European Commission

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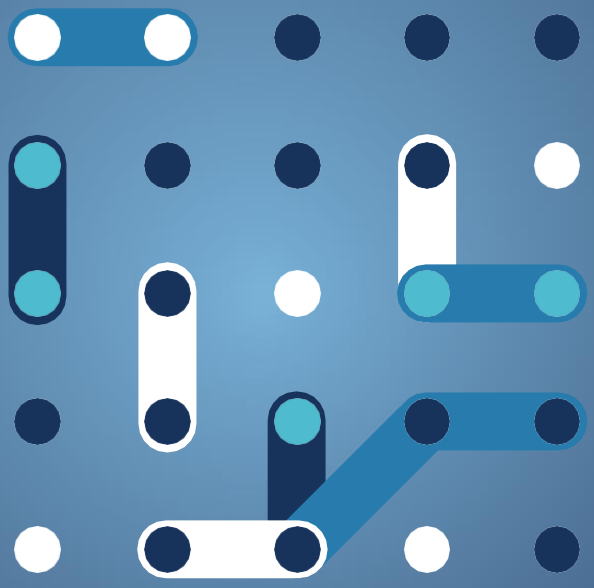
Interoperability of flexibility assets

2.0

Data Management Working Group



May - 2022

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ACKNOWLEDGEMENTS

The editors would like to acknowledge the valuable inputs from BRIDGE projects and Data Management WG who participated in the meetings and consultation rounds as well as members of the SPRING team, all contributing to this BRIDGE Interoperability of flexibility assets Report.

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Interoperability of flexibility assets 2.0

Data Management Working Group

May 2022

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PDF	ISBN 978-92-76-99539-5	doi: 10.2833/431263	MJ-03-23-057-EN-N

Luxembourg: Publications Office of the European Union, 2023

Manuscript completed in May 2022

First edition

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Executive Summary

During the BRIDGE General Assembly held on March 11th and 12th 2020 in Brussels, one of the conclusions was to work on the "Interoperability of flexibility assets", with the following objectives:

- Enable interoperability of flexibility assets by maintaining a set of recommendations, best practices and possibly tools.
- Focus on interoperability at function layer (system use-cases, services) and information layer (semantic interoperability, data models …).
- Cover the full flexibility chain, from the bidding/negotiation/activation of flexibility to the control of the flexibility assets on the field.
- Rely on inputs from the BRIDGE projects when it is it the most relevant considering their timeline, e.g. at M12 when the use-cases and the architecture are defined.
- Define and run a stable methodology that will be used during several years to build up results based on the outcomes of the past projects while also integrating the outcomes of the new projects.

Within the BRIDGE Data Management WG, a subgroup has been set in 2020 to define the methodology. Once the methodology was set and agreed, some BRIDGE projects contributed by providing information about the architecture and solutions being used in their projects. The results of these activities were presented during the BRIDGE General Assembly of March 2021 and publicly published in April 2021 in a BRIDGE report under title "Interoperability of flexibility assets".

Following this first release and the BRIDGE General Assembly held in March 2021, the following activities have been performed:

- A consultation phase has been launched to collect feedback from the projects on the reference framework (see Annex 1).
- Then, the reference framework has been updated, including the addition of two new Generic Business Processes (GBPs, see §3).
- Finally, a collections of use-cases has been performed (see Annex 2) to allow the application of the methodology to 36 use-cases from 14 projects. These use-cases have been cross-studied and analysed, resulting in outcomes related to the used standards and solutions, the identified gaps, the involved actors and functions, and the relevant scenarios for each GBP (see §4).

As a conclusion of the work performed between April 2021 and February 2022, six main findings and recommendations are detailed (see §5.1):

- *Updated catalogue of standards*: the catalogue of standards has been updated. It should be continously updated, year after year, based on the new BRIDGE projects. Also, it should be further disseminated and its results made easily accessible and reusable.
- *Contribution to standards development*: the BRIDGE projects have identified requirements and features that are missing in current standards/solutions. The upcoming BRIDGE user group should be used to carry these needs and suggestions to the standardisation bodies, but also to provide visibility to the BRIDGE projects about the standards under development.
- *Relevance and benefits from the Generic Business Processes*: the reference framework has been extended and now covers five GBPs, with a larger consensus on their content. This reference framework should be further enhanced and extended to cover use-cases beyond flexibility. In addition, these GBPs should be reused as a basis for future use-cases' development and could also be used as a template or library for the BRIDGE use-cases repository.
- The three remaining findings and recommendations are focusing on some interfaces for which specific actions should be performed to enable further interoperability:
    - *Interoperability of demand-response and appliances*: this interface covers the interaction between the Flexibility Provider (e.g. prosumer) and its flexible assets (e.g. appliances), mainly covering the flexibility offer, the flexibility activation and the flexibility forecast.

- *Settlement subprocess*: this groups of interfaces focuses on the settlement, which appears very rarely or only partly implemented by the BRIDGE projects, despite it will be required to enable implementation in a real-life context.

- *Market interfaces*: these interfaces are used in GBPs 1 and 3 to enable the Flexibility Consumer to push a flexibility request to the flexibility market and the Flexibility Service Provider to place a selling to this market.

Finally, these six findings and recommendations are mapped to the areas of the Digitalisation of Energy Action Plan (DoEAP), under development by the European Commission, in particular:

- Developing a European data exchange framework
- Benefits for consumers: literacy, skills, digital tools to empower citizens
- Mobilising investments
- Enhancing Cybersecurity

1 Introduction

The Data Management Working Group aims to cover a wide range of aspects ranging from the technical means for exchanging and processing data between interested stakeholders to the definition of rules for exchange, including security issues and responsibility distribution in data handling. Accordingly, the WG has identified 3 areas of collaboration around which mutual exchange of views and discussions have been set:

1. **Communication Infrastructure**, embracing the technical and non-technical aspects of the communication infrastructure needed to exchange data and the related requirements
2. **Cybersecurity and Data Privacy**, entailing data integrity, customer privacy and protection and general security of energy systems
3. **Data Handling**, including the framework for data exchange and related roles / responsibilities, together with the technical issues supporting the exchange of data in a secure and interoperable manner, and the data analytics techniques for data processing

This report fits into the 3nd area "Data Handling" and is covering the topic of "Interoperability of flexibility assets".

This topic of "Interoperability of flexibility assets" has been discussed and its scope defined during the BRIDGE General Assembly held on March 11th and 12th 2020 in Brussels. As a conclusion (see [1]), the following objectives have been listed:

- Enable interoperability of flexibility assets by maintaining a set of recommendations, best practices and possibly tools.
- Focus on interoperability at function layer (system use-cases, services) and information layer (semantic interoperability, data models …).
- Cover the full flexibility chain, from the bidding/negotiation/activation of flexibility to the control of the flexibility assets on the field.
- Rely on inputs from the BRIDGE projects when it is it the most relevant considering their timeline, e.g. at M12 when the use-cases and the architecture are defined.
- Define and run a stable methodology that will be used during several years to build up results based on the outcomes of the past projects while also integrating the outcomes of the new projects.

Within the BRIDGE Data Management WG, a subgroup has been set in 2020 to define the methodology. Once the methodology was set and agreed, some BRIDGE projects contributed by providing information about the architecture and solutions being used in their projects. The results of these activities were presented during the BRIDGE General Assembly of March 2021 and publicly published in April 2021 in a BRIDGE report under title "Interoperability of flexibility assets".

Following this first release and the BRIDGE General Assembly held in March 2021 online, a consultation phase has been launched to collect feedback from the projects on the reference framework (see Annex 1). Then, the reference framework has been updated (see §3). Finally, a collections of use-cases has been performed (see Annex 2) to allow the application of the methodology to 36 use-cases from 14 projects. This report includes both the updated reference framework (see §3) and the results of the analysis conducted on the above-mentioned use-cases (see §4).

2 General methodology

The main purpose of this methodology is to share learnings and recommendations from projects to achieve and ensure interoperability of flexibility assets, including standards assessment (adequacy, maturity ...) and gaps identification.

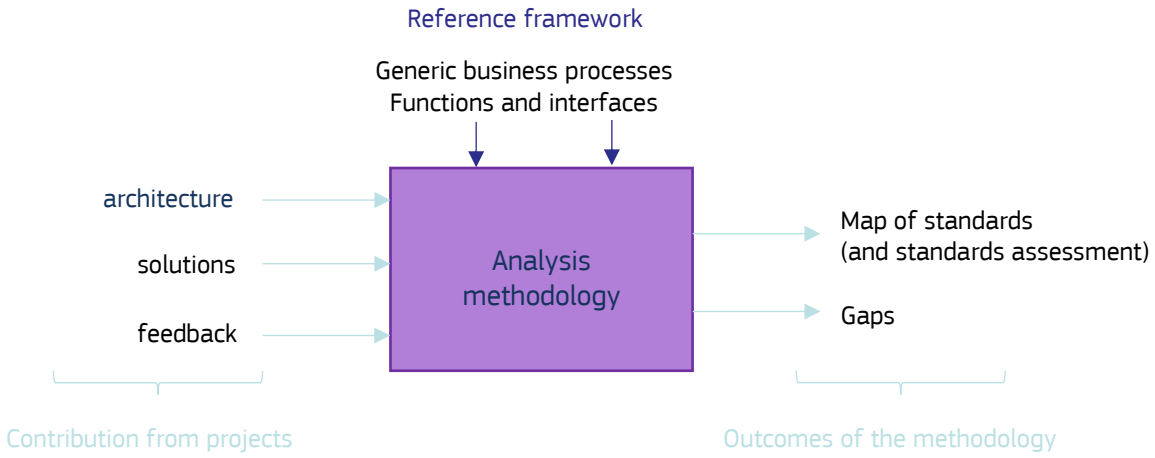
The achievement of these results is facing two main challenges:

- Things are evolving very fast, both from requirements and solutions perspective, meaning that the learnings and recommendations should be updated very often, based on feedback and results from new projects.
- Each of the projects are developing and/or using solutions that might be very different, making very difficult to directly compare and merge results and feedback.

In order to overcome these challenges, the methodology detailed in this section is based on two main principles:

- While the analysis methodology is stable, it relies on a reference framework that will be updated when novel use-cases or market models will appear. Also, the analysis can be run regularly to include results and feedback from new projects.
- As a common denominator between all the projects, the reference framework defines some generic business processes, which are agnostic to any specific technical solution. Each of the projects' specific solutions will be mapped to these generic business processes to enable cross-projects comparison and analysis.

This diagram below depicts how the methodology relies on a reference framework allowing to compare and harmonise the contributions from different projects with different technical solutions, and how it will be used to regularly analyse contributions from new projects to maintain outcomes such as map of standards and assessment and gaps identification.



Color legend: stable – update in case of novel use-cases – regular update to include inputs from new projects

Figure 1. Description of the general methodology to study the interoperability of flexibility assets

2.1 Reference framework to study interoperability of flexibility assets

This reference framework is a common base to compare and harmonise the contributions from different projects with different technical solutions.

It relies on generic business processes, made of functions and interfaces, with which each project's use-cases and architecture can be mapped to identify and assess existing solutions/standards and highlight gaps.

2.1.1 Generic business process

Each generic business process is a description of a process between business roles such as DSO and Aggregator. It is decomposed into subprocesses which are called "functions" (see below). These functions may require information exchange between roles, through interfaces. They may also require external data (e.g. metering data) or external command capabilities (e.g. load control).

Such business process description allows to cover both the function layer and the information layer of the SGAM, which are the focus for the interoperability of flexibility assets. They are called "generic" because they are independent to any technical solution and several use-cases could be mapped to them.

These generic business processes are described with a simple diagram derived from BPMN. Each row refers to a role. Functions are represented as rectangles and interfaces are represented as arrows. In case several paths are possible, the alternative path is drawn with dotted lines.

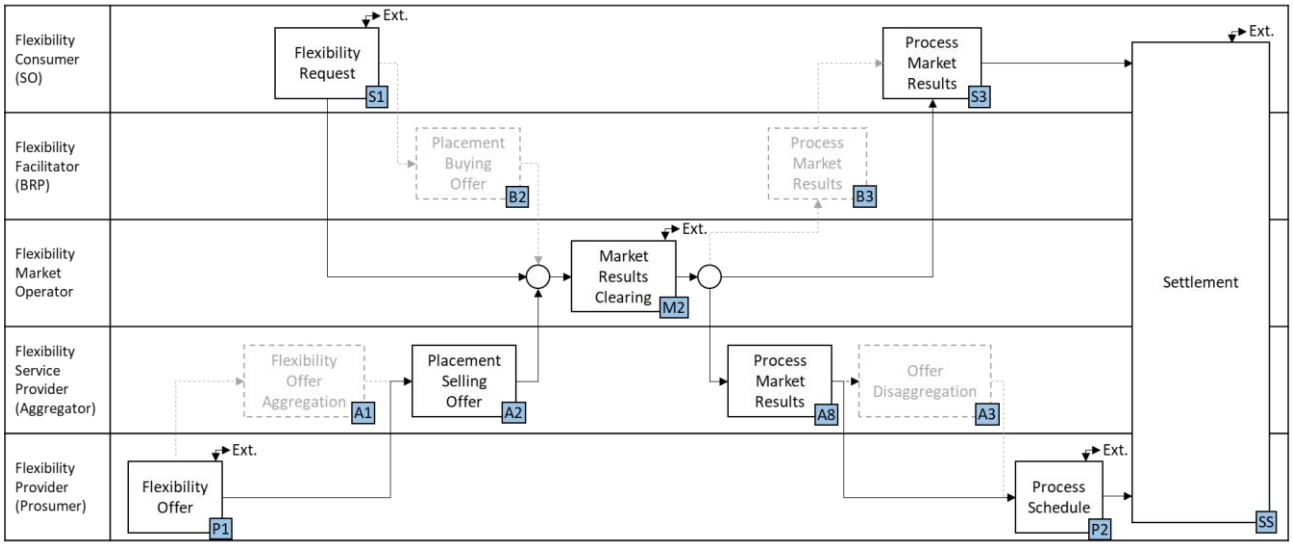


Figure 2. Example of business process diagram

2.1.2 Functions and interfaces

The "functions" represent each of the steps of the business process. They receive inputs from the previous function, use external data or command, and finally provide outputs to the following function. They can be decomposed into "subfunctions", which might be useful for more detailed mapping with some specific architecture.

They are defined with the following table:

X1 / Function name	
Description	This cell describes the purpose of the function, e.g. “the Aggregator collects flexibility offers of all prosumers and calculates the available flexibility for its portfolio”
Inputs	This cell lists the inputs received from the previous function, e.g. “Flexibility offer of prosumer(s)”
Outputs	This cell lists the outputs provided to the following function, e.g. “Aggregated flexibility”
External required data or command	This cell lists the data or commands that are not linked to the previous or following functions but are required to realise the function. An example of external data could be “weather data”, “metering data”, … An example of command could be “control of flexible loads”.
Decomposition into functions/subfunctions	This cell describes the decomposition of the function into subfunctions.

Table 1. Template for function description

The “interfaces” represent the information exchanges between the functions. They are defined with the following table:

X1 → Y1	
Purpose	This cell describes the purpose of the information exchange, e.g. “inform Aggregator about possible flexibility on Prosumer side”
Involved roles	This cell lists the involved roles
List of exchanged data	This cell lists the exchanged data, e.g. “Flexibility offer”

Table 2. Template for interface description

The analysis of the functions allows to study function layer interoperability. The analysis of the interfaces allows to study information layer interoperability.

2.2 Analysis methodology

2.2.1 Principle of the analysis

Each project will provide a description of its system architecture, based on the SGAM model. At least the function and information layers are required.

This architecture will be mapped to the adequate generic business process, depending on the use-case, allowing to make the link e.g. between the data exchanges described in the SGAM information layer and the interfaces defined in the generic business process.

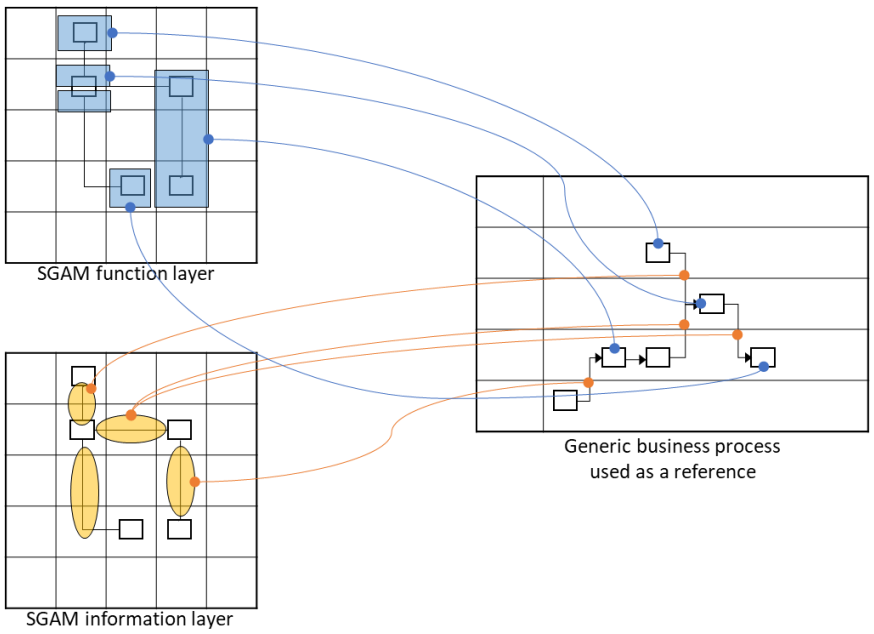


Figure 3. Mapping between a system architecture and the adequate generic business process

For each of the functions and interfaces, the project will describe:

- What solutions/standards are used
    - In case of standard-based solutions, if any extension/modification/deviation to the standard has been required, and why
- If the solutions/standards completely fulfil the needs
    - If not, what is missing
- If some gaps have been identified, e.g. no existing solution for a specific function or interface
    - In such case, what solution has been put in place (proprietary/specific?)

This information will be used to feed:

- The Map of standards, which lists, for each function and interface, the existing solutions and their adequacy
- The list of Gaps, depicting where some solutions are missing, possibly requiring standardisation effort (e.g. to extend existing standard or define new standards)

2.2.2 Contribution from projects

The following contributions will be required from projects as an input to the analysis:

- A description of the system architecture, based on the SGAM model. At least the function and information layers are required.
- The list of the solutions/standards being used for each of the functions and interfaces, including for each of them: if any extension/modification/deviation to the standard has been required, and why;

if the solutions/standards completely fulfil the needs; if some gaps have been identified and in such case what has been done.
- A tentative mapping of the system architecture to the relevant generic business processes.

Such information will be requested when it makes the more sense for the project: usually at M12 or M18, when the use-cases and architecture are already defined.

2.2.3 Expected outcomes

As described in §2.2.1, two main outcomes are expected: Map of standards (possibly with standards assessment) and Gaps identification

The purpose of these outcomes is:

- to help new projects (and the industry) to quickly identify which solutions[1]/standards are available to achieve their use-cases, and how much they fulfil the needs;
- to drive future standardisation work, e.g. to extend existing standards or define new standards.

2.2.3.1 Map of standards

The map of standards lists, for each of the functions and interfaces, the existing solutions/standards, how they fit to the requirements and if some items are missing.

It can be described with the following table:

Interface	Standard	Provided solution	Missing items
Interface X	Standard A		
	Standard B		
	Standard C		
	Standard D		
	Standard E		

Table 3. Example of standard mapping

Such mapping can be completed with standard assessment, e.g. to assess the maturity of a standard, its future-proofness or its adoption by the industry.

2.2.3.2 Gaps

A list of gaps will be established, detailing for which functions or interfaces the projects are missing proper solutions. A gap could be that there is no existing solution or that the existing solutions are incomplete.

[1] By "solution" we mean non-standardised specifications (e.g. proprietary, open specification, ...)

3 Reference framework to study interoperability of flexibility assets

In this chapter, the reference framework is described. As defined in §2.1, it is made of generic business processes, functions and interfaces.

3.1 Definition of terms

3.1.1 Flexibility

For the sake of clarity in the following discussion, it is helpful to define the terms and relations used in the latter context.

The first term to be defined is the flexibility itself. According to [y (Smart Grid Task Force, "Regulatory Recommendations for the Deployment of Flexibility: EU SGTF-EG3 Report," 2015)] flexibility can be defined as follows:

"On an individual level, flexibility is the modification of generation injection and/or consumption patterns in reaction to an external (signal or activation) in order to provide services within the energy system."

This generic definition was further extended by [x (Characterisation of flexibility services, V 1.1)] into a definition that is already touching some details related to the relations between system components and the implementation of flexibility, what might in the end limit the generality of the definition. But what is more important is that [x] also defines parameters to describe the flexibility. Such parameters are very important to define and measure flexibility and it is crucial for the operations related to flexibility to be able to do that. It is important in order to be able to define the flexibility offer (or request) and its respective value, but also for the verification process that the flexibility was indeed released.

Thus, to summarise in a generic way, we can say that:

"Flexibility is a service based on measurable and verifiable modification of energy production and/or consumption behaviour in reaction to external signal (request or activation)."

3.1.2 Flexibility stakeholders

Further, in order to discuss processes based on this service, we can define a set of generic stakeholders related to providing and consuming flexibility. These can be as follows:

Flexibility Provider – is a party that is able and willing to adapt or modify its energy-related behaviour in exchange for some compensation. This party operates in its own name and is not representing anyone else. It can be a private and small energy grid stakeholder, but it can be also industrial and large stakeholder. In general, it is an energy prosumer.

Flexibility Consumer – is a party that needs the flexibility, i.e., it is willing to provide some compensation for the flexibility providers in order to achieve (or avoid) a specific condition in the energy grid. This role can be representing a TSO, DSO, BRP and other energy grid stakeholders that may require the change of energy grid parameters.

Flexibility Service Provider (incl. aggregator) – is a party that is (mainly) not offering flexibility by its own, but it rather represents the individual flexibility providers to make them access the market, in exchange for some fraction of the compensations they get for the flexibility. It bundles (aggregates) the flexibility

offered by its clients and by that may offer more flexibility to larger flexibility consumers. It needs to handle the individual flexibility providers.

Flexibility Facilitator – is a party that represent one or several Flexibility Consumers to make them access the market. Depending on the local regulation and market model, this party might not be necessary or might part of the BRP scope.

Flexibility Market Operator – is a party that connects the flexibility providers and flexibility consumers. It may require these parties to have specific features or parameters to be able to participate in the service processes, e.g. minimum amount of flexibility that may be provided or only industrial parties. It provides means to announce flexibility requests and/or offers allowing the providers/aggregators and consumers to find each other to use and provide the service.

Depending on the Generic Business Processes, these stakeholders can be mapped to one party or another, e.g. in GBP1 the Flexibility consumer is the SO, while in GBP3 it is the BRP.

