European Commission

# bridge

## Reference Framework

### Updated report 2024

Data Management Working Group

October - 2024

**AUTHORS**

Olivier Genest, *Trialog*

Isidoros Kokos, *Intracom Telecom*

Mário Couto, *EPRI*

Ismini Dimitriadou, *Hypertech*

Krzysztof Piotrowski, *IHP*

Stelios Zikos, *CERTH/ITI*

**OTHER CONTRIBUTORS**

Ferdinando Bosco, *Engineering*

Marjolaine Farre, *Trialog*

Dune Sebilleau, *Trialog*

Kostas Tsatsakis, *Suite5*

Pinelopi Valiouli, *isZEB*

Denisa Ziu, *Engineering*

Joaquim Meléndez i Frigola, *Universitat de Girona*

Elena Boskov Kovacs, *Blueprint Energy*

Vincenzo Croce, *Engineering*

Jukka Rinta-Luoma, *Fingrid*


**CONTRIBUTION FROM PROJECTS**

ACCEPT, BRIGHT, ebalance-plus, ECHO, EDDIE, ELECTRON, ENERGICA, Enershare, ENFLATE, EUniversal, FEVER, FlexCHESS, GIFT, IANOS, int:net, InterConnect, MAESHA, NaturSea-PV, OMEGA-X, OneNet, OPENTUNITY, PARITY, PARMENIDES, PlatOne, Re-Empowered, REEFLEX, RESCHOOL, RESONANCE, ROBINSON, SENDER, SERENE, SINNOGENES, Senergy-Nets, TIGON, X-FLEX

**BRIDGE WG/TF CHAIRMANSHIP**

Olivier Genest – *Chair*

**EUROPEAN COMMISSION**

European Climate, Infrastructure and Environment Executive Agency
Directorate C - Green research and innovation
Unit C.C2 “Horizon Europe Energy”

Directorate General for Energy
Directorate B – Just Transition, Consumers, Energy Efficiency and Innovation
Unit B5 – Innovation, Research, Digitalisation, Competitiveness

Contact: Mugurel-George Păunescu ; Mariana Stantcheva
E-mail : mugurel-george.paunescu@ec.europa.eu ; mariana.stantcheva@ec.europa.eu
European Commission
B-1049 Brussels

**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 Secretariat team, all contributing to this BRIDGE Reference Framework Report.

# Reference Framework

Data Management Working Group

October 2024

## LEGAL NOTICE



| PDF Web | ISBN 978-92-9405-151-6 | doi: 10.2926/9862411 | HZ-01-24-018-EN-N |
|---|---|---|---|

Luxembourg: Publications Office of the European Union, 2024

Manuscript completed in October 2024

First edition

# INDEX

# List of Acronyms and Abbreviations

| | |
|---|---|
| AhG | Ad-hoc Group |
| BPMN | Business Process Model and Notation |
| BRP | Balance Responsible Party |
| BTM | Behind-the-Meter |
| CG-SG | Coordination Group on Smart Grids |
| CEN | *Comité Européen de Normalisation* (European Committee for Standardisation) |
| CENELEC | *Comité Européen de Normalisation en ÉLectronique et en ÉlectroteChnique* (European Committee for Electrotechnical Standardisation) |
| DER | Distributed Energy Resources |
| DMWG | Data Management Working Group |
| DR | Demand Response |
| DSO | Distribution System Operator |
| EG | Expert Group |
| EMS | Energy Management System |
| ESCo | Energy Service Company |
| ETSI | European Telecommunications Standards Institute |
| EV | Electrical Vehicle |
| FO | Flexibility Offer |
| FSP | Flexibility Service Provider |
| FTM | Front-of-the-Meter |
| GBP | Generic Business Process |
| GUC | Generic Use Case |
| HEMRM | Harmonised Electricity Market Role Model |
| IEC | International Electrotechnical Commission |
| IRM | Interface Reference Model |
| LEC | Local Energy Community |
| MO | Market Operator |
| M&V | Measurement & Verification |
| P2P | Peer-to-peer |
| SG-CG | Smart Grid Coordination Group |
| SGAM | Smart Grid Architecture Model |
| SGTF | Smart Grid Task Force |
| SLA | Service Level Agreement |
| SO | System Operator (i.e. TSO or DSO) |

| | |
|---|---|
| TSO | Transmission System Operator |
| UC | Use-Case |
| UML | Unified Modelling Language |
| WG | Working Group |

# List of references


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.

BRIDGE, «BRIDGE – Interoperability of flexibility assets – April 2021,» [En ligne]. Available: https://ec.europa.eu/energy/sites/default/files/documents/bridge_wg_data_management_interoperability_of_flexibility_assets_report_2020-2021.pdf.

BRIDGE, «Interoperability of flexibility assets - Version 2.0,» 2022. [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/a00be176-ac1f-11ed-b508-01aa75ed71a1/language-en.

BRIDGE, «BRIDGE General Assembly March 2022 – Conclusions & Next Steps,» [En ligne]. Available: https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/sites/default/files/download/BRIDGE%202022%20GA%20-%20Conclusions.pdf.

BRIDGE, «Reference framework v1.0,» [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/13183bbf-4d33-11ee-9220-01aa75ed71a1/language-en/format-PDF/source-294051135.

BRIDGE, «BRIDGE Use Cases Repository,» [En ligne]. Available: https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/use-cases-repository.

BRIDGE, «Set up a use case repository 2.0,» 2022. [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/30ac0765-ac1e-11ed-b508-01aa75ed71a1/language-en.

IEC, «Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list,» 2015.

ebIX, EFET, ENTSO-E, «Harmonised Electricity Market Role Model,» [En ligne]. Available: https://www.ebix.org/artikel/role_model.

SGTF EG1, «Towards Interoperability within the EU for Electricity and Gas Data Access & Exchange,» March 2019. [En ligne]. Available: https://energy.ec.europa.eu/system/files/2019-05/eg1_main_report_interop_data_access_0.pdf.

CEN-CENELEC-ETSI Smart Grid Coordination Group, «Sustainable Processes,» November 2012. [En ligne]. Available: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN-CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/smartgrids_sustainableprocesses.pdf.

IEC, «Application integration at electric utilities - System interfaces for distribution management - Part 1: Interface architecture and general recommendations».

EPRI, «Measurment and Verification (M&V) for Distributed Energy Resources Providing Grid Services - New Complexities, Common Approaches, and Research Needs,» 2021.

OneNet, «D3.4 Regulatory and demo assessment of proposed integrated markets,» [En ligne]. Available: https://www.onenet-project.eu//wp-content/uploads/2023/09/OneNet_D3.4_V1.0.pdf.

OneNet Project, «D3.4 Regulatory and demo assessment of proposed integrated markets,» 2023.

CoordiNet, «D2.1 Markets for DSO and TSO procurement of innovative grid services: Specifications of the architecture, operation and clearing algorithms,» 2021.

Smart Grid Task Force, «Regulatory Recommendations for the Deployment of Flexibility: EU SGTF-EG3 Report,» 2015.

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

# List of Figures

# List of Tables

# Executive Summary

Initially, the topic of "Interoperability of flexibility assets" was discussed and its scope defined during the BRIDGE General Assembly held on 11-12 March 2020 in Brussels[1]. A first report[2] on this topic was published in April 2021. It included a Reference Framework made of 3 Generic Business Processes (GBPs) and performed an interoperability analysis over 10 use cases from 4 projects. Since then, the Reference Framework has been extended to add 2 new GBPs and proposes a first version of the settlement subprocess. This second version of the Reference Framework was detailed in the "Interoperability of flexibility assets" report version 2.0[3] completed in June 2022, together with an interoperability analysis based on 36 use cases from 14 projects.

Following the BRIDGE General Assembly of March 2022[4], it was decided to focus the activities on the further development of the Reference Framework, in particular:

- Refine the existing GBPs based on the feedback from new projects;
- Extend the Reference Framework to include new GBPs beyond flexibility;
- Improve the Settlement subprocess based on the BRIDGE projects that are effectively implementing settlement.

A report[5] was published in June 2023 to present an update of the Reference Framework, now describing 7 GBPs and also detailing the Settlement subprocess. It also identified 3 main recommendations:

- Ensure consistency with existing standards and ongoing initiatives (e.g. IEC 62913, SGTF EG1).
- Identify expectations and related benefits from the Generic Business Processes.
- Further understand the implementation of the Settlement sub-process.

