of engagement strategy
Stakeholder	Name of stakeholder/ organisation
Purpose of engagement	Why are you engaging the stakeholder? Which role does the stakeholder play for a successful outcome of the use case?
Stakeholder impact and influence	How high/low is the influence and impact on the use case objectives? (refer to the mapping exercise)
Engagement strategy	How can the stakeholder be engaged? What are the expectations from the use case management about the stakeholder?
Key concerns, interest, and expectations	What are the stakeholder's key interests and concerns? How does it fit with the expectations from the use case management?
Key relations to other actors	Which key relations to other actors in the social ecosystem can you identify? What is the likely significance of this relation, and which influence may the relation have?
Timing and frequency of engagement	When and how often will the stakeholder be engaged?
Form of engagement	In which form will you engage with the stakeholder?

In practice, the above approach may be organised in a template, as shown below.

Stakeholder	Purpose of engagement	Stakeholder influence & impact	Engagement strategy	Key concerns, interest, and expectations	Key relations to other actors	Timing & frequeny of engagement	Form of engagement
Name of stakeholder/ organisation	*Why are you engaging the stakeholder? Which role does the stakeholder play for a successful outcome of the use case?*	*How high/low is the influence and impact on the use case objectives? (refer to the mapping exercise)*	*How can the stakeholder be engaged? What are the expectations from the use case management about the stakeholder?*	*What are the stakeholder's key interests and concerns? How does it fit with the expectations from the use case management?*	*Which key relations to other actors in the social ecosystem can you identify? What is the likely significance of this relation, and which influence may the relation have?*	*When and how often will the stakeholder be engaged?*	*In which form will you engage with the stakeholder?*

Figure 9. Suggestion for a template for structuring the stakeholder mapping.

PHASE 3 – Engaging with stakeholders

When approaching and engaging with stakeholders, the work may take point of departure in the seven principles for stakeholder engagement developed by the Horizon 2020 project OrganiCity [10]. These principles will be presented below and put into context of experiences from other projects. Further, it is recommended to develop procedures to systematically track and reflect on the information and learnings which can be derived from the engagement activities, and how it can be used for the technological development. A suggestion for a structure for keeping a log of activities is outlined in the end of the section.

OrganiCity's Seven principles for engaging with stakeholders [11]

Principle 1: EMPOWER ADJACENT COMMUNITIES AND CHAMPION ADVOCATES

Instead of developing new communities from scratch, we focus on empowering the people who are already doing innovative work and are actively involved in similar areas.

Principle 2 DESIGN FOR TRUST, ESPECIALLY AROUND CHANGE

Trust is an essential factor for successful co-creation. Foster confidence through every stage of the engagement journey through clear communication and credible action. Human interaction builds and sustains trust better than money or power, so engage on an emotional level with people.

There are two kinds of trust that need to be developed and maintained over the course of your engagement journey: trust between the people involved, and trust in the project. In both cases, trust can be fostered through open and transparent communication, personal interaction and by acting reliably.

Principle 3 FACILITATE PERSONAL AND COMMUNITY OWNERSHIP

The best way to build interest is to allow the community to take ownership of the goal: build a shared vision of what it should be and include them in the process of making the vision a reality. In the end, the outcome will be more resilient because everyone would have a vested interest in this.

Principle 4 DEBATE AND CO-CREATE ACROSS COMFORT ZONES

Diversity is a powerful driver of innovation. People with different perspectives, experiences and skills have the creative potential to solve problems. Including diversity amongst stakeholders breach silos between sectors, and encourage the cross fertilisation between initiatives and groups. Successful co-creation requires diversity, willingness for people to step outside of their comfort zones and maintaining an open dialogue.

Principle 5 USE CHALLENGE AREAS AS CATALYSTS FOR INNOVATION

"Data" is not easy to understand nor to engage with – particularly if we wish to include citizens and users with different backgrounds and experience. Working with challenges around themes that resonate with citizens daily lives, interests and concerns will foster dialogue, ideas and involvement.

Principle 6 RESPECT THE VALUE OF VENUE: THE RIGHT SPACE AT THE RIGHT TIME

Selecting the right space and time for your activities requires an understanding of your needs and the needs of the community you are engaging with. Ask yourself if your goal is fulfilled with a one-off event or further events over time. Think about the room size you need and on which time of the day to invite people. Since our physical and virtual spaces are increasingly overlapping and interconnect; people expect a fluid and transparent experience across the digital and physical world.