3.2 Generic business processes

3.2.1 GBP1 – Flexibility for SO through open market

The generic business process for the case of SOs (i.e. DSO or TSO) utilising flexibility through open market mechanism - mapping mostly to the case of grid normal operation - is presented in the following figure. The diagram depicts the different subprocesses/functions of each stakeholder in the flexibility lifecycle. In the open market scenario, the process may involve all the relevant stakeholder in the flexibility market:

- System Operator (SO) as a Flexibility Consumer, aiming to optimise the operation of the grid via the use of flexibility. This SO initiates the process of flexibility activation lifecycle (function S1), assesses the flexibility offered by the market (function S3) and handles the settlement process (function S).
- Balance Responsible Party (BRP), acting as a Flexibility Facilitator for flexibility procurement, placing a buying offer in the flexibility market (function B2), processing the results (function B3) and handling some part of the settlement process (function B4). In some cases, the BRP is skipped and the SO goes directly to the Market.
- Flexibility Market Operator (FMO), enabling the flexibility trading by operating a market (function M2).
- Flexibility Service Provider (e.g. Aggregator), facilitating the pooling of flexibility from various sources (function A1), participating in the market (function A2) and optimally managing its portfolio (function A3) to provide the contracted flexibility. It also provides a settlement function for the utilised flexibility source.
- Prosumer, the Flexibility Provider, which is offered to the market via the aggregator (function P1), activated taking care modelled preferences and constraints (function P2) and properly remunerated or penalised (function S).

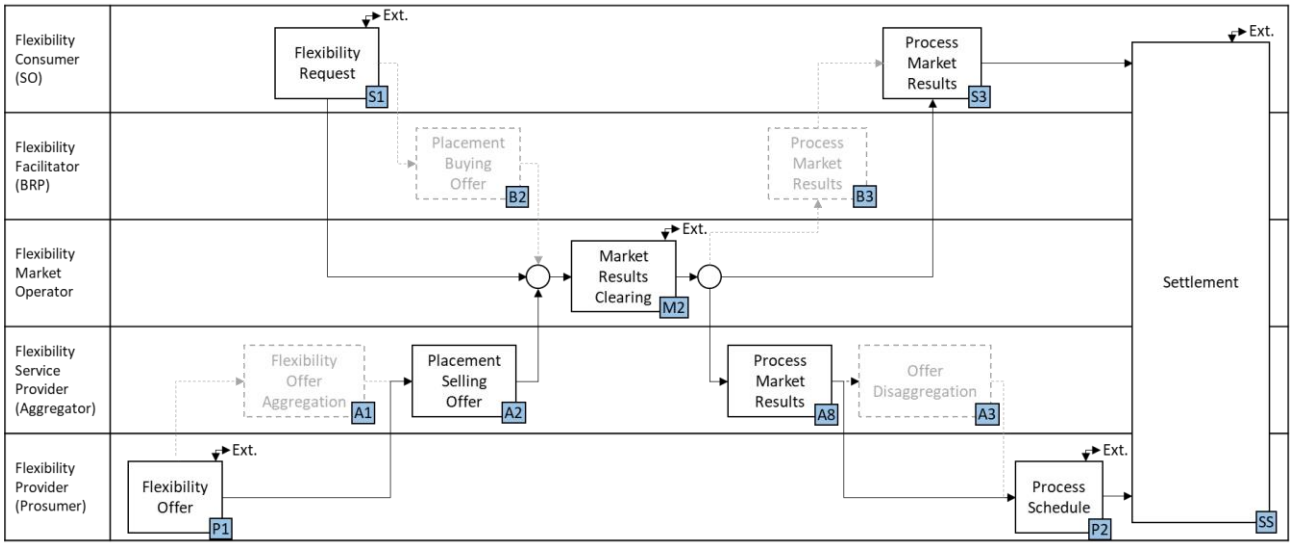


Figure 4 Business process diagram – GBP1 "SO flexibility through open market"

3.2.2 GBP2 – Flexibility for SO via prior bilateral agreement

The SO (i.e. DSO or TSO) business process for flexibility via prior bilateral agreement (Figure 5) is quite different from the one described above, even though flexibility is offered to SO in this case as well. The purpose of this case is to provide near real-time flexibility activation after a SO request, in particular for the SO to deal with an emerging network congestion/load balancing problem. Delivery of flexibility is not expected to be performed through a market; therefore, no market operator is involved in order to simplify and speed up the process. The highest priority must be given due to the emergency status. Therefore, in case there are other flexibility offers and requests available in a market (e.g., Local Flexibility Market), these planned transactions could be temporarily disregarded.

The roles that are involved in this process are the SO, the Aggregator, and the Prosumers. The SO flexibility via prior bilateral agreement process comprises two distinct phases:

- In the first phase, a bilateral agreement between the SO and the Aggregator is made in order to define details such as minimum/maximum amount of flexibility, pricing of the service that Aggregator provides to the SO, and estimated amount of aggregated flexibility that can be provided. The amount of flexibility that can be delivered to SO is determined dynamically by the Aggregator, who continuously estimates aggregated flexibility within a rolling horizon T, based on the flexibility offers that are received by the participating prosumers. Flexibility is being updated within T, however, it is usually considered fixed for a period of time defined by a fixed timestep (current time + timestep).
- The second phase is initiated when the SO effectively requires flexibility, for example, when detecting or predicting a critical network problem and, therefore, requests flexibility from the Aggregator based on the bilateral agreement. The amount of flexibility that will be provided to SO is calculated dynamically by the Aggregator.
- During runtime, prosumers provide the information on the availability of flexibility to the Aggregator, including amount of flexibility, duration, time span, etc. The set of parameters should include the amount of available flexibility, the time span and the conditions, under which the flexibility offer is valid to enable the Aggregator to evaluate the availability of flexibility at a specific time and classify it according to the different needs of the SO (immediate actions in case of time-critical emergency events and planning to compensate for predicted forecast deviations).
- Under normal conditions, the process ends with the generation of asset control schedules at the prosumers' side, flexibility activation, and settlement.

- The applied rules are defined by the Regulator, however, the Regulator does not participate actively in the process during runtime. However, the Regulator is expected to perform control/audit to assure that the agreement is in line with the set rules.

Regarding the settlement process, a separate "settlement subprocess" is defined, which this process is discussed in further detail in section 3.2.6 The defined settlement subprocess is common for all GBPs.

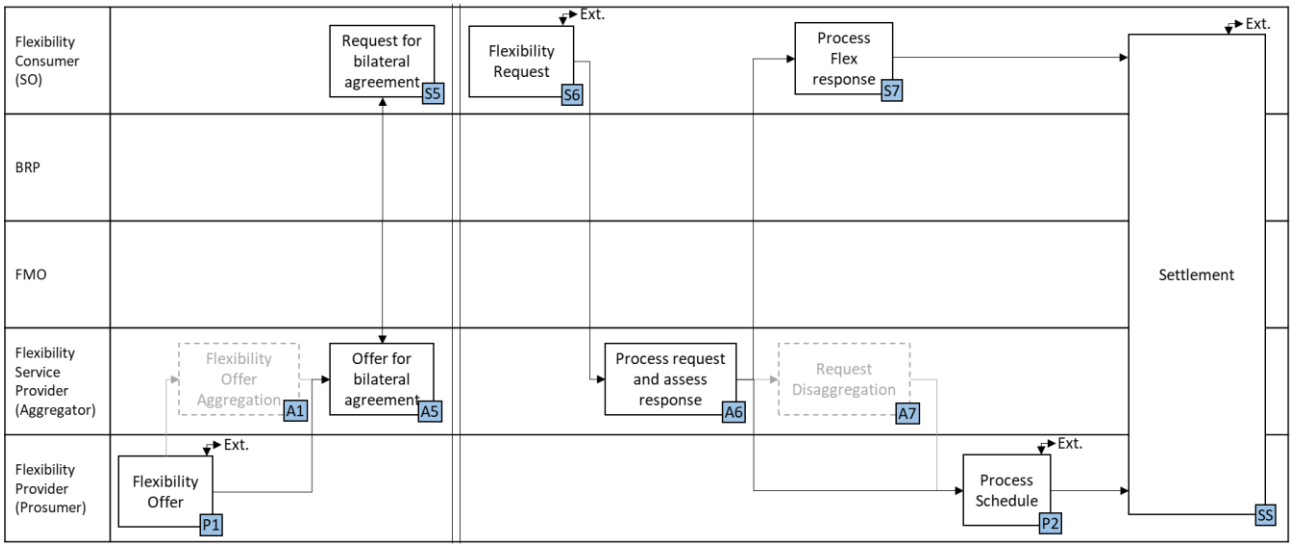


Figure 5. Business process diagram for GBP2 "SO flexibility via prior bilateral agreement"

3.2.3 GBP3 – Flexibility for BRP portfolio optimisation

The main objective of balancing markets is to deal with the power system's temporary imbalances to ensure grid stability and security of supply. The flexibility can be used to optimise trading portfolios and reduce balancing cost resulting from deviations between scheduled and actual inflow/off-take. The costs for this balancing mechanism are charged to BRPs with an imbalance in their portfolio. The BRPs optimise their portfolio so that instantaneous deviations between predicted and actual production and consumption are kept as low as possible to avoid imbalance costs and prevent the power system to enter the emergency mode. The flexibility services are offered to energy suppliers/BRPs from the aggregator flexibility asset pools comprising the flexibilities services offered by customers or network users to balance the flexibility assets in the grid or energy markets. The responsibility might be carried out by existing bundled roles in the energy market, like energy suppliers with variable prices, aggregators.

It is worth emphasising that the BRP defines its optimisation strategy by undertaking roles of an aggregator and using the received flexibility offer. Moreover, the BRP can participate in new or existing balancing power markets and energy services. The difference between the DSO leveraging flexibility through open market and portfolio optimisation is the market settlement is undertaken by the BRP. Market settlement is analysed further in section 3.2.6, entitled 'Settlement subprocess', and is common across all GBPs, incl. GBP3.

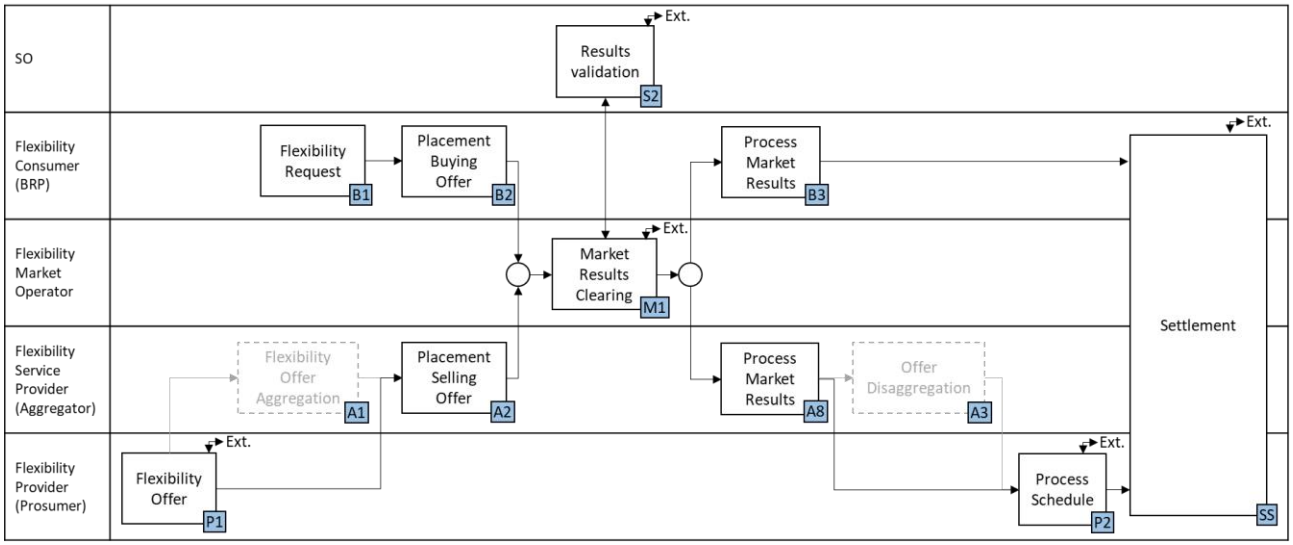


Figure 6: Business process diagram for GBP3 “BRP portfolio optimisation”

3.2.4 GBP4 – Flexibility for energy community optimisation

The main objective of an energy community is to optimise the energy flows within the community. This optimisation can follow different strategies, e.g. the goal may be to maximise the collective self-consumption (i.e. adapt consumption to be equal to production so there is no energy exchange with the grid outside the community). The energy community is managed by a Flexibility Service Provider, or Aggregator. Independent from the goal and from the participation to the market, there are some actions related to the internal optimisation within the energy community as shown in the Figure 7. In case the optimisation process is not done by a central entity, but by some distributed approach involving the community members, the Flexibility Service Provider, or Aggregator, is virtually present. The energy community as a whole can also participate to the above GBPs, either as an active participant (the Aggregator/Flexibility Service Provider has access to market) or as a Prosumer represented by another (external) Aggregator/Flexibility Service Provider. The GBP covers scenarios related to energy communities, virtual power plants and similar.

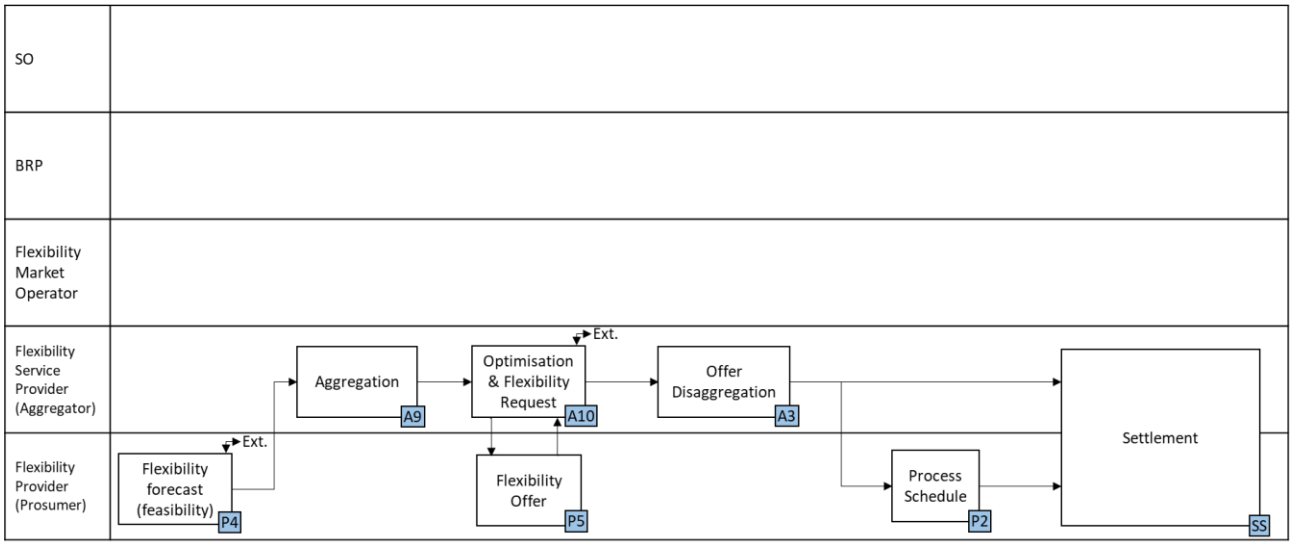


Figure 7. Business process diagram for GBP4 "Energy community optimisation"

3.2.5 GBP5 – Implicit flexibility using dynamic steering signals

The flexibility offering and buying can be realised in an implicit way. The demand for adapting energy production and consumption can be triggered by issuing adequate signals (e.g. price signal, CO_2/kWh indicator or other grid notifications) that should indicate if there is too much or too less energy in the grid and the Prosumers should adapt. This approach is usually applied with focus on active energy, but extending the trigger can also cause this approach to be useful in other areas of flexibility (power factor, etc.). Mainly in this GBP there exists no bidding phase, the flex consumer defines the signal parameters (e.g. price table or peak notice) with the hope to have enough prosumers reacting according to the wish of the buyer. The accounting is done according to the measured amount of flexibility provided with respect to potential additional parameters (like power factor).

This approach actually does not need to involve the market nor the aggregator. But variations are possible in different realisations. In the basic approach the flex consumer takes the risk of being exploited by the flex providers, i.e., if they are very flexible, they can become speculators, they can consume only cheap energy, while producing energy while it is expensive. Here it is necessary to be supported by regulations.

This GBP is still under construction. A tentative business process diagram for the “price signal” scenario is provided below:

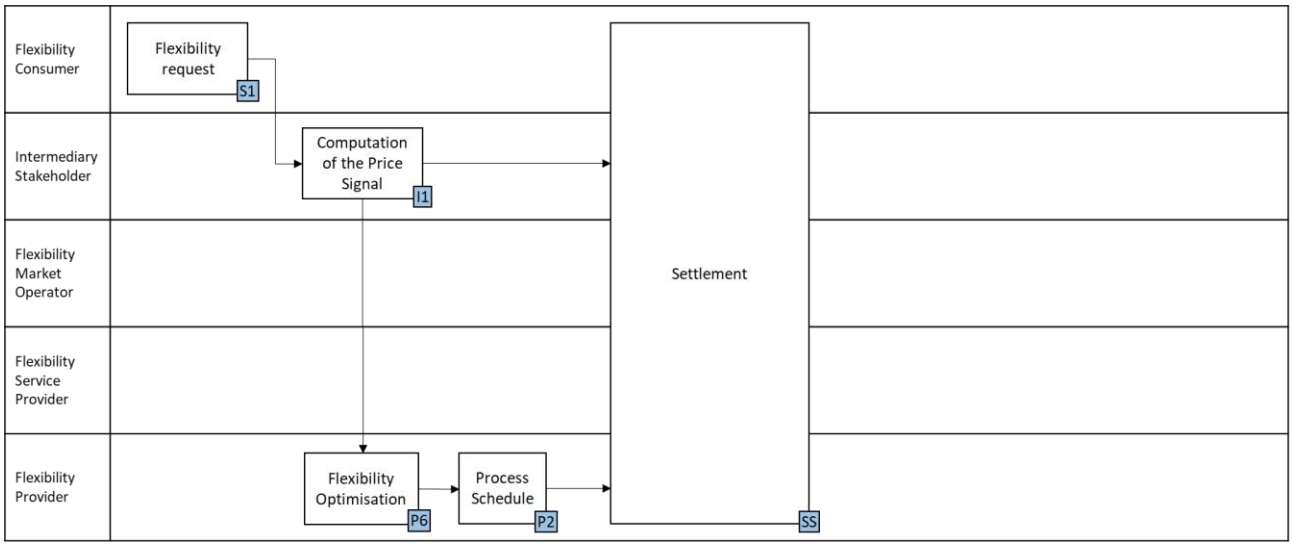


Figure 8. Tentative business process diagram for GBP5 "Implicit flexibility using dynamic steering signals" (“price signal” scenario)

3.2.6 Settlement subprocess

The purpose of the settlement is to prepare the billing process by determining the delivered flexibility and computing the flexibility fee based on the contractual agreement between the Flexibility Service Provider (e.g. Aggregator) and the Flexibility Consumer (e.g. SO or BRP). It relies first on the quantification of the provided flexibility, and then on the comparison/reconciliation of the flex fee between the flexibility Provider and the flexibility Consumer.

As this phase is similarly structured for all the Flexibility GBPs, it is described in a common subprocess.

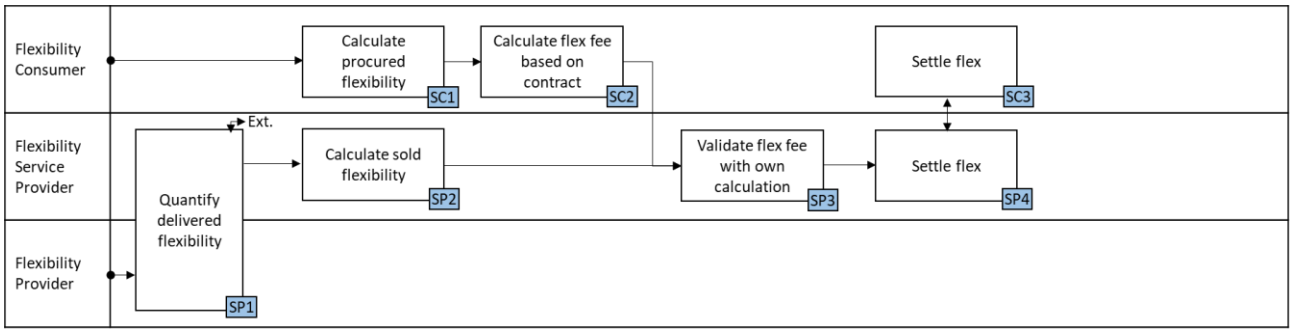


Figure 9. Business process diagram for the Settlement subprocess

3.3 Functions and interfaces

This section describes the functions and interfaces used in the generic business processes.