This report presents the activities performed in 2023-2024 on these three priority areas, in particular:

1. A survey has been conducted to identify the expectations from the BRIDGE projects and how the Reference Framework could be practically improved.
    - There is a strong interest to conduct a survey on the standards used in the projects and their mapping to the GBPs, as done in 2020 and 2021.
    - The Reference Framework should be extended to support more use cases and the existing GBPs could be further investigated to increase the generalisation of the framework.
2. A workstream has been launched to establish an updated Generic Actor List to enable the definition of use case to be harmonised, in particular within the BRIDGE Use-Case Repository.
    - Experts from the projects and CEN/CLC/ESTI CG-SG will be involved and a first revision is planned at the end of 2024.
3. A guideline for settlement implementation has been developed.
    - Adaptable baseline methodologies should be standardised to support various flexibility products and grid conditions.
    - Standardised protocols and granularity requirements should be established for real-time data exchange.
    - Data collection, validation and exchange should be standardised, including accuracy and frequency requirements, to ensure reliable settlement calculations.

---

[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.

[2] BRIDGE, «BRIDGE – Interoperability of flexibility assets – April 2021,» [En ligne]. Available: https://ec.europa.eu/energy/sites/default/files/documents/bridge_wg_data_management_interoperability_of_flexibility_assets_report_2020-2021.pdf.

[3] BRIDGE, «Interoperability of flexibility assets - Version 2.0,» 2022. [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/a00be176-ac1f-11ed-b508-01aa75ed71a1/language-en.

[4] BRIDGE, «BRIDGE General Assembly March 2022 – Conclusions & Next Steps,» [En ligne]. Available: https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/sites/default/files/download/BRIDGE%202022%20GA%20-%20Conclusions.pdf.

[5] BRIDGE, «Reference framework v1.0,» [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/13183bbf-4d33-11ee-9220-01aa75ed71a1/language-en/format-PDF/source-294051135.

- Robust notification mechanisms should be implemented to alert stakeholders about discrepancies between ordered and delivered flexibility volumes.

# Introduction

The Data Management Working Group aims to cover a wide range of aspects, from the technical means for exchanging and processing data between stakeholders to the definition of rules for exchanging, including security issues and responsibility distribution. 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 is part of the 3rd area, "Data Handling", and covers the topic of a "Reference Framework" for interoperability.

Initially, the topic of "Interoperability of flexibility assets" was discussed and its scope defined during the BRIDGE General Assembly held on 11-12 March 2020 in Brussels[6]. A first report[7] on this topic was published in April 2021. It included a Reference Framework made of 3 Generic Business Processes (GBPs) and performed an interoperability analysis over 10 use cases from 4 projects. Since then, the Reference Framework has been extended to add 2 new GBPs and proposes a first version of the Settlement subprocess. This second version of the Reference Framework was detailed in the "Interoperability of flexibility assets" report version 2.0[8] completed in June 2022, together with an interoperability analysis based on 36 use cases from 14 projects.

Following the BRIDGE General Assembly of March 2022[9], it was decided to focus the activities on the further development of the Reference Framework. The report[10] published in June 2023 presented an update of the Reference Framework, now including 7 Generic Business Processes and also detailing the Settlement subprocess.

In 2023-2024, the work around the Reference Framework focuses on three topics:

- Identify the expectations from the BRIDGE projects and how the Reference Framework could be practically improved.
- Launch the definition of an updated Generic Actor List, to enable the definition of the use cases to be defined, in particular within the BRIDGE Use-Case Repository.
- Develop a guideline for settlement implementation.

This report presents the results of these three activities. The Reference Framework is attached in Annexe 1.

[6] 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.

[7] BRIDGE, «BRIDGE – Interoperability of flexibility assets – April 2021,» [En ligne]. Available: https://ec.europa.eu/energy/sites/default/files/documents/bridge_wg_data_management_interoperability_of_flexibility_assets_report_2020-2021.pdf.

[8] BRIDGE, «Interoperability of flexibility assets - Version 2.0,» 2022. [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/a00be176-ac1f-11ed-b508-01aa75ed71a1/language-en.

[9] BRIDGE, «BRIDGE General Assembly March 2022 – Conclusions & Next Steps,» [En ligne]. Available: https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/sites/default/files/download/BRIDGE%202022%20GA%20-%20Conclusions.pdf.

[10] BRIDGE, «Reference framework v1.0,» [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/13183bbf-4d33-11ee-9220-01aa75ed71a1/language-en/format-PDF/source-294051135.

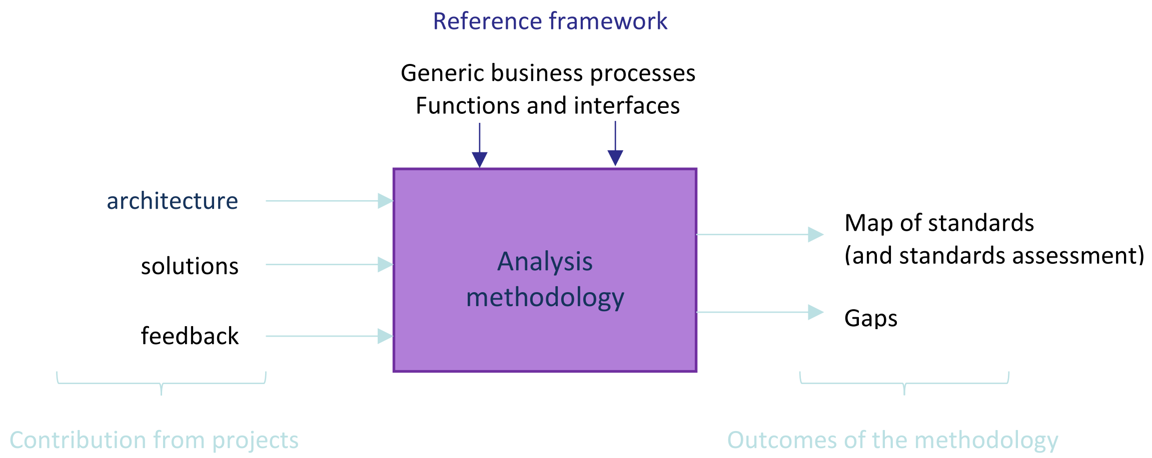
# 1 General approach

## 1.1 Context

The Reference Framework was initially developed to support a methodology to analyse how projects achieve interoperability of flexibility assets, including standards assessment (adequacy, maturity …) and gaps identification.

Used as a common denominator between all the projects, the Reference Framework's objective was to define some generic business processes (GBPs), which are agnostic to any specific technical solution, enabling the mapping of each of the projects' specific solutions to these GBPs to enable cross-projects comparison and analysis.

This diagram below depicts how the methodology relied on the Reference Framework to compare and harmonise the contributions from different projects with different technical solutions, and how it was used to analyse these contributions to establish outcomes such as a map of standards, standards 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 Reference Framework as part of the methodology set in 2020 to study the interoperability of flexibility assets

Following the BRIDGE General Assembly of March 2022, it was decided to focus on the development and enhancement of the Reference Framework, beyond flexibility, as a tool to support interoperability and to harmonise use cases descriptions between projects (e.g. via the BRIDGE use-case repository).

## 1.2 Reference Framework components

The Reference Framework is a common base to compare and harmonise the use cases from different projects with different technical solutions.

It relies on GBPs, made of functions and interfaces, with which each project's use cases and architecture can be mapped.

