TwinERGY – European Projects Innovation and Cooperation roadmap

D3.1

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Deliverable

PROJECT ACRONYM	GRANT AGREEMENT #	PROJECT TITLE
TWINERGY	**957736**	**Intelligent interconnection of prosumers in positive energy communities with twins of things for digital energy markets**

DELIVERABLE REFERENCE NUMBER AND TITLE

D3.1
TwinERGY – European Projects Innovation and Cooperation roadmap

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DISSEMINATION LEVEL

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Statement of Originality

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Executive Summary

This present document is D3.1 "TwinERGY – European Projects Innovation and Cooperation roadmap" of the TwinERGY project, funded by the European Commission's Innovation and Networks Executive Agency (CINEA) under its Horizon 2020 Research and Innovation programme (H2020). The aim of this report is to present the interactive discussions of TwinERGY project with BRIDGE Working Groups (WGs) of Data Management, Regulation, Customer and Citizen engagement. The TwinERGY approaches are described to accommodate data management, regulation and customer engagement issues along with the respective methodologies and recommendations of BRIDGE WGs. The report provides a methodological step-wise approach and a roadmap towards establishing cooperation of TwinERGY with common approaches in an effective manner. As first key activity to set and prioritize objectives as well as to recognize threats and opportunities based on BRIDGE initiatives and experience, this report identified multiple recommendations per WG. At the Data Management particular effort shall be given on handling of sensitive data their access and storage as well as to assure cyber-security and privacy policies for any data exchanges in all layers on interoperability of Smart Grid Architecture Model (SGAM) framework. The increased need for data exchanges among multiple actors implies the requirement for interoperability in the communication and informational layer, fact which has also to be regarded at TwinERGY systems' design. In the Customer Engagement context TwinERGY presents a wide range of activities addressing the topic in a very efficient manner, while BRIDGE suggested the strategic approach of Involve, Engage and Evolve. At the Regulation level beyond the regulatory framework discussion, a suggestion of the report foresees cross-sector integration and the need for facilitating regulation for cross-sector exchange of any type of both private data and public data, e.g., through the means of regulation for data spaces and data interoperability implementing acts.

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1 Introduction

This Chapter provides an introduction on the scope of the document as well as its structure.

1.1 Scope and structure of the document

This report aims at providing an overview of the main BRIDGE Working Groups and their key activities and outcomes as a matter of identifying the relevance with TwinERGY's project common approaches. Therefore, the TwinERGY's project key objectives on the same topics are also presented along with the methodological approach to establish cooperation among TwinERGY and BRIDGE activities. The common approaches applied during the TwinERGY project have been shared with BRIDGE working groups activities in order to obtain useful feedback for the TwinERGY project itself.

This report is organized in three main Chapter as follows:

- Chapter 2 which provides an overview on BRIDGE and its subsequent Working Groups along with the methodologies followed in TwinERGY to approach data management, regulation and customer engagement topics,
- Chapter 3 that entails the perceived interaction of TwinERGY with BRIDGE Working Groups, providing a set of potential recommendations for TwinERGY
- Chapter 4 that provides the concluding remarks of this report.

1.2 Abbreviation list

Table 2 presents the main abbreviations used in this document.

Table 1. Abbreviation list

Acronym	Full Name
AMI	Advanced Metering Infrastructures
CAPEX	Capital Expenditure
CE	Citizen Engagement
CDMP	Core Data Management Platform

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CIM	Common Information Model
DER	Distributed Energy Resources
DR	Demand Response
DSF	Demand-Side Flexibility
DOS	Denial-of-Service
GDPR	General Data Protection Regulation
HERM	Harmonized Energy Role Model
HEMS	Home Energy Management System
ICT	Information and Communication Infrastructure
SM	Smart Meter
WG	Working Groups
TEP	Transactive Energy Platform
OPEX	Operational Expenditures

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2 Relevance with BRIDGE initiatives

This Chapter aims at presenting the orchestration of the BRIDGE Working and their main activities. The TwinERGY's project key objectives on the same topics are also presented, while the methodological approach to establish cooperation among TwinERGY and BRIDGE activities.

2.1 BRIDGE Working Groups

BRIDGE is a European Commission's initiative that aims to bridge Smart Grid, Energy Storage, Islands and Digitalization Projects, creating a structured view of cross-cutting issues. BRIDGE is organized along four working groups; namely Data management, Regulation, Business models and Consumer and Citizens engagement, that collectively provide the outcome of their work and openly discuss on what topics to collaborate the forthcoming year(s). The main goal of BRIDGE initiative it to promote the orchestrated coordination of all the four working groups for the preparation of reports with essential recommendations for the European Commission on various topics of the energy sector aiming at facilitating the uptake of digitalization technologies, as a matter of achieving the goals of the Green Deal.

A brief presentation of the four main WGs of BRIDGE is given below, presenting their strategic goals as structed in [1].

Data Management

The Working Group on Data Management is working on:

- *Information and Communication Infrastructure (ICT)*, capturing the technical and non-technical standpoint of the communication infrastructure necessary for exchange data requirements, including information interchanges issues that are essential to achieve TSO and DSO coordination,

- *Cybersecurity and Data Privacy*, entailing data integrity, customer privacy and protection,

- *Data Handling*, including the framework for data exchange and related roles and responsibilities, together with the technical issues supporting the exchange of

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data in a secure and interoperable manner, and the data analytics techniques for data processing.

This working group is composed of three main actions as it is depicted in Figure 1.

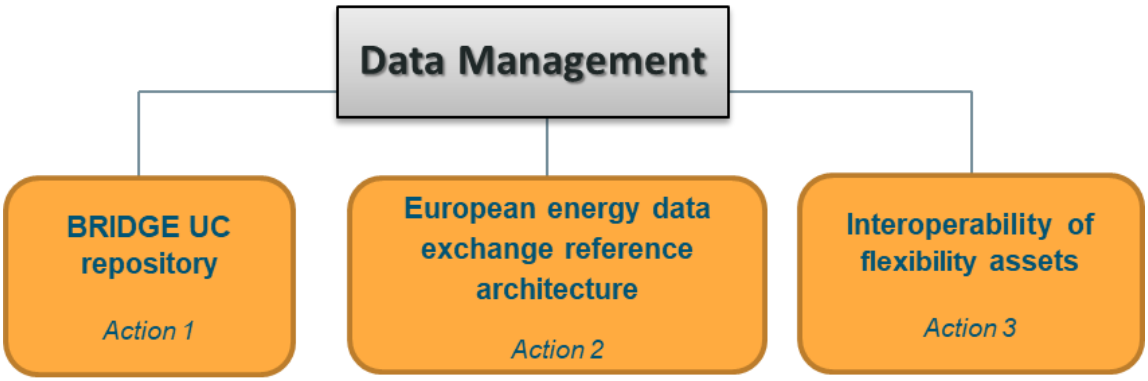

Figure 1. Data management workflows composition

BRIDGE Data Management action 1 aims at creating an easily accessible use case repository for any relevant R&D projects. This can support activities to develop and agree (high-level / specific) use cases, originated from previously participated BRIDGE projects as well as newly initiated ones. The purpose of this repository is to explore data use cases and interfaces – from the aspect of e.g., access to data, market for flexibilities, operational planning data, forecasting and services related to end customers-. The activities of this workflow do provide an input to other BRIDGE topics (e.g., interoperability, data exchange architecture, cybersecurity *etc.*). The repository may be also exploited for data maturity and integrity assessment towards the potential implementation of use cases foreseen and developed.

The European energy data exchange reference architecture action aims at developing a conceptual European data exchange model beyond the electricity sector (i.e., exploiting cross-sector synergies), including functional elements such as data governance, data access and standardization requirements. The core activity is to define the interoperability among platforms ensuring GDPR compliance and data owner's control over their data. This task is foreseen to elaborate new data roles considering the provision and extensions of Harmonized Energy Role Model, as well to apply the Common Information Model (CIM) for operations that are for TSO-DSO coordination and suggest possible extensions.

The last action on Interoperability of flexibility assets works towards the definition of a methodology that will allow the thorough analysis of BRIDGE projects use cases (including system use cases) and their anticipated implementation by mapping them onto a reference framework. This reference framework is composed of three generic business processes

including (1) the provision of flexibility for System Operators through an open market, (2) the provision of flexibility for System Operators via a prior bilateral agreement, and (3) the provision of flexibility for Balance Responsible Parties through an open market.

Customer and citizen engagement

The Working Group on Consumer and Citizen Engagement deals with the following topics:

- Consumer Segmentation, analysis of cultural, geographical and social dimensions
- Value systems – Understanding Customers
- Drivers for Consumer and Citizen Engagement
- Effectiveness of Engagement Activities
- Identification of what triggers behavioral changes (e.g., via incentives)
- The Regulatory Innovation to Empower Consumers

This working group is currently composed of the following main actions as it is depicted in Figure 2.

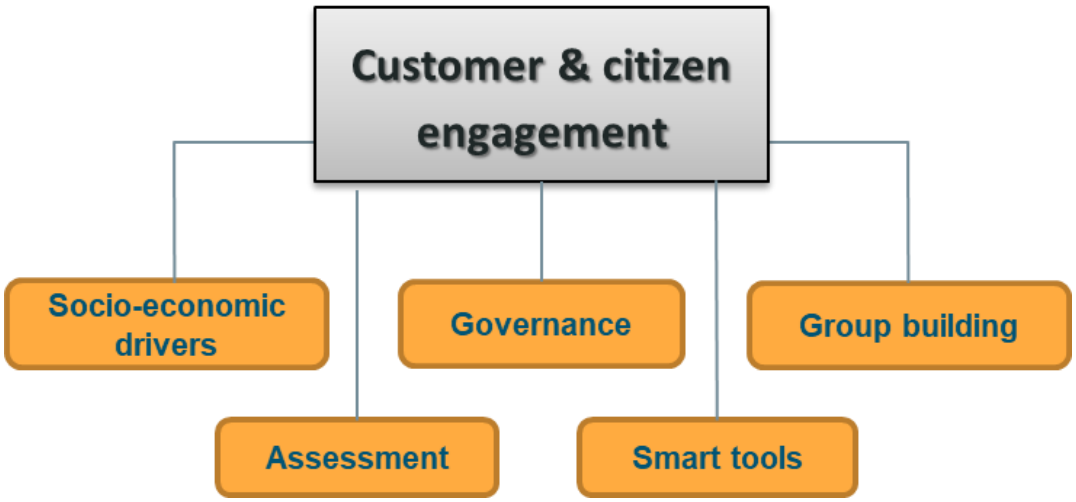

Figure 2. Customer and citizen engagement workflows composition

Regulation

The Working Group on Regulation works mainly on the following topics:

- The regulatory framework required to provide clear rules and responsibilities on ownership, competition, technical modalities and financial conditions, for island and mainland cases, for energy storage technologies.

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- Regulatory challenges regarding the incentives for demand-side response, commercial arrangements, cooperation with TSO and DSO, smart meter data, and other barriers affecting smart grids.