3.3.1 Functions

3.3.1.1 Summary of relevant functions per Generic Business Process

Function	GBP1	GBP2	GBP3	GBP4	GBP5
S1 / Flexibility Request	✓				✓
S2 / Results validation			✓		
S3 / Process Market Results	✓				
~~S4 / Process Settlement~~					
S5 / Request for bilateral agreement		✓			
S6 / Flexibility request		✓			
S7 / Process Flex response		✓			
B1 / Flexibility request			✓		
B2 / Placement of Buying Offer	(✓)		✓		
B3 / Process Results	(✓)		✓		
~~B4 / Process Settlement~~					
M1 / Market Results Clearing (BRP)			✓		
M2 / Market Results Clearing (SO)	✓				
A1 / Flexibility Offer Aggregation	(✓)	(✓)	(✓)		
A2 / Placement Selling Offer	✓		✓		
A3 / Offer Disaggregation	(✓)		(✓)	✓	
~~A4 / Settlement Disaggregation~~					

Function	GBP1	GBP2	GBP3	GBP4	GBP5
A5 / Offer for bilateral agreement		✓			
A6 / Process request and assess response		✓			
A7 / Request disaggregation		(✓)			
A8 / Process market results	✓		✓		
A9 / Aggregation				✓	
A10 / Optimisation & Flexibility request				✓	
P1 / Flexibility offer	✓	✓	✓		
P2 / Process schedule	✓	✓	✓	✓	✓
~~P3 / Process Settlement~~					
P4 / Flexibility forecast (feasibility)				✓	
P5 / Flexibility offer (energy community)				✓	
P6 / Flexibility optimisation					✓
I1 / Computation of Price Signal					✓
SS / Settlement subprocess: • SP1 / Quantify delivered flexibility • SP2 / Calculate sold flexibility • SP3 / Validate flex fee with own calculation • SP4 / Settle flex • SC1 / Calculate procured flexibility • SC2 / Calculate flex fee based on contract • SC3 / Settle flex	✓	✓	✓	✓	✓

3.3.1.2 S functions

S1 / Flexibility Request	
Description	The Flexibility Consumer sends a flexibility request to the market or to the Flexibility Facilitator, specifying volume, date(s), location, expiration date (and price in the case of market bid).
Inputs	
Outputs	Flexibility request
External required data	Flexibility pool, Grid Operational Status, Flexibility availability
Decomposition into functions/subfunctions	

S2 / Results validation	
Description	The foreseen result of the market cycle is provided by the Flexibility Market Operator to the SO, so the SO can validate that the proposed plan is acceptable from the grid perspective.
Inputs	Flexibility offers and offer results (what, when, where, how much, ...)
Outputs	Acceptance or refusal of the proposed plan
External required data	Grid operational status
Decomposition into functions/subfunctions	

S3 / Process Market Results	
Description	The SO receives information on activated flexibility. It processes the result and in case of inadequate volumes, corrective actions are taken (e.g. new request). It also informs about the corresponding flexibility transaction/agreement to enable the settlement.
Inputs	Flexibility order

Outputs	Corrective actions Flexibility transaction/agreement
External required data	
Decomposition into functions/subfunctions	

~~S4 / Process Settlement~~
Deprecated

S5 / Request for bilateral agreement	
Description	The Flexibility Consumer makes a request to the Flexibility Service Provider to make bilateral agreement regarding the flexibility that can be provided
Inputs	Special flag to indicate an emergency operation scenario Desirable amount of flexibility
Outputs	Start iterative negotiation process with the Flexibility Service Provider
External required data	
Decomposition into functions/subfunctions	

S6 / Flexibility request	
Description	Flexibility Consumer makes a flexibility request to the Flexibility Service Provider to deal with a predicted grid issue (e.g. emergency situation)
Inputs	
Outputs	Time period Amount of energy

S6 / Flexibility request	
	Location information
External required data	Grid network area status (emergency state)
Decomposition into functions/subfunctions	

S7 / Process Flex response	
Description	Flexibility Consumer processes the flexibility response received. It also informs about the corresponding flexibility transaction/agreement to enable the settlement.
Inputs	Flexibility response
Outputs	Selected flexibility response Flexibility transaction/agreement
External required data	
Decomposition into functions/subfunctions	

3.3.1.3 B functions

B1 / Flexibility request	
Description	The Flexibility Consumer prepares a flexibility request, specifying volume, date(s), location, expiration date (and price in the case of market bid).
Inputs	
Outputs	Flexibility request
External required data	Production/Consumption forecast, Portfolio status, Flexibility availability
Decomposition into functions/subfunctions	

B2 / Placement of Buying Offer	
Description	Flexibility Facilitator places a flexibility bid in the market, specifying volume, date(s), location, expiration date and price.
Inputs	Flexibility request by Flexibility Consumer
Outputs	Flexibility request to the market
External required data	
Decomposition into functions/subfunctions	

B3 / Process Results	
Description	Flexibility Facilitator receives information on activated flexibility. It forwards relevant information to Flexibility Consumer. It also informs about the corresponding flexibility transaction/agreement to enable the settlement.
Inputs	Flexibility order (s) from market
Outputs	Flexibility order(s) to Flexibility Consumer Flexibility transaction/agreement
External required data	
Decomposition into functions/subfunctions	

~~B4 / Process Settlement~~
Deprecated

3.3.1.4 M functions

M1 / Market Results Clearing (BRP)	
Description	Matching of the buying requests and the selling offers from the Flexibility Service Provider
Inputs	Flexibility request from Flexiblity Consumer Selling offer(s) from Flexibility Service Provider Validated Results
Outputs	Market Results clearing
External required data	Flexibility pool
Decomposition into functions/subfunctions	

M2 / Market Results Clearing (SO)	
Description	Matching of the request (buy) and offers (sell) of flexibility.
Inputs	Flexibility request from Flexiblity Consumer Selling offer(s) from Flexiblity Service Provider
Outputs	Flexibility order(s)
External required data	Flexibility pool
Decomposition into functions/subfunctions	

3.3.1.5 A functions

A1 / Flexibility Offer Aggregation	
Description	Flexibility Service Provider collects flexibility offers of all Flexibility Providers and calculates the available flexibility for its portfolio.
Inputs	Flexibility offer of Flexibility Providers

A1 / Flexibility Offer Aggregation	
Outputs	Aggregated flexibility
External required data	
Decomposition into functions/subfunctions	

A2 / Placement Selling Offer	
Description	Flexibility Service Provider places a bid of flexibility in the market. The bid has an expiration date and the location of the grid. Location can relate to physical infrastructure (e.g. substation, feeder) or logical segment (area of the grid).
Inputs	Aggregated flexibility
Outputs	Flexibility offer (market level)
External required data	
Decomposition into functions/subfunctions	

A3 / Flexibility Offer Disaggregation	
Description	Flexibility Service Provider receives flexibility schedule from the market. It activates flexibility of Flexibility Providers following internal process of optimisation.
Inputs	Flexibility order from market or optimisation process
Outputs	Flexibility order(s) of Flexibility Provider(s)
External required data	
Decomposition into functions/subfunctions	

~~A4 / Settlement Disaggregation~~
Deprecated

A5 / Offer for bilateral agreement	
Description	The Flexibility Service Provider provides an offer for bilateral agreement with the Flexibility Consumer
Inputs	Aggregated flexibility (calculated from previous step)
Outputs	Min/Max amount of flexibility that can be used after a Flexibility Consumer flexibility request Price per flexibility unit to be paid for providing the service to the Flexibility Service Provider
External required data	
Decomposition into functions/subfunctions	

A6 / Process request and assess response	
Description	Flexibility Service Provider receives the flexibility request and checks if it is valid according to the bilateral agreement. If yes, highest priority is given to respond to the flexibility request.
Inputs	Flexibility request information (time period, amount of energy, location)
Outputs	Flexibility schedule returned as response
External required data	
Decomposition into functions/subfunctions	

A7 / Request disaggregation	
Description	Flexibility Service Provider performs disaggregation of the selected flexibility response to the appropriate Flexibility Providers, by applying optimisation methods
Inputs	Flexibility that can be provided to Flexibility Consumer after its request
Outputs	Flexibility schedule(s) of prosumer(s)
External required data	
Decomposition into functions/subfunctions	

A8 / Process market results	
Description	Flexibility Service Provider receives information on activated flexibility. It forwards relevant information to disaggregation or directly to the Flexibility Provider.
Inputs	Flexibility order(s) from market
Outputs	Flexibility order(s) to disaggregation or Flexibility Provider
External required data	
Decomposition into functions/subfunctions	

A9 / Aggregation	
Description	The Flexibility Service Provider aggregates all available flexibility forecasts received from the flexibility providers within their portfolio. This Function is very similar to A1. It is to be investigated if there are major differences stemming from the different GBPs or if these two can be merged.
Inputs	Flexibility forecast per flexibility provider (prosumer)

A9 / Aggregation	
Outputs	Aggregated flexibility forecast (I.e., community/portfolio-level flexibility forecast, where portfolio here comprises all available and eligible flexibility providers).
External required data	None
Decomposition into functions/subfunctions	

A10 / Optimisation & Flexibility request	
Description	The Flexibility Service Provider receives (on a dynamic or static way) an optimisation request/task (depending on the optimisation scenario/use case) and performs an iterative optimisation process. Based on the initial flexibility offers by the Flexibility Providers, the Flexibility Service Provider may send an individual flexibility request to eligible Flexibility Providers and receive a reassessed flexibility offer from them. Based on the available offers, the optimisation engine calculates and produces the flexibility profile at the cumulated level.
Inputs	Aggregated flexibility forecast Flexibility offer per flexibility provider (prosumer)
Outputs	Flexibility request to each prosumer Aggregated flexibility profile (flexibility profile at community or portfolio level based on the aggregation of available flexibility offers per prosumer)
External required data	Optimisation constraints and goals (the optimisation scenario driving the optimisation and calculation of the required flexibility, translated into optimisation constraints)
Decomposition into functions/subfunctions	

3.3.1.6 P functions

P1 / Flexibility offer	
Description	Flexibility Provider's flexibility is provided to the Flexibility Service Provider. Flexibility Provider is aware and agrees that provided flexibility can be procured via market transactions or based on bilateral agreement between the Flexibility Consumer and the Flexibility Service Provider (incentives for prosumer involvement can be provided in the latter case).
Inputs	Flexibility calculation from individual assets: P2H, EV charging, etc. Flexibility time period
Outputs	Flexibility offer
External required data	Any data required for calculating flexibility that can be offered dynamically based on current and forecasted parameters' values: usage patterns, types of devices, set-points preferences, weather data (including forecasts), calendar
Decomposition into functions/subfunctions	

P2 / Process schedule	
Description	Flexibility Provider receives flexibility schedule from the Flexibility Service Provider. Assets are activated following the received schedule. It also informs about the corresponding flexibility transaction/agreement to enable the settlement.
Inputs	Disaggregated Flexibility order/request/offer (from Flexibility Service Provider to Flexibility Provider)
Outputs	Control actions (to controllable assets) based on flexibility request Verification of response to flexibility request Flexibility transaction/agreement
External required data	Control of assets (response from controllable assets)
Decomposition into functions/subfunctions	

~~P3 / Process Settlement~~
Deprecated

P4 / Flexibility forecast (feasibility)	
Description	The Flexibility Provider (prosumer) generates flexibility forecasts based on data from available IoT infrastructure (meters, sensors, etc.). This Function is very similar to P1. It is to be investigated if there are major differences stemming from the different GBPs or if these two can be merged.
Inputs	Metering and sensoring IoT data / Request for provision of flexibility forecast
Outputs	Prosumer-level flexibility forecast
External required data	Metering and sensor IoT data, weather data (including forecasts)
Decomposition into functions/subfunctions	

P5 / Flexibility offer (energy community)	
Description	The Flexibility Provider receives a flexibility request by the Flexibility Service Provider, assesses it and returns their flexibility offer (I.e., the flexibility profile that they can offer in response to the request made by the Service Provider)
Inputs	Flexibility request by the Flexibility Service Provider
Outputs	Flexibility offer per prosumer
External required data	None
Decomposition into functions/subfunctions	

P6 / Flexibility optimisation	
Description	The Flexibility Provider receives the implicit steering signal (dynamic energy price, CO2/kWh indicator, etc.) and decides on the activation of available assets
Inputs	The implicit steering signal
Outputs	Schedule for activating the available assets
External required data	
Decomposition into functions/subfunctions	

3.3.1.7 I functions

I1 / Computation of Price Signal	
Description	The explicit flexibility request is translated into an implicit steering signal to be distributed among the interested Flexibility Providers
Inputs	Explicit Flex Request
Outputs	Implicit steering signal (energy price)
External required data	
Decomposition into functions/subfunctions	

3.3.1.8 Settlement functions

SP1 / Quantify delivered flexibility	
Description	The Flexibility Provider and/or the Flexibility Service Provider quantify the flexibility that has been indeed provided/delivered by the Flexibility Provider, based on appropriate measurements and monitoring.
Inputs	Flexibility transaction/agreement

SP1 / Quantify delivered flexibility	
Outputs	Delivered flexibility (how much, when, ...)
External required data	Metering data
Decomposition into functions/subfunctions	

SP2 / Calculate sold flexibility	
Description	The Flexibility Service Provider maps the delivered flexibility with the flexibility contract(s) to characterise the sold flexibility.
Inputs	Delivered flexibility (how much, when, ...)
Outputs	Sold flexibility (contract reference, quantity, time period, ...)
External required data	
Decomposition into functions/subfunctions	

SP3 / Validate flex fee with own calculation	
Description	The Flexibility Service Provider validates the compensation fee for the sold flexibility by comparing the flex fee claimed by the Flexibility Consumer and the flex fee computed by itself based on the contract and sold flexibility.
Inputs	Sold flexibility Compensation fee for the procured flexibility (from Flexibility Consumer)
Outputs	Compensation fee for the sold flexibility
External required data	
Decomposition into functions/subfunctions	

SP4 / Settle flex	
Description	The flexibility transactions are validated and the payment information for settlement is agreed between the Flexibility Consumer and the Flexibility Service Provider.
Inputs	Compensation fee for the sold flexibility
Outputs	
External required data	
Decomposition into functions/subfunctions	

SC1 / Calculate procured flexibility	
Description	The Flexibility Consumer calculates the amount (and time period) of procured flexibility, based on the existing contracts and past Flexibility requests
Inputs	Flexibility transaction/agreement Price signals (for GBP5)
Outputs	Procured flexibility
External required data	
Decomposition into functions/subfunctions	

SC2 / Calculate flex fee based on contract	
Description	The Flexibility Consumer computes the compensation fee for the sold flexibility based on the contract and procured flexibility
Inputs	Procured flexibility
Outputs	Compensation fee for the procured flexibility

SC2 / Calculate flex fee based on contract	
External required data	
Decomposition into functions/subfunctions	

SC3 / Settle flex	
Description	The flexibility transactions are validated and the payment information for settlement is agreed between the Flexibility Consumer and the Flexibility Service Provider.
Inputs	Compensation fee for the sold flexibility
Outputs	
External required data	
Decomposition into functions/subfunctions	

3.3.2 Arrows (information flows)

3.3.2.1 Summary of relevant interfaces per Generic Business Process

Interface	GBP1	GBP2	GBP3	GBP4	GBP5
P1 → A1	(✓)	(✓)	(✓)		
A1 → A2	(✓)		(✓)		
P1 → A2	✓		✓		
A1 → A5		(✓)			
P1 → A5		✓			
A2 → M2	✓				

Interface	GBP1	GBP2	GBP3	GBP4	GBP5
M1 → B3			✓		
M1 → A8			✓		
~~B3 → B4~~					
~~B4 → A4~~					
P4 → A9				✓	
A9 → A10				✓	

S1 → B2	(✓)				
B2 → M2	(✓)				
S1 → M2	✓				
M2 → B3	(✓)				
B3 → S3	(✓)				
M2 → S3	✓				
~~S3 → B4~~					
~~B4 → A4~~					
~~S3 → S4~~					
~~S4 → A4~~					
M2 → A8	✓				
A8 → A3	(✓)	(✓)			
A3 → P2	(✓)	(✓)	✓		
A8 → P2	✓	✓			
~~P2 → P3~~					
~~A4 → P3~~					
A5 ↔ S5	✓				
S6 → A6	✓				
A6 → S7	✓				
A6 → A7	(✓)				
A7 → P2	(✓)				
A6 → P2	✓				
~~S7 → S4~~					

A10 ↔ P5				✓	
A10 → A3				✓	
S1 → I1					✓
I1 → P6					✓
P6 → P2					✓
S3 → SS	✓				
P2 → SS	✓	✓	✓	✓	✓
S7 → SS		✓			
B3 → SS			✓		
A3 → SS				✓	
I1 → SS					✓
S1 ↔ Ext	✓				
S2 ↔ Ext			✓		
S6 ↔ Ext		✓			
M1 ↔ Ext			✓		
M2 ↔ Ext	✓				
~~A4 ↔ Ext~~					
P1 ↔ Ext	✓	✓	✓		
P2 ↔ Ext	✓	✓	✓		
P4 ↔ Ext				✓	
A10 ↔ Ext				✓	

A2 → M1	✓
B1 → B2	✓
B2 → M1	✓
M1 ↔ S2	✓

SP1 → SP2	✓	✓	✓	✓	✓
SP2 → SP3	✓	✓	✓	✓	✓
SC1 → SC2	✓	✓	✓	✓	✓
SC2 → SP3	✓	✓	✓	✓	✓
SP3 → SP4	✓	✓	✓	✓	✓
SP4 ↔ SC3	✓	✓	✓	✓	✓
SP1 ↔ Ext	✓	✓	✓	✓	✓

3.3.2.2 Internal interfaces

P1 → A2

Option 1: with Aggregation

P1 → A1	
Purpose	Inform Flexibility Service Provider about possible flexibility on Flexibility Provider side for the next hour/day/…
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Flexibility offer (what, when, where, how much, …) Could be: ● A set of Timeseries of flexibility (tolerance) including *baseline* (estimation of desired power consumption considering only Flexibility Provider's comfort), *upper bound* (maximum energy that can absorb) *lower bound* (minimum energy required). ● *Granularity* of the timeseries, its *length* (horizon) and *unit* is also contained in message description. ● Location: geographical (latitude and longitude) or grid-related (substation ID or connection point)

P1 → A2	
	• Communication endpoints for central EMS (or individual assets) Other information: e.g. flexibility timeseries are valid till are not exploited, once the flexibility is used, Flexibility Service Provider needs to consider a rate of flexibility adjustment or make frequent queries to get latest updates from Flexibility Provider. Or data about rebound effects of storage-like flexibility.

A1 → A2	
Purpose	Inform about aggregated flexibility that can be offered to the market
Involved roles	Flexibility Service Provider
List of exchanged data	Flexibility offer (what, when, where, how much, …)

Option 2: no aggregation

P1 → A2	
Purpose	Inform Flexibility Service Provider about possible flexibility on Flexibility Provider side for the next hour/day/…
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Flexibility offer (what, when, where, how much, …) Could be: • A set of Timeseries of flexibility (tolerance) including *baseline* (estimation of desired power consumption considering only Flexibility Provider's comfort), *upper bound* (maximum energy that can absorb) *lower bound* (minimum energy required). • *Granularity* of the timeseries, its *length* (horizon) and *unit* is also contained in message description. • Location: geographical (latitude and longitude) or grid-related (substation ID or connection point) • Communication endpoints for central EMS (or individual assets) Other information: e.g. flexibility timeseries are valid till are not exploited, once the flexibility is used, Flexibility Service Provider needs to consider a rate of flexibility adjustment or make frequent queries

P1 → A2	
	to get latest updates from Flexibility Provider. Or data about rebound effects of storage-like flexibility.

P1 → A5

Option 1: with Aggregation

P1 → A1	
Purpose	Inform Flexibility Service Provider about possible flexibility on Flexibility Provider side for the next hour/day/...
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Flexibility offer (what, when, where, how much, ...) Could be: ● A set of Timeseries of flexibility (tolerance) including *baseline* (estimation of desired power consumption considering only Flexibility Provider's comfort), *upper bound* (maximum energy that can absorb) *lower bound* (minimum energy required). ● *Granularity* of the timeseries, its *length* (horizon) and *unit* is also contained in message description. ● Location: geographical (latitude and longitude) or grid-related (substation ID or connection point) ● Communication endpoints for central EMS (or individual assets) Other information: e.g. flexibility timeseries are valid till are not exploited, once the flexibility is used, Flexibility Service Provider needs to consider a rate of flexibility adjustment or make frequent queries to get latest updates from Flexibility Provider. Or data about rebound effects of storage-like flexibility.
A1 → A5	
Purpose	Communication of the available aggregated flexibility for the horizon of interest, to be processed with an offer optimisation function (regarding portfolio of clients, and estimation of the bids/imbalance fees).

P1 → A5	
Involved roles	Flexibility Service Provider
List of exchanged data	Aggregated flexibility offers per zone

Option 2: no aggregation

P1 → A5	
Purpose	Inform Flexibility Service Provider about possible flexibility on Flexibility Provider side for the next hour/day/...
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Flexibility offer (what, when, where, how much, ...) Could be: ● A set of Timeseries of flexibility (tolerance) including *baseline* (estimation of desired power consumption considering only Flexibility Provider's comfort), *upper bound* (maximum energy that can absorb) *lower bound* (minimum energy required). ● *Granularity* of the timeseries, its *length* (horizon) and *unit* is also contained in message description. ● Location: geographical (latitude and longitude) or grid-related (substation ID or connection point) ● Communication endpoints for central EMS (or individual assets) Other information: e.g. flexibility timeseries are valid till are not exploited, once the flexibility is used, Flexibility Service Provider needs to consider a rate of flexibility adjustment or make frequent queries to get latest updates from Flexibility Provider. Or data about rebound effects of storage-like flexibility.

A2 → M2	
Purpose	Submit flexibility offer to the market

Involved roles	Flexibility Service Provider MO
List of exchanged data	Flexibility offer (what, when, where, how much, …)

S1 → M2

Option 1: through Flexibility Facilitator

S1 → B2	
Purpose	Inform about flexibility need that should be placed to the market
Involved roles	Flexibility Consumer Flexibility Facilitator
List of exchanged data	Flexibility request (what, when, where, how much, …)
B2 → M2	
Purpose	Place flexibility request
Involved roles	Flexibility Facilitator MO
List of exchanged data	Flexibility request (what, when, where, how much, …)

Option 2: direct

S1 → M2	
Purpose	Place flexibility request
Involved roles	Flexibility Consumer MO
List of exchanged data	Flexibility request (what, when, where, how much, …)

S1 → M2

M2 → S3

Option 1: through Flexibility Facilitator

M2 → B3	
Purpose	Inform about flexibility transaction/agreement
Involved roles	MO Flexibility Facilitator
List of exchanged data	Flexibility order (what, when, where, how much, …)

B3 → S3	
Purpose	Inform about flexibility transaction/agreement
Involved roles	Flexibility Facilitator Flexibility Consumer
List of exchanged data	Flexibility order (what, when, where, how much, …)

Option 2: direct

M2 → S3	
Purpose	Inform about flexibility transaction/agreement
Involved roles	MO Flexibility Consumer

M2 → S3	
List of exchanged data	Flexibility order (what, when, where, how much, …)

M2 → A8	
Purpose	Inform about flexibility transaction/agreement
Involved roles	MO Flexibility Service Provider
List of exchanged data	Flexibility order (what, when, where, how much, …)

A8 → P2	

Option 1: with Aggregation

A8 → A3	
Purpose	Inform about flexibility transaction/agreement
Involved roles	Flexibility Service Provider
List of exchanged data	Flexibility order (what, when, where, how much, …)
A3 → P2	
Purpose	Inform about flexibility activation to be scheduled (disaggregated)
Involved roles	Flexibility Service Provider Flexibility Provider
List of exchanged data	Flexibility order (what, when, where, how much, …)

A8 → P2

Option 2: no aggregation

A8 → P2	
Purpose	Inform about flexibility activation to be scheduled
Involved roles	Flexibility Service Provider Flexibility Provider
List of exchanged data	Flexibility order (what, when, where, how much, ...)

A3 → P2 (for GBP4)	
Purpose	Inform about flexibility activation to be scheduled (disaggregated)
Involved roles	Flexibility Service Provider Flexibility Provider
List of exchanged data	Flexibility order (what, when, where, how much, ...)