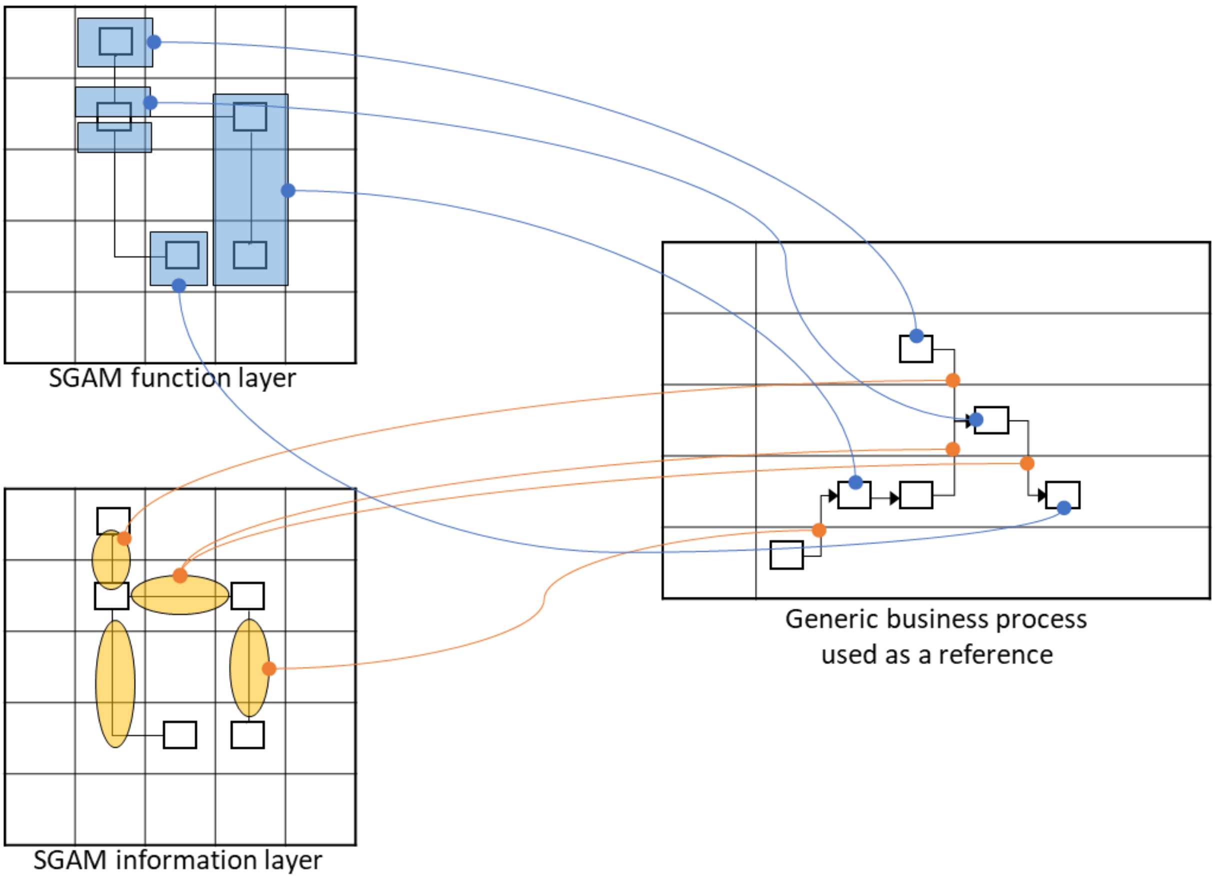



Figure 2: Example mapping between the SGAM layers of a specific solution/use case and a Generic Business Process used as a reference

## 1.2.1 Generic business process

Each GBP is a description of a process between business roles such as DSO and aggregator. It is broken down 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 a business process description allows users 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 GBPs 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. Where several paths are possible, the alternative path is drawn with dotted lines.

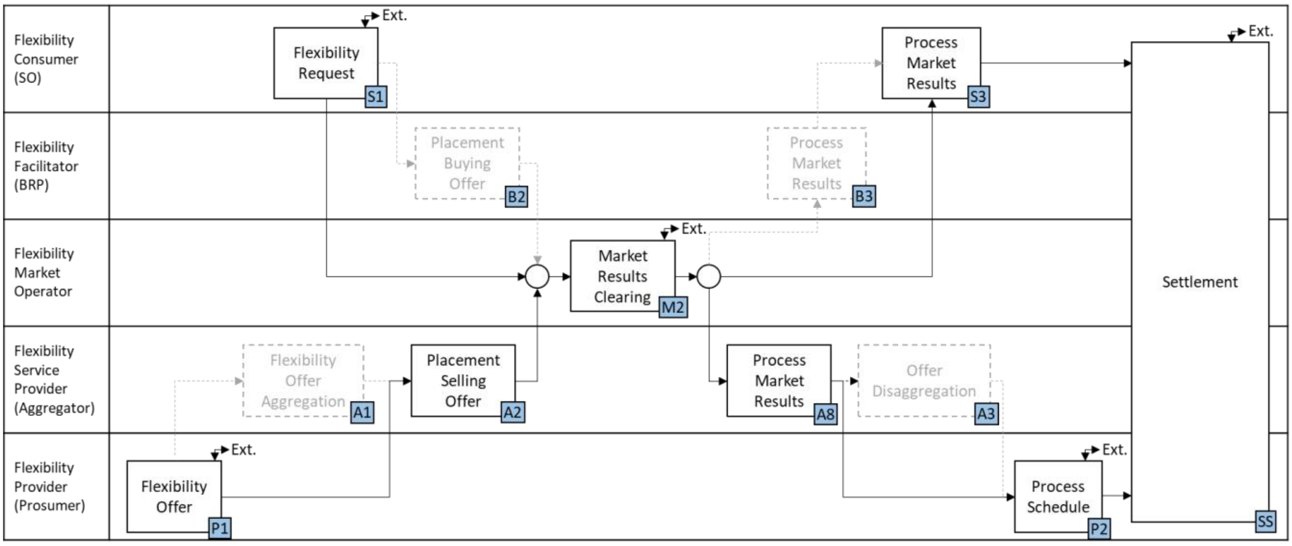



Figure 3. Example of business process diagram

## 1.2.2 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 commands, and finally provide outputs to the following function. They can be broken down into “subfunctions”, which might be useful for more detailed mapping with some specific architecture.

They are defined in 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 perform 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 in 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 function layer interoperability to be studied. The analysis of the interfaces allows information layer interoperability to be studied.

### 1.2.3 Extension of the Reference Framework

A survey was performed in January 2023[11] to identify relevant GBPs to be added, based on use cases from contributing projects. As a result, three new GBPs have been added: E-mobility based flexibility; P2P energy trading; Energy monitoring and energy management of households.

Following this update, it was acknowledged that the Reference Framework is now mature and therefore further benefits should be explored to help ongoing and future projects, including the framework's practical use. Two complementary approaches have been implemented:

- A survey was distributed to all BRIDGE projects to identify their needs and expectations, as well as their current barriers to the use of the Reference Framework (see §2.1).
- The establishment of an updated Generic Actor List has been initiated to enable use-case harmonisation, in particular via the BRIDGE Use-Case Repository (see §2.2).

## Settlement implementation

A workstream on settlement was initiated in 2020, in particular by identifying and cooperating with the BRIDGE projects implementing settlement. The focus was to understand how settlement is handled within each project and if their implementation can be mapped to the Settlement subprocess currently set out in the Reference Framework. Five projects were analysed in 2023 report[12].

The next approach was to extract the main approaches and recommendations from these projects to support other ongoing or future projects. The result is a guideline on settlement implementation (see §3).

[11] BRIDGE, «Reference framework v1.0,» [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/13183bbf-4d33-11ee-9220-01aa75ed71a1/language-en/format-PDF/source-294051135.
[12] BRIDGE, «Reference framework v1.0,» [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/13183bbf-4d33-11ee-9220-01aa75ed71a1/language-en/format-PDF/source-294051135.

# 2 Increasing the impact of the Reference Framework

## 2.1 Investigation from BRIDGE projects

### 2.1.1 Reference Framework Usability Survey

A survey was launched in January 2024 to analyse how the Reference Framework is already supporting BRIDGE projects for use-case development and to identify ways to increase its impact and associated benefits. To this end, a survey was shared with projects, investigating their expectations and benefits regarding BRIDGE GBPs.

The questionnaire is analysed in the following table.