Business models

Business Model working group has been inactive since mid-2019. Nevertheless, this WG was reactivated during the 2021 BRIDGE event. The Business Models working group aims at:

- Defining common language and frameworks around business model description and valuation

- Identifying and evaluating existing and new or innovative business models from the project demonstrations or use cases

- The development of a simulation tool allowing for the comparison of the profitability of different business models applicable to smart grids and energy storage solutions is being developed and tested by the Working Group members

2.2 TwinERGY project

TwinERGY aims at introducing a first-of-a-kind Digital Twin framework by incorporating the required intelligence towards the local optimization through Demand Response (DR). The participation of end-users in DR schemes is foreseen to take-place without distorting their well-being and comfort-level, defined by multiple vectors, of consumers in their daily lives.

The project explores new business options in regard to DR schemes by proposing optimization tools and real-time decision-making tools incorporating Distributed Energy Resources (DER) for the energy management of systems.

To increase citizen and customer participation in such innovative schemes and services and after all representation in the energy marketplace(s), certain best practices for citizen engagement are set in place (more in information in Chapter 3). Concurrently, TwinERGY will design, implement and integrate a sophisticated suite of innovative tools, modules and services to steer end-users, enhancing their awareness providing near-real-time monitoring of consumption patterns, energy habits, generation/demand forecasts, and information about shared DERs. This is foreseen to be performed by imparting local intelligence via

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properly established Digital Twin-based Consumer-Centric Energy Management and Control Decision Support mechanisms, towards the optimization of DR participation. All such functionalities are essential to support the end-user's proper understanding of their consumption and generation profiles (i.e., if micro/mini generation is installed), and subsequently their potential capacity to offer Demand-Side Flexibility (DSF) in balancing and other ancillary services marketplaces.

The TwinERGY project thoroughly explores new potential business models and formulations to support the widespread implementation of DR. End-users' enhanced engagement is not solely the solution to promote DR flexibility; therefore, new business models are investigated, mainly, via the introduction of new stakeholders (e.g., aggregators/local energy communities). These may represent end-users in energy markets, taking over the subsequent processes such as technicalities on market mechanisms, forecasts, energy transaction *etc.* Therefore, TwinERGY will propose an open and Transactive Energy Marketplace for populating DER and flexible resources and to allow the direct negotiation of aggregators (i.e., based on their contractual assignments) and marketplaces for flexibility procurement.

2.3 Methodological approach to establish connections with BRIDGE

The scope of this task is to utilize other projects' results and recommendations, and more specifically from relevant projects participating or having participated in BRIDGE initiative. It is worth mentioning that BRIDGE already provides, through its actions, a structured view of cross-cutting issues and several key recommendations by leveraging inputs received from dialogues with multiple relevant projects. Therefore, in order to establish this cooperation of TwinERGY with common approaches in an efficient manner, a plan has been posed with some methodological steps as follows:

- **Step-1:** Define and prioritize objectives,
- **Step-2:** Identification of threats and opportunities,
- **Step-3:** Create Action Steps-Define synergies facilitating the objectives,
- **Step-4:** Provide a schedule/timeline for actions,
- **Step-5:** Measure the progress.

The methodological approach to address these five steps is illustrated in Figure 1, as a matter of creating an interactive communication with BRIDGE Working Groups (WG).

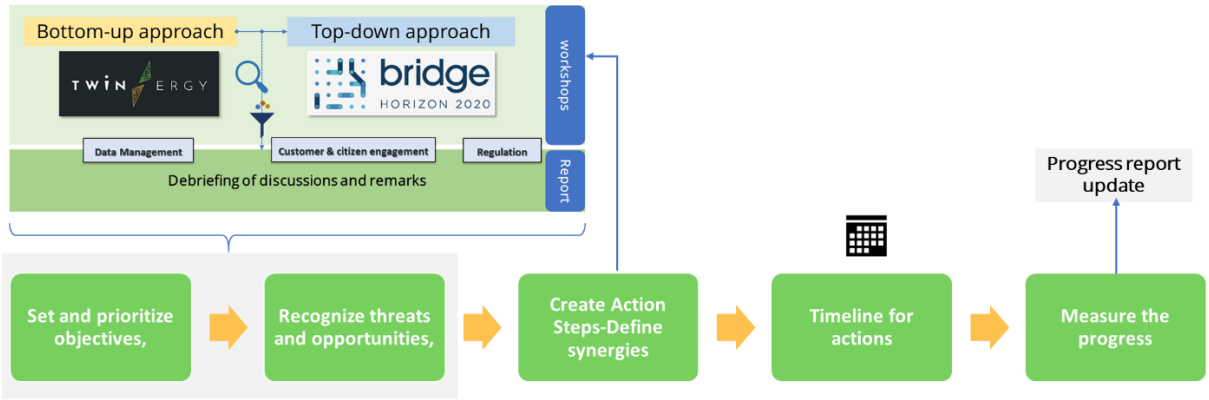

Figure 3. Methodological approach followed in Task 3.1.

Steps 1-2

The first two steps rely on the exploration of potential topics and objectives of interest as well as the identification of threats and opportunities on common approaches are addressed concurrently. Within the two first methodological steps, and as TwinERGY project is still in the design phase, the goal is to obtain feedback and recommendations useful for the emerging TwinERGY concepts and their subsequent design. At BRIDGE level there are multiple reports and activities performed, which might be beneficial for TwinERGY's project approaches and implementation steps. Therefore, workshops were organized per each BRIDGE WG where the TwinERGY solution and planned methodologies were presented. This step provided a bottom-up approach collecting useful information per topic for TwinERGY along with open questions for discussion with the BRIDGE members. The opposite stream direction approach considered a presentation about key activities and recommendations per BRIDGE WG, where experts –already active members of the various BRIDGE WGs- tried to focus on the reports and key findings of BRIDGE that would prove useful for the TwinERGY project and the various relevant activities. The iteration with BRIDGE members resulted to several useful highlights for the TwinERGY project which are thoroughly discussed in Chapter 3.

Step 3

The definition of action steps is essentially part of the outcome delivered by the interaction with BRIDGE WGs. From one side TwinERGY project has representative partners to monitor and contribute the ongoing BRIDGE initiatives; on the other side the recommendations provided in the initial set of workshops with BRIDGE for the actual design and implementation steps of the project is considered as a very important activity. This methodological step is foreseen to be also enhanced with the open discussions with H2020 R&D projects i.e., INTERRFACE, OneNet, CoordiNET where further synergies and actions might be identified as part of Task 3.2 (to be reported in D3.2 respectively).

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Step 4

In regard to the timeline of all the foreseen actions, this is illustrated in Figure 4. In the first place, there are initial steps to determine the representative partners of TwinERGY in the BRIDGE WGs. Accordingly, a set of workshops was arranged to initiate interactive discussions with BRIDGE, as described above. The open discussion with other R&D projects is scheduled to take place on a regular basis, starting from month 12. Following this, a second iteration of BRIDGE-TwinERGY is expected to take place, in the form of a workshop/forum, and will be organized to discuss the refinements of TwinERGY and reflect them on actions of BRIDGE WGs. This will be conducted towards exploiting the findings, results and designed system and receive potential feedback from BRIDGE latest recommendations. Finally, the participation and contribution of TwinERGY in the BRIDGE WGs is a continuous task throughout the project is considered as the most important activity, as it gives the space for TwinERGY partners to contribute and learn from the BRIDGE activities. The timing –as an indicative plan- of all aforementioned activities is illustrated below:

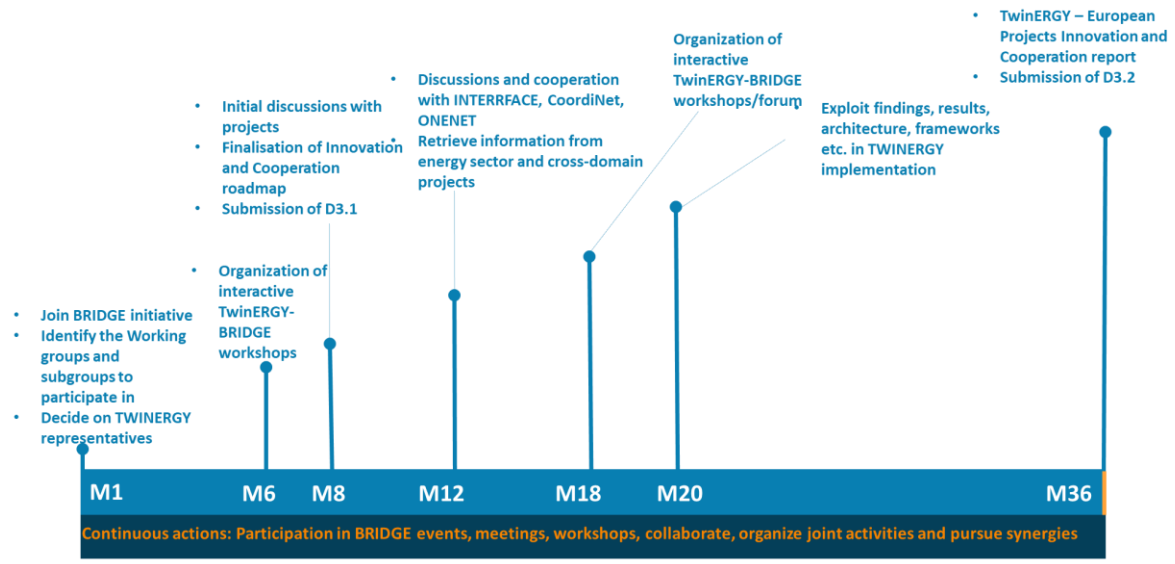

Figure 4. Timeline of past and anticipated next steps on the establishment of cooperation with BRIDGE & other R&D projects

Step 5

As a matter of monitoring the progress of the identified actions as well as to assess the participation of TwinERGY on BRIDGE initiatives, a progress report will be composed prior to each reporting period, based on the template and recommendations of the BRIDGE Secretariat and DG Energy. According to this, the information to be collected will contain all necessary information concerning the representation of TwinERGY on each WG combined with the estimated allocated effort, the actual involvement on BRIDGE reports, actions and recommendations. All such information will be reflected in the assessment report with

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lessons learnt that might be important for TwinERGY along with potential synergies with other BRIDGE projects.

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3 Analysis of results

This chapter presents the analysis of the iterative discussions of TwinERGY project with the three Working Groups of BRIDGE (i.e., Data Management, Regulation, Customer and Citizen Engagement). This analysis encompasses the common approaches of the BRIDGE platform as well as the current methodologies and practices adopted in TwinERGY. At the end of the presentation of the common BRIDGE and TwinERGY approaches, a set of recommendations are formed based on the discussions took place with BRIDGE Working Groups.

3.1. Common approaches based on interaction with BRIDGE experts

In this section there are presented common BRIDGE approaches as well as outputs from BRIDGE surveys per WG.