A5 → S5	
Purpose	Bid/offer for bilateral agreement (iterative phase) Note: As a prerequisite, bilateral agreements between Flexibility Consumer and Flexibility Service Provider (and/or Flexibility Provider) must be foreseen in the regulation. Involved parties (Flexibility Consumer, Flexibility Service Provider) have to proceed with the bilateral agreement in fully compliance with the regulation dictates.
Involved roles	Flexibility Consumer Flexibility Service Provider
List of exchanged data	Imbalance Settlement period and its duration. Hourly table of flexibility and corresponding offer

A5 → S5	
	Request/bid for flexibility in specific slot(s) of time Validation/refusal message Re-consider offers until all the forecasted energy requirement is safely satisfied. Lead time; Time before the (recurring) flexibility option expires. Problematic point (node) Remuneration scheme Others: ● Maximum number of activations ● Minimum time between activation ● Penalties for deviation from contract

S6 → A6	
Purpose	Flexibility request in operation phase (once the agreements are settled)
Involved roles	Flexibility Consumer Flexibility Service Provider(s)
List of exchanged data	Amount of flexibility and timing Location (geocoding or node specification) of the points in which flexibility is required

A6 → S7	
Purpose	Flexibility response
Involved roles	Flexibility Consumer Flexibility Service Provider
List of exchanged data	Response; Validation, rejection

A6 → P2

Option 1: with Aggregation

A6 → A7	
Purpose	Inform about flexibility agreement
Involved roles	Flexibility Service Provider
List of exchanged data	Flexibility order (what, when, where, how much, …)
A7 → P2	
Purpose	Inform about flexibility activation to be scheduled
Involved roles	Flexibility Service Provider Flexibility Provider
List of exchanged data	Flexibility order (what, when, where, how much, …)

Option 2: no aggregation

A6 → P2	
Purpose	Inform about flexibility activation to be scheduled
Involved roles	Flexibility Service Provider Flexibility Provider
List of exchanged data	Flexibility order (what, when, where, how much, …)

A2 → M1	
Purpose	Submit flexibility offer to the market

Involved roles	Flexibility Service Provider MO
List of exchanged data	Flexibility offer (what, when, where, how much, …)

B1 → B2	
Purpose	Inform about flexibility need that should be placed to the market
Involved roles	Flexibility Consumer
List of exchanged data	Flexibility request (what, when, where, how much, …)

B2 → M1	
Purpose	Place flexibility request
Involved roles	MO Flexibility Consumer
List of exchanged data	Flexibility request (what, when, where, how much, …)

M1 ↔ S2	
Purpose	Exchange between market and SO to ensure a harmless and efficient bid selection from the grid perspective
Involved roles	SO MO
List of exchanged data	Flexibility offers and offer results (what, when, where, how much, …) Acceptance or refusal of the proposed plan of the MO and/or selection of most relevant offers from SO perspective

M1 → B3	
Purpose	Inform about market results to Flexibility Consumer
Involved roles	MO Flexibility Consumer
List of exchanged data	Market results (what, when, where, how much, ...)

M1 → A8	
Purpose	Inform about market results to Flexibility Service Provider
Involved roles	MO Flexibility Service Provider
List of exchanged data	Market results (what, when, where, how much, ...)

P4 → A9	
Purpose	Inform the Flexibility Service Provider of available flexibility at prosumer level.
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Flexibility forecasts per flexibility provider

A9 → A10	
Purpose	Provide the optimisation engine of the aggregator with data on the available community- or portfolio-level flexibility.
Involved roles	Flexibility Service Provider
List of exchanged data	Aggregated flexibility forecast

A10 → P5	
Purpose	Inform Flexibility Provider of a request for the provision of flexibility
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Request for flexibility

A10 → A3	
Purpose	Inform aggregator about the actual flexibility that can be offered by the Flexibility Provider
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Prosumer flexibility offer

S1 → I1	
Purpose	Provide the flexibility need to the Intermediary Stakeholder so it can compute the Price Signal to be transmitted to the potential Flexibility Providers
Involved roles	Flexibility Consumer Intermediate Stakeholder
List of exchanged data	Flexibility request

I1 → P6	
Purpose	Inform the prosumer about the energy price for the upcoming periods
Involved roles	Intermediate Stakeholder Flexibility Provider
List of exchanged data	Implicit steering signal (energy price)

P6 → P2	
Purpose	Inform the Flexibility Provider about the flexibility to schedule
Involved roles	Flexibility Provider
List of exchanged data	Schedule for activating the available assets

S3 → SS	
Purpose	Inform about the past flexibility transaction/agreement to enable the settlement
Involved roles	Flexibility Consumer
List of exchanged data	Flexibility transaction/agreement

P2 → SS	
Purpose	Inform about the past flexibility transaction/agreement to enable the settlement
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Flexibility transaction/agreement

S7 → SS	
Purpose	Inform about the past flexibility transaction/agreement to enable the settlement
Involved roles	Flexibility Consumer
List of exchanged data	Flexibility transaction/agreement

B3 → SS	
Purpose	Inform about the past flexibility transaction/agreement to enable the settlement
Involved roles	Flexibility Consumer
List of exchanged data	Flexibility transaction/agreement

A3 → SS	
Purpose	Inform about the past flexibility transaction/agreement to enable the settlement
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Flexibility transaction/agreement

I1 → SS	
Purpose	Inform about the past price signals to enable the settlement
Involved roles	Intermediary Stakeholder Flexibility Consumer
List of exchanged data	Price signals

3.3.2.3 External interfaces

S1 ↔ Ext	
Purpose	Exchange data for Flexibility Request
Involved roles	Flexibility Consumer, External

List of exchanged data	Flexibility pool, Grid Operational Status, Flexibility availability

S2 ↔ Ext	
Purpose	Exchange data for Results validation
Involved roles	SO, External
List of exchanged data	Grid operational status

S6 ↔ Ext	
Purpose	Exchange data for Flexibility request
Involved roles	Flexibility Consumer, External
List of exchanged data	Grid network area status (emergency state)

M1 ↔ Ext	
Purpose	Exchange data for Market Results Clearing (BRP)
Involved roles	MO, External
List of exchanged data	Flexibility pool

M2 ↔ Ext	
Purpose	Exchange data for Market Results Clearing (SO)
Involved roles	MO, External
List of exchanged data	Flexibility pool

P1 ↔ Ext	
Purpose	Exchange data for Flexibility offer
Involved roles	Flexibility Provider, External
List of exchanged data	Any data required for calculating flexibility that can be offered dynamically based on current and forecasted parameters' values: usage patterns, types of devices, set-points preferences, weather data, calendar

P2 ↔ Ext	
Purpose	Exchange data for Process Schedule
Involved roles	Flexibility Provider, External
List of exchanged data	Control of assets

P4 ↔ Ext	
Purpose	Trigger received by third party or the community to provide flexibility forecast
Involved roles	Flexibility Provider
List of exchanged data	Request for flexibility forecast

A10 ↔ Ext	
Purpose	Trigger the optimisation engine of the aggregator to request flexibility offers from available prosumers
Involved roles	Flexibility Service Provider
List of exchanged data	Request for flexibility

3.3.2.4 Settlement subprocess interfaces

SP1 → SP2	
Purpose	Provide the characteristics (amount, time, ...) of the provided/delivered flexibility to the Flexibility Service Provider
Involved roles	Flexibility Service Provider Flexibility Provider
List of exchanged data	Delivered flexibility (how much, when, ...)

SP2 → SP3	
Purpose	Provide the information about the sold flexibility (contract, amount, time, ...)
Involved roles	Flexibility Service Provider
List of exchanged data	Sold flexibility (contract reference, quantity, time period, ...)

SC1 → SC2	
Purpose	Inform about the procured flexibility
Involved roles	Flexibility Consumer
List of exchanged data	Procured flexibility (contract reference, quantity, time period, ...)

SC2 → SP3	
Purpose	Inform the Flexibility Service Provider about the calculated compensation fees for the procured flexibility
Involved roles	Flexibility Consumer Flexibility Service Provider

List of exchanged data	Compensation fee for the procured flexibility

SP3 → SP4	
Purpose	Inform about the compensation fee to be paid for the sold flexibility
Involved roles	Flexibility Service Provider
List of exchanged data	Compensation fee for the sold flexibility

SP4 ↔ SC3	
Purpose	Validate the flexibility transactions and agree on the payment information for settlement
Involved roles	Flexibility Consumer Flexibility Service Provider
List of exchanged data	Flexibility transaction data Payment information

SP1 ↔ Ext	
Purpose	Collect metering data to characterise the provided/delivered flexibility
Involved roles	Flexibility Provider Flexibility Service Provider
List of exchanged data	Metering data

4 Interoperability study based on projects

4.1 Input from projects

A collection of use-cases and data from BRIDGE project has been launched in November 2021. Finally, 36 use-cases from 14 projects have been provided as inputs for this study:

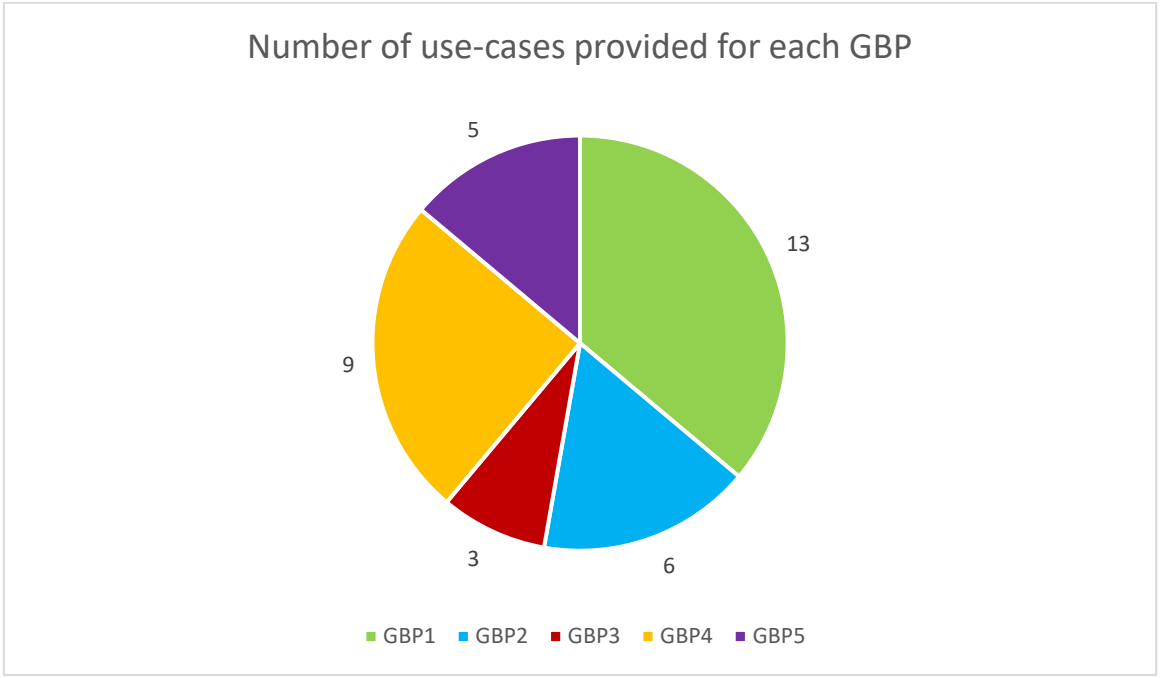


Figure 10. Number of use-cases provided for each GBP

The list of use-cases per project is detailed below:

Project	Use-case name	GBP id	UC_id
InterConnect	French Pilot – HLUC 2 – Dynamic tariff	5	IC1
InterConnect	Dutch Pilot – HLUC1 – Optimise sustainability	5	IC2
ROBINSON	Energy Management System (EMS)	4	RO1
GIFT	Congestion avoidance	1	GI1
GIFT	Fish Farm LEC	1	GI2
GIFT	Smart Harstad LEC	1	GI3
GIFT	Procida LEC	1	GI4
PARITY	Congestion management by DSO through operation of LFM to increase DER penetration (UC-08)	1	PA1
PARITY	Red light grid management using automated control of distributed DER (UC-11)	2	PA2
ACCEPT	UC9 – Participation in implicit Demand Response schemes	5	AC1
ACCEPT	UC13 – Increase self-consumption at local community level	4	AC2
MERLON	Network Constraints Management	1	ME1
MERLON	Network Constraints Management on Imbalance Detection	2	ME2
MERLON	ILES Participation in Ancillary Services	3	ME3
MERLON	Collective Self-Consumption in ILES	4	ME4
X-FLEX	Ancillary Services participation – Grid operator level	1	XF1

X-FLEX	IDM portfolio optimisation considering the operational conditions	3	XF2
X-FLEX	Intra Portfolio Optimisation with flexible sources	4	XF3
X-FLEX	Ancillary Services participation - TSO level	1	XF4
MAESHA	Frequency control	1	MA1
MAESHA	Voltage control	2	MA2
MAESHA	Minimisation of the consumption peak	1	MA3
MAESHA	Maximisation of the use of RES	4	MA4
MUSE GRIDS	Multi energy local renewable energy communities	4	MU1
SENDER	Residential Explicit Demand Response	1	SE1
SENDER	Minimising the electricity bill	5	SE2
iElectrix	Güssing	2	IE1
iElectrix	EDIS	2	IE2
FEVER	HLUC 01 Advanced network congestion management considering DER & grid flexibility	1	FE1
FEVER	HLUC 14: Form a first example of a regional flexibility exchange model	3	FE2
ebalance-plus	Flexibility measures II: Virtual Power Plant (VPP) services based on building solutions (IoT devices, PV and storage) (UC9)	4	EB1
ebalance-plus	Flexibility measures I: Virtual Power Plant (VPP) services based on district solutions (variable PV generation, storage and V2G) (UC8)	4	EB2
ebalance-plus	Flexibility measures III: Price/CO2 based optimisation (demand response) (UC10)	5	EB3
ebalance-plus	Volt-VAr optimisation with increasing RES generation (UC5)	4	EB4
FLEXIGRID	UC-6	2	FL1
FLEXIGRID	UC-8	1	FL2

The detailed information for each use-case has been provided following the template detailed in Annex 2.

4.2 Analysis of project's input as a whole

Based on the inputs from the projects, several analyses are performed:

- List of relevant standards/solutions per GBP interface
- List of implemented extensions/modifications per standard
- List of identified gaps per GBP interface
- List of system functions per GBP function
- List of system actors per use-case and GBP role
- List of scenarios for each GBP

4.2.1 List of relevant standards/solutions per GBP interface

The table below lists the solutions and standards implemented by the projects for each interface. It has several objectives:

1) to offer a catalogue of relevant standards per interface;
2) to identify if several standards are in competition for one interface and which standards are the most used;
3) to identify which interfaces led to the use of internal or proprietary solutions.

Considering the limited number of occurrences for some interfaces, e.g. because they are not implemented by projects or the used solution is not defined yet, the most significant lines are highlighted in **bold**.

The references of the listed solutions/standards are detailed in Annex 3.

Interface	List of solutions/standards (occurrence)	Number of internal or proprietary[2]
P1 → A1	**FlexOffer (6)** **USEF (3)** **Modbus (3)** **OCPP (2)** **IEC 60870-5-104 (3)** **DLMS/COSEM (1)** **IEC 61850 (1)**	**3**
A1 → A2	**ERRP (2)** **EQUIGY (2)** **OpenADR (2)** **FlexOffer (2)** **CIM (1)** **IEC 61850 (1)**	**7**
P1 → A2	Modbus (2) xEMS (2) OpenADR (1)	2
A1 → A5	IEC 60870-5-101 (1) DLMS/COSEM (1) IEC 60870-5-104 (1)	4
P1 → A5	DLMS/COSEM (1) IEC 60870-5-104 (1) ProfiNET (1)	1

[2] "Proprietary" means vendor-specific or private specification (i.e. not standard nor open specification)

Interface	List of solutions/standards (occurrence)	Number of internal or proprietary[2]
A2 → M2	**FlexOffer (3)** **USEF (2)** **ERRP (1)** **EQUIGY (2)** **OpenADR (2)**	**4**
S1 → B2	– (not implemented)	
B2 → M2	– (not implemented)	
S1 → M2	**CIM (4)** **OpenADR (1)** **USEF (1)** **FlexOffer (1)**	**4**
M2 → B3	– (not implemented)	
B3 → S3	– (not implemented)	
M2 → S3	USEF (1) FlexOffer (1)	2
M2 → A8	**FlexOffer (3)** **USEF (2)** **ERRP (2)** **EQUIGY (2)** **OpenADR (2)**	**4**
A8 → A3	**FlexOffer (4)** **ERRP (2)** **EQUIGY (2)**	**8**

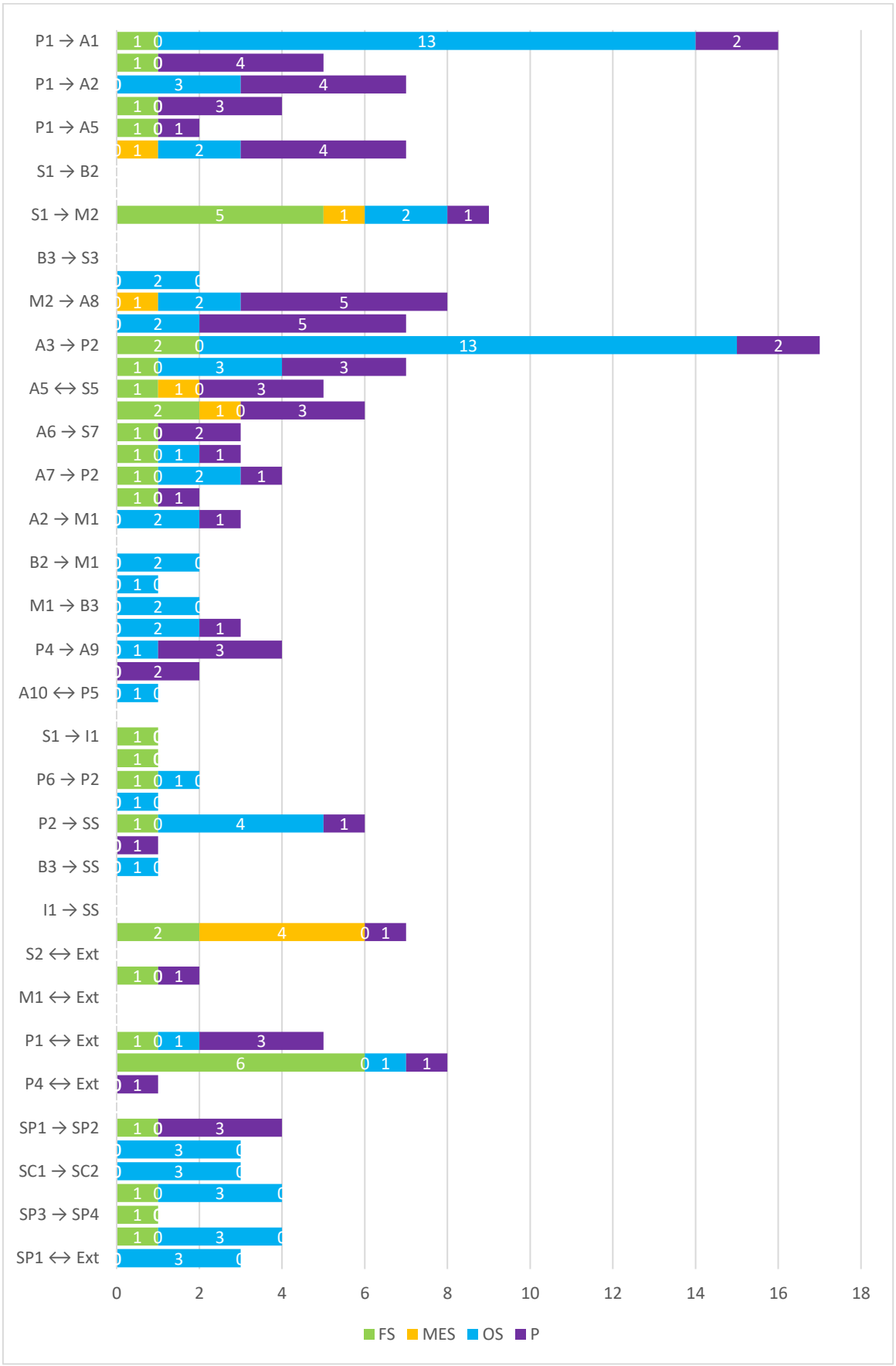
Interface	List of solutions/standards (occurrence)	Number of internal or proprietary[2]
	OpenADR (2)	
A3 → P2	**FlexOffer (6)** **USEF (4)** **Modbus (3)** **OCPP (2)** **IEC 60870-5-104 (2)** **OpenADR (1)** **IEC 61850 (1)**	**2**
A8 → P2	xEMS (2) Modbus (2) OpenADR (2)	1
A5 ↔ S5	IEC 60870-5-104 (2)	3
S6 → A6	IEC 60870-5-104 (2) Open ADR (1)	3
A6 → S7	IEC 60870-5-104 (2)	2
A6 → A7	IEC 60870-5-104 (2) Modbus (1)	1
A7 → P2	OpenHAB (1) ProfiNET (1) IEC 60840-5-104 (1) Modbus (1)	1
A6 → P2	ProfiNET (1) IEC 60840-5-104 (1)	2
A2 → M1	USEF (1)	1

Interface	List of solutions/standards (occurrence)	Number of internal or proprietary[2]
	FlexOffer (1)	
B1 → B2	– (not implemented)	
B2 → M1	USEF (1) FlexOffer (1)	0
M1 ↔ S2	USEF (1)	0
M1 → B3	USEF (1) FlexOffer (1)	1
M1 → A8	USEF (1) FlexOffer (1)	0
P4 → A9	USEF (1)	3
A9 → A10	–	3
A10 ↔ P5	Modbus (1)	0
A10 → A3	–	1
S1 → I1	–	2
I1 → P6	FlexOffer (1)	1
P6 → P2	OCPP (2)	2
S3 → SS	FlexOffer (1)	3
P2 → SS	**Z-Wave (1)** **FlexOffer (2)** **IEC 61850 (1)**	**6**
S7 → SS	–	2
B3 → SS	FlexOffer (1)	0

Interface	List of solutions/standards (occurrence)	Number of internal or proprietary[2]
A3 → SS	– (not implemented)	
I1 → SS	– (not implemented)	
S1 ↔ Ext	CIM (5) IEC 60870-5-104 (1)	0
S2 ↔ Ext	– (not implemented)	
S6 ↔ Ext	CIM (1)	1
M1 ↔ Ext	– (not implemented)	
M2 ↔ Ext	– (not implemented)	
P1 ↔ Ext	xEMS (1) Modbus (1)	2
P2 ↔ Ext	Modbus (4) OCPP (2)	3
P4 ↔ Ext	–	1
A10 ↔ Ext	– (not implemented)	
SP1 → SP2	**USEF (3)** **IEC 60870-5-104 (2)** **IEC 60870-5-101 (1)**	**6**
SP2 → SP3	USEF (3) IEC 60870-5-104 (1)	3
SC1 → SC2	USEF (3) IEC 60870-5-104 (1)	3
SC2 → SP3	USEF (3)	1

Interface	List of solutions/standards (occurrence)	Number of internal or proprietary[2]
	IEC 60870-5-104 (2) IEC 60870-5-101 (1)	
SP3 → SP4	IEC 60870-5-104 (2) IEC 60870-5-101 (1)	3
SP4 ↔ SC3	USEF (3) IEC 60870-5-104 (2)	0
SP1 ↔ Ext	Z-Wave (3)	0

The diagram below summarises the type[3] of solution for each interface:



[3] Possible values: "FS" = Fully standard, "MES" = Modified or extended standard", "OS" = Open Specification, "P" = Proprietary

4.2.2 List of implemented extensions/modifications per standard

The table below lists the extensions/modifications applied to each standard in the projects. Its main objectives are:

- to feed standards development by highlighting needs from standards' users and possible solutions;
- to allow reusability of extension/modifications done by previous projects, by pinpointing which project did which extension.