Table 3 Reference Framework Usability Survey

| BRIDGE Reference Framework Section |
| --- |
| **Q1. Please rate the usefulness of the Reference Framework for your project.** |
| **Q2. How did you use the framework?** |
| **Q3. Did you face any difficulties in using/understanding the framework? (e.g. from regulation, standards or other expert groups)?** |
| **Q4. If yes, please explain** |
| **Q5. Do you see inconsistencies between BRIDGE Reference Framework and other frameworks?** |
| **Q6. If yes, please explain** |
| Generic Business Process (GBP) Section |
| **Q7. Please indicate which GBPs are relevant for your project(s)** |
| **Q8. Please rate the level of alignment of your UC with GBPx** |
| **Q9. Please describe main misalignment points (if any)** |
| **Q10. Please indicate how satisfied you are with the level of detail of the GBP analysis** |
| **Q11. Please indicate any suggestions for improvement of the GBP analysis** |
| **Q12. Are there any GBPs that you would like to see added in the Framework? Please, briefly describe them** |
| Standards Mapping Section |
| **Q13. In 2020 and 2021, surveys were conducted to identify relevant standards for each interface of the GBPs. Please rate the usefulness of this work** |
| **Q14. Would you consider an updated analysis of standards useful?** |
| Concluding Section |
| **Q15. Do you have suggestions on how to make the Reference Framework more practical?**<br>**(e.g. formal UML/BPMN modelling of the GBPs, online browsing tools to see relevant standards/references for each interface)** |

### 2.1.2 Usability Survey Results

The survey was answered by 27 projects (ROBINSON, EUniversal, ACCEPT, InterConnect, MAESHA, RESONANCE, NaturSea-PV, PARMENIDES, SERENE, ENFLATE, IANOS, Energica, ECHO, ELECTRON, RESCHOOL, OPENTUNITY, int:net, Enershare, SENDER, ELECTRON, TIGON, SINNOGENES, REEFLEX, EDDIE, FlexCHESS, ebalance-plus, Re-empowered) represented by 19 different organisations.

In regards to the usefulness of the framework, as presented in the following figure, most projects have a positive experience from using it.

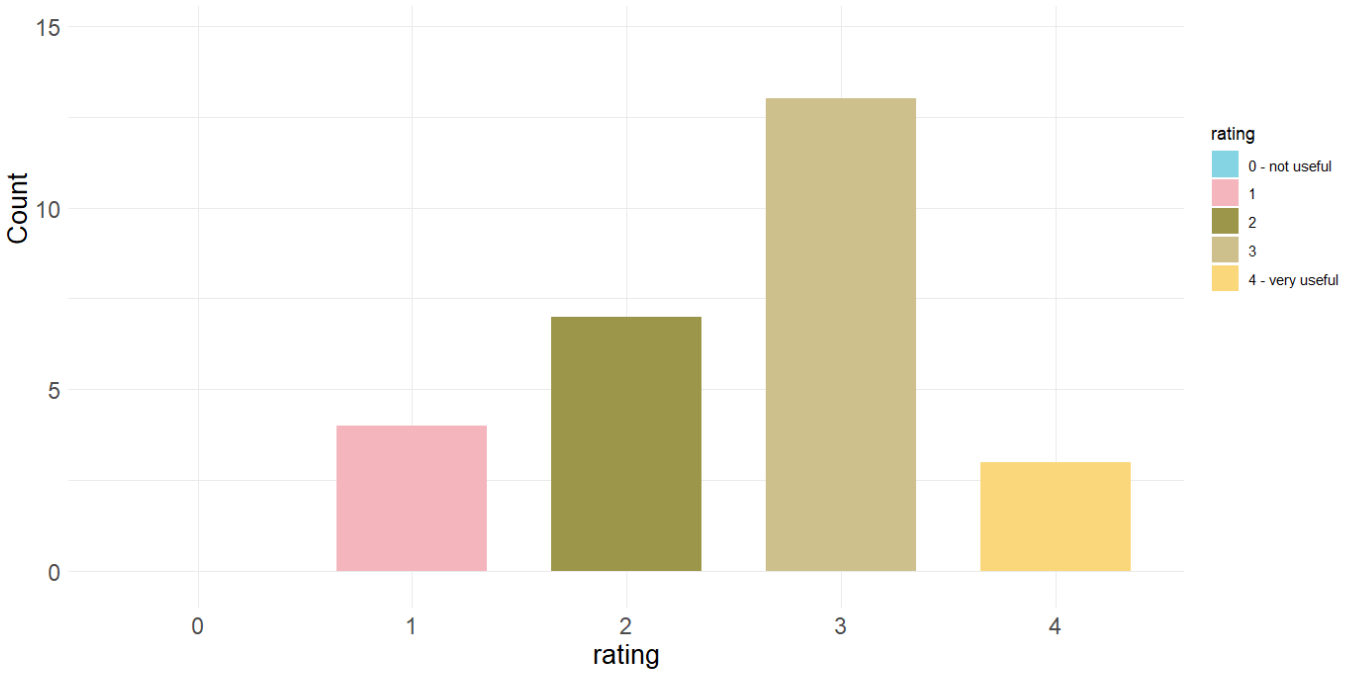



Figure 4 Q1. Please rate the usefulness of the Reference Framework for your project

As presented in Figure 4, most of the projects have found the work useful for guiding the UC design, for validation of UC design and source of standards or for other uses. Figure 5 below details how it has been used, mostly to support UC design and identify relevant standards.

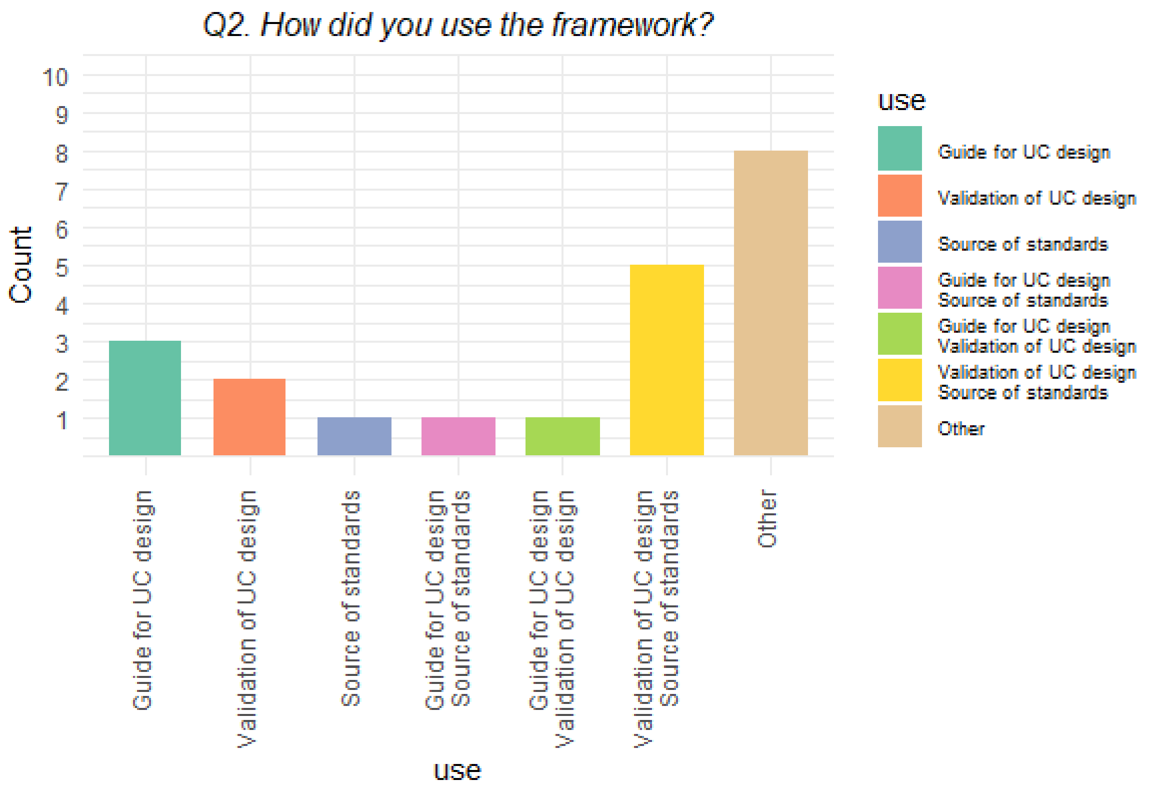



Figure 5 Q2. How did you use the framework?

Most of the projects didn't face challenges in using the framework (Figure 6) with some reported difficulties (Q4) in understanding regulation aspects related to the effort of modelling the respective flow or design constraints of the projects.