3.1.1. Data Management

As was presented in the chapter 2, BRIDGE Data Management WG deals with several topics from the definition of BRIDGE Use Case Repository, to the mapping of data exchanges into a reference framework into certain Business cases to examine interoperability issues, as well as to the development of a conceptual data exchange reference European architecture exploiting potential collaboration with cross sectors. These activities aim at:

- Examining interoperability issues through the mapping of data exchanges and comparing them to a reference framework
- Development of a European data exchange reference architecture to exploit potential collaboration across sectors.

In the iteration with the BRIDGE initiatives, several points from past BRIDGE activities were presented and the relevant ones were reported to be considered in TwinERGY project.
In regard to this WG, past seminal reports to be considered for TwinERGY's own work are the TSO/DSO coordination report [2] as well as the Cybersecurity and Resilience report [3].

TSO-DSO coordination topics

The report summarized some key points that might be interesting to be considered by BRIDGE such as:

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Regulatory concerns on TSO/DSO coordination

- DSOs should be actively incentivized to use DSF services.
- The process of products' standardization is still ongoing, yet certain degree of flexibility is deemed important, to limit hampering innovation and technology lock-in.
- Detailed products for congestion management should be developed.
- The tight link between market-based mechanisms for flexibility services and other regulatory and technical mechanisms, which prescribes proper management to avoid conflicting set-ups.
- All potential market designs including decentralized and distributed forms shall be investigated in the frame of existing and new system flexibility system services.
- The role of market operator and the subsequent degree of regulation should be regarded.

The same report provides recommendations for data management topics such as:

- The need to define "interoperability of platforms" focusing on data exchange among several actors including TSOs, DSOs, Flexibility Service Providers, Balance Responsible Parties, Market Operators, Regulators with the ambition towards replicability and scalability.
- Such data exchange among actors must be assured to follow GDPR policies and data owner's control.
- Review and refine the need for new data roles and harmonize them accordingly to be facilitated in Harmonized Energy Role Model (HERM) which provides the designation of a single name for each role and domain that are prevalent within the electricity market. This part is essential for the system's design (business and system use cases) to avoid confusions on the terminology of roles and actors.
- Data exchange between system operators (including DSOs) shall consider the CIM standards and propose extensions.

Cybersecurity and Resilience

It is essential when exploring data management issues to address data integrity, privacy and security of data providers as well as to assure security of the system as a whole. In BRIDGE such topics are analytically discussed in the Cybersecurity and Resilience report [3].

In brief this report covers the full data life-cycle by defining the following methodological steps:

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- *Data Capture*: the data is obtained from sensing devices and actuators or even through user input.
- *Data Exchange*: the process through which data is exchanged among assets or actors by relying on two primary layers of interoperability. The communication interoperability layer that regards the communication protocols and infrastructures for the dispatch of data from a data producer to a data consumer. The semantic layer interoperability refers to semantics of the message that is conveyed -including also ontologies-. Both layers are essential to be accounted for data exchange among the involved actors, and are important to be considered for the implementation of interoperable data exchange platforms.
- *Data Storage/Sink*: the data may need to be stored at the premises of the data consumer, e.g., for future use or to provide access to it to agreed third-parties. This data is observed to be stored "as is" or after post-processing e.g., to anonymize or aggregate it.
- *Data Access*: the access to the data is provided depending on the contractual agreements, the sensitivity of the data and the local regulation.

Based on this methodological approach for segmenting data processes, BRIDGE provided recommendations on the different data flows. Focusing on DSO to aggregator, aggregator to prosumer, prosumer to aggregator and prosumer to DSO. The goal is to create efficient interfaces on all levels (i.e., all interoperability layers of SGAM) but also exploring transversal requirements for interoperability, cybersecurity and privacy. From the iteration with BRIDGE, recommendations pertinent to the TwinERGY project were reflected and are presented in Section 3.3.1.

<u>European energy data exchange model</u>

The electricity sector has been undergoing a significant transformation that commenced with the continuous integration of distributed generation, renewables and storage, fact which has brought much complexity in each planning and operation stages following the active network management paradigm. Deploying digitalization technologies in the electricity sector, has been regarded of pivotal importance towards active network management in the electricity grid, enabling system operators (i.e., both Transmission System Operators (TSOs) and Distribution System Operators (DSOs)) to exploit the use of distributed resources in cost-effective and secure supply of electricity for all market participants. The emergent digitalization promotes end-users' active participation into marketplaces taking advantage of their DSF sources. This will inevitably create innovative new services, technical solutions, products and marketplaces [4].

The European energy data exchange model captures these emergent technological and business changes into the electricity grid and proposes several recommendations for the conceptualization of data exchanges among multiple actors, facilitating the integration with other sectors such as water and gas. Based on [4] data exchange platforms may be perceived as a middleware framework that bundle versatile processes, information exchanges and data management and integration for a more consumer-centric power system.

Some of these relevant recommendations were reflected to TwinERGY project during the discussions and are presented in this report in Section 3.3.1.

3.1.2. Customer engagement

The BRIDGE Customer and Citizen engagement and its key-finding of approaches may be organized in two stages. The first stage refers to the activities performed up to 2019 and the second one that concerns the current activities. The first stage is classified into the following clusters:

- **Customer Engagement Cycle:** R&I projects could produce procedural knowledge on ex ante/ ex post analysis and KPI.
- **Barriers to implementation and customers' analysis:** understanding barriers to project/programme implementation and the specific needs of a wide range of customers in their energy-related activity (see Figure 5).
- **Drivers for Speeding-up the engagement:** series of R&I projects focus on activating and speeding-up the Customer Engagement Cycle.
- **ABC book (Common knowledge center) of Customer Engagement:** handbook wording and the way valuable knowledge will be stored and retrieved.

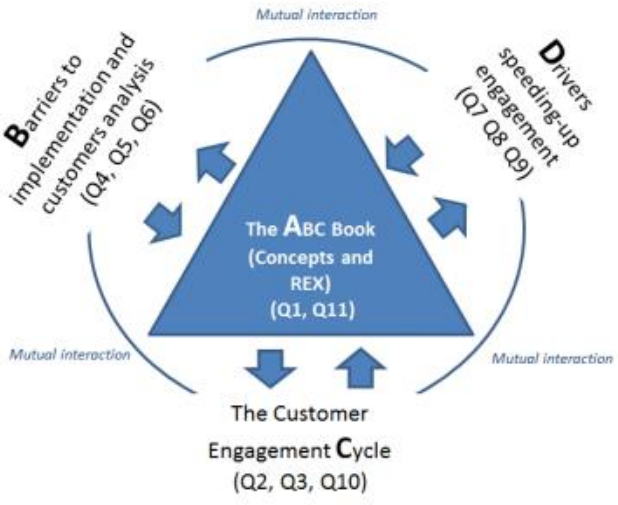

Figure 5. ABC cluster approach.

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The second stage of BRIDGE Customer and Citizen engagement WG, which is active and composed of five subgroups, deals with the following topics:

- **Socio-economic drivers subgroup:** The goal is to explore the socio economic, environmental and cultural drivers of engagement. To collect information and experiences of the varying strategies for engagement-based consumer profiles and cultural basis.
- **Group building subgroup:** The goal is to uncover the ways to mobilize consumers to act collectively and build a consumer group.
- **Governance subgroup:** The goal should be to explore governance models for collective action groups. This looks at principles that are the base for citizen participation.
- **Assessment subgroup:** The goal is to find a range of indicators and monitoring technics to understand, monitor and assess the development of collective action group.
- **Smart tools subgroup:** The goal is to have an exhaustive list of tools and technologies supporting consumer participation and the ways those tools are supporting consumer involvement.

The Customer Engagement WG has collected results from surveys and analyses which are presented on [5]. In this report the following key conclusions are given. Customer engagement in DR schemes shall most importantly need to listen to customers. As a second consideration is the need of adequate regulation to allow customer involvement in certain DR schemes. BRIDGE pilot projects tend to have a relatively low level of customer engagement, particularly with domestic users, in contrast with solar and battery projects that have the exact opposite experience. This highlight is important since domestic users are willing to enroll in such projects, but their engagement decreases with time. As a consequence, many BRIDGE projects face declining customer engagement in the long run, which is not necessarily case for industrial customers.

Another highlight of this BRIDGE report refers to the lower importance of customer segmentation; this can be justified when distinguishing between vulnerable and educated customers, since the core focus shall be on comprehending customer needs as well as providing them a variety of useful and simple information in order to have effective communication. The suggestion is that segmentation should not replace direct ways of interaction and dialogue with customers but should rather provide a more diversified customer engagement strategy. In BRIDGE, a common point for all pilot projects is to only include customers that are willing to cooperate [5].

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The approach that this WG of BRIDGE has adopted to deal with customer engagement issues foresees a horizontal approach for all subgroups, by focusing on collective actions to empower consumers.

3.1.3. Regulation

This working group is composed of the following main actions as depicted in Figure 6.

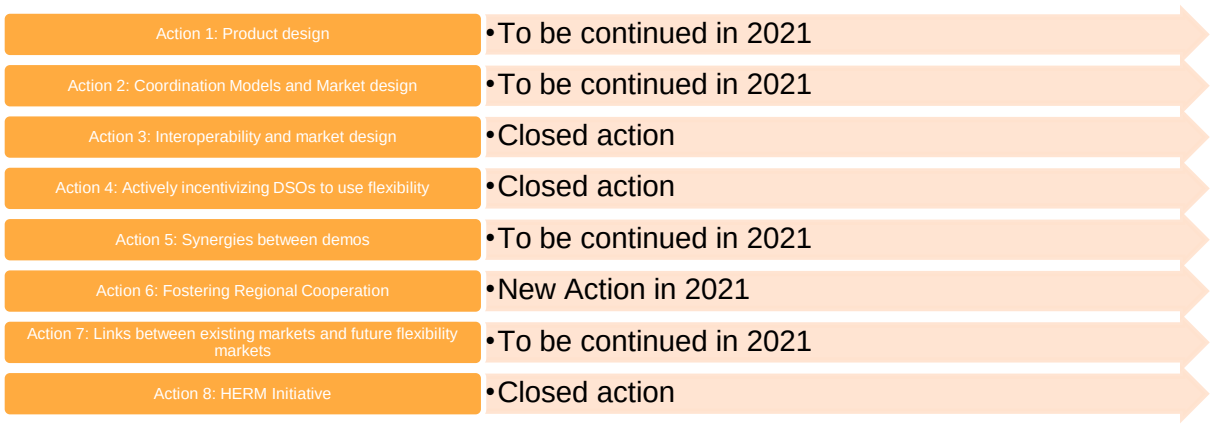

Figure 6. Regulation workflows composition

Action 1: Product design

The main objective of these action is to share and collect findings from several projects that analyze product design issues, and collect such data in a common repository. The analysis so far, has led to the creation of a list of primary product attributes as illustrated in Figure 7, for services such as congestion management, frequency control, voltage control, inertial response, fast frequency response, ramping, controlled islanding and black start. Most importantly, there is an ongoing EU-wide process striving towards product standardization as per the Art. 32 of the Electricity Market Directive [6] that foresees the standardization of congestion management flexibility products in particular. Hence, it is recommended that such standardisation is implemented at least at the Member State level to limit the costs for market participants in offering the products.