Standard	Project / UC	Extension/modification/deviation
CIM	GIFT	• Addition of readingQuality to Reading class • ReadingType moved from Reading to MeterReading
	FLEXIGRID	• Adding type of economics (typeOfEconomics) indicating whether economics option is set to 1-pricing signal or 2-number of activation • Addition of information about used activation option (typeOfEconomicsApplied)
FlexOffer	FEVER	• Needed extension to support settlement information
USEF	X-FLEX	• Modification: USEF like approach to address this information exchange à flex offer from DER Asset to Aggregator and reverse • Extension to provide more details about Aggregator provision of flexibility (e.g flex up/down, different pricing parameters & divisibility level) • Modification of the schema in order to address the project requirements for M1 → A8 interface
	MERLON	• Modification to meet project specific requirements for settlement
IEC 68070-5-104	iElectrix	• The standard IEC 60870-5-104 lacks description to model smart meters. Hence, generic building blocks are defined using object-oriented methods, in the form of interface classes to model smart meters for flexibility functions.

4.2.3 List of identified gaps per GBP interface

The table below lists the gaps identified for each GBP interface. It could be either gaps related to the interface in general (e.g. missing standard) or gaps related to the use of a specific standard for this interface (e.g. missing feature in existing standard).

The main objectives of this table are:

- to feed standardisation roadmap by identifying standardisation gaps, i.e. interfaces for which a standard is missing;
- to feed standards development by highlighting needs from standards' users.

Interface	Project / UC	Gaps identified
P1 → A1	GIFT	No standard solution for flexibility offer data exchange ⇒ using open specification FlexOffer
	X-FLEX	USEF is not addressing this part of information exchange
A2→M2	X-FLEX	Missing multiple pricing parameters and divisibility in USEF
M2 → A8	X-FLEX	Missing multiple pricing parameters and divisibility in USEF
A3 → P2	GIFT	No standard solution for flexibility offer data exchange ⇒ using open specification FlexOffer
	X-FLEX	USEF is not addressing this part of information exchange
A2 → M1	X-FLEX	Missing multiple pricing parameters and divisibility in USEF
M1 ↔ S2	X-FLEX	Missing multiple pricing parameters and divisibility in USEF
M1 → B3	X-FLEX	Missing multiple pricing parameters and divisibility in USEF
M1 → A8	X-FLEX	Missing multiple pricing parameters and divisibility in USEF
A2 → M2	X-FLEX	Missing multiple pricing parameters and divisibility in USEF
P4 → A9	X-FLEX	USEF is not addressing this part of information exchange

4.2.4 List of system functions per GBP function

The tables below list, for each GBP, the system functions mapped to each GBP function. Their main objectives are:

- To show differences in system implementation of the GBP functions, based on the system function names;
- To identify the GBP functions that are rarely or never implemented in the systems.

Note: "Use" is equal to the number of use-cases implementing this function over the number of use-cases for this GBP.

GBP1

Function ID	Function name	Use	Keywords
S1	Flexibility Request	92%	Flexibility Request, Forecast, Grid Modelling
S3	Process Market Results	38%	Market Results, Validation, Flexibility Trading
B2	Placement Buying Offer	0%	NA
B3	Process Market Results	0%	NA
M2	Market Results Clearing (SO)	77%	Market Clearing, Flexibility Trading
A1	Flexibility Offer Aggregation	46%	Flexibility Aggregation, Offering Flexibility
A2	Placement Selling Offer	38%	FlexOffer, Submission of bids
A3	Offer Disaggregation	53%	Dissagregation, Flexibility Activation
A8	Process market results	46%	Flexibility Management, Flexibility Activation
P1	Flexibility offer	100%	Flexibility Offer, Flexibility Forecast
P2	Process schedule	100%	Flexibility Provision, Submission of bids, Flexibility Activation

SS	Settlement subprocess	7%	Flexibility Settlement,
SP1	Quantify delivered flexibility	46%	Flexibility Delivery, Monitoring Data, Data Collection
SC1	Calculate Procured Flexibility	23%	Remuneration, Rewards and penalties, Trading, Validation
SC3	Settle flex	15%	Remuneration, Rewards and Penalties

GBP2

Function ID	Function name	Use	Keywords
S5	Request for bilateral agreement	67%	Bilateral agreement, request, negotiation
S6	Flexibility request	100%	Emergency detection, request, flexibility detailed information
S7	Process response	50%	Settlement, transaction, monitoring
A1	Flexibility offer aggregation	67%	flexibility collection
A5	Offer for bilateral agreement	67%	Aggregation, offering
A6	Process request and assess response	83%	Validation, response evaluation
A7	Request disaggregation	33%	Optimisation, disaggregation
P1	Flexibility offer	100%	Flexibility calculation, service
P2	Process schedule	100%	Dispatch, setpoint, asset activation, flexibility schedule
SS	Settlement	33%	Billing, payment
SP1	Quantify delivered flexibility	17%	Quantification

GBP3

Function ID	Function name	Use	Keywords
S2	Results validation	0%	Market result, flexibility forecast
B1	Flexibility request	33%	Request, flexibility market
B2	Placement of Buying Offer	33%	Flexibility trading, offer
B3	Process results	33%	Response, activated flexibility
M1	Market Results Clearing (BRP)	100%	Clearance, market results
A1	Flexibility Offer Aggregation	67%	Aggregation, offering
A2	Placement Selling Offer	100%	Offer, trading
A3	Offer Disaggregation	67%	Disaggregation, offer
A8	Process market results	100%	Request
P1	Flexibility offer	100%	Offer, service
P2	Process schedule	100%	Schedule, asset activation, disaggregation, setpoints
SS	Settlement subprocess	33%	Settlement, fee, response verification, payment, penalty
SP1	Quantify delivered flexibility	67%	Response verification, quantification
SP3	Validate flex fee with own calculation	0%	Fee, payment, penalty
SC1	Calculate procured flexibility	33%	Procurement, capacity, period
SC3	Settle flex	0%	Flexibility transaction, payment

GBP4

Function ID	Function name	Use	Keywords
P2	Process schedule	56%	Control actions for devices, Asset flexibility schedule
P4	Flexibility forecast (feasibility)	67%	Weather / flexibility forecasting, calculating baseline flexibility, asset flexibility, Reading measurements
P5	Flexibility offer	44%	Offer verification / validation / negotiation, Providing flexibility, Aggregated flexibility in LEC
A3	Offer Disaggregation	67%	Sending individual setpoints, Flexibility request, Asset flexibility order,
A9	Aggregation	78%	Collecting individual status data, Aggregating individual flexibility forecasts, Energy profile aggregation
A10	Optimisation and flexibility request	78%	Control system, Calculating optimal consumption profile, Sending optimal profile, Receiving responses, Negotiation of the profile, Flexibility optimization, Flexibility order, Evaluating compliance
SS	Settlement subprocess	44%	Calculating the final energy bill, Asset flexibility settlement, Flexibility delivery, Flexibility settlement, Flexibility compensation

GBP5

Function ID	Function name	Use	Keywords
S1	Flexibility Request	40%	Demand Response request
I1	Computation of the Price Signal	80%	Calculating optimal energy retail price, Calculating the steering signal based on input parameters
P2	Process Schedule	100%	Control signals for devices
P6	Flexibility Optimisation	100%	Minimising the cost, Optimising the energy consumption
SS	Settlement subprocess	20%	Final energy bill creation

4.2.5 List of system actors per use-case and GBP role

The tables below list, for each GBP, the system actors of each project fulfilling each GBP business roles. Their main objectives are:

- To show differences in system implementation of the GBP roles, based on the system or business actors names;
- To identify the GBP roles that are rarely or never implemented in the systems;
- To prepare a possible catalogue of solutions existing for each GBP actor, to be reused as part of the exploitation of each project results, e.g. for future projects or pilots or commercial deployment.

GBP1

Project/UC	GBP business role	Project actor	Solution(s) relevant to project actor
GIFT/GI1	Flexibility Market Operator		VPS module “Flexibility market”
	Flexibility Service Provider		VPS module “Flexibility manager”
	Flexibility Provider		xEMS
GIFT/GI2	Flexibility Consumer		Grid observability system
	Flexibility Market Operator		VPS module “Flexibility market”

	Flexibility Service Provider		VPS module “Flexibility manager”
	Flexibility Provider	Fish farms	
GIFT/GI3	Flexibility Consumer		Grid observability system
	Flexibility Market Operator		VPS module “Flexibility market”
	Flexibility Service Provider		VPS module “Flexibility manager”
	Flexibility Provider	EV station	

GIFT/GI4	Flexibility Consumer		Grid observability system
	Flexibility Market Operator		VPS module “Flexibility market”
	Flexibility Service Provider		VPS module “Flexibility manager”
	Flexibility Provider	Industrial prosumers	
PARITY/PA1	Flexibility Consumer	DSO (implied)	DSO Toolset component
	Flexibility Market Operator		Local Energy Market / Local Flexibility Market Platform
	Flexibility Service Provider	Aggregator (implied)	Aggregator Toolset component
	Flexibility Provider	Residential / office buildings Prosumers	
MERLON/ME1	Flexibility Consumer		Integrated Local Energy System Energy Management (ILESEM)
	Flexibility Market Operator		Marketplace
	Flexibility Service Provider	Global Flexibility Manager (GFM)	

	Flexibility Provider	Local Flexibility Manager (LFM)	
X-FLEX/XF1	Flexibility Consumer		GRIDFLEX
	Flexibility Market Operator		MARKETFLEX
	Flexibility Service Provider		SERVIFLEX
	Flexibility Provider	DER Flexibility Agents (different type)	
X-FLEX/XF4	Flexibility Consumer	TSO	
	Flexibility Facilitator		MARKETFLEX
	Flexibility Market Operator		MARKETFLEX, TSO mFRR platform
	Flexibility Service Provider		SERVIFLEX
	Flexibility Provider	DER Flexibility Agents (different type)	
MAESHA/MA1	Flexibility Consumer	TSO	

	Flexibility Market Operator	TSO	
	Flexibility Service Provider	FMTP	
	Flexibility Provider	Battery, Power-to-hydrogen system, PV power plants, Industrial consumers, Residential consumers, Electric Vehicle	
MAESHA/MA3	Flexibility Consumer	DSO	
	Flexibility Market Operator	DSO	
	Flexibility Service Provider	FMTP	
	Flexibility Provider	Battery, Industrial consumers, Residential consumers, Electric Vehicle and LECs	
SENDER/SE1	Flexibility Service Provider	Aggregator	
	Flexibility Provider		Sender Solution
FEVER/FE1	Flexibility Consumer	DSO (Implied)	DSO Toolbox & FSCA
	Flexibility Market Operator	FTP	

	Flexibility Service Provider	FMS
	Flexibility Provider	xEMS & FSPA
FLEXIGRID/FL2	Flexibility Consumer	DSO
	Flexibility Service Provider	SGC
	Flexibility Provider	Group controllable power generator owners

GBP2

Project/UC	GBP business role	Project actor	Solution(s) relevant to project actor
PARITY/PA2	Flexibility Consumer	DSO (implied)	DSO Toolset component
	Flexibility Service Provider	Aggregator (implied)	Aggregator Toolset component
	Flexibility Provider	Residential/office building prosumers	
MERLON/ ME2	Flexibility Consumer		Integrated Local Energy System Energy Management (ILESEM)

	Flexibility Market Operator		Marketplace
	Flexibility Service Provider	Global Flexibility Manager (GFM)	
	Flexibility Provider	Local Flexibility Manager (LFM)	
MAESHA/MA2	Flexibility Consumer	DSO	
	Flexibility Market Operator	DSO	
	Flexibility Consumer	PV power plant, Battery, Power-to-Hydrogen, industrial and residential consumers	
iElectrix/IE1	Flexibility Consumer	DSO EMS and ATOS EMS	
	Flexibility Service Provider	DSO EMS and ATOS EMS	
	Flexibility Provider	BESS Controller	
iElectrix/IE2	Flexibility Consumer	DSO	
	Flexibility Service Provider	BESS Controller	
	Flexibility Provider	BESS Inverter	

FLEXIGRID/FL1	Flexibility Consumer	DSO	
	Flexibility Facilitator	DSO	Aggregator EMS
	Flexibility Service Provider	VES (Virtual Energy Storage)	
	Flexibility Provider	Commercial and Residential buildings	

GBP3

Project/UC	GBP business role	Project actor	Solution(s) relevant to project actor
MERLON/ ME3	Flexibility Consumer	-	-
	Flexibility Facilitator	-	-
	Flexibility Market Operator	Fast Frequency Response (FRR) Market	-

	Flexibility Service Provider	Local Aggregator (implied)	Integrated Local Energy System Energy Management (ILESEM)
	Flexibility Provider	Prosumer (implied)	Battery Management Module (BMM)
	System Operator	-	-
X-FLEX/ XF2	Flexibility Consumer	-	-
	Flexibility Facilitator	-	-
	Flexibility Market Operator	Intra-day market operator (implied)	MARKETFLEX - A system responsible for the trading of flexibility among different stakeholders. Among the different functionalities served, a key aspect is the provision of services to address DSO requirements
	Flexibility Service Provider	Aggregator (implied)	SERVIFLEX - A system operated by the Flexibility Aggregator to aggregate / disaggregate the available flexible sources based on business needs/available market services. In this case scenario, the available flexibility is offered via the marketplace to the DSO to address DSO needs.
	Flexibility Provider	Prosumer (implied)	DER Flexibility Agents (different type)
	System Operator	DSO (implied)	GRIDFLEX - A suite of grid-oriented tools complementing DSO's legacy systems enabling more advanced observability and management of the distribution grid. In this use case, the specific sub module responsible for the calculation of flexibility to address a congestion issue is considered

FEVER/ HLUC14	Flexibility Consumer	BRP	Balancing Responsible Party Management System (BRPMS)
	Flexibility Facilitator	-	-
	Flexibility Market Operator	Flexibility Market Operator	Flexibility Trading Platform (FTP)
	Flexibility Service Provider	Aggregator	Flexibility Management System (FMS)
	Flexibility Provider	Prosumer	Energy Management System (xEMS) & Flexibility Service Providing Agent (FSPA)
	System Operator	-	-

GBP4

Project/UC	GBP business role	Project actor	Solution(s) relevant to project actor
ROBINSON/ RO1	Flexibility Service Provider	Not clearly defined – the operator of the EMS	Energy Management System (EMS)

	Flexibility Provider	Fish factory, Electrolysers, Prosumers	TBD
ACCEPT/ AC2	Flexibility Service Provider	Energy community as the aggregator	TBD
	Flexibility Provider	Prosumers – members of the energy community	TBD
MERLON / ME4	Flexibility Service Provider	Energy community	Integrated Local Energy System Energy Management (ILESEM)
	Flexibility Provider	LEC members	Battery Management Module (BMM), Global Flexibility Manager (GFM)
X-FLEX/ XF3	Flexibility Service Provider	Flexibiloity aggregator	SERVIFLEX
	Flexibility Provider	Not clearly defined – assumed to be prosumers	Flexibility agents (different kinds)
MAESHA/ MA4	Flexibility Service Provider	Not clearly defined	EMS (various)
	Flexibility Provider	LEC members	LEC members' controllable devices (EV, HVAC, etc.)
MUSE GRIDS/ MU1	Flexibility Service Provider	Not clearly defined – operator of the EMS	Energy Management System (EMS)
	Flexibility Provider	Local Energy Community, and its members	TBD, controllable devices of LEC members (EV, HVAC, etc)

ebalance-plus/ EB1	Flexibility Service Provider	Aggregator	Energy aggregator flexibility management system (distributed over the management units – CMUs, LVGMUs, MVGMUs, TLGMU – x.AGGR)
	Flexibility Provider	Customers (Prosumers)	Flexibility management algorithm executed on the CMU – CMU.FLEX, devices of the customer and their individual control systems.
ebalance-plus/ EB2	Flexibility Service Provider	Aggregator	Energy aggregator flexibility management system (distributed over the management units – DERMUs, LVGMUs, MVGMUs, TLGMU – x.AGGR)
	Flexibility Provider	Customers (Facility Managers)	Flexibility management algorithm executed on the DERMU – DERMU.FLEX, devices within the buildings and their individual control systems (BEMS).
ebalance-plus/ EB4	Flexibility Service Provider	Utility/DSO	Control algorithms DMS.VVC / MVGMU.VVC
	Flexibility Provider	DER Owner	Control algorithms executed on the DERMU

GBP5

Project/UC	GBP business role	Project actor	Solution(s) relevant to project actor
InterConnect/ IC1	Flexibility Consumer	TSO (RTE)	
	Intermediary Stakeholder	Not directly defined	Flex Manager
	Flexibility Provider	Prosumers (implicit)	Box ThermoVault, ENGIE EMS, TEMS
InterConnect/ IC2	Flexibility Consumer	DSO	TNO RefFlex platform

	Intermediary Stakeholder	(Included in the above)	
	Flexibility Provider	Consumer (implicit)	Building Management System (BMS)
ACCEPT/ AC1	Flexibility Consumer	DSO	ACCEPT Solution Emulator (ASE)
	Intermediary Stakeholder	Local Energy Community	Retailer Tool
	Flexibility Consumer	Prosumers / Consumers	BAM
SENDER/ SE2	Flexibility Consumer	ANY (Not defined)	
	Intermediary Stakeholder	ANY (Not defined)	
	Flexibility Provider	Consumer	SENDER Solution
ebalance-plus/ EB3	Flexibility Consumer	None	
	Intermediary Stakeholder	Not directly defined,	Optimisation algorithms, Cloud system
	Flexibility Provider	Prosumers	Control and optimisation algorithms running on the Customer Management Unit (CMU), Controllable devices of prosumers.

4.2.6 List of scenarios for each GBP

The tables below list, for each GBP, the scenarios of the provided use-cases: who is the beneficiary of the flex (e.g. DSO), who is the provider of the flex (e.g. building EMS), what is the final purpose (e.g. congestion management). Their main objectives are:

- To identify for which purpose each GBP is the most relevant / the most frequent;
- To highlight similarities and differences in the way to achieve a common purpose, depending on the chosen approach (i.e. GBP)

GBP	Project/UC	Beneficiary	Provider	Purpose
GBP1	FEVER/ HLUC01	DSO	Aggregator of flexible assets, individual prosumers.	Congestion management
	FLEXIGRID/ Use case 8	DSO	DSO's own assets – hydraulic power plants	Power quality guarantee in especial operation of the distribution system, i.e. Islanding mode operation
	GIFT/ Congestion Management	DSO	Fish Farm, EV Station, E-Ferry, Industrial Prosumers	Congestion management
	GIFT/ Fish Farm LEC	DSO	LEC: Fish Farms	decarbonise the fish farms energy consumption
	GIFT/ Smart Harstad LEC	DSO	LEC: EV Station	Decarbonise transport. Increase LEC autonomy and efficiency
	GIFT/Procida LEC	DSO	LEC: Industrial Prosumer, PV, Storage	Decarbonise transport. Increase LEC autonomy and efficiency
	MAESHA/ Frequency control	TSO	Through Aggregator;	Frequency Control

		PV power plant, Battery, Power-to-Hydrogen system, Electric Vehicle, Industrial consumer, Residential consumer	
MAESHA/ Minimisation of the consumption peak	DSO	Through Aggregator; Local Energy Community, Battery, Electric Vehicle, Industrial consumer, Residential consumer	Minimising consumption peak
MERLON/ *Network Constraints Management*	SO?	Through Aggregator; Battery, PV, EV Charging, Flexible Loads	Network Constraints Management
PARITY/ UC-08	DSO	Not specified	Congestion management by DSO through operation of Local Flexibility Market to increase DER penetration
SENDER/ Residential Explicit Demand Response	SO	Through Aggregator; Heating Ventilating Air-Conditioning (HVAC) systems, lighting systems, Hot Water Tanks, EVs	Out of scope of UC. Focuses on flexibility activation
XFLEX/ Ancillary Services participation – Grid operator level	DSO	Through Aggregator; Battery, HVAC, P2H systems (DHW and electrode boilers), EVs	Congestion management by DSO, through local flexibility marketplace

	XFLEX/ Ancillary Services participation - TSO level	TSO	Through Aggregator; Battery, HVAC, P2H systems (DHW and electrode boilers), EVs	Provide flexibility to the TSO while ensuring the DSO's grid is compliant with technical limitation (mFRR)
GBP2	PARITY/PA2	DSO	Residential and office buildings (through aggregator)	Congestion and voltage management
	MERLON/ME2	DSO?	Commercial and residential buildings, EV charging (through aggregator)	Network Constraints Management on Imbalance Detection
	MAESHA/MA2	DSO	Battery, Power-to-Hydrogen, PV power plant, industrial and residential consumers (through market operator)	Voltage control
	iElectrix/IE1	DSO	BESS Controller (through aggregator)	Congestion and voltage management
	iElectrix/IE2	DSO	BESS Inverter (through aggregator)	Congestion and voltage management
	FLEXIGRID/FL1	DSO	Commercial and residential buildings (through aggregator)	Congestion management
GBP 3	MERLON/ ME3	TSO (implied)	Aggregator	Fast Frequency Response ancillary services

	X-FLEX/ XF2	DSO (implied)	Aggregator, prosumer (through flexibility agents)	Intra-day balancing services, correction of daily electricity procurement imbalances
	FEVER/ HLUC14	BRP	Aggregator, prosumer (through relevant management and optimisation systems)	Balancing services (within BRP portfolio, regional flexibility market-level balancing, trans-regional balancing)
GBP4	ROBINSON/ RO1	LEC	LEC Members	Local community optimisation EMS with fish factory, electrolyser and prosumers scenarios
	ACCEPT/ AC2	LEC	LEC Members	Local community optimisation (increase of local consumption by aligning demand to local production)
	MERLON / ME4	LEC	LEC Members	The main objective of this use case is to evaluate the optimal management of the portfolio flexibility sources in order to meet a specific community level objective
	X-FLEX/ XF3	LEC	LEC Members	Optimisation process in order to use RES power in optimal way at site where several numbers and types of flex storage assets are installed and available in the field. Along with the excess of RES and optimal use of storage means, the optimisation process is also incorporating demand side flexibility related aspects
	MAESHA/ MA4	LEC	LEC Members	This use case aims at implementing collective self-consumption operations and hybridising assets (EV charging station and air-conditioning units) with photovoltaic panels to maximise the use of Renewable Energy Sources
	MUSE GRIDS/ MU1	LEC	LEC Members	Maximise synergies among energy networks to increase flexibility and the share of renewable energy

	ebalance-plus/ EB1	LEC	LEC Members	Building level optimisation to achieve defined energy consumption/production goals
	ebalance-plus/ EB2	LEC	LEC Members	District level optimisation to achieve defined energy consumption/production goals
	ebalance-plus/ EB4	DSO, LEC (indirect)	LEC Members (DER owners)	Two scenarios (distributed and centralised) for grid optimisation (part of grid or community) to improve the resilience of the grid
GBP5	InterConnect/ IC1	TSO	Prosumers (implicit)	Synchronise the customer's consumption with the period of best prices from the power supplier
	InterConnect/ IC2	DSO	Consumers	Lower the energy costs for the end users, Reduce grid peak load and optimise the use of RES from the DSO perspective (DSO generates the prices directly)
	ACCEPT/ AC1	DSO	LEC Members (Prosumers, Consumers)	Provide optimal solutions at the Local Energy Community (LEC) Level, according to the agreed role, i.e. Aggregator, Retailer, ESCO, and based on inputs such as demand/generation flexibility, forecast, devices/Assets availability etc
	SENDER/ SE2	ANY (not defined)	Consumer (user of the SENDER Solution)	Minimise the electricity bill of consumer owning a dynamic tariff contract by synchronising the operation of household's devices with period of lowest prices from the energy supplier and/or distribution system operator. The UC only uses the dynamic prices as input, does not generate these.
	ebalance-plus/ EB3	Prosumers (LEC)	Prosumers	Reduce building energy bills and CO2 emissions Enable an automatic load response to price signals (price-based demand response programs)

		Enhance the control strategy of power-to-heat technologies coupled with thermal storage to increase building flexibility The UC generates a steering signal (not the price) according to some input parameters (including the price) to indicate the optimum energy usage times.