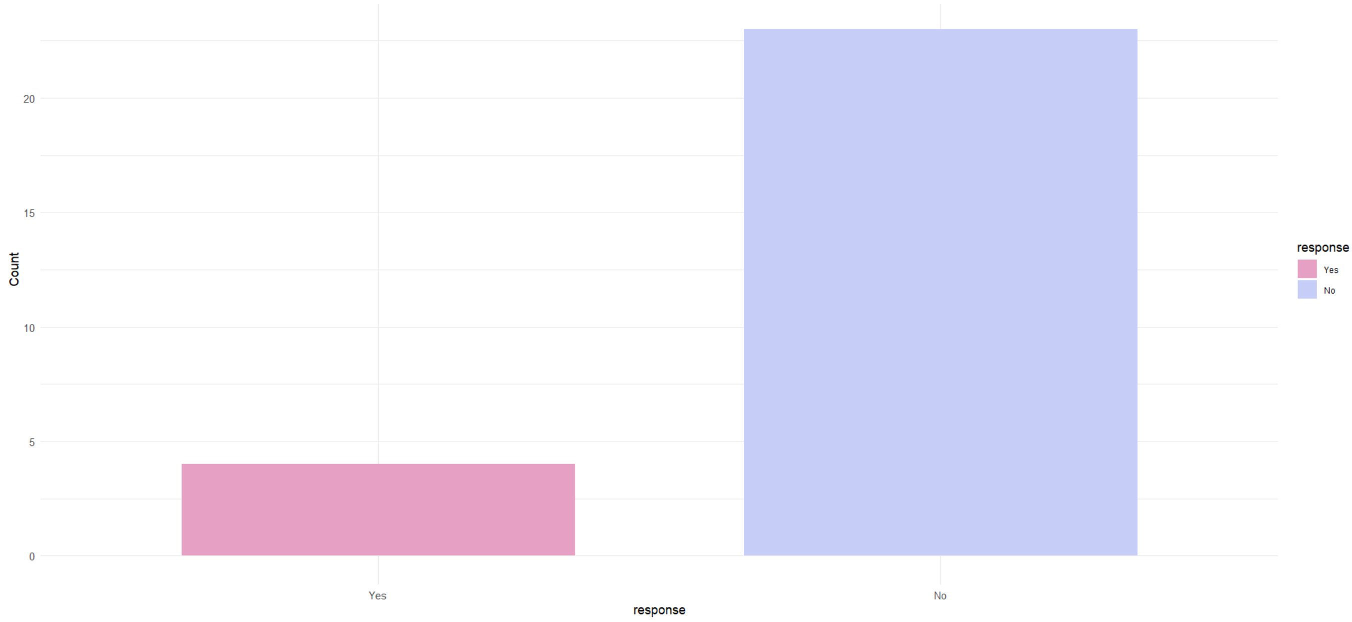



Figure 6 Q3. Did you face any difficulties in using/understanding the framework? (e.g. from regulation, standards or other expert) – pink = yes ; blue = no

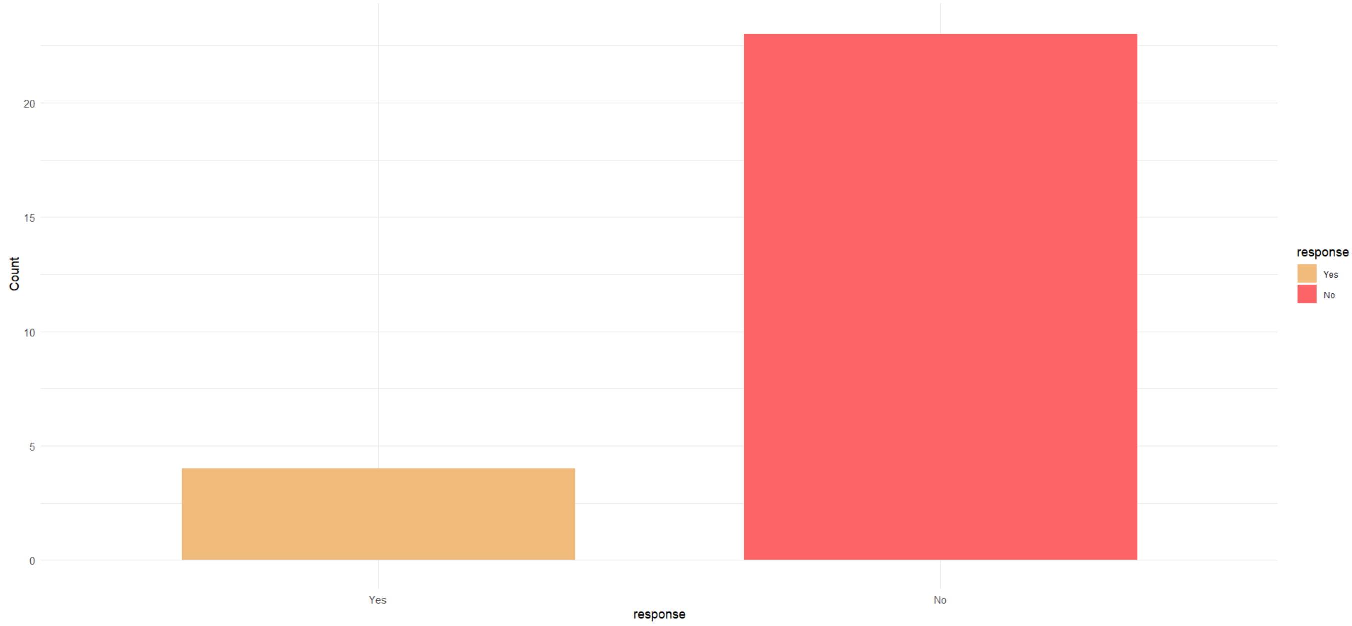



Figure 7 Q5. Do you see inconsistencies between BRIDGE Reference Framework and other frameworks? orange = yes, red = no

No major inconsistencies were indicated with other references/frameworks (Figure 7), but projects have complementarily reported (Q6) the use of additional frameworks (e.g. IEC 62746-2; EN 50491-12; IEC 62913-2), in particular for flexibility activation/provision as well as regulatory and legal / certification frameworks.

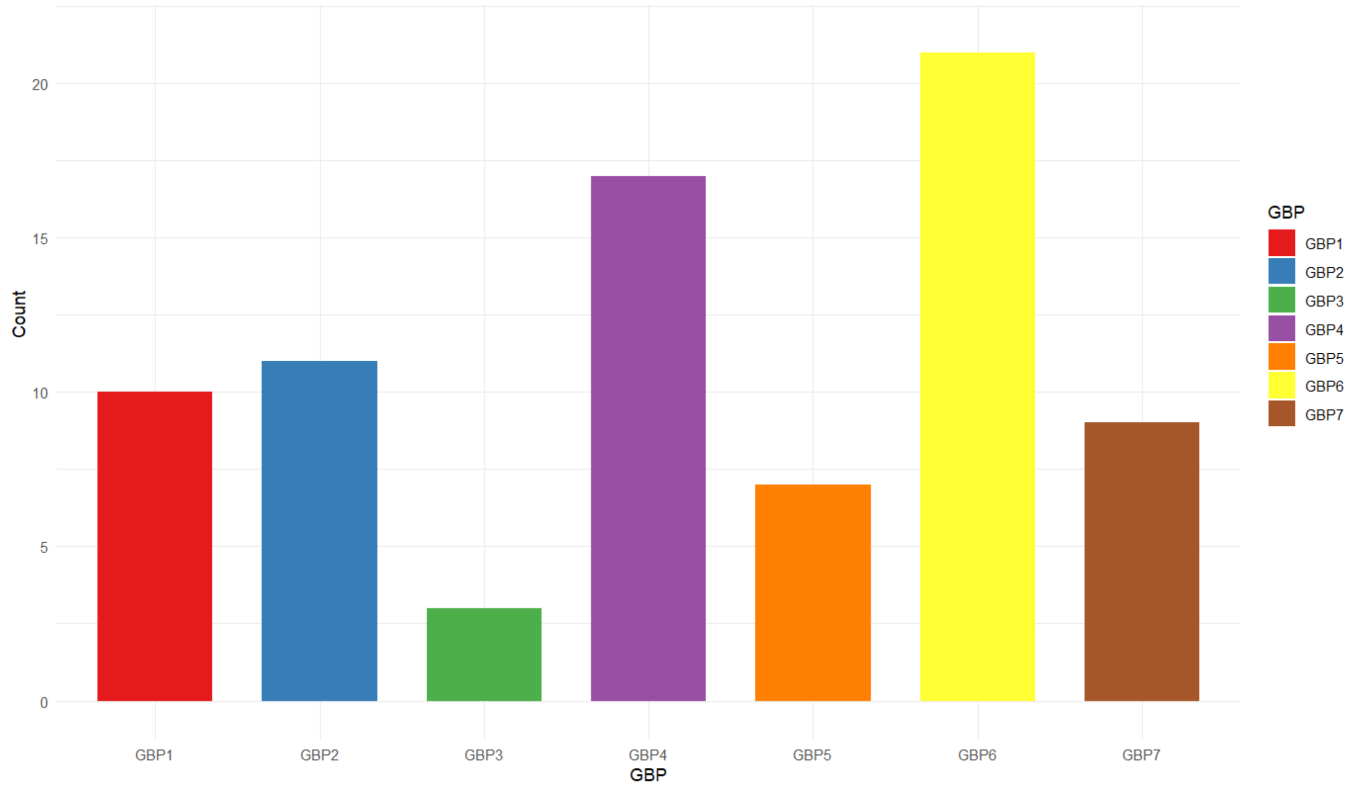



Figure 8 Q7. Please indicate which GBPs are relevant for your project(s)