Principle 7: PROVIDE A CLEAR JOURNEY FOR PARTICIPATION AND VALUE VISIBILITY

Make all stages of the project accessible to guarantee effective co-creation. Provide a clear visibility of the journey: what stage are we at and what will happen next? Stakeholders give generously of their time, contributing ideas, comments or learnings. Correspond their contribution by clearly communicating where their efforts will lead.

PHASE 4 – Monitoring (the output of) stakeholder engagement and feedback loops to the users

Phase 4 acknowledges the importance of following up on the stakeholder engagements that have found place during the piloting, ensuring that the involved stakeholders are informed about the outputs of the engagements. Where possible, users and stakeholders should be invited to engage with the results and output, and to provide further feedback and comments. Also, on an impact level, it is necessary to systematically record the user engagements and to follow and describe the results of these engagements and the possible positive (and negative) changes for citizen's everyday lives the project has evoked.

Human-centred solutions and pathways for societal impact

OMEGA-X Objective 9 aims at integrating a user-centric and collaborative approach throughout the project's lifetime. This integration is targeted at three different levels in the project: At the **pilot level**, as described above, at the **collaboration level** as described in the first part of this deliverable, and the **impact level,** addressed in this section. As the above discussed findings of BRIDGE show, many EU funded projects addressing energy systems add a SSH approach and user engagement activities only in the final phase of the project. OMEGA-X strives for an early integration to ensure that the necessary activities and engagements are built in the pilots and the project and that not only a technological, but also societal impact can be achieved.

In the preparation phase of the pilots, SSH related activities will focus on four areas:

1. Stakeholder and user engagement: Guiding the pilots in identifying opportunities and pathways for value creation for user engagement and cocreation activities, especially also on a community level.
2. Ecosystem level: Societal impact on a community level can be achieved by engaging with existing communities that work on similar issues, as well as local governmental institution that have set green and social priorities for the near future and can integrate the findings of OMEGA-X in relevant activities delivering on their goals. An example is the role Maia municipality plays in the Flexibility use case.
3. Policy level: Societal impact can also be achieved on a higher level, by the formulation of policy recommendations based on the learnings of OMEGA-X and other projects that have an impact on society.
4. Project level (internal): Already in the initial phase identifying qualitative and quantitative KPIs so planned activities can tune in towards achieving these KPIs, and in the end societal impact. 4is a first attempt to list a few possible Key Performance Indicators that directly and indirectly can be found in the DoA and in the descriptions of the pilots. This work will be continued and finetuned in later project stages.

Table 4. Preliminary overview of possible KPIs for societal impact

OMEGA-X KPIs for Societal impact (DoA)	OMEGA-X Use Case Families			
	Renewables	Flexibility	Energy Communities	Mobility
Number of stakeholders sharing data/services involved	>7	>7	>7	>7
Number of locations involved	>2	>2	>2	>2
Number of Energy Communities involved	#	#	#	#
Collaboration with use cases in sister projects	#	#	#	#
Services that increase quality of life in pilot site	#	#	#	#
Incentives for communities & companies to adopt a collaborative approach	#	#	#	#
Increased acceptance and participation of consumers on data sharing for energy services	>%	>%	>%	>%
Trust in data sharing increased amongst stakeholders	>%	>%	>%	>%
Energy affordability for citizens	>%	>%	>%	>%
Decrease of energy poverty	<%	<%	<%	<%
Citizens' access to energy services	>%	>%	>%	>%
Diversity amongst stakeholders (including gender balance)	>%	>%	>%	>%
Increased consumer satisfaction.	>%	>%	>%	>%
New energy services developed in collaboration with consumers and citizens.	#	#	#	#
Policy recommendations delivered that have the potential to increase citizens quality of life.	#	#	#	#

5. Conclusion

This handbook outlines the building blocks that are needed to deliver towards OMEGA-X Objective 9 "Integrating a user-centric and collaborative approach throughout the project's lifetime". This approach will ensure that OMEGA-X contributes to the European ambition to empower citizens and communities in the green energy transition. The handbook has presented best practices for user engagement, as well as pathways to achieve societal impact: Based on interviews with the Use Case Family leaders and written contributions, a first description of the pilots in terms of user engagement, possible barriers for data sharing and implementation, and societal impact was provided. The descriptions of the Use Case Families show a large variety concerning the sector, technologies, challenges and stakeholders. The pilots are still in their preparatory phase. So far, only the Use Case Family Local Energy Communities (LEC), has planned for concrete activities for user engagement. This handbook hopes to encourage Use Case Family leaders to look at various forms and pathways for working with users, communities and societal impact and the building blocks presented here will be further developed in cocreation processes with the pilots through activities in later project stages.

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