4.3 Main outcomes

Based on §4.2.1

The analysis of the used standards/solutions per GBP interface allows to identify which solutions are relevant for which interfaces. Also, it allows to identify the interfaces for which mostly internal or proprietary solutions are used.

Considering that several responding projects are still at early stage, the collected information does not allow to achieve significative results for all the interfaces. However, 9 interfaces are covered by enough projects to already reach interesting conclusions.

Regarding the main learnings, it appears that, for most of the interfaces, de facto standards from the industry (e.g. FlexOffer, USEF, OCPP, ...) are in leading positions. However, they are quite scattered, showing that further alignment and development are required to ensure interoperability. Also, the development of standards should be considered, either based on existing de facto standards or by building new standards taking into account the functions and data exchanges required to support flexibility.

Finally, it seems necessary to make this mapping between interfaces and standards/solutions available to all the BRIDGE projects and beyond, to ease the reuse of existing solutions and experience from past projects, instead of starting from scratch when starting any new project.

Based on §4.2.2

Six extensions or modifications have been described by the projects, covering 4 solutions/standards. These propositions should be pushed to the organisations developing these standards. Their feedback would allow either:

- To confirm the gap and use the proposed solution; or
- To confirm the gap and develop alnother solutions; or
- To deny the gap and explain how it is already covered; or
- To consider the proposed usage out of the scope of the standards.

The BRIDGE user group, as being developed by BRIDGE Data Management WG, should allow to achieve, and further extend, this feedback from BRIDGE projects to existing solutions/standards. It is also identified that the standards development organisation could provide early drafts of their standards to the BRIDGE proects in order to gain experience and collect feedback on their adequacy with the requirements from the projects.

Based on §4.2.3

Twelve gaps have been identified by the projects, covering 10 interfaces. The first action to be done by the projects reporting them is to check, in light of the catalogue of standards developed in this document, if the solutions/standards used by the other projects would fulfil their need or not. If not, the identified gaps should be pushed to standards development organisation to confirm the need and, if needed, launch a new standard development.

As for the proposition of extensions/modification (see above), the BRIDGE user group, as being developed by BRIDGE Data Management WG, should allow to push these gaps to the relevant organisation. Also, these standards development organisation could provide early drafts of their new standards to the BRIDGE projects in order to check if they meet the requirements from the projects.

Related to GBPs definition

GBP1

Flexibility for SO through open market was updated based on the input received on it first iteration (2021). In the updated version a direct link of flexibility providers with the market was established to cover relative cases. Based on the receive input, around half of the projects have modelled the flexibility aggregation functions. On the other hand, the role of Flexibility Facilitator (i.e. BRP) and the relevant functions, seems not to be part of the UC modelled in GBP1.Finally, most projects seem not to consider in detail the settlement process, which makes validation of the newly modelled functions difficult.

GBP2

According to the information from use cases, most actors can be suitably mapped to the functions and GPB's roles presented in the GBP2. However, one of the use cases reported that the flexibility service could not be offered through an aggregator, as there was no flexibility service provider (FSP) in its use case. In other words, the flexibility was offered via flexibility market operator (FMO), which was not presented in the business model of the GBP2.

Regarding the settlement process, most of the use cases of GBP2 have not been considered and focused on the detail of this process. Nonetheless, this process must be considered seriously for implementation in a real-life context.

GBP3

All three of the reported use cases involve the functions of the GBP which include actors from the prosumer level up to the Flexibility Market Operator, namely the declared flexibility offer by the Flexibility Provider (P1) and the consequent aggregated selling offer placed by the Flexibility Service Aggregator in the Flexibility Market (A2), the Market Clearing Results by the Flexibility Market Operator (M1), which are then passed down to the Aggregator for processing (A8) and from there, after the disaggregation of those results, to the Flexibility Provider in the form of a Process Schedule (P2).

Functions that concern the final consumer of the flexibility services, as well as the system operator, seem to not be the focus of most of the reported use cases, as they are not actively being looked at and considered in the reported use cases. Similarly, the GBP roles of the Flexibility Consumer and the System Operator are not assumed within those use cases by any project party and/or developed project system.

All three projects with use cases reported under GBP3 have developed technical solutions for carrying out the necessary functionalities and operations of the business process.

GBP4

This GBP4 was introduced in this document, but the inputs from the projects show that it actually fits the scenarios covered by the projects' use cases. The differences between projects show that the GBP4 covers two main flows.

In the first, the flexibility providers directly prepare and provide their flexibility predictions/estimations (P4) and the flexibility service provider aggregates these (A9), performs optimisations based on these inputs (aggregated and individual) (A10) and then distributed the disaggregated flexibility requests (A3), which are then executed or scheduled for execution (P2).

In the second flow, the service provider obtains the aggregated data from other sources than the flex provider directly and the flow starts already in A10. Based on the aggregated data the flexibility service provider performs the optimisations and negotiates the current flexibility offers with each flexibility provider individually (loop of data exchange A10 – P5) In this flow the disaggregation step (A3) is not needed since the flexibility requests are already distributed and agreed with the individual flexibility providers. This flow requires an

additional link between function P5 and the execution / schedule of the request in P2. Further, each flexibility provider needs to estimate its flexibility so the function P4 could also be involved by P5 (another alternative link). Thus, to support this second flow it is suggested to add alternative links (dashed arrow) between P4 and P5 (bidirectional?), as well as between P5 and P2 (from P5 to P2). Having the link between P4 and P5 would be helpful in reflecting the flexibility estimation in the flexibility request negotiation phase.

Most of the use cases for GBP4 do not consider the settlement step. This is mainly due to the relatively initial state of the use cases. But this step is crucial for the applicability of the use cases in real life.

GBP5

This GBP is also new. It is defined in a very generic way and the inputs show that there might be some improvements to cover more scenarios related to implicit flexibility. But the GBP5 seems to fit the use cases of the projects, is generic enough and defined in a way that it supports many different implicit signals, like price, energy mix, etc.

The main possible changes in the GBP definition involve: 1) the signal generation, and 2) the signal use.

In the signal generation part, the parties that generate the steering signal may be merged, if the flexibility consumer (e.g. the DSO) generates the steering signal (e.g. the price) on its own. In this case the I1 would migrate into the flexibility consumer level, creating an alternative flow (e.g. dashed lines).

In the signal use part, there might also be a flexibility service provider involved. The flexibility service provider can directly use the implicit steering and can generate the explicit flexibility requests (however this scenario is rather a special case of GBP4).

Many of the projects do not cover the signal generation, but rather focus on the reaction to the implicit flexibility steering.

Similar to GBP4, most of the GBP5 use cases do not consider the settlement phase. It needs to be improved as this step might be crucial for the real-world applicability.

Based on §4.2.6

GBP1

The process was modelled to present the case where a system operator is utilising flexibility through open market mechanism for optimising the operation of the grid. The use cases modelled by the different projects concern:

- for DSOs: Congestion management, Islanding operation, Minimising consumption peak, support decarbonisation and increase of autonomy and efficiency of LEC;
- for TSOs: Frequency control.

A variety of assets was considered for providing flexibility: Fish Farm, EV, E-Ferry, Flexible Loads (e.g. HVAC, lighting systems, Hot Water Tanks), hydraulic power plant, Electrical Battery, Power-to-Hydrogen, Power-to-Heat. Flexible assets in many cases were provided via Aggregator, whilst there exist cases where DSO utilises own assets.

GBP2

There are 6 use cases from 5 projects mapped to GBP2. The main purpose of those use cases is to utilise flexibility for congestion and voltage management to avoid network reinforcement, safety, and reliability of grid operation in an emergency state. The majority of the flexibility service has been done through an aggregator. However, one of those projects, flexibility was not offered to the flexibility consumer via an aggregator, as the flexibility service was offered via market operator instead of an aggregator. Moreover, it

can be clearly seen that DSO is the actor who gains beneficiary for utilising the flexibility service from various kinds of the flexibility providers such as commercial and residential buildings, EV charging, BESS, Power-to-Hydrogen, and PV power plant.

GBP3

The main objective of the project use cases mapped to GBP3 is to offer balancing services to the flexibility consumer (although the flexibility consumer is in most cases implied and not directly reported). Balancing services could be used to optimise and balance the flexibility consumer's portfolio, balance the demand and supply of a whole network region or, going beyond the limits of a single region, ensure trans-regional balance of the network. One of the projects that reported a use case under this specific GBP has indicated a specific ancillary services product, which helps manage frequency disruptions caused by system imbalances (imbalances between demand and supply) at a national level, namely the service of Fast Frequency Response (FFR).

GBP4

It is visible that all the projects involve the main function of the GBP4 – function A10 (some projects did not do the mapping that is why the number is not 100%). This function is driven mainly by the optimisation of the energy flows in the local energy communities. The goal is, for instance, to increase self-consumption, but also to increase the resilience of the grid.

Thus, it can be considered that the beneficiaries are the LEC members (or the LEC as a sum of them) and the individual members provide the flexibility.

GBP5

The most scenarios for the GBP5 use cases are related to the optimisation of energy consumption related to some parameters, like the energy cost or the energy aspects, like energy mix (e.g. the CO2 generation related to the energy). There are also scenarios, where the actual steering signal is a mix of parameters, calculated in a way to express some specific aspects, like: energy price + energy mix. It is also possible to involve other aspects, like the grid congestion. It is the choice of the flexibility provider to react to the signal.

For the projects' use cases the main beneficiary was a DSO or TSO, and the flexibility providers are Prosumers. However, there are cases where the beneficiary is not clearly defined and it might by any stakeholder, or where the beneficiaries are the Prosumers themselves (or the local energy community, they participate in).

5 Conclusion and perspectives

5.1 Main findings and recommendations

5.1.1 General

This sections descriptions the main findings and recommendations regarding the interoperability of flexibility assets.

Topic	Updated catalogue of standards
Findings	An updated catalogue of used standards/solutions for each interface has been provided. It identifies 15 solutions, as listed in Annex 3 and maps them to the interfaces of the GBPs. For most of the interfaces, de facto standards from the industry (e.g. FlexOffer, USEF, OCPP, ...) are in leading positions. However they are quite scattered, showing that further alignment and development are required to ensure interoperability.
Recommendation	1. Continue improving the catalogue of standards, year after year, by collecting new use-cases and updating existing use-cases from the projects. In particular, several projects were not mature enough yet to provide the details of each solutions/standards for each interface. 2. Foster the development or evolutions of standards to cover all the interfaces of the GBP, either based on existing de facto standards or by building new standards taking into account the functions and data exchanges required to support flexibility. 3. Disseminate this catalogue in an easy and useful manner, e.g. by relying on existing mapping tools (such as IEC mapping tool) and promoting these results, to make the results easily findable and reusable by future flexibility-oriented projects.

Topic	Contribution to standards development
Findings	Being innovative, BRIDGE projects are identifying requirements and features that are missing in existing solutions/standards. Also, they could be an interesting place for experimentating new standards under development.
Recommendation	1. Rely on the BRIDGE user group being set up in the scope of Data Management WG Action #4 to cooperate with standard development organisation (such as ISO or IEC, but also industry alliances such as USEF, FlexOffer User Group, ...) to push propositions and needs from the projects, but also to gain access to standards under development. 2. Possibly, set-up a place where the identified extensions or modifications of existing solutions/standards are made available to all the current and future flexibility-oriented projects.

Topic	Relevance and benefits from the Generic Business Processes
Findings	The reference framework for flexibility has been udpated and extended based on the real use-cases and systems implemented by BRIDGE projects. It now describes five Generic Business Processes (GBPs): • GBP1: Flexibility for SO through open market • GBP2: Flexibility for SO via prior bilateral agreement • GBP3: Flexibility for BRP portfolio optimisation • GBP4: Flexibility for energy community optimisation • GBP5: Flexibility with the use of price signals Each GBP defines both the functions and the interfaces of which it is composed. These GBPs are the common denominators between use-cases from different projects aiming the same business objectives, allowing a cross-projects interoperability study but also contributing to the design of future flexibility-oriented use-cases.
Recommendation	1. Keep improving the existing GBPs and developing new GBPs based on the use-cases implemented in the BRIDGE projects. In particular, cross-sector flexibility should be further considered. 2. Push this reference framework at a wider scope, e.g. to contribute to regulation or business models related activities, first within BRIDGE and then at EU level. 3. Consider using this reference framework as a basis for future use-cases development, e.g. as templates or library for UC repository, … 4. Consider extending this approach to cover GBPs beyond flexibility and transversal GBPs related to data governance and data analysis.

5.1.2 Specific to some interfaces

This section describes the interfaces for which specific actions should be performed to enable further interoperability.

Topic	Interoperability of demand-response and appliances (all GBP)
Findings	Three interfaces are related to home appliances: ● P1 ↔ Ext: related to P1 "Flexibility Offer" ● P2 ↔ Ext: related to P2 "Process Schedule" (i.e. flex activation) ● P4 ↔ Ext: related to P4 "Flexibility forecast" These interfaces have been described only by few projects, and show several different solutions/standards depending on the type of asset (EV, HVAC, heat pump, …) and the original sector of the solution providers (energy industry, white goods, smart home, …).
Recommendation	1. Set-up a specific actions for next year looking at the interoperability of home appliances to provide flexibility and further services, based on the approach developed in InterConnect project ("interoperable and smart homes and grids", DT-ICT-10-2018-19), the experience and needs from all the BRIDGE projects (in particular "demand-response and customer engagement" (LC-SC3-EC-3-2020) projects), the EC DG ENER and JRC work on home appliances interoperability, and future work of "interoperability community" support action (HORIZON-CL5-2021-D3-01-03). 2. Cooperate with CEN-CLC-ETSI and IEC to assess how these interfaces are currently covered by existing, under-development and future-development standards.

Topic	Settlement subprocess (all GBP)
Findings	The settlement process is described (and most probably implemented) only by very few projects. However, this process will need to be considered seriously to enable implementation in a real-life context.
Recommendation	1. Investigate why the settlement is generally not implemented in BRIDGE projects and what are the faced barriers, from both business, technical, regulatory and privacy perspectives. 2. Analyse how the settlement is covered by existing standards (e.g. CIM) and check if any transposition would be required to make them applicable to flexibility.

Topic	Market interfaces (GBPs 1 & 3)
Findings	Four interfaces with the market are described in GBPs 1 & 3: ● Flexiblity Consumer pushing a flexibility request to the Flexibility Market Operator (S1 → M2 for GBP1, B2 → M1 for GBP3)

Topic	Market interfaces (GBPs 1 & 3)
	• Flexibility Service Provider placing a selling offer to the Flexiiblity Market Operator (A2 → M2 for GBP1, A2 → M1 for GBP3) Based on the data collected from the projects, many different solutions are used for these interfaces. However, to enable a large development of the flexibility markets, it will be required to rely on a common solution allowing any Flexibility Consumer to push its requests to any flexibility market and any Flexibility Service Provider to place its selling offers also to any flexibility market.
Recommendation	1. Investigate what are the on-going activities related to this interface, in particular in EU associations (e.g. ENTSO-E), industry consortiums (e.g. USEF, FlexOffer) and standardisation (e.g. IEC TC57 WG16). 2. Identify, extract and bring to BRIDGE what could be useful for current and future projects.

5.2 Relation to the Digitalisation of Energy Action Plan (DoEAP)

The European Commission is currently defining an Action Plan related to the digitalisation of the energy sector[4]. It will be presented in autumn 2022 to "*help to develop a competitive market for digital energy services and digital energy infrastructure that are cyber-secure, efficient and sustainable*". It is articulated around five working areas, provisionally identified as:

- Developing a European data exchange framework
- Benefits for consumers: literacy, skills, digital tools to empower citizens
- Mobilising investments
- Enhancing Cybersecurity
- Climate neutrality of the ICT

Together with several other initiatives, BRIDGE is expected to contribute to the DoEAP. Therefore, the table below maps the findings & recommendations of this report to the five working areas, replying to the following question: "how each 'finding & recommendation' contributes to the five DoEAP areas?"

<table>
<tr><th></th><th>EU data exchange framework</th><th>Benefits for consumers</th><th>Mobilising investments</th><th>Enhancing Cybersecurity</th><th>Climate neutrality of the ICT</th></tr>
<tr><td>Updated catalogue of standards</td><td rowspan="3">Contribute to the interoperability framework</td><td></td><td rowspan="2">Contribute to the development, implementation and upscaling of digital solutions for the energy system</td><td></td><td></td></tr>
<tr><td>Contribution to standards development</td><td></td><td></td><td></td></tr>
<tr><td>Relevance and benefits from the Generic Business Processes</td><td></td><td></td><td>Raise security and privacy concerns related to data exchanges</td><td></td></tr>
<tr><td>Interoperability of demand-response and appliances</td><td rowspan="3">Support the development of demand-side flexibility</td><td>Support citizen engagement</td><td></td><td></td><td></td></tr>
<tr><td>Settlement subprocess</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Market interfaces</td><td></td><td></td><td></td><td></td></tr>
</table>

[4] See EC dedicated webpage: https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13141-Digitalising-the-energy-sector-EU-action-plan_en

5.3 Next steps

The activities of the Action #3 should be continued in 2022 and beyond.

Based on the recommendations, several actions have been identified, either to extend and enhance the methodology and its reference framework, or to strengthen the impact of its results by disseminating them and supporting their reuse. In addition, some specific actions have been identified to further analyse three specific interfaces, respectively related to “Demand-response and home appliance”, “Settlement subprocess” and “Market interfaces”.

Considering the amount of identified actions, setting a realistic time plan will probably first require to prioritise the topics and the actions, based on the needs from BRIDGE projects and the expectations from the European Commission.

6 Annex 1: Consultation of BRIDGE projects and impact on the Reference Framework & GBPs

A consultation of BRIDGE projects has been performed between July 1st and July 15th 2021, to collect feedback on the reference framework and the Generic Business Processes (GBPs) defined in [2].

This annex details the content of the questionnaire, the received answers and the impact on the Reference Framework and GBPs.

6.1 Questions for BRIDGE projects

6.1.1 General questions

- (1.1) Do the 7 assumptions detailed in §3.2.1 seem OK or do you think they should be reassessed?
- (1.2) Do you see any additional business role that is missing in the existing GBPs?

6.1.2 Use-cases and GBPs

For each of the flexibility-related use-cases of your project:

- (2.1) To which GBP could it be mapped? Or what is the closest GBP?
  - If no existing GBP seems suitable, please indicate which GBP should be added
- (2.2) Do you see any divergence or missing part between the GBP and your use-case?
  - e.g. missing business role, missing function, missing interface, …

6.1.3 Contribution to next steps

- Would you be volunteer to provide detailed information about your UCs and their mapping to the GBPs, to be integrated into this year analysis? (see template in Annex 2 (page 120))

Please provide answers to these questions by July 15th 2021,
using the following online form: https://forms.gle/YyAzWY8EjC4QoKdq5

6.2 Answers to the questions

6.2.1 General questions

6.2.1.1 (1.1) Assumptions

Q1 (GBP1): is the settlement performed by the parties (DSO, BRP, Prosumer) or by the market operator (MO)? ⇒ It is assumed that the settlement is done by the parties.

23 OK, 5 Should be reassessed

- ACCEPT: In developed, fully functional energy markets, the Market Operator is responsible for not only the clearing but also the settlement of all flexibility transactions between aggregators and BRPs/SOs. As such, I would suggest we modify GBP accordingly to include both options (i.e., one where the party requesting the flex is responsible for the settlement, and one where the MO is the responsible party).
- EU-SysFlex: 'Settlement' is too generic term in this context. It should be split down at least into the quantified verification of actual activation, billing between FSP and SO, remuneration of supplier, and financial imbalance settlement. That would enable better allocation of responsibilities to individual roles.
- INTERRFACE: possibly settlement might be exploited to be done by MO or National DataHub
- OneNet: The verification part (i.e. quantification of actually activated flexibilities) of the settlement is the responsibility of Flexibility Register Operator. Invoicing concerns FST and buyer (TSO, DSO). In financial imbalance settlement ISR (Imbalance Settlement Responsible) and BRP are involved.
- PARITY: Settlement is possible to be done by the Market Operator in certain cases, e.g. when Blockchain technology is employed and there are defined SLAs and smart contracts between the parties.

Based on these answers, the Settlement is defined as a separate "Settlement subprocess", more detailed, that will be reused by all the relevant GBPs (see §3.2.6).

Q2 (GBP1): could the DSO directly go to the market or is it required to have the BRP as an intermediary between the market and the DSO? ⇒ It is assumed that both options are possible.

27 OK, 3 Should be reassessed

- EU-SysFlex: Hard to see why should BRP be involved. Is there any such practice actually?
- MAGNITUDE: The DSO should go directly to the market.
- OneNet: We don't see need for BRP involvement. Besides, DSO and TSO should be treated in the same manner as they buyers of flexibility.

Based on these answers, both options are kept in GBP1.
This option will be reassessed following the analysis of more use-cases from BRIDGE projects: do projects involve the BRP or any other Flexibility Facilitator in this case?