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Category	Attribute(s)
Related to provision	- Preparation and ramping period - Activation (FAT) and deactivation periods - Min. / Max. volume to be activated - Symmetry (direction) - Min. / Max. number of activations - Min. / Max. duration of provision - Time between activations (recovery time) - Activation mode
Related to bid composition	- Resource aggregation allowance - Granularity - Divisibility
Related to remuneration	- Activation (energy) price - Availability (capacity) price
Related to location	- Location on the grid

Figure 7. List of primary product attributes

Action 2: Coordination Models and Market design

The main objective of this action is to conduct an investigation on different coordination models and market designs such as centralized, decentralized and distributed markets, by exploring the link between explicit and implicit flexibility mechanisms. In the current phase this task has already performed a survey on relevant projects inquiring on the scope of coordination mechanisms, the definitions used, definition on high level/market coordination models as well as the effectiveness of the proposed market designs per project. This survey highlights the need for:

- A standard market/coordination framework design
- A debate on regulated vs. market-based solutions
- Interplay between tariff solutions (i.e., tariff designation)
- Assessment of market/coordination models

Action 3: Interoperability and market design

This action has been moved to be led by the Data Management WG.

Action 4: Actively incentivizing DSOs to use flexibility

This action aims at determining the regulatory barriers for DSO's to actually utilize DSF, as well as to determine any regulatory barriers on regulated product's remuneration mechanisms.

Action 5: Synergies between demos

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This action intends to gather experience and create a base of knowledge between different projects concerning barriers, enablers, and on developing methodologies. For this purpose, this action has proposed the generation of "ID cards" to capture specific information for each project.

Action 6: Fostering Regional Cooperation

Action 6 aims at identifying common results and recommendations for projects that are associated with flexibility market operators in order to provide an overview of project solutions to facilitate regional cooperation among TSOs and DSOs.

Action 7: Links between existing markets and future flexibility markets

This action is focused on the creation of links between existing markets and future flexibility markets by:

- Investigating projects that work on flexibility markets
- Identifying major recommendations
- Identifying common results in projects with a flexibility market operator role and functions.
- Investigating if gaming and market power is discussed and the possibility of having tangible results available.

Conducting a survey on the topics above, BRIDGE has highlighted the possibility of integrating multiple dimensions in markets as well as any assessment methods (i.e., baseline) should consider the grid constraints.

Action 8: HERM Initiative

This action has been completed in cooperation with the Data Management WG and its focal point was to propose a harmonized definition of electricity market role based on BRIDGE selected project models with particular exploitation on those dealing with flexibility services (such as CoordiNet, FEVER, GOFLEX, INTERRFACE and Platone). The final highlights of those activities are foreseen to be reflected on a proposal to activate cooperation with ENTSO-E, ebIX, and EFET towards the harmonized HERM.

Future plans of Regulation WG for 2021

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The Regulation WG continues its activity following the composition of four main tracks as depicted in Figure 8, as a matter of sharing best practices among projects and to provide recommendations on product and services definitions, flexibility mechanisms as well as flexibility market design including coordination schemes.

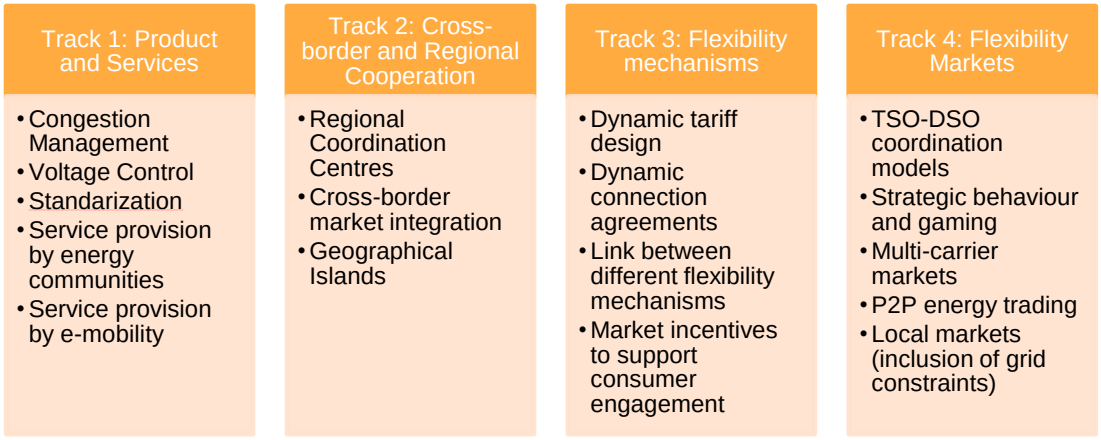

Figure 8. Future steps of Regulation WG for 2021

3.2. Common approaches based on BRIDGE indices

This section presents common approaches and methodologies identified so far from TwinERGY projects, focusing on the three main areas of the BRIDGE WGs.

3.2.1. Data Management

TwinERGY Core Data Management Platform (CDMP)

In the scope of TwinERGY project, the technical approach is foreseen to propose a common interoperable framework which will be used by the pilot systems. For this purpose, the TwinERGY Core Data Management Platform (CDMP) will be developed by implementing interoperable functionalities in the informational layer as a matter of providing data integration to multiple data source and make them available for the involved actors ensuring accuracy and transparency. At the function layer, the CDMP platform will provide the proper suite as a virtual working space for the different tools and applications.

In Figure 9, a conceptual representation of the CDMP architecture is presented. On the left-hand side appear the data sets coming from several distributed systems and the way those reach the platform is via APIs & Files.

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Several functionalities and services lie in the proposed CDMP such as:

- **Data Collection service**: this is mainly responsible for ingesting pilot system's data in the CDMP. Data mapping is responsible to ensure that data sources' specific attributes are properly mapped onto the TwinERGY data model. Data curator part is foreseen to be responsible to treat the data meaning out of frame values or empty ones will be cleaned and then stored.
- **Data Governance service**: Ensuring the proper ingestion, mapping and curation of data. Common Information Model (CIM) management part is there in order to ensure that the data set will be properly adapted based on specific attributes to store them in the platform.
- **Data security and storage service**: Saving data and meta-data will be possible in the CDMP platform by indexing them as well, along with a data backup and a recovery mechanism.

Open APIs will be available to communicate the data with the modules and the Digital Twins.

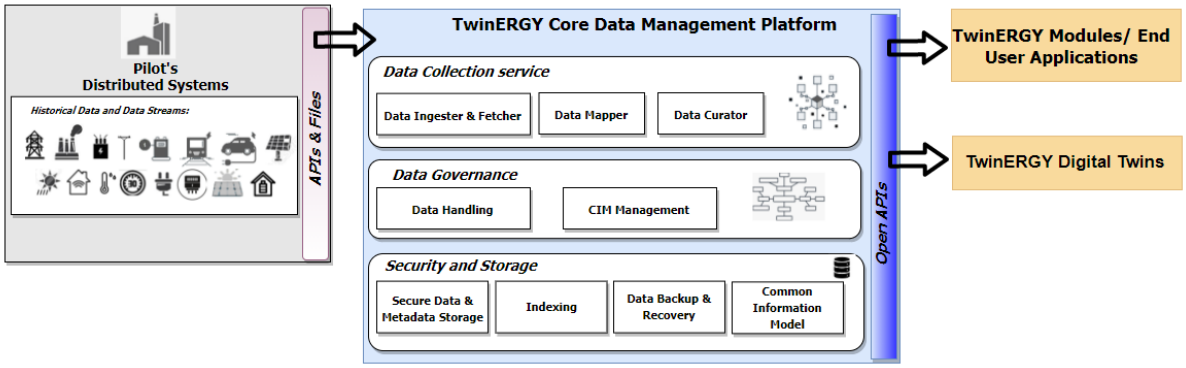

Figure 9. TwinERGY Core Data Management Platform.

Usage of data and information by TwinERGY modules or End-User application, exceeds the Core Data Management Platform responsibilities.

The aforementioned approach towards the implementation of the CMDP platform will follow steps to adopt the Data management models:

- Extensively study the smart grid data modelling landscape and select specific open standards, semantic models and ontologies for further elaboration depending on their relation to the TwinERGY scope. Currently under review are, IEC CIM, OpenADR, SAREF, SAREF4ENER, etc.
- Define the TwinERGY common information model based on data structure and semantics of assets available from the TwinERGY demonstrators

- Build a mapping feature to perform the necessary transformation to the ingested data.
- Continuous life-cycle management of the TwinERGY CIM to accommodate new concepts/ fields that are required to ensure semantic interoperability

In Figure 10 a mapping of the CDMP platform into Energy Data Exchange Reference architecture is performed for the information and communication layers.

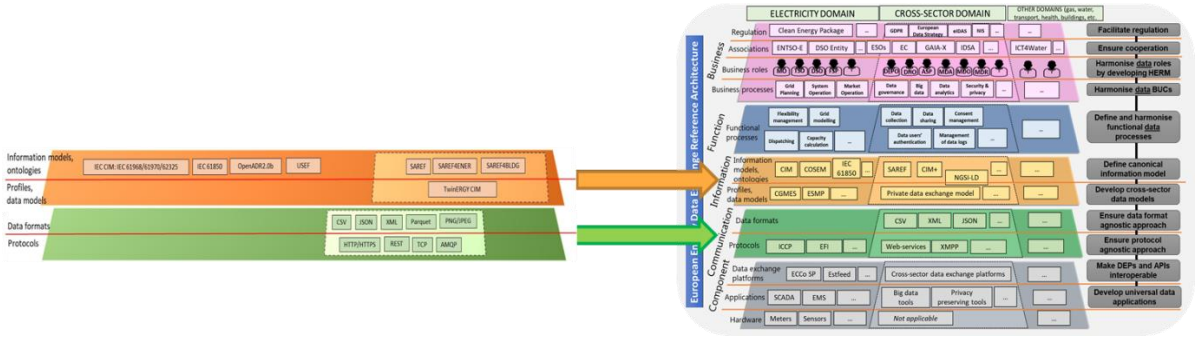

Figure 10. TwinERGY Data Management Platform and the European Energy Data Exchange Reference Architecture

Data access and privacy

- Design and deliver the Data Security Services Bundle in TwinERGY based on the concrete requirements of the energy stakeholders and the features prioritized for the TwinERGY development activities in each iteration.
- Different layers for data security and privacy assurance to be delivered indicatively involve:
    - attribute-based access control policies services that formally describe the circumstances under which access requests to data assets should be granted
    - multiple data anonymization methods for data providers to achieve the right balance in the "privacy vs utility" trade-off in their real-time and batch data streams.
    - end-to-end encryption services for data assets that are ingested and for key sharing to authorized data consumers.

Digital Twin

Some approaches and thoughts were also presented in the iteration with BRIDGE Data Management WG considering the approaches and concerns on the design of DT components. Those are presented as follows.