As presented in Figure 8, all of the GBPs were found relevant from the projects that participated in the survey, with *GBP6: Energy monitoring and energy management* and *GBP4: Flexibility for energy community optimisation,* having the most widespread use. Also, GBP3 (Flexibility for BRP portfolio optimisation) appears to be the less relevant.

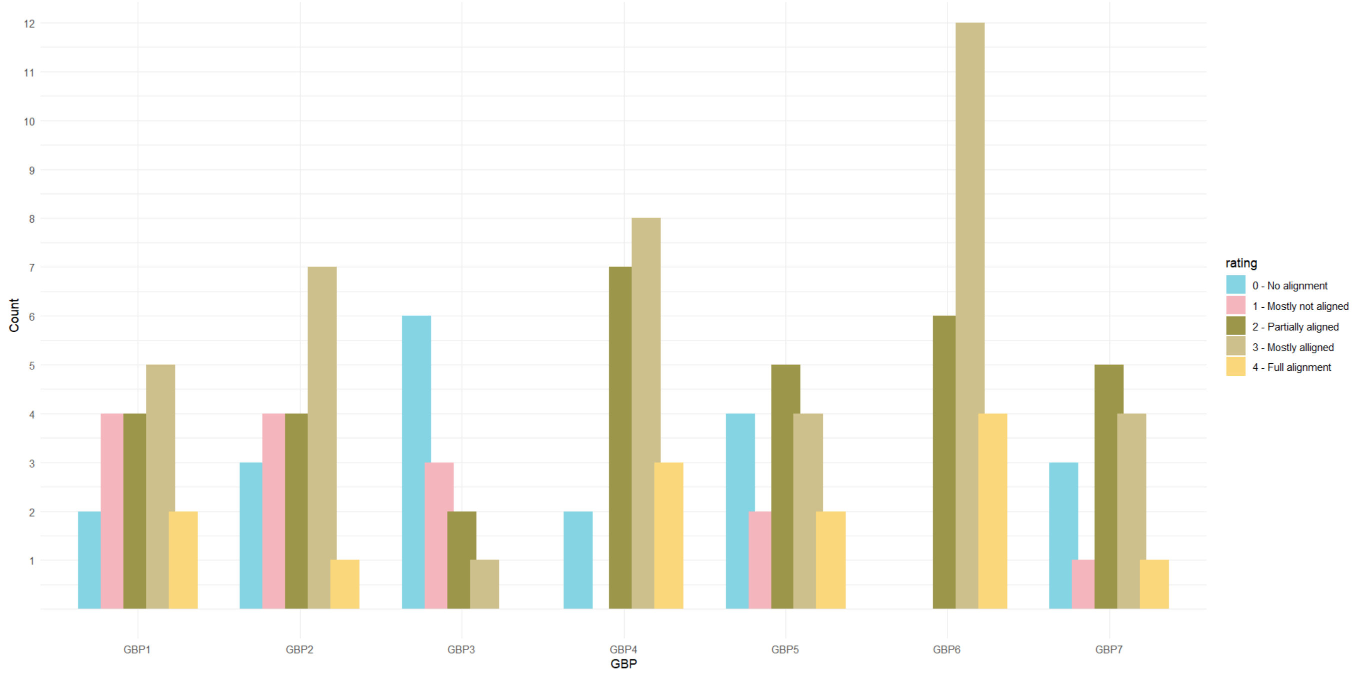



Figure 9 Q8. Please rate the level of alignment of your UC with GBPx
from “0 – No alignment” (blue) to “4 – Full alignment” (yellow)

In terms of alignment per *GBP3: Flexibility for BRP portfolio optimisation* seems the least aligned whereas *GBP6: Energy monitoring and energy management* seems to have a high level of alignment. The main misalignment points (Q9) concern:

- The main misalignment is around the fact that there is no intermediary party between the flexibility provider and the flexibility consumer (i.e., the flexibility service provider).
- “We see some specificities of LEC, P2P and energy monitoring use cases in some pilots (typically due to market structure or specific business models)”
- “Use cases have been established in 2020 / 2021 before the set out of the current version of the Reference Framework.”
- “BRIDGE GBP focus on flexibility trading/procurement but not so much on flexibility provision/activation”
- GBPs not relevant/considered for/in the project scope (e.g. Settlement, P2P)

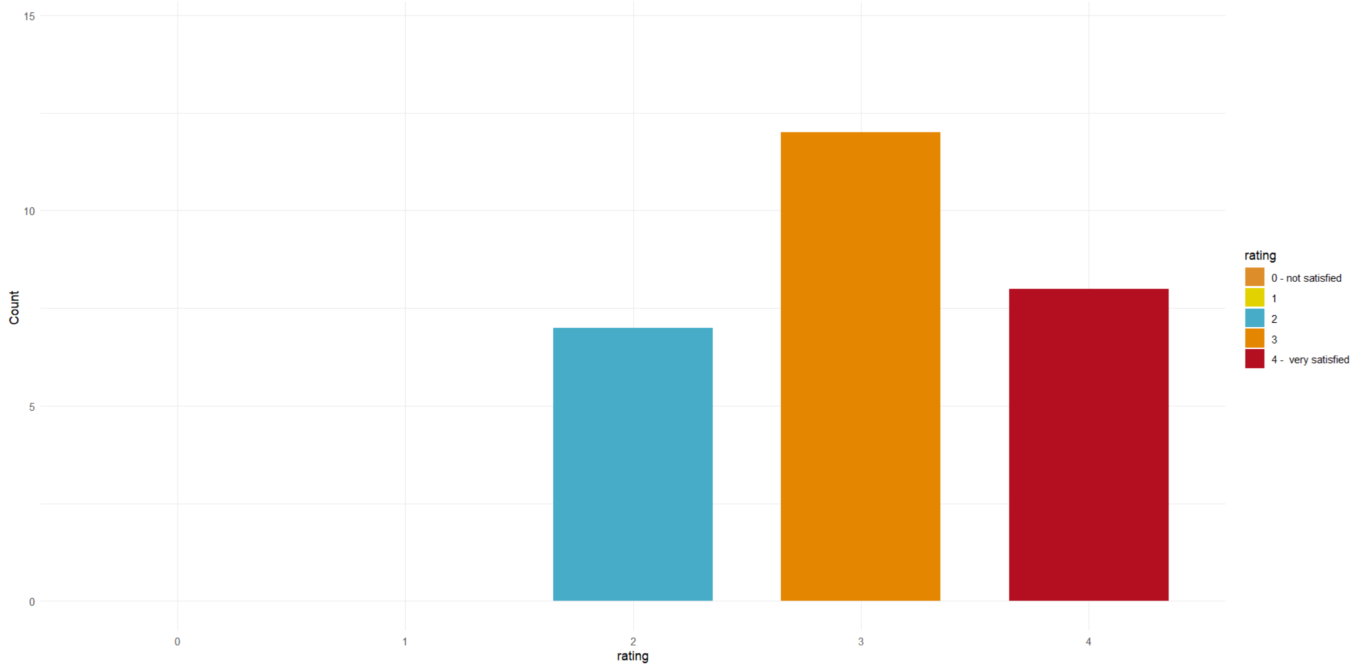



Figure 10 Q10. Please indicate how satisfied you are with the level of detail of the GBP analysis from “0 – Not satisfied” to “4 – Very satisfied” (red)

The overall rating of the granularity of detail of GBPs is satisfactory for the projects (see Figure 10).