Q3 (GBP1): could the Prosumer directly go to the market or is it required to have the Aggregator as an intermediary between the Prosumer and the market? ⇒ it is assumed that the Prosumer must go to market via an Aggregator.

24 OK, 5 Should be reassessed

- EU-SysFlex: The trigger for deciding this should be minimum size of the bid (which can be different per product). If individual unit (prosumer) is less than required minimum size then it needs to be aggregated.
- GIFT: Empowering of prosumers to become market actors including the option of direct market access is the target.
- OneNet: If prosumer is large enough (minimum capacity to be defined in product description) it does not need to go via aggregator.
- PlatOne (IT demo): Prosumer can go directly to the market without an Aggregator. In Platone project (Italian Demo), Aggregator is a necessary intermediary role.

Based on these answers, it seems that in some cases one single actor is playing both Prosumer and Aggregator roles. However it stays relevant to keep both roles separated in the GBPs.

Q4 (GBP2): is the flexibility offer a static commitment (e.g. between X and Y, whatever the conditions) or a somehow dynamic commitment depending on external conditions (e.g. weather, ...)? ⇒ it is assumed that a flexibility offer may be a dynamic commitment.

27 OK, 3 Should be reassessed

- eNeuron: For Q4, dynamic or static flexibility offer I would expect both options are possible, depending on the service/market.
- EU-SysFlex: Normally, until 'gate closure time' FSP is allowed to modify its bid. After that it should be fixed but you can have some rules for the availability of this bid. In the end it is all about flexibility product specification. (Why do you have this discussion for GBP2 but not for GBP!?)

Based on the answers, the Prosumer should provide all the required information to enable the Aggregator to evaluate what flexiblity amount can be provided at a specific time. The set of parameters should include the amount of available flexibility, the time span, as well as the conditions, under which the flexibility offer is valid.

Q5 (GBP2) if answer to Q4 is "static", should we add in the process that, in function A6, the Aggregator involves the Prosumers to validate/re-evaluate the possible flexibility? Or do we simply consider that the commitment from the Prosumer is final and will need to be honoured whatever the conditions? ⇒ as answer to Q4 is "dynamic", it is assumed that the Aggregator handles Flexibility Requests from SO, in A6, without involving the Prosumer.

20 OK, 3 Should be reassessed

- ACCEPT: In reality, the Prosumer should declare (in the bilateral contract) the max flex that they can provide technically. However, depending on their circumstances, the actual flex they can provide at different times may vary. As such, the Aggregator should always request a flexibility forecast from prosumers (e.g. day-ahead forecast or intra-day forecast), which could also be confirmed closer to (near) real-time. This could assist the aggregator with assessing the adequacy of the flexibility available from their formed Virtual Power Plants and deciding whether or not they should dispatch additional assets.
- EU-SysFlex: I don't think we should be concerned about the relations between aggregator and prosumer. I would leave it for the market to decide.
- PARITY: A day-ahead, or intra-day or even near real-time forecast for flexibility should be given to aggregator before activation.

Based on the answers, it is assumed that the Aggregator / Flexibility Service Provider has all the required information, based on what was provided earlier by the prosumer, as the flexibility offer addresses amount, timely availability and conditions of the flexibility offer.

Q6 (GBP2): should we keep the settlement functions (S4 and A4) as the market operator is not involved in this process? ⇒ It is assumed to keep them so far and reassess them when more use-cases from projects will have been analysed.

23 OK, 4 Should be reassessed

- ACCEPT: The proposal here is to re-assess this once more use cases (from European projects) become available.
- EU-SysFlex: See comment at Q1.

Based on these answers, the Settlement is defined as a separate "Settlement subprocess", more detailed, that will be reused by all the relevant GBPs (see §3.2.6).

Q7 (GBP2): should the regulator or any other regulatory party be involved in the "A5 → S5" interface? ⇒ It is assumed that the regulator is not directly involved.

23 OK, 3 Should be reassessed

- PlatOne HL demo: I would rephrase it as follows: It is assumed that the regulator is not directly involved, but establishes a framework that monitors and ensures the trustworthiness of the "A5 → S5" interface.
- PlatOne IT demo: NRA should be involved in bilateral agreement
- SYNERGY: The regulator shall be directly involved in Q7 to define boundary conditions for flexibility transactions, and minimum flexibility product requirements for different types of services.

The rules are defined by the Regulator, however it is not directly involved, i.e. it is not exchanging data when running the process. The Regulator may perform control/audit to check that the agreements are aligned with the rules.

Other comments

- EU-SysFlex: I don't see good justification for having separately GBP2. For me in this case TSO/DSO plays the role of market operator (don't mix roles and actors!). However, if you mention emergency situations it should be dealt separately from market situations. Emergency situations should be approached quite differently.
- MAESHA: I do not fully understand Q6 and the link with the presence of the market operator in this GBP. According to me, the settlement functions should be present in all cases, even if lightened in GBP2.
- OSMOSE: General comments regarding the assumptions (not one in particular):
  - A) You should define what do you mean by "flexibility" : does it include for example voltage regulation, capacity markets, frequency regulation?
  - B) Only "prosumers" are mentioned in the document but flexible generation (including renewable) is a huge source of flexibility in the system. and what about storage?
  - C) "emergency status" is mentioned in the document. I am wondering if emergency is the proper wording since it is usually referring to abnormal operation of the system whereas for example congestion management is the daily life of a SO. Maybe we should refer to different "priority ranks"?
- TwinERGY: Please consider that prosumers could have a very small RES-unit/Storage, so there is not much money to make and the system operation could cost more, if it is too complex and handles too many parties.

- INTERRFACE: There might be potential interest to explore flexibility procurement for cross-sectoral needs. This would be an essential topic to explore in collaboration with Action #2

Based on these answers, the following changes are implemented:
- Definition of a generic flexibility settlement subprocess.
- Definition of the flexibility and the flexibility actors.

6.2.1.2 (1.2) Additional business roles

12 Yes, 20 No

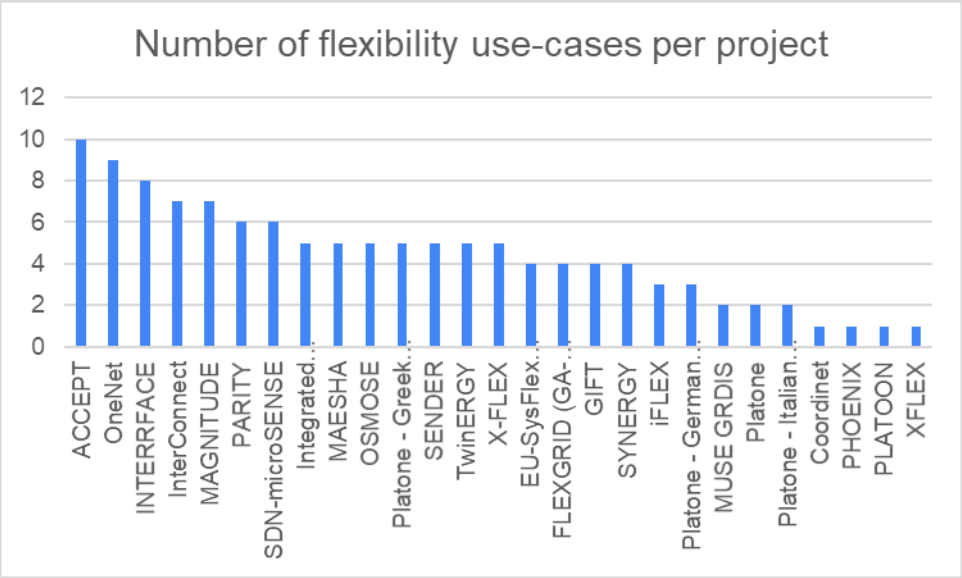
- ACCEPT: Energy communities, as an intermediate level between the individual prosumer and the aggregator. However, debating whether this role could fall under either the prosumer (i.e., the definition of the 'prosumer' is wide enough to include communities). There are also roles missing for other GBPs, not currently analysed in the relevant report, such as ESCOs and Suppliers.
- EU-SysFlex: Metered Data Administrator (HEMRM role), Optimisation Operator (new role), Flexibility Register Operator (new role)
- FLEXGRID: In FLEXGRID, the DSO (i.e. FlexBuyer) can go directly to the market without the need to have a BRP as an intermediary. In fact, BRP can also participate in the proposed DLFM as an individual FlexBuyer. The interesting research issue is "how to deal with the imbalances incurred at the distribution network (DN) level due to the required flexibility procurement by the DSO?". In FLEXGRID, we assume a Reactive Distribution Level Flexibility Market (DLFM) architecture, in which the DLFM reacts to the decisions made at the TN level. Thus, the accountability for the DLFM-related imbalances is allocated to the FlexSuppliers (i.e. aggregators). Generally, there is a need to design a holistic energy market architecture (cf. x-DLFM architectures proposed by FLEXGRID) in order to specifically address all the changes that will be incurred in the existing market actors and processes due to the introduction of a new flexibility market.
- MERLON: Not exactly adding a role but introducing (perhaps as part of the Aggregator role) the concept of Local Energy Community
- InterConnect: Renewable energy community manager; Local Flexibility Aggregator
- MAGNITUDE: Metering-related roles are missing in the existing GBPs. In the case of multi-energy systems providing flexibility, the interactions with the gas and/or heat/cooling sectors and the associated roles are not represented in the existing GBPs.
- OneNet: The role of flexibility system provider is mentioned in the OneNet business use cases but not in the existing generic business processes.
- OSMOSE: Unsure if this is a business role but the case where multiple SO have access to the same flexibility products is not mentioned. This is a critical point regarding interface between TSO and DSO, and between TSOs for cross border markets.
- PlatOne DE demo: Neutral party responsible for settlements and/or certification of the fulfilment of transaction (flexibility provision).
- PlatOne IT demo: HEMRM Regulation Working Group (Action 7) elaborated different business roles that can be introduced in the existing GBPs.
- PLATOON: Data owners and data users (e.g. Analytics Service Providers)

Based on these answers, the following changes are implemented:
- "Flexibility roles" are defined in §3.1.2: they make explicit the role of each actor in the specific scope of a flexibility exchange.
- Metering or similar related roles are not explicitely included in the GBPs definition, they are directly involved in the process. However, their contribution is covered by the "Ext" interfaces, which means that external parties (such as meter data operator) can provide required data to feed some of the functions.

- The role of Energy Communities will be investigated and considered under a new Generic Business Process focusing on intra-community, peer-to-peer transactions.

6.2.2 Use-cases & GBPs

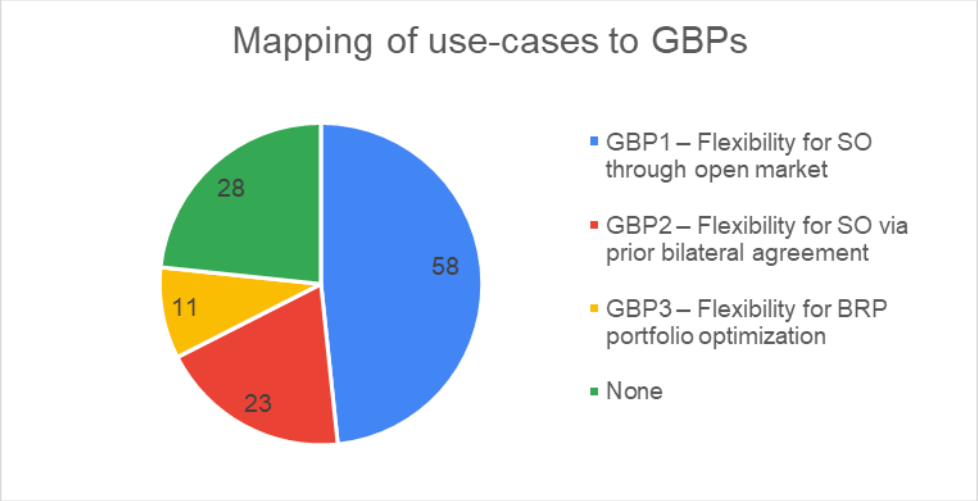
120 use-cases have been submitted:



6.2.2.1 (2.1) GBP mapping

6.2.2.1.1 Overall mapping

The mapping of the project's use-cases shows a predominance of GBP1. Approximately 23% of the use-cases cannot be mapped to any of the 3 existing GBPs.



6.2.2.1.2 Missing GBPs

Project	Name of the use-case	GBP to be added
ACCEPT	Consumer demand-side flexibility forecasting and optimisation taking into account comfort boundaries, activity patterns and possible requirements related to ambient assisted living	Potentially - depends on use cases gathered from all projects and prioritisation of those.
ACCEPT	Intra-day district-level DER flexibility management for community self-balancing	Potentially - depends on use cases gathered from all projects and prioritisation of those.
ACCEPT	Participation in implicit Demand Response schemes	Potentially - depends on use cases gathered from all projects and prioritisation of those.
ACCEPT	Day-ahead smart charging flexibility quantification via EV usage pattern profiling and forecasting	As the use case currently stands (focuses on flex forecast rather than dispatch), I would not consider this a priority.
ACCEPT	Increase self-consumption at community level	Potentially - depends on use cases gathered from all projects and prioritisation of those.
ACCEPT	Community-level P2P flexibility/ energy exchange based on locally produced renewable energy	Potentially - depends on use cases gathered from all projects and prioritisation of those.
ACCEPT	Local self-consumption employing Virtual Energy Storage optimisation via pre-heating/ pre-cooling techniques	Potentially - depends on use cases gathered from all projects and prioritisation of those.
ACCEPT	Demand elasticity profiling-forecasting-aggregation and analysis in community level followed by consumption pattern optimisation through price signalling	Potentially - depends on use cases gathered from all projects and prioritisation of those.
MAESHA	Maximising the use of RES	The project is also considering the "Maximising the use of RES" UC that is quite difficult to map to the existing GBPs. The UC is focused on the fostering of self-consumption operations (individual and collective) and the promotion of hybridisation of EV charging points and cooling/cold production units with PV installation. The main beneficiaries of this UCs are end-users and indirectly SO if we consider that those operations will lead to a lower demand. However, it is a bit unclear to me if we can consider those UCs as “flexibility UCs” relevant for this questionnaire and the Action group. If we consider demand flexibility as the ability to change electricity output or demand in reaction to an external signal and if we map this external signal to the DER forecast then it could be considered as flexibility UCs and a new GBP should be added, with the following business roles: • Prosumer • ESCO – Energy Service Company • DSO (depending on the characteristics of the installation)
MAESHA	Energy access	The project is also considering the "Energy access" UC that is quite difficult to map to the existing GBPs. The UC is focused on fighting energy precariousness with energy solar through the development of renewable energy communities and the creation of specific business models for such LECs. The main beneficiaries of those UCs are end-users and indirectly SO if we consider that those operations will lead to a lower demand. However, it is a bit unclear to me if we can consider those UCs as “flexibility UCs” relevant for this questionnaire and the Action group.

		If we consider demand flexibility as the ability to change electricity output or demand in reaction to an external signal and if we map this external signal to the DER forecast then it could be considered as flexibility UCs and a new GBP should be added, with the following business roles: • Prosumer • ESCO – Energy Service Company • DSO (depending on the characteristics of the installation)
OSMOSE	WP3 demo: Grid forming control for inverters	Today the provision mechanism is not defined but grid forming relies only on local measures to be activated. It could for example be required in grid connection requirements for all generators. Only technical feasibility is assessed in the project.
OSMOSE	WP5 demo: Synthetic inertia by Wind farms	
PARITY	UC-4: Human-centric and contract-safeguarding energy and flexibility transactions in LFM, on the basis of context-aware flexibility profiles	This use case focuses on the participation of prosumers (number of peers) of an energy community in P2P energy and flexibility transactions using smart contracts. The DSO monitors the grid conditions and defines grid constraints that must be respected. Settlement is done by the market operator (blockchain-based market engine).
Platone	Prosumer Self-Consumption	
Platone - German Demo	UC 1 – Virtual Islanding/Community Energy Sharing/Maximisation of Self-Consumption	UC 1 –targets to simulate generation and consumption of a energy community that practices energy sharing to increase self-consumption. The community makes use of own flexibility for own purposes.
Platone - Greek Demo	UC-GR-1 Functions of the State Estimation tool given conventional measurements	UC-GR-1, 2 and 5 due to their nature cannot be reflected in a Generic Business Process. They refer to tools and assets in the hands of the DSO for advanced network observability, which is a key prerequisite for the effective use of any kind of flexibility, no matter which Generic Business Process the latter falls within.
Platone - Greek Demo	UC-GR-2 PMU data integration into SE tool	UC-GR-1, 2 and 5 due to their nature cannot be reflected in a Generic Business Process. They refer to tools and assets in the hands of the DSO for advanced network observability, which is a key prerequisite for the effective use of any kind of flexibility, no matter which Generic Business Process the latter falls within.
Platone - Greek Demo	UC-GR-5 PMU integration and Data Visualisation	UC-GR-1, 2 and 5 due to their nature cannot be reflected in a Generic Business Process. They refer to tools and assets in the hands of the DSO for advanced network observability, which is a key prerequisite for the effective use of any kind of flexibility, no matter which Generic Business Process the latter falls within.
PLATOON	PLATOON	Predictive maintenance and asset operation optimisation
SDN-microSENSE	Investigation of Versatile Cyberattack Scenarios and Methodologies Against EPES	
SDN-microSENSE	- Massive False Data Injection Cyberattack Against State Operation and Automatic Generation Control	
SDN-microSENSE	Large-scale Islanding Scenario Using Real-life Infrastructure	
SDN-microSENSE	EPES Cyber-Defence against Coordinated Attacks	

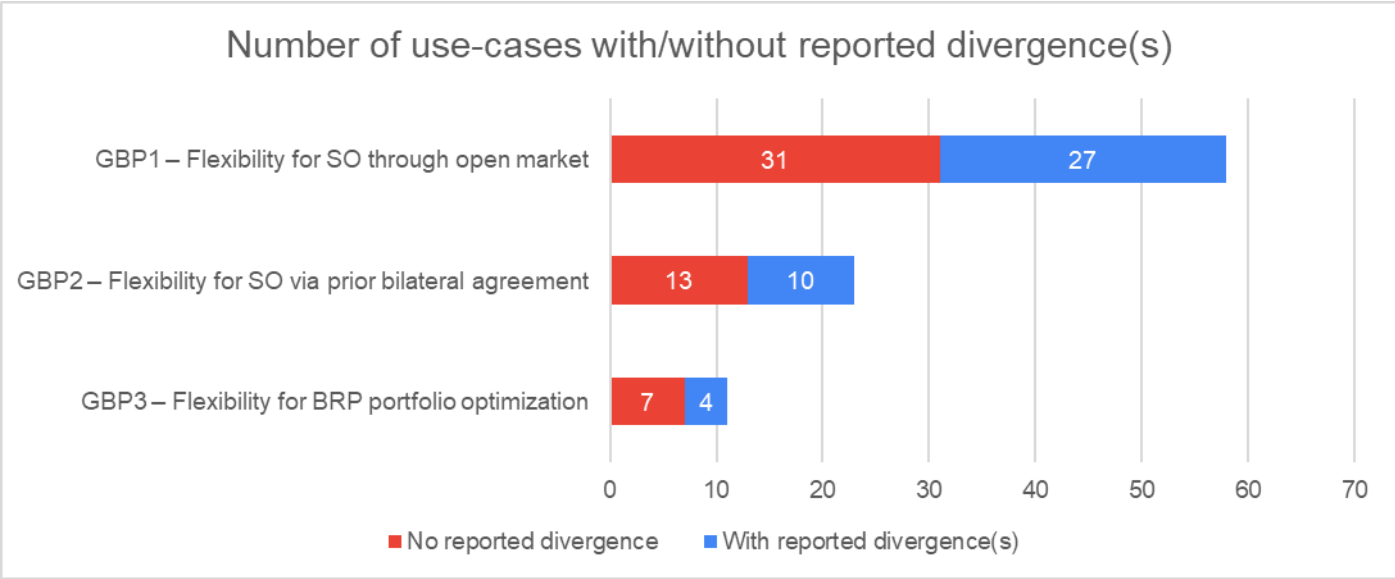
SDN-microSENSE	Distribution Grid Restoration in Real-world PM Microgrids	
SENDER	Maximise the use of Renewable Energy Sources (RES)	This use case benefits mainly end-users and non the system operators.
SENDER	Minimise Electricity Bill	This use case benefits mainly end-users and non the system operators.
SENDER	Remote monitoring and control of household's devices	This use case benefits mainly end-users and non the system operators.
SENDER	Peer-to-Peer trading	This use case benefits mainly end-users and non the system operators.
TwinERGY	UC6: Consumers engagement in Demand Side Management Programs utilising feedback mechanisms	Does not fit directly into the GBPs, it is not a market with binding character, more a recommendation and awarding system. Nevertheless, it may be the simplest way to control/shift loads, which cannot be controlled by EMS in the background. In my opinion, a simple mechanism to inform the consumers about the grid state and best times for consumption is missing, considering Demand Side Management by Consumers based on their behavior. That is where UC06 would fit. Considering the possibly not automated controllable loads (e.g. an older washing machine etc.), it is a small power shift but implemented by many it can have a large impact and be an active part of the solution

Based on these comments, the following changes are implemented:

- Add a specific GBP for optimisation inside an energy community, e.g. maximisation of self consumption.
- Add a specific GBP for implicit demand-response (via tariff or notification).

6.2.2.2 (2.2) Divergences with GBPs

Several divergences have been reported by the projects, in paticular for GBP1:



6.2.2.2.1 Divergences with GBP1

Project	Name of the use-case	Divergence with GBP1
EU-SysFlex (based on Estonian and Finnish demos)	Single Flexibility Platform demo	Prequalification missing in GBP.
FLEXGRID (GA-863876)	FLEXGRID Automated Trading Platform (ATP) offers advanced market clearing services to the Flexibility Market Operator	In FLEXGRID, we assume a new market actor called Flexibility (or Local) Market Operator (FMO/LMO) that operates a novel Distribution Level Flexibility Market (DLFM). In this use case, we have developed 3 main network-aware market clearing algorithms, namely: 1) Flexibility market clearing algorithm to clear the energy product (i.e. congestion problem at the common TSO-DSO coupling point). 2) Flexibility market clearing algorithm to clear the active power reserve product (i.e. for local congestion management) 3) Flexibility market clearing algorithm to clear the reactive power reserve product (i.e. for voltage control events).