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Data access and storage | Data management models

- The DT IT-infrastructure might be deployed in either centralized or decentralized (i.e., on a cloud) manner.
- On which layer shall data be processed, in the cloud or also locally?
- Implementation via a single central database or distribution of services and data sets across gateways?
- Accessibility: Some proprietary services or devices might impede access to essential data which might be a barrier on the implementation.

Interoperability on the informational layer

- Different services, devices and general architectural approaches (e.g., DT concepts) might use different data formats, ontologies and semantics that need to be harmonized across the entire informational layer, this is further exploited at Task 4.3
- Interoperability at the communication layer
    - Different devices, services might use different communication protocols on different OSI layers and varying paradigms (REST, subscribe/publish etc.) that need to be harmonized and mapped to a common communication layer

Cyber-security and privacy | End-user rights

- Collected data must be sufficiently pseudonymized and justified
- Data that cannot be fully anonymized for functional reasons has to be sufficiently secured and protected from unauthorized access
- Collected data from end-user has to be made accessible to them on demand and provided in a readable format
- Integration of third-party services for end-users should be engaged on an opt-in basis

Regulation impact on data interoperability

- Public interfaces for accessing collected data might have to follow regulated standards
- In Germany, energy-generators of all kinds (PV etc.) have to be recorded in a public market register and provided in a specific data format
    - Other EU countries might maintain similar registers but on a different regulatory basis with and with different captured specifications

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3.2.2. Customer engagement

TwinERGY focal point is customer engagement in DR schemes as well as to enhance the awareness of end-users on their consumption profiles. Therefore, there are several activities and tasks investigating the topic of customer engagement, from research approaches by conducting surveys to get factual results and conclusions, to considerations on the architectural systems design. The main activities of TwinERGY on customer engagement topics are highlighted in the following sections.

Business models analysis

For the TwinERGY project the customer engagement topic is of essential importance along with the business model analysis. Customer engagement is a key element on the transition from centralized to decentralized energy systems with adopted frameworks such as the Transactive Energy Market. Figure 11 represents different activities, value systems and dimensions to ensure proper customer engagement where one can clearly see the distinction between the core and supporting activities which influences the value creation process in the energy sector. Moreover, for TwinERGY project, it is important to distinguish the difference in value creation between the traditional and the modern value creation systems and structures.

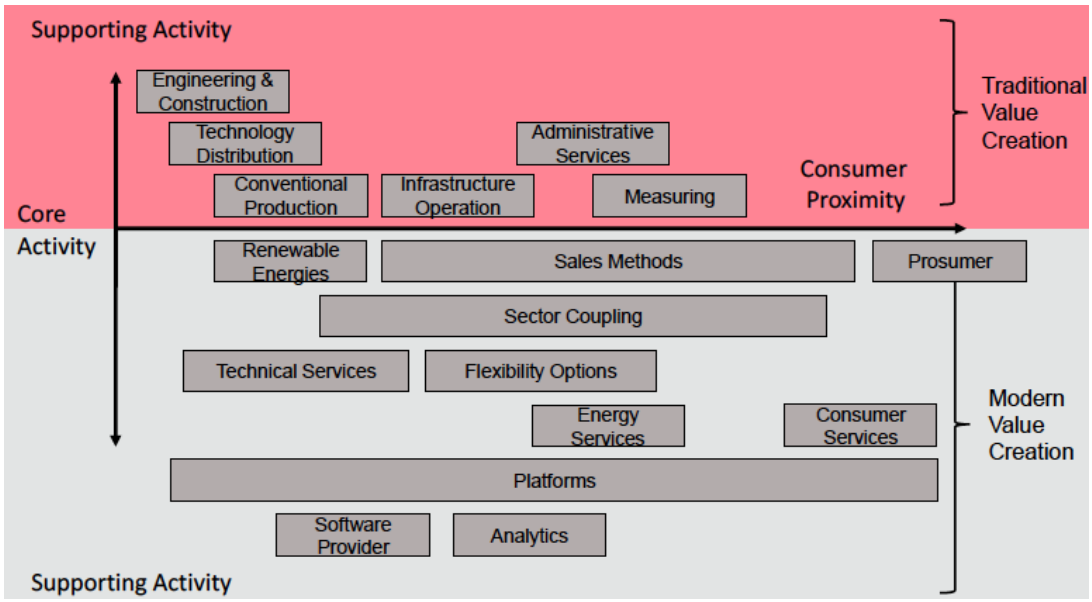

Figure 11. Dimensions and business model classes [7]

To assure this, the research activities on the corresponding task dealing with Business models and customer engagement, the following plan is applied in Task 2.3 :

Phase 1

- Task 1 - Identified specific audience from primary and secondary sources.
- Task 2 - Established business processes relevant to the case.
- Task 3 - Record key business resources and partners.

Phase 2

- Task 1 - Develop a strong value proposition.
- Task 2 - Improve the current energy business models and lean towards decentralized energy model.

TwinERGY works along the creation of a value proposition in the energy system that will accommodate an increased customer engagement by following the business scheme in Figure 12, with the goal to attract customers in DR programmes. That is therefore performed with the provision of value to customers with some incentive schemes which shall be combined with utility value. Within this task, the first shortcomings from the reviewed the existing business models have provided suggestions for improved business models which can be demonstrated and tested in our TwinERGY demo sites, by touching upon the potential of improvement and shift from the utility-centric business model, through the use of transactive energy principles and the growth of DERs and smart devices (IoT), to an improved business model with increased value proposition and value creation. The improvements of the models can be further justified by the fact that recently energy markets are increasingly seeking for flexibility product/services, driven by several factors, such as, increased use of renewable sources, and smart devices. Thus, according to the outcomes of Task 2.3 the focus of newly arisen business models on DR should particularly address the capabilities and bring value proposition, to empower small and medium-sized end-users into them.

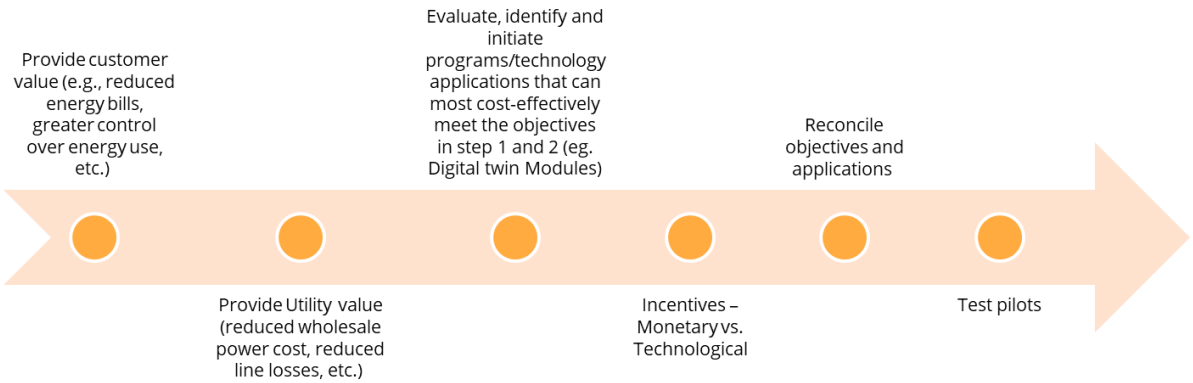

Figure 12. A roadmap to customer engagement

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Citizen Engagement and Co-design: framework and guidance

The Citizen Engagement framework adopts the approach presented by the Bristol pilot site, which aims at identifying the important elements to achieve customer engagement and deploy them in the other demo cases, which is a set of activities orchestrated in Task 2.1 of TwinERGY. The idea behind a share methodological framework among pilots acts as a lingua franca for consortium partners allowing to steer pilot leaders in the process of planning pilot activities as well as to allow the comparative analysis across pilots .Therefore, the associated pillars towards customer engagement refer to technology deployment by onboarding, to streamlined usage of technologies along with the deployment of skillsets for end-users towards social relationship and awareness on their consumption profiles. The Bristol Approach is comprised of a six-step framework for delivering projects that places people and communities at the heart of innovation and aims to understand the issues they care about. Rather than 'pushing' technology or pre-determined 'solutions' onto people, it focuses on supporting people to work together to 'pull-in' the knowledge, technology and resources needed to tackle a problem (see Figure 13).

At TwinERGY level, the approach adopted does not commence with identification from the perspective of the community/citizen; The issue which has been identified is sustainable use of energy, and a new tool (Digital Twin) has been identified already as well.

More analytically, the Bristol Approach builds on the guiding principles above presented, and sheds and expands the Design and Deployment phase to include elements specific to an energy-related project focused on Demand Response. The design of proper incentives is an essential pillar of DSF; yet, end-users still need to have comprehensive interpretation and visualization of such incentives. An important feature is that end-users understand their consumption data, available and activated flexibility, and other KPI on load shifting or changing of consumption patterns.

This approach has led to the preparation of Developed Engagement Approaches document for Citizen Engagement (CE) framework for:

- Developing EDI (Equity, Diversity and Inclusion) document for CE framework
- Working with Ideas for Change, meeting regularly to develop processes and prepare workshops
- Planned and carried out workshop for the Bristol pilot site on Recruitment and Engagement
- Planned and carried out workshop (1) for all pilots on Citizen Engagement Framework

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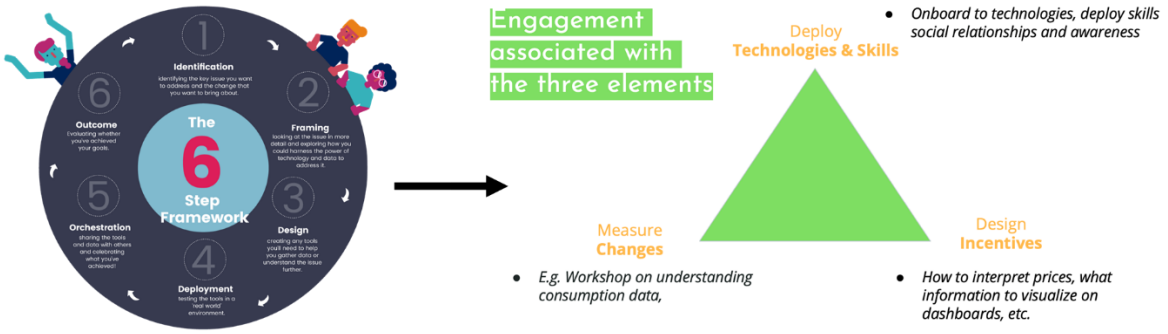

Figure 13. TwinERGY's approach on Citizen Engagement and Co-design: framework and guidance

Drivers for Customer Engagement

The main drivers for Customer Engagement pointed out by TwinERGY were classified as follows:

Core Motivators

- Monetary incentives
- Assurance of certain level of comfort
- Pro-environmental attitudes
- Social acceptance (e.g., social influence by participating in communities)

Simplicity Factors (i.e., whether the end-users have the capability to participate and get engaged)

1. Physical effort (e.g., time investment)
2. Mental effort (e.g., customer do need to confront special skillset to participate)
3. Non-routine (e.g., need for end-user change of their routine and to what extent)

TwinERGY technical approach

<u>Digital Twins</u>

Digital Twins will offer consumers a real-time acknowledgement of consumption patterns, energy behaviors, generation/demand forecasts and demand/storage flexibility capacity, enabling a personalized DR optimization through automation and remote controls.