Some suggestions on improvement (*Q11. Please indicate any suggestions for improvement of the GBP analysis),* concern:

- “Align with work in other DMWG Actions, with work of the Smart Grid Task Force, refine the sub-process on settlement, include examples of GBP end-to-end implementation from projects to provide further details of certain processes.”
- “Possibly include more intermediate steps for some of the GBPs?”
- The process could be simplified or having a simplified version e.g. flexibility market operator could be omitted if not involved in the process

regarding possible additions to the framework (Q12. Are there any GBPs that you would like to see added in the Framework? Please, briefly describe them), the project indicated the following ideas:

- “Add GPB related to flexibility provision / activation.”
- “GBP related to Energy Apps?”
- “Allocation and management of dynamic connections”
- “Data-driven Digital Twins”
- “EU-wide interoperable Energy Community solutions”
- “Community dataspace for Net Zero homes”

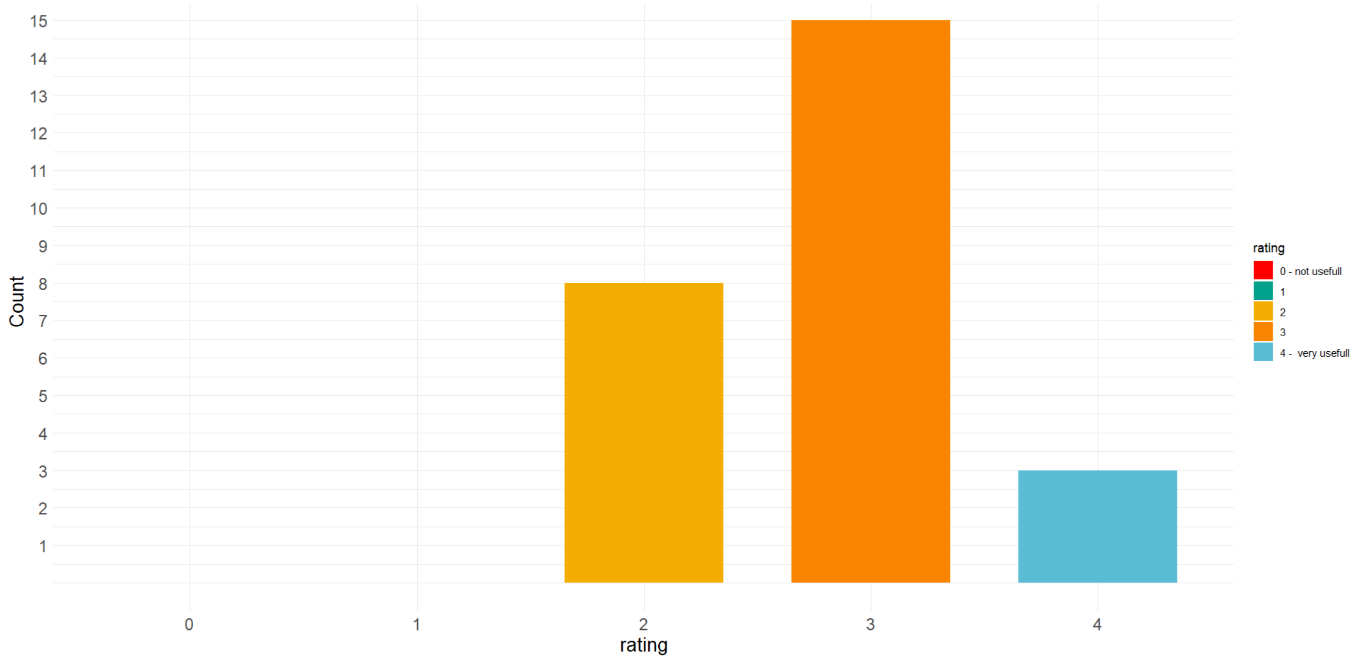



Figure 11 Q13. In 2020 and 2021, surveys were conducted to identify relevant standards for each interface of the GBPs. Please rate the usefulness of this work from “0 – Not useful” to “4 – Very satisfied” (blue)

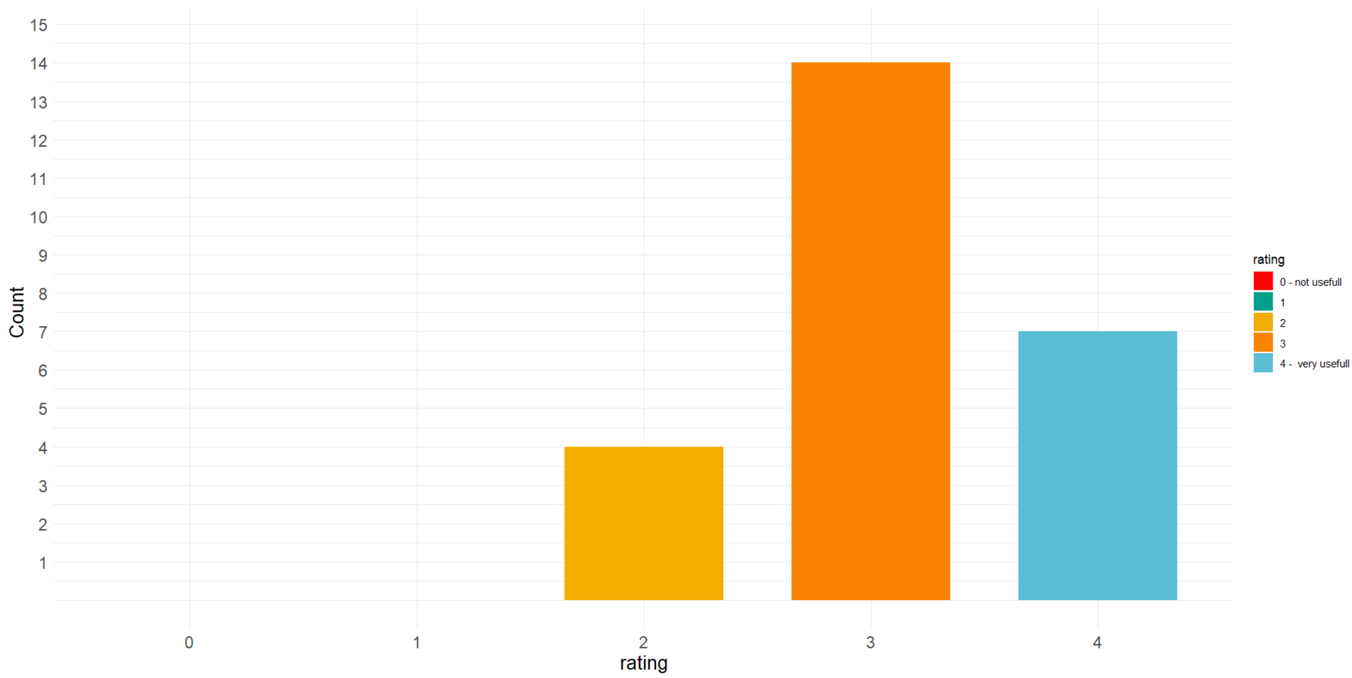



Figure 12 Q14.Would you consider an updated analysis of standards useful? from “0 – Not useful” to “4 – Very satisfied” (blue)

Analysis of the usefulness of standards mapping was also conducted with projects indicating as useful both the previous analysis (Q13) on standards that took place in 20-21 (Figure 11) as well as the possibility (Q14) of an updated analysis (Figure 12).

Finally, in terms of improving the usability of the framework (*Q15. Do you have suggestion on how to make the Reference Framework more practical?), the following ideas were provided:*

- Online browsing tools for standards/interface references (even at GBP level)
- "Online tool with mapping to relevant standards"
- "A formal UML modelling of the GBP would facilitate their comparison with use cases UML diagrams from other projects."
- More formal BPMN process modelling can be leveraged (with clear start and end events of the processes) to avoid wrong interpretations of the process diagrams and clear demarcations of the attributes used in the diagrams. The details of the interface that can be linked to the diagrams would be add-on.
- "Roadmap and responsibilities for developing Operating Environments and core services / core service provider legal framework. "
- Work could be merged with the use case repository (action #1) and show the overlaps of each use case and the GBPs to visualise similarities or differences
- Practical examples could be useful for understanding the GBP.