		We have developed both auction-based (i.e. day-ahead and longer term context) and continuous pay-as-bid (i.e. near-real-time context) market clearing algorithms.
FLEXGRID (GA-863876)	FLEXGRID ATP offers advanced flexibility demand management services to system operators	FLEXGRID is the first to propose the creation of a distribution network-aware FlexRequest to manage contingency and uncertainty in a Distribution Level Flexibility Market (DLFM) context. In FLEXGRID, the DSO runs a network-aware stochastic OPF with uncertainty and contingency. Then, the DSO sends network-aware FlexRequests to FMO. Finally, the FMO runs a deterministic market clearing with network-aware FlexRequests that include the location tag. This process is sub-optimal (in terms of social welfare) compared to the stochastic market clearing algorithm run by the FMO. However, it is a realistic solution to deal with the incumbent data sharing process between the DSO and the FMO (i.e. DSO is not willing to disclose its sensitive network data to any other market actor). Another major real-life business problem that FLEXGRID deals with is the fact that today's day-ahead energy market clearing is unaware of the distribution network (DN) topology (i.e. DN is seen as a "copper-plate"). As a result, FLEXGRID tries to answer the following questions: 1) How can the proposed Distribution Level Flexibility Market (DLFM) be incorporated in the existing EU regulatory framework? 2) Which is the timing (sequence) of the proposed markets? 3) How does this timing affect the market architecture model (i.e. how inputs/outputs change)? 4) Which are the changes that are incurred due to the introduction of the new DLFM? To answer the questions above, FLEXGRID tests and evaluates the performance of 3 main x-DLFM architectures, namely: 1) Reactive DLFM: the DLFM follows up the dispatch decisions made at the Transmission Network (TN) Level. This architecture is compatible with the existing EU regulatory framework and thus has been selected for further development at higher TRL within the project. 2) Proactive DLFM: the DLFM precedes the TN-level markets. It can be deal better with local congestion management and voltage control issues, but it requires more advanced ICT infrastructure at the DN level. 3) Interactive DLFM: this architecture requires an advanced ICT infrastructure in order to facilitate the interactive message exchanges between the TSO and DSO and between the MO and FMO.
FLEXGRID (GA-863876)	FLEXGRID offers advanced flexibility supply management services to energy service providers (ESPs)	In FLEXGRID, we assume that the FlexOffer is created in a dynamic and automated way. It is not a straight-forward process and does not depend only on external conditions, but on the online management of the FlexAsset portfolio! FLEXGRID researches on bidding structure, truthfulness, real-time constraints, complexity incurred by diverse FlexAsset modeling, uncertainty, portfolio's risk management, stacked revenue maximisation, trade-off between ESP's OPEX and CAPEX, etc.
FLEXGRID (GA-863876)	FLEXGRID ATP offers automated flexibility aggregation services to aggregators	Not really! As a research thread, in FLEXGRID, we also consider a novel B2C flexibility market in which the aggregators incentivise its end users to provide their flexibility with the least possible cost, via advanced retail pricing schemes (e.g. behavioral real time pricing schemes in which each end prosumer is rewarded based exactly on each own personalised contribution towards the total aggregated flexibility).
GIFT	Congestion avoidance	The roles of MO and aggregator are merged in a virtual power system, and the BRP doesn't intervene. The settlement process is not described in the use-case. The four use-cases of the project (described below)

		have the same overall GBP, the differentiation being mostly at the prosumer level, for instance with the organisation in local energy communities.
GIFT	Fish Farms LEC	The roles of MO and aggregator are merged in a virtual power system, and the BRP doesn't intervene. The settlement process is not described in the use-case.
GIFT	Smart Harstad LEC	The roles of MO and aggregator are merged in a virtual power system, and the BRP doesn't intervene. The settlement process is not described in the use-case.
GIFT	Procida LEC	The roles of MO and aggregator are merged in a virtual power system, and the BRP doesn't intervene. The settlement process is not described in the use-case.
InterConnect	HLUC 1 - Belgium pilot - Thor park. Community cost optimisation	No BRP is present. The settlement process is not described.
InterConnect	Portuguese pilot - HLUC 7 - Flexibility Aggregation of Commercial Buildings	No BRP is present. The role of MO is played by the Retailer. The settlement process is not described.
InterConnect	Portuguese pilot - HLUC 09 - Enabling P2P flexibility sharing within renewable energy community via Blockchain enablers for SAREF services	No BRP is present. The prosumers are organised into a renewable energy community. The role of market operator is played by the aggregator. The settlement is computed by the renewable energy community manager.
InterConnect	Greek pilot - HLUC 3 - Flexibility Provision	No MO (replaced by local Aggregator/ Flexibility scheduling)
INTERRFACE	Demo 5.3: multiple BUCS: mFRR, aFRR, FCR	settlement might be performed by the national datahub in certain cases, incorporation of BRP in settlement
INTERRFACE	Demo 5.3: Congestion Management (CM) Operational, CM short-term, CM long-term	1) settlement might be performed by the national datahub in certain cases 2) incorporation of BRP in settlement
INTERRFACE	Demo 6.1: Distribution grid users participating in P2P local market	Settlement performed by local market settlement unit, incorporation of BRP in settlement
INTERRFACE	Demo 7.1: Inter-zonal provision of FCR, aFRR and mFRR services Business Use Case	Market settlement performed by regional interzonal flexibility market place in coordination with SOs
MAGNITUDE	Multi-energy systems providing flexibility to the aFRR procurement mechanism	The interactions between SO and aggregator for the activation of flexibility delivery are missing.
MAGNITUDE	Multi-energy systems providing flexibility to the mFRR procurement mechanism	The interactions between SO and aggregator for the activation of flexibility delivery are missing.
MAGNITUDE	Multi-energy systems providing flexibility to capacity market	The capacity requirements mechanisms are very different from one country to the other. Additional interactions are generally needed and should be represented to completely describe the process.
OneNet	Northern cluster demo BUC (Northern Flexibility Market)	Northern demo uses additional business roles like Metered Data Administrator (HEMRM role), Optimisation Operator (new role), Flexibility Register Operator (new role). It seems grid prequalification process is missing and maybe some specific functionalities like bid optimisation, grid impact assessment.
PARITY	UC-9: Provision of ancillary services to overlay ancillary service market operated by TSO	Settlement is done by the market operator (blockchain-based market engine).
Platone - German Demo	UC 2 – Flex Provision/Virtual Power Plant	Part of this use case could also be mapped with GBP2
Platone - Greek Demo	UC-GR-3 Distribution Network limit violation mitigation	UC-GR-3 and 4 could be considered somewhat close to the GBP1 and GBP3 in the sense that the network tariffs are a facilitator for a more efficient market and network operation that coexists with the existing

		or future electricity supply market, while the DSO does not actually participate in the market or the settlement process. However, we should note that given that the network tariffs are regulated at the moment, flexibility via network tariffs could only be managed assuming that there will be an interface with the regulator.
Platone - Greek Demo	UC-GR-4 Frequency support by the distribution network	UC-GR-3 and 4 could be considered somewhat close to the GBP1 and GBP3 in the sense that the network tariffs are a facilitator for a more efficient market and network operation that coexists with the existing or future electricity supply market, while the DSO does not actually participate in the market or the settlement process. However, we should note that given that the network tariffs are regulated at the moment, flexibility via network tariffs could only be managed assuming that there will be an interface with the regulator.
TwinERGY	UC2: RES Generation in domestic and tertiary buildings	Apartment buildings and individual houses will be equipped with smart meters, local and public storage facilities and IOT devices such as smart plugs. These are integrated with the Transactive Energy Module giving prosumers a powerful insight of their power consumption and redistribution to the local energy market (LEM). Therefore, the local marketplace is considered hereby.
TwinERGY	UC4: Prosumers empowerment in local energy trading markets	Local energy platform also in this case

Based on these comments:

- With regards to Prequalification, it needs to be clarified if this relates to the flexible assets (for market participation) or the request/bid to the marlket? The former is out of scope. In the latter case, clarifications are needed on who performs this and when.
- Setllement process will be modelled seperately and referenced as external subprocess in GBP1 to tackled the complexity of extra roles/functions.
- With regards to the interactions between SO and aggregator for the activation of flexibility delivery, we have modelled in the diagram only market related transactions, but if important it could be added as new process.

6.2.2.2.2 Divergence with GBP2

Project	Name of the use-case	Divergence with GBP2
MERLON	NETWORK CONSTRAINTS MANAGEMENT	In the use-case, no open market has been assumed as in the GBP2. However, the time-scale is different than in GBP2. We do not foresee near real-time activation, but day-ahead flexibility offerings and activation schedule. Thus, perhaps the GBP2 can be enhanced towards this direction
MERLON	Network Constraints Management on Imbalance Detection	Our Use Case is pretty similar with the description of the GBP2. However, it is not clear to us the timing and the content of the bilateral agreements considering it is assumed a dynamic flexibility estimation. Do we assume for example that this agreement is a contract like the capacity ones? Or these agreements include a

		contract with a flexibility estimation for each ISP within a specific horizon? In the latter case, the agreement is being modified based on the dynamic calculation of flexibility or it is assumed fixed for a short horizon (e.g. for the next hour)
MERLON	Emergency Islanding	Emergency Islanding of some part of the network to increase security of supply is not foreseen in the GBPs. The view is that the GBP2 can be extended and be more generic to include possibly this use case as well
InterConnect	French pilot - HLUC2: Dynamic tariff	No BRP involved. No details on bilateral agreement between Aggregator and SO in the Use Case description
InterConnect	German pilot - HLUC 3 - Grid stability via power limitation at grid connection	No BRP involved. The bilateral agreement isn't handled in the use-case, it is considered as a prerequisite.
InterConnect	Italian pilot - HLUC 1 - Digital Platform for End-User Control and Awareness	The bilateral agreement isn't handled in the use-case, it is considered as a prerequisite. The "Living Service Provider" act as a local flexibility provider that connects the prosumer and the aggregator.
MAGNITUDE	Multi-energy systems providing flexibility for congestion management	Depending on the contract, the activation may be "automatic", namely may not need any second phase, e.g. reduce consumption every day in winter between 7:00 and 9:00 or between 18:00 and 20:00.
OSMOSE	WP5 demo: Congestion management by industrial consumers and wind farms	In the process, it seems the SO can estimate the flexibility request without any information from the flexibility providers whereas it is usually the other way around: the SO select the offers based on its grid constraints. In the case, the selection process is made in an "Energy management system" located in the TSO control room.
OSMOSE	WP5 demo: Voltage regulation by industrial consumers and wind farms	Today there is no voltage provision market due to the low liquidity (it is a very local issue) and the low associated costs (voltage regulation has no operational costs for generators). The procurement is ensured through grid connection requirements. Thus the diagram to agree on a bilateral contract is not applicable.
TwinERGY	UC1: Home Energy Management/UC8: Consumer's engagement in demand response programs utilising personalised comfort/health-oriented services	The UC01 fits currently well in the GBP2 – Flexibility for SO via prior bilateral agreement. Anyway, a more reactive approach would be taken into consideration in the forthcoming months of the project. Probably it will include the role for the BRP in order to place an offer to the flexibility of the near future.

The purpose of this GBP is to provide near real-time flexibility activation after the system operator (SO) requests the flexibility service with a bilateral agreement to deal with network congestion/load balancing problems under emergency conditions. In addition, the market operator (MO) is not involved in this GBP to simplify this business process and speed up solving the emergency events.

There are a bit points that differ from the GBP2, which can be concluded as follow:

- The timestep for offering flexibility is not provided near real-time activation in some projects. However, the flexibility will be offered using fixed timestep based on schedule, e.g., day-ahead. Regarding the bilateral agreement, there is no use of bilateral agreement in some use cases, but the contract is defined as a prerequisite or according to connection requirements.
- There is no need for an activation process in some projects, as this process will be made automatically depending on the season. In addition, the BRP will be included in the business process to separate the role of the market operator from an aggregator.
- Regarding the unintentional islanding event, this event is not presented in the GBP, and some projects suggested that this case should be included in the GBP.
- According to the conclusions of the project feedback, there are some points of view that are different from the GBP2, and most of them are not in the scope of GBP2. However, we can add some information in the function of actors related to the feedback to make the role of some actors more clearly although some feedback falls outside of the scope of GBP2.

6.2.2.2.3 Divergence with GBP3

Project	Name of the use-case	Divergence with GBP3
MAGNITUDE	Multi-energy systems providing flexibility to the day-ahead energy market	The aggregator is a BRP too. As previously mentioned, the interactions with the gas and/or heat/cooling sectors are missing.
MAGNITUDE	Multi-energy systems providing flexibility to the intraday energy market	The aggregator is a BRP too. As previously mentioned, the interactions with the gas and/or heat/cooling sectors are missing.
OSMOSE	WP6 demo: Close to real time cross border market	Exchanges are allowed very close to real time and cross border. to ensure the security of the mechanism, SO constraints must be taken into account in the market clearing and not only after for validation. The market clearing is thus performed by the TSO which use its grid data. This applies also for today cross border markets where simplified grid constraints are taken into account in the clearing.
PARITY	UC-10: Participation of LFM-enabled flexibility to national wholesale energy market	Settlement is done by the market operator (blockchain-based market engine).

There are no significant deviations among use cases of Horizon 2020 projects and the GBP3, only simplifications of GBP3 where an actor assumes more than one role (e.g., the aggregator also plays the role of the BRP) and wider scopes of application of GBP3 (e.g., multi-vector portfolios of an aggregator/BRP and cross-border exchanges of electricity).
Two project particularities were mentioned by two projects:

- The first refers to the role of the TSO under near real-time cross-border electricity exchanges, where the TSO is responsible for the clearing of the market. However, this falls outside of the scope of GBP3, as it focuses on the clearing of the wholesale market, and not a flexibility market.
- The second particularity refers to the use of a blockchain platform used by the market operator to perform the settlement process instead of the BRP.

Based on the aforementioned conclusions, it is not deemed necessary to make any change nor addition to GBP3.

6.2.2.2.4 Other comments

MERLON

- S5→ input: desirable amount of flexibility. Is this an external input? Flag : is this flag an external input or it is identified by the SO?
- S6→ only amount of energy is mentioned in the outputs / what about power? What about primary control on balancing services ? Are we considering this case?
- P1→A1: divisibility can be added
- P3→ same description as P2. Is this correct?
- A1→A5: how the horizon of interest is determined ?

Based on these comments, the following changes are implemented:

- The divisibility (i.e. ability to provide partial flex (not only on-off)) will be added in P1→A1
- The descriptions of P2 and P3 will be checked and corrected if required.

6.2.3 (3.3) Contribution to next steps

15 projects volunteered to provide detailed information this year about their UCs and their mapping to the GBPs: ACCEPT, EU-SysFlex, FLEXGRID (GA-863876), GIFT, iFLEX, MERLON, InterConnect, MAESHA, MAGNITUDE, MUSE GRIDS, OneNet, PARITY, SENDER, SYNERGY, X-FLEX.

1 Annex 2: Template for collecting data from projects

For each of the **flexibility use-cases** of your project, please duplicate and fill in the section 1.1.1 below. All the use-cases from a single project should be provided into a single Word document.

Please list the documented use-cases in the table below:

Project	Use-case name	GBP id (1 to 5)
XXX	YYY	
XXX	YYY2	

The reference framework, including the description of each GBP, function and interface, is detailed in a dedicated document provided together with this template.

Please send your data by e-mail by November 17th 2021
to olivier.genest@trialog.com and datamanagement@h2020-bridge.eu

1.1.1 Project XXX – Use case YYY

1.1.1.1 Summary of the use-case

Objectives

Indicate the objectives of the use-case

Actors

List and describe the actors of the use-case (and the associated flexibility roles)

Flexibility Role	System Actor	Short Description
Flexibility Consumer	XXX	Provide a short description of the actor
	ZZZ	
Flexibility Facilitator		
Service Operator (SO) *For GBP3 only*		
Intermediary Stakeholder *For GBP5 only*		
Flexibility Market Operator		
Flexibility Service Provider		
Flexibility Provider		

Short narrative

Short narrative description of the use-case

1.1.1.2 SGAM of the use-case

Put the SGAM diagrams of the use-case, at least function and information layers

Preferably, all the functions and interfaces should be uniquely numbered in the diagrams

Business layer

<image>

Function layer

<image>

Information layer

<image>

1.1.1.3 Mapping with the generic business process

This use-case is related to "GBP1-5"

Mapping between the Flexibility roles & UC actors

Please include all the Flexibility roles (based on §3.1.2) relevant for the corresponding GBP. Example below is for GBP1 "SO flexibility through open market".

Flexibility role	Mapped UC actor	Comment
Flexibility Consumer		
Flexibility Facilitator		
Flexibility Market Operator		
Flexibility Service Provider		
Flexibility Provider		

Mapping between the GBP functions & UC functions

Please include all the GBP functions (based on §3.3.1). Example below is for GBP1 "SO flexibility through open market".

GBP function	Mapped UC function	Comment
S1		
S3		
B2		

GBP function	Mapped UC function	Comment
B3		
M2		
A1		
A2		
A3		
A8		
P1		
P2		
SP1		
SP2		
SP3		
SP4		
SC1		
SC2		
SC3		

Mapping between the GBP interfaces & UC interfaces

Please include all the GBP interfaces (based on §3.3.2), including those with external actors ("XX ↔ Ext."). Example below is for GBP1 "SO flexibility through open market".

GBP interface	Mapped UC interface	Comment
P1 → A1		
A1 → A2		

GBP interface	Mapped UC interface	Comment
P1 → A2		
A2 → M2		
S1 → B2		
B2 → M2		
S1 → M2		
M2 → B3		
B3 → S3		
M2 → S3		
M2 → A8		
A8 → A3		
A3 → P2		
A8 → P2		
S3 → SS		
P2 → SS		
S1 ↔ Ext		
M2 ↔ Ext		
P1 ↔ Ext		
P2 ↔ Ext		
SP1 → SP2		
SP2 → SP3		
SC1 → SC2		

GBP interface	Mapped UC interface	Comment
SC2 → SP3		
SP3 → SP4		
SP4 ↔ SC3		
SP1 ↔ Ext		

1.1.1.4 Solutions/standards being used

Interfaces (information models)

Please include all the GBP interfaces (based on §3.3.2), including those with external actors ("XX ↔ Ext."). Example below is for GBP1 "SO flexibility through open market".

Note: here we focus on information models (= information layer), not communication protocols (= communication layer).

GBP interface	Used information model solution/standard	Type (*)	Extension/modification/deviation (if any, and why)	Gaps identified (if any)	Extra information / Comment
P1 → A1					
A1 → A2					
P1 → A2					
A2 → M2					
S1 → B2					
B2 → M2					
S1 → M2					
M2 → B3					
B3 → S3					
M2 → S3					
M2 → A8					

GBP interface	Used information model solution/standard	Type (*)	Extension/modification/deviation (if any, and why)	Gaps identified (if any)	Extra information / Comment
A8 → A3					
A3 → P2					
A8 → P2					
S3 → SS					
P2 → SS					
S1 ↔ Ext					
M2 ↔ Ext					
P1 ↔ Ext					
P2 ↔ Ext					
SP1 → SP2					
SP2 → SP3					
SC1 → SC2					
SC2 → SP3					
SP3 → SP4					
SP4 ↔ SC3					

GBP interface	Used information model solution/standard	Type (*)	Extension/modification/deviation (if any, and why)	Gaps identified (if any)	Extra information / Comment
SP1 ↔ Ext					

(*) Possible values: “FS” = Fully standard, “MES” = Modified or extended standard”, “OS” = Open Specification, “P” = Proprietary

2 Annex 3: References to the mentioned standards and solutions

The table below list the standards and solutions mentioned in the document.

Standard / solution	Description	Link
CIM	Common Information Model Defined by IEC 61970 (EMS), IEC 61968 (DMS) and IEC 62325 (Market).	IEC TC57
DLMS/COSEM	Device Language Message Specification / Companion Specification for Energy Metering Defined by IEC 62056, in particular IEC 62056-5-3 (application layer) and IEC 62056-6-2 (interface classes).	IEC TC13
EQUIGY	The status of this solution (open or proprietary) should be further investigated	
ERRP	ENTSO-E Reserve Resource Process Defined by ENTSO-E	ENTSO-E
FlexOffer	Format and protocol to describe energy flexibility, defined by former EU projects (Mirabel, TOTALFLEX, GOFLEX, ...)	FlexOffer User Group
IEC 60870-5-101 IEC 60870-5-104	Protocol for telecontrol (SCADA) IEC 60870-5-101 defined the application and IEC 60870-5-104 defined its transport over network.	IEC TC57
IEC 61850	Protocol for intelligent electronic devices at electrical substations.	IEC TC57
Modbus	Protocol for industrial electronic devices. De facto standard managed by the Modbus Organisation	Modbus Organisation
OCPP	Open Charge Point Protocol De facto standard manage by the Open Charge Alliance	Open Charge Alliance
OpenADR	Open Automated Demand Response Now standardised as IEC 62746-10-1	OpenADR Alliance

Standard / solution	Description	Link
OpenHAB	Open Home Automation Bus	openHAB Foundation
ProfiNET	PROcess FIeld NETwork	PROFIBUS
USEF	Universal Smart Energy Framework	USEF Foundation
xEMS	x Energy Management System x can be F-factory, H-home, C-charging or CD-chargingdischarging	GOFLEX D3.1
Z-Wave		Z Wave Alliance

List of Acronyms and Abbreviations

AMI	Advanced Metering Infrastructure
BESS	Battery Energy Storage System
BPMN	Business Process Model and Notation
BRP	Balance Responsible Party
CEMS	Customer Energy Management System
CIM	Common Information Model
DER	Distributed Energy Resources
DR	Demand Response
DSO	Distribution System Operator
EMS	Energy Management System
ESB	Enterprise Service Bus
EV	Electrical Vehicle
FAQ	Frequently Asked Questions
FO	Flexibility Offer
FS	Fully Standard
GBP	Generic Business Process
GW	GateWay
HLUC	High-Level Use-Case
HVAC	Heating, Ventilation and Air-Conditioning
IEC	International Electrotechnical Commission
LEC	Local Energy Community
LV	Low Voltage
MES	Modified or Extended Standard
MO	Market Operator
MV	Medium Voltage
NA	Not Applicable
OCPP	Open Charge Point Protocol
OS	Open Specification
P	Proprietary
PLC	PowerLine Communications
PUC	Primary Use-Case
RTU	Remote Terminal Unit
SCADA	Supervisory Control And Data Acquisition

SDO	Standards Development Organisation
SGAM	Smart Grid Architecture Model
SGC	Smart Grid Controller
SO	System Operator (i.e. TSO or DSO)
TSO	Transmission System Operator
UC	Use-Case
VPS	Virtual Power System
WG	Working Group

List of references

[1] BRIDGE, «BRIDGE General Assembly February 2020 – Conclusions & Next Steps,» [En ligne]. Available: https://www.h2020-bridge.eu/wp-content/uploads/2020/03/BRIDGE-GA2020_Conclusions-and-next-steps.pdf.

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[3] IEC, «IEC TR 63097:2017 Smart grid standardization roadmap,» [En ligne]. Available: webstore.iec.ch/publication/27785.

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MJ-MJ-03-23-057-EN-N

Publications Office
of the European Union

ISBN 978-92-76-99539-5