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Transactive Energy Platform (TEP)

TwinERGY will implement nodal electricity markets for the distribution grid, offering participants the ability to sell their flexible energy loads and excess capacity on an open market to the (micro) grid operators or through peer-to-peer trading. TEP will create a trustless auction house where flexible capacity and demand from DERs are auctioned off through encrypted, shared, immutable, and publicly auditable Smart Contracts.

Comfort / Well-being Service

DR optimization is performed considering the physiological data from user's wearable devices, in order to optimize both energy usage and comfort (well-being) levels.

TwinERGY Social Approach

Monetary Incentives

By utilizing the Transactive Energy Platform consumers can find a way to effectively leverage and monetize the emerging DER infrastructure.

Social Comparison

Through the social network platform, consumers will be able to compare energy use between different neighbourhoods, a household's energy use to that of a similar neighbourhood, and tenants in the same buildings as a point of comparison for an individual's own behavior.

Community Rewards

By putting to use the TwinERGY system gamification elements, consumers will be rewarded with 'TwinERGY Points' that can be redeemed in exchange for "eco positive" goods and services shared across the community.

Consumers behavioral analysis & strategies for consumer engagement

TwinERGY addresses the customer engagement topics with Task 4.1 and 4.2 to investigate and provide findings on consumers' behavioral analysis as well as on strategies for consumer engagement. Analytical surveys are foreseen to be performed that will work along the identification the most significant motivators and barriers.

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Value systems - Understanding Customers

Firstly, it is essentially to obtain a clear background on the understanding of customers in the topics of on customer engagement such as increased awareness on consumption profiles and participation on DR schemes. It is essential to comprehend what is the perception of consumers on the usage of new technologies to collect and use real time information and the information provided delivers good value for them.

Drivers for Customer Engagement

Based on data collected via an online questionnaire on these Tasks (4.1/4.2), to understand consumers motivations and barriers to engage in the energy markets and to adopt energy solutions, possible motivations and barriers already identified in literature review and in-depth qualitative interviews with the cooperation of relevant stakeholders (e.g., ADENE and DECO) will be tested with the questionnaire. Additionally, the identification what are the actual trigger element on behavioral changes (e.g., via incentives or DR schemes) of customer is a matter to be thoroughly addressed within this same task.

Customer Segmentation, analysis of cultural, geographical and social dimensions

A segmentation based on socio-demographics data and on the motivations/barriers found -in the survey of T4.1- as most relevant was set, to understand different consumer segments. Also, cultural and social dimensions of Hofstede will be analyzed and taken into consideration to understand cultural differences. This segmentation should go beyond basic consumption levels or demographic characteristics, understanding, also, the current degree of engagement.

Effectiveness of Engagement Activities

Engagement activities shall be based on:

1. Educate customers – these topics are not of general knowledge and consumers may not be aware of the barriers or drivers to engage in the proposed solutions.
2. Strategies based on the identified motivators and the setting of specific recommendations per consumer cluster (i.e., based on socio-demographics).
3. Previous successful consumer engagement strategies in similar projects.

Methodological framework and Architecture Design

End-users' participation is key feature on the architectural design of TwinERGY. The diverse values that end-customers hold and the context in which they live imply that they respond differently to the approach adopted by the project. The project will therefore develop a methodological system development to analyze behavior attitudes and classify or segment

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end-customers, beyond the identification of basic consumption levels. The following description include some of the main elements to be analyzed prior to system design.

Customer Segmentation, analysis of cultural, geographical and social dimensions

- Technological background of individual customers must be considered.
- Younger customers can be engaged passively via social media and other more advanced means.
- Older generations require additional efforts for engagement, such as active bilateral communication, or use of more traditional media, such as newspapers.

Value systems - Understanding Customers | Drivers for Customer Engagement

- Customers might have different expectations regarding the targeted objectives within TwinERGY by using the developed approaches.
- Saving money by optimizing energy tariffs.
- Reducing electricity consumption by maximizing RES usage.
- Environmental concerns.
- Additional revenue streams by applying newly developed business models.
- Gamification: Competing among neighbors/districts/cities (most used RES etc.)

Effectiveness of Engagement Activities

- Quantify effectiveness of the engagement strategy by evaluating number of active customers throughout project runtime vs number of initially introduced customers.
- Customers that regularly engage with the provided technologies can be considered active (e.g., by checking dashboard information, pro-actively reacting to behavior change incentives or DR schemes, or participating in public workshops)

Identification of what triggers behavioral changes (e.g., via incentives or DR schemes)

- Conduct regular interviews and questionnaires throughout project runtime, evaluating customer's individual drivers and incentives for behavioral changes.
- Experimenting with different engagement approaches and quantifying their effectiveness singling out triggers with biggest impact.

The Regulatory Innovation to empower Consumers

- Tax-reform are needed to make use of DR services financially viable.
- Simplifying bureaucratic efforts to facilitate accessibility to the services proposed by the TwinERGY project.

3.2.3. Regulation

Social, cultural and ethical barriers for innovation

Most social and cultural barriers are routed in regulatory barriers. For instance, technological barriers might be considered lesser important when business models and subsequent regulatory framework are inadequate. Examples of regulatory barriers include the lack of appropriate price signals, access to different markets, limiting technical prequalification processes, and complicated bureaucratic procedures. These barriers are further addressed in Task 2.4 of TwinERGY. This task, and its corresponding deliverable D2.5 provide a reasoned analysis of barriers both customers and flexibility service providers encounter and potential manners to overcome them and facilitate the adoption of the TwinERGY business models.

Regulatory recommendation and Standardization

In Task 12.3, TwinERGY will thoroughly investigate and assess the full adoption of the Clean Energy Package, as well as provide an assessment of the new Network Code for Cybersecurity and the Guideline on Interoperability. Its main purpose will be to focus on the regulatory and standardization recommendations with the objective to facilitate the development of DR projects. Additionally, TwinERGY will also leverage the outcomes of the T2.4 work, where different barriers to DR have been analysed, through public communications and workshops.

The expected challenges and barriers were outlined and grouped into five different categories by T2.4 of TwinERGY, as illustrated in Figure 14. Expected challenges and barriers. The first category focuses on the lack of revenue streams for DSF and for adequate framework for the aggregators -which are main actors to reflect DR-. The incentives for system operators, and the remuneration of regulated activities need to be addressed by the regulatory framework, in particular regarding the use of flexibility services. The current focus of remuneration structures is for regulated activities, overly benefits physical grid reinforcement by focusing on the required capital expenditure (CAPEX). Flexibility services on the other hand, have different cost structures, with a heavier weight of the operational expenditures (OPEX). A more balanced approach should consider both, what is commonly known as a TOTEX approach. Another significant barrier that should be clearly addressed by

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regulation, is the access to end-users data, data sharing, interoperability and cybersecurity in particular of Advanced Metering Infrastructures (AMI) such as Home Energy Management System (HEMS) and Smart Meters (SMs). The proposed regulatory recommendations will be used to impact the delegated and implementing acts from the EC on Interoperability and Cybersecurity.

The potential new Network Code for DSF will have a significant impact on flexibility procurement, in particular regarding local flexibility markets and the appropriate market design to facilitate DSO's use of flexibility services. Finally, the Clean Energy for all Europeans legislative package has a particular focus on energy communities; yet, very little evolution has already been performed by Member States, impacting one possible adoption of the TwinERGY solutions. All these barriers will be thoroughly addressed by these TwinERGY tasks.

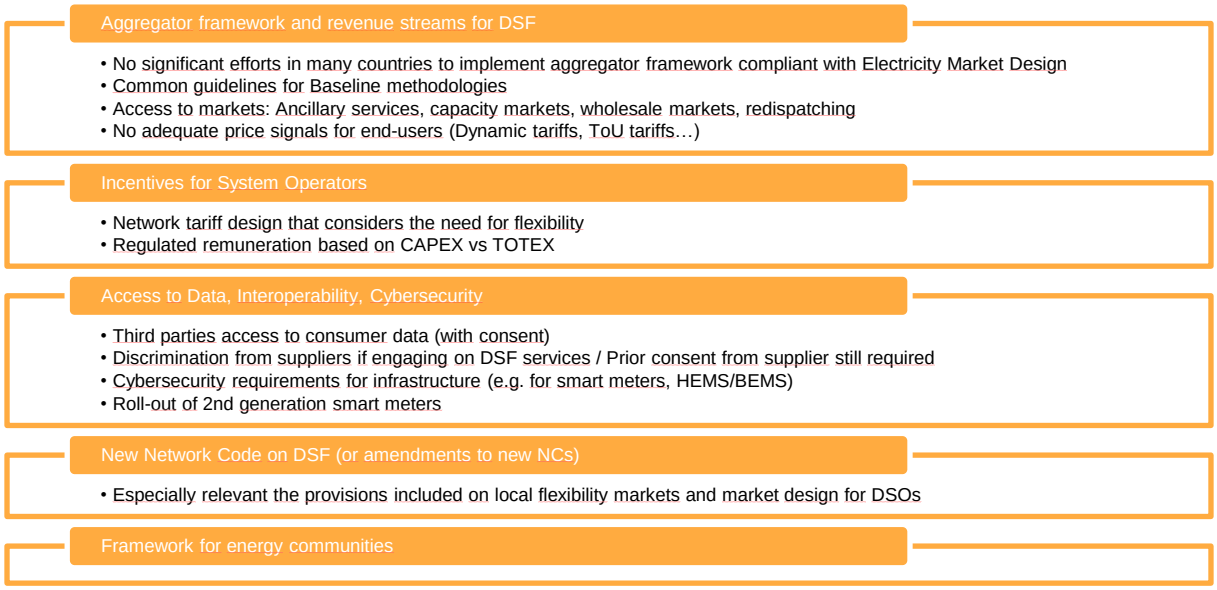

Figure 14. Expected challenges and barriers

Ethics, Legislation & Standardization

TwinERGY currently has two relevant active tasks one on the identification of ethics and legal requirements as well as on working on the data licenses. The first outcome of TwinERGY on legal and ethics has been on a preparation of some sort of inventory as a matter of applying a horizontal approach among demos (i.e., baseline principle) to consider the needs/requirements that are of relevance for all. Further, the needs of all sides (e.g., prosumers, supplier side) are considered, to the extent relevant and feasible. Examples of

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specific requirements per public/private sector under a given jurisdiction maybe provided as well.

Issues that will be outlined within TwinERGY approach on this topic are summarized as follows:

- The TwinERGY approach mentioned the concern that effective compliance of regulation in reality should be beyond box-ticking.
- Several instruments must be employed to achieve effective ethics and compliance regulation (e.g., regulations, contracts, code of engagement)
- Behaviour plays a key role in reality when it comes on how rules are implemented, fact which will reflect on user engagement in the pilots.
- Effective protection of consumers' (and other stakeholders' rights) call for a consideration of privacy & security by design and throughout the data lifecycle.

Pilot Case

In the discussion with BRIDGE several points were mentioned to capture the demo site's specificities in regard to Bristol's pilot.

The current UK framework on demand response, allows for some DR offerings, including traditional off-peak charges (e.g., night tariffs) or experimental options that leverage storage (e.g., Tesla Energy Plan from Octopus).

With respect to incentives for DR they are currently predominantly financial. Therefore, participating end-users might need to adopt commercial arrangements requesting to submit smart meter data, sub-metered data. This could be facilitated by third-parties getting access to the end-users. Nonetheless, in the UK there is an entity for data management by Smart DCC with interfaces to several companies.

With respect to storage ownership and procurement of storage services, it is predominantly associated with the individual household and their adoption from commercial entities is not yet considered as a common solution. Concerning new market design options leading to new services, business models and roles for system operators, there is a variety of innovators including integrators of energy systems, data analytics companies (e.g., bills management at household or commercial level), living labs (e.g., Energy Systems Catapult) etc.

With respect to barriers and challenges, a survey conducted by EnergyREV project identified the challenge of minimum literacy (i.e., skillset) in owning a battery and how to exploit its use in an efficient manner. Data ownership/value sharing, is an important component to be

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accounted for on regulatory framework since legislation is significantly different in EU Member States.

3.3. Recommendations

A collection of some potential recommendations based on the multiple BRIGE surveys are presented.

3.3.1. Data Management

In the interactive discussion with BRIDGE several points were highlighted as potential recommendations for TwinERGY approaches and designs in regard to data management topics. Therefore, the following points are important to be essentially addressed on systems and architecture's design.

Handling of sensitive data (data access & storage)

BRIDGE WG mentioned that key point of most H2020 projects are data and information exchange, and analytics meta-data via sharing of large volumes of data. Sharing of data among several actors, access to third parties to data (e.g., end-user's load actual profile) as well as data sinks in architecture, require to ensure all pillars for data authenticity, integrity and confidentiality.

Important issues to be concerned about shall be GDPR policies which prescribe particular principles that might impact the flow of sensitive data among actors in the smart grid.

- The purpose limitation principle that prevents from using personal data for undeclared purposes, particularly when the original scope of collecting data is not respected. The original purpose has to be well-defined and acknowledged by the user; yet, the dispatch of this data to third parties for other purpose is not implied by default.
- The data minimization principle which prescribes that data collected and processed should not be maintained and stored or further used unless this is essential for reasons are clearly posed in advance to support data privacy. This principle clearly impacts and limits exchange of sensitive data between actors in the smart grid context.

BRIDGE has proposed potential solutions in the context of ensuring data privacy in [3], [8].

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Alternative practices to address this issue could be either *physical*, where the system somehow delimits a logical boundary, ensuring the data does not flow out of it (e.g., geo-blocking, de-military zone-only access, secure communication, etc.), or *logical*, where the information is encrypted prior to its exchange.

In regard to the data management model, BRIDGE has observed that some projects select a shared database model, and others a message-based integration of remote systems. It shall be mentioned that there is not a common strategy to adopt, since both imply different approaches with pros and cons. For instance:

Adopting a message-based model might provide versatile benefits such as loose coupling, more reliable security-mechanisms and better scalability. On the other hand, a shared-database integration model foresees a unique setup of data repository and the process of exchanging information is based on write and read of same resource, acting as data generator and receiver respectively.

In the message-based integration approach, raw physical data repository is only accessed by specific data services that allow other processes and services to query for pieces of information. The data transmitted to potential recipients is tailored to the needs and permissions of the receiver; hence, data aggregation or even anonymization may be easily performed. Nonetheless, it should be mentioned that that the attack surface area is rather limited in message-based approach. Despite the fact that message-based approach may be commonly adopted among R&D projects, in a survey conducted by BRIDGE on Cybersecurity found that, due to its implementation, real field applications, when upscaling is needed, appear to be rather complex.

Achieving information model interoperability & ICT interoperability

Interoperability is a key technical aspect, necessary to enable the interaction among actors, systems or sub-systems to exchange data and information, and understand the underlying information the exact same way. It is a key requirement for any system in which several actors are handling and sharing data.

Cyber-security is required to ensure the confidentiality, authenticity and integrity of the data. Concerning data privacy practices and data protection those are essential to ensure that data exchanged and accessed in compliance with the contractual agreements and obligations between the commercial actors and the General Data Protection Regulation (GDPR) as far as citizen data are concerned.

Interoperability also applies to communication layer as well, which corresponds to the communication protocols used for the exchange of the data from the originator to the

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destination. The semantic interoperability refers to the methodological manner the data is modelled to carry its semantic information. Much effort needs to be performed in both levels of communication and information layer. In this regard, more standardization does not appear to provide the solution, but may deteriorate it. This is a topic that needs proper coordination of all the communication to comprehend the need and facilitate the alternative(s) in both communication and information layer.

Cyber-security and privacy concerns

BRIDGE projects highlight the requirements for cyber-security and privacy concern for all components by reflecting the standards [9] conducting a thorough analysis of vulnerabilities and threats over the five layers of SGAM.

- Function layer: Security solutions should be designed to defense against man-in-middle, connection hijacking, replay, reflection, and denial-of-service (DOS) attacks on unsecured networks [3], [8].
- Business layer: Lack of accessibility of standardization documents considering security requirements and solutions in energy field leads to poor risk assessment and vulnerabilities of smart grids.
- Component layer: digital solutions do require the analytical assessment of any associated risks for system operators implying hefty investments.
- Information and Communication layer: as DSOs are managing and operating more critical infrastructure such as actuators and intelligent electronic devices all pertinent associated vulnerabilities of the system shall be maintained confidential.

Define cross-sector data models and exploiting collaborations |Core Data Management Platform

BRIDGE has explored the importance in the electricity towards cross-sector integration which based on [4] may rise mutual and versatile benefits for all involved actors including the end-users. This concept stems from the fact that the energy sector comprises many electrical system, natural gas and district heating utilities. Other sectors such as mobility and transportation are paving the path of *electrification-of-everything*, which clearly implies inter-dependencies with the electricity sector. For this purpose, BRIDGE already has proposed a conceptual European Energy Data Exchange Reference Architecture that particularly explores the implementation of interoperability functionalities in all layers, proposing extended functionalities for cross-sector integration.

At the data management level, BRIDGE suggests in the reference architecture that the definition of canonical information model facilitating cross-sector data exchange, e.g., by

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extending Common Information Model (CIM) and/or integrating other sectors' canonical data models with CIM. -This recommendation should be adapted for the TwinERGY project specificities. Study the benefit to use ontologies to support cross-sector interactions. Additionally, essential practice towards integration of other sectors is to develop cross-sector data models and profiles. Such recommendations and generally the approach of BRIDGE reference architecture shall be a potential tool that could be considered while designing the CDMP.

The TwinERGY project expressed the following concerns and challenges in regard to the CDMP platform and particular regarding the Common Information Model development and its compliance with a wealth of standards involved in the energy domain. This part is foreseen to be addressed by the proposition of the TwinERGY data model which will cover all the foreseen requirements for compliance. An additional challenge of the CDMP is its required capability to accommodate a variety of data formats and data ingestion methods.

Digital Twin

In regard to the DT, it was expressed that the data collection regulation can be a potential barrier for implementation if inadequate regulation persists. Therefore, commercialization of the developed solution might have to re-evaluate the associated risks.

3.3.2. Customer engagement

A fundamental objective of TwinERGY is to examine new ideas or explore model scenarios in real-time without obstructing physical processes and operations, to ultimately improve DR without interrupting the daily schedules and operations of consumers. Customer engagement in TwinERGY pilot sites possess a pivotal role for which there are versatile approaches and mature methodologies to maximize the engagement and overcome any potential barriers. Within the interactive discussion with BRIDGE it was proposed that the BRIDGE report Customer Engagement Working that summarizes a list of recommendations and findings might be of great interest to be studied by TwinERGY. Some key points are summarized below pertinent to TwinERGY's project approaches.

BRIDGE particularly suggests that within the project design it is quite beneficial to account for specific KPIs for end-users as a strategic tool of engagement. Several projects are developing specific KPI's for their customer engagement; i.e., how will projects measure the development of habitual changes, customer engagement and the acceptance of new technologies. Nonetheless, BRIDGE suggests that there is also focus attained on how to deliver real value to customers as well as to adopt methodological approaches on how to

provide feedback on the strategic KPIs being collected in both qualitative and quantitative methods.

BRIDGE also recommends the simple approach on promoting customer engagement that is based in three strategic steps as illustrated in Figure 15.

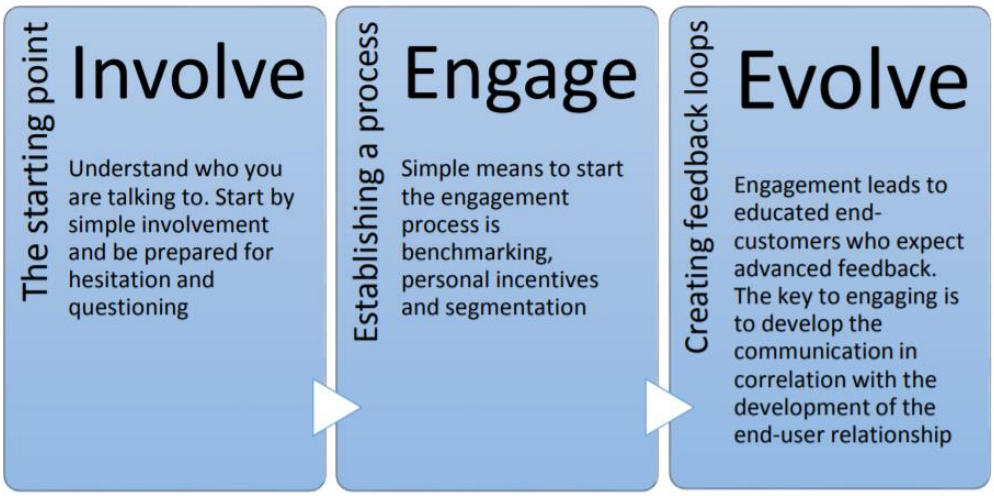

Figure 15. Customer engagement strategy: Involve- Engage- Evolve

BRIDGE additionally suggests to address the following essential questions regarding customer engagement:

- Assessing consumers value creation such as supporting end-user to understand the benefits of DR beyond electricity bills reduction, educating end-users via training on demand response topics and technological solutions; adopting also, streamlined tools with user-friendly user interfaces *etc*.
- Assessing the effectiveness of customer engagement.
- Comprehending and defining KPIs for customer engagement.
- Obtaining consumers and maintaining them, in view of replicability in different countries (with different languages, regulations, etc.) - Partners of each country may help this issue.
- Target the right strategies/drivers for consumers as well as to maintain a long-term engagement with consumers.

3.3.3. Regulation

Table 2 shows the tasks and activities of the Regulatory WG based on the organization of the four tracks. The green colored cells represented the suggested tasks that TwinERGY could actively participate in to provide and receive feedback.

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Table 2. Placement of TwinErgy's interests on Regulatory WG Tracks

Track 1: Products and services	Track 2: Cross border and Regional Cooperation	Track 3: Flexibility mechanisms	Track 4: Flexibility Markets
Product design for congestion management	Regional coordination Centres	Dynamic Tariff Design	TSO-DSO coordination
Product design for voltage control	Cross-border market integration	Dynamic connection agreements	Strategic behaviour gaming
Product standardization	System security	Link between different flexibility mechanisms	Multi-carrier markets/sector integration
Service provision by energy communities	Geographical Islands	Market incentives to support consumer engagement	P2P energy trading
Service provision by e-mobility	Network planning		Local markets (inclusion of grid constraints)
Pricing of System services			Energy Islands

In the BRIDGE Regulation WG reports there are several findings on storage ownership and procurement of storage devices and storage valorization. A reminder from BRIDGE might be that based on the Clean Energy for all Europeans package, the European Commission, has not explicitly addressed the unbundling requirements of the current EU legal framework, resulting in different unbundling requirements along the member states. Therefore, one implication is that changes on regulatory framework could be proposed for energy storage. Additionally, network operators (TSO and DSO) are not allowed to own and control a battery system at the same time due to unbundling requirements. Provided the benefits of storage for grid operation, network operators should be incentivized to buy battery storage services from third parties.

BRIDGE proposes that TwinERGY could potentially explore the storage valorization for providing new flexibility services such as self-consumption (e.g., shared storage infrastructure in a condominium), multi-building storage sharing as well as for the provision of services to the grid operation.

On the regulations part, the changes on the electricity sector imply the emergence of new business models particularly accommodating DSF and generally the active participation of end-users. Therefore, TwinERGY shall explore business scenarios where the market and regulatory framework accounts for the following:

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- DER installed at the level of distribution grid to be allowed to participate to the market either directly or via aggregators,
- support the development of local concepts e.g., energy communities, microgrids, shared assets in buildings,
- consider business models with dynamic pricing given that smart meters should be available.

In regard to the Regulatory WG, a relevant topic -currently part of the Data Management WG- should be the recommendations given by the "*European energy data exchange reference architecture report*" that addresses several regulation concerns and recommendations towards the facilitation of cross-sector integration, e.g., through the means of regulation for data spaces and data interoperability implementing acts. Accordingly, to achieve this cross-sector integration there is need to ensure cooperation between appropriate associations to on cross-sector and cross-border data management [4]. Therefore, a suggestion would be to reflect system approaches and methodologies on this proposed reference architecture.

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4 Conclusions

This report outlined the main activities of BRIDGE Working Groups on Data Management, Customer and Citizen Engagement as well as Regulation, by sharing common approaches, best practices and general recommendations developed in them. The TwinERGY methodological approaches and notions towards system designs were presented by providing open questions and driving feedback from BRIDGE.

The main points derived from the interaction is that in regard to Core Data Management Platform TwinERGY shall take on board the main findings of BRIDGE mainly pertaining the Cybersecurity and Resilience report, which may provide substantial support towards TwinERGY's design. Additionally, the BRIDGE European reference architecture was also introduced and proposed to be utilized for the mapping of Digital Twin and the Core Data Management Platforms suites, as a matter of exploiting the recommendations of integrating cross-sector activities within the implementation.

In regard to Customer Engagement, it was observed that TwinERGY presents a wide range of activities addressing the topic in a very efficient manner. The BRIDGE best practices were also presented and some key findings were also highlighted.

Concerning regulatory topics, BRIDGE, essentially suggested the exploitation of scenarios that do consider the unbundling requirement, but also explore business models that develop local concepts towards customer engagement facilitation, making use of shared assets such as batteries. Additionally, the BRIDGE reference architecture proposes several recommendations on regulation topics towards cross-sector integration which shall be reflected at TwinERGY scenarios.

On the facilitation of cooperation with BRIDGE initiatives it is foreseen that TwinERGY will have active participation in BRIDGE WGs and the corresponding sub-groups in each case, following the proposed roadmap plan.

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References

[1] BRIDGE webpage [Online]

[2] BRIDGE Data Management WG, "TSO-DSO coordination", 2019, [Online].

[3] BRIDGE Data Management WG, "Cybersecurity and Resilience", 2019, [Online]

[4] BRIDGE Data Management WG," European energy data exchange reference architecture", 2021, [Online]

[5] BRIGE "Customer Engagement Working Group Bridge Findings and Recommendations Report" 2015-2017

[6] Directive (EU) 2019/944 of the European Parliament and of the Council, [Online]

[7] Johannes Giehl, Hayri Gocke, Benjamin Grosse, Johannes Kochems and Joachim Muller-Kirchenbauer – Survey and Clasification of Business Models for the Energy Transformation. Energies 2020, 13, 2981; doi:10.3390/en13112981

[8] BRIDGE Data Management WG, "Main findings and recommendations", 2019, [Online]

[9] SGCG/M490/G_Smart Grid Set of Standards Version 3.1

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Annex

Working documents and guidelines for the interactive discussion between TwinERGY and BRIDGE WGs

In this Annex the document that provided the guidelines for the coordinated discussion with BRIDGE WG as a matter of receiving feedback and recommendation on TwinERGY approaches and designs.

The aim of this document is to coordinate all necessary experts and organization to participate in forthcoming workshops and events between BRIDGE work groups (Data Management, Regulation, Customer Engagement). The aim is to identify and explore common approaches for consistent material preparation regarding the presentation of results and success stories, lessons learnt, recommendations as well as participation to common discussion to align strategies and activities of common interest.

Definitions

BRIDGE Experts: experts that have been past members of BRIDGE working group(s), either from the consortium members or along with external BRIDGE partners to be invited.

TwinERGY Ambassadors: are considered all beneficiaries that are leading the activities of interest relevant to the various BRIDGE working group(s).

TwinERGY Observers: consortium members that are new members of the BRIDGE working group(s) as part of their activity in TwinERGY.

Potential BRIDGE documents that provide horizontal insights:

- Energy Communities in the EU Task Force Energy Communities
- BRIDGE-GA-2021-Final-Conclusions.pdf (h2020-bridge.eu)

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Data Management

Audience to be involved in the interaction with Data Management interaction with BRIDGE Institutions working on data management within TwinErgy.

Working group in BRIDGE	**Partners that participate for TwinERGY**
Data Management	ED, TH-OWL, SUITE5, STAM, UoP

Relevant work packages and tasks to be incorporated with discussions and collaboration within data management working group:

- WP4: Methodological framework and **Architecture Design** (TH OWL)
- WP5: Data Collection and Communication Platform (SUITE5)

Potential BRIDGE documents to be considered by TwinERGY:

- "Action #1 – Set up a use case repository"
- Interoperability of flexibility assets
- BRIDGE Reference Architecture
- Cybersecurity recommendations
- Main findings and barriers from BRIDGE projects

Candidate topics for discussion:

Lately, the ambitions of European Commission to enable consumers and prosumers to take part in the energy transition, have been highlighted in several initiatives such as the Clean Energy Package [Directive (EU) 2019/944]. This should be realized through equipping end-users with proper tools and rights to access energy markets. The former has enabled consumers to access and assess their own energy data and share it among -contracted- third parties, under their consent. Along with novel commercial services based on data sharing, there are evolving services relying on demand-side flexibility. Following there is a list of potential topics to be discussed with the BRIDGE initiatives:

- Technical perspectives on data management:
  - Data access and storage (i.e., handling of sensitive, proprietary data)
  - Data management models: (shared database (unique data repository) or message-based integration of remote systems)
  - Interoperability on the informational layer (i.e. typically a serious barrier)
  - Interoperability at the communication layer

- Cyber-security and privacy
- Legislation implication for the Regulation sector
  - End-user rights
  - Regulation impact on interoperability

BRIDGE Experts	ED, SUITE5
TwinERGY Ambassadors	SUITE5, TH-OWL
TwinERGY Observers	STAM, UoP, **ETRA (involvement at Systems architecture design, and modules interoperability)**

Customer Engagement

Working group in BRIDGE	**Partners that participate for TwinERGY**
Customer Engagement	UoP, STAM, TH-OWL

Relevant work packages and tasks to be incorporated with discussions and collaboration within customer engagement working group:

- WP2: Stakeholder Requirements, Obstacles to innovation and Business Models
- WP4: **Methodological framework** and Architecture Design (TH OWL)
- WP9: Pilots (UoP)

Potential BRIDGE documents to be considered by TwinERGY:

- **Bridge Customer Engagement Working Group – Final report June 2019**

Candidate topics for discussion:

TwinERGY highlights the importance of taking into account the following value chain in order to promote better customer engagement. Nonetheless, achieving an increased level of user engagement is a complicated topic since there multiple factors and elements to be addressed. Amongst them are:

• Customer Segmentation, analysis of cultural, geographical and social dimensions,
• Value systems - Understanding Customers
• Drivers for Customer Engagement
• Effectiveness of Engagement Activities
• Identification of what triggers behavioral changes (e.g.,via incentives or DR schemes)
• The Regulatory Innovation to empower Consumers

Questions/topics to be addressed within BRIDGE iteration:

- Customer engagement cycle
- What is the real challenge of customer engagement?
- What have not worked so far?
- Best practices towards customer engagement?
- Social approach?

BRIDGE Experts	ETRA
TwinERGY Ambassadors	KWMC, WEC, UoP, TH-OWL, UNL
TwinERGY Observers	STAM, SMARTen

Regulation

Working group in BRIDGE	**Partners that participate for TwinERGY**
Regulation	ETRA, UoP

Relevant work packages and tasks to be incorporated with discussions and collaboration within Regulation working group:

- WP2: Stakeholder Requirements, Obstacles to innovation and Business Models
- WP10: Exploitation and Business Plans (UNIVBRIS)
- WP12: Ethics, Legislation and standardization (ARTHUR'S LEGAL)

Potential BRIDGE documents to be considered by TwinERGY:

- Recommendations on Selected Regulatory Issues from experience and knowledge

Candidate topics for discussion:

The current regulatory framework for flexibility management and trading along Europe needs to provide clear rules and responsibilities, competition, technical modalities and financial conditions, considering multiple business cases (e.g.,market mechanisms, tariff schemes, entry barriers). Regulatory challenges arise regarding the incentives for demand-side response, commercial arrangements, cooperation with TSO and DSO, smart meter roll out etc.).

- Storage ownership and procurement of storage services
- New market design options, leading to new services, business models and roles

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for system operators (connecting the topic with Demand Response models, enablers *etc.*)

BRIDGE Experts	ETRA
TwinERGY Ambassadors	UNIVBRIS, SMARTen, ARTHUR'S LEGAL
TwinERGY Observers	ETRA, UoP