### 2.1.3 Usability Survey Conclusions

The survey has provided useful information on the usability of the framework and how to increase its value to BRIDGE projects. During the next period, the working group should leverage the survey results and identify how to better align GBPs with project use cases, extend the list of GBPs, improve the practicality of the framework and its alignment with other frameworks.

## 2.2 Contribution to the BRIDGE Use Case Repository

### 2.2.1 Opportunity to harmonise use-case descriptions thanks to the Reference Framework

The BRIDGE Use-Case Repository[13] has been set up to gather use cases from many different projects. However, one of the challenges of using this database is the heterogeneity of the UC descriptions and the lack of references or a glossary. Thanks to the massive adoption of IEC 62559-2[14] template, heterogeneity is not about the structure of the use cases' content but the semantics used to describe the use cases.

This challenge is in fact what motivated the development of the Reference Framework: when performing the first analysis of use cases from different projects in 2020[15], there was a need to establish a reference and map it with each of the use cases to enable cross-project analysis.

When looking at use cases, it appears that the following items would benefit from harmonised semantics:

[13] BRIDGE, «BRIDGE Use Cases Repository,» [En ligne]. Available: https://bridge-smart-grid-storage-systems-digital-projects.ec.europa.eu/use-cases-repository.
BRIDGE, «Set up a use case repository 2.0,» 2022. [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/30ac0765-ac1e-11ed-b508-01aa75ed71a1/language-en.
[14] IEC, «Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list,» 2015.
[15] BRIDGE, «BRIDGE – Interoperability of flexibility assets – April 2021,» [En ligne]. Available: https://ec.europa.eu/energy/sites/default/files/documents/bridge_wg_data_management_interoperability_of_flexibility_assets_report_2020-2021.pdf.

- Functions: a function is a feature that the system or a part of it is implementing. It may be related to business (e.g. energy management) or be horizontal (e.g. authentication). Similar functions are found across systems, however, often with different names.
- Actors: an actor is an entity that communicates and interacts within a use case[16]. It can include people, software applications, systems, databases, … Actors endorse roles. Similar actors are found across systems, however, often with different names. The mapping to roles is already helping as the roles are somehow already harmonised (see the HEMRM[17]). However this approach lacks precision and does not reflect the system perspective (system actors).
- Information exchanged: to offer the functions, actors are exchanging information. This is detailed in each step of the scenarios (see Section 4 of the UC template). The description of information is already being harmonised, in particular through the development of ontologies (such as SAREF4ENER or IEC CIM). However, there is no convergence yet.

As seen in §1.2 and Annex 1, the Reference Framework covers these 3 items: GBPs focus on defining which stakeholders (i.e. actors) are performing which functions based on which Information and through which data exchanges (i.e. interfaces). Therefore, there is a relevant opportunity for Action #3 "Reference Framework" to build libraries of functions, actors and information exchange to support the harmonisation of use-case descriptions within the BRIDGE Use-Case Repository.

## 2.2.2 Generic Actor List

The Generic Actor List is a concept defined in IEC 62559-2[18] Section 6. In particular, it has the following objective: "[with a] a generic actor list […], only actors of this generic actor list should be used as far as possible in the use case". It is also stated that a Generic Actor List includes: "(1) System actors [that] are covering functions or devices (for example in the energy system area, system actors are defined in the interface reference model (IEC 61968-1); (2) business actors [that] specify in fact a "role" (roles can be taken by diverse entities)"

The Supporting Materials of the SGTF EG1 report of 2019[19] emphasise the need for a Generic Actors List. In particular, an existing list is referenced: "A list of actors provided by CENCENELEC-ETSI SG-CG in the Sustainable Processes report as well as the actors defined in the Harmonised Electricity Market Role Model can be used here".

Indeed, in the CEN/CENELEC/ETSI Sustainable Processes report[20], a generic list of actors is detailed in Annexe A (12 pages of actors description). This list is mostly based on IEC Interface Reference Model (61968-1:2012) and the Harmonised Electricity Market Role Model (HEMRM) available at that time (named "ENTSO-E role model" in the document). Other sources are referenced such as "SGTF EG3", "AhG Charging", "GUC". This list contains 170 entries and certainly requires updating.

The IEC 62559-2[21] documents list the expected information for each actor:

| Field | Example / Comment |
|---|---|
| Area | Example: Smart grid/energy systems |
| Mapping to grouping | Example: To sort requirements for "smart metering" within the area "energy system" |

[16] IEC, «Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list,» 2015.
[17] ebIX, EFET, ENTSO-E, «Harmonised Electricity Market Role Model,» [En ligne]. Available: https://www.ebix.org/artikel/role_model.
[18] IEC, «Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list,» 2015.
[19] SGTF EG1, «Towards Interoperability within the EU for Electricity and Gas Data Access & Exchange,» March 2019. [En ligne]. Available: https://energy.ec.europa.eu/system/files/2019-05/eg1_main_report_interop_data_access_0.pdf.
[20] CEN-CENELEC-ETSI Smart Grid Coordination Group, «Sustainable Processes,» November 2012. [En ligne]. Available: https://www.cencenelec.eu/media/CEN-CENELEC/AreasOfWork/CEN-CENELEC_Topics/Smart%20Grids%20and%20Meters/Smart%20Grids/smartgrids_sustainableprocesses.pdf.
[21] IEC, «Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list,» 2015.

| | |
|---|---|
| Name of the actor | Example: Distribution system operator (DSO) |
| Abbreviation for the actor name | Example: DSO |
| Actor type<br>(e.g. roles, application, …) | Example: DSO is a role, an energy management system (EMS) is an application |
| Definition of actor | Here the actor shall be described. Usually the actor is taken from an existing actor list so that the definition already exists |
| Possible actors fulfilling this role | Example: For the actor "meter operator" it might be a DSO or an independent meter operator, depending on the national background or the specific project |
| International, regional or national relevance | Actors might differ in definition depending on regional or national legislation or markets |
| Source of the definition | Actors should be based as far as possible on existing data models in the relevant area or domain<br><br>Example: Data models like CIM common information model (IEC 61968/61970) or COSEM in the metering domain (IEC 62056) |
| Parent | This column is used to build up a kind of hierarchy of actors<br><br>Example: A grid operator as parent of transmission or distribution system operator (TSO or DSO) |
| Further comments | |

Table 4: List of relevant fields for each of the actors in a Generic Actor List

Considering the current scope and purpose of the new Generic Actor List, it is proposed to focus on the following fields: Area, Name of the actor, Actor type, Definition of actor, Source of the definition.

### 2.2.3 Update of the Generic Actor List

As mentioned above, the Generic Actor List established by CEN/CENELEC/ETSI in 2012 is based on outdated sources. Therefore, an update of this list is planned, based on updated references and new sources, in particular:

- IEC Interface Reference Model (IRM) as defined in IEC 61968-1:2020[22];
- Harmonised Electricity Market Role Model (HEMRM) as set out in its release of January 2022[23].

For this update, the following approach has been set out:

[22] IEC, «Application integration at electric utilities - System interfaces for distribution management - Part 1: Interface architecture and general recommendations».
[23] ebIX, EFET, ENTSO-E, «Harmonised Electricity Market Role Model,» [En ligne]. Available: https://www.ebix.org/artikel/role_model.

1. A first analysis is performed by the leader of this task (Trialog, on behalf of InterConnect and RESONANCE)
2. Groups of experts, clustered by area, are set up to further analyse each actor and build the updated list
3. The updated list will be submitted to CEN/CLC/ETSI Coordination Group on Smart Grid (CG-SG) for validation and approval
4. The updated list will be included in the BRIDGE Use-Case Repository as a library of actors
5. If relevant, this updated list will also be shared with IEC standardisation

## Plan for the Generic Actor List Update

Step 1 has been performed by Trialog, on behalf of InterConnect and RESONANCE. The first analysis contains about 200 entries. The list of actors has been clustered depending on the area and priorities have been established:

| Area | Number of items | Priority |
|---|---|---|
| Grid Management | 68 | 1 (high) |
| Smart Metering | 15 | 1 (high) |
| Electric Mobility | 12 | 1 (high) |
| Market Operation | 31 | 1 (high) |
| Power Generation / DER | 7 | 2 (medium) |
| Smart Home / Smart Building / Smart City | 23 | 2 (medium) |
| Data Management | 5 | 2 (medium) |
| Customer Relationship | 15 | 3 (low) |
| Third parties / Other | 23 | 3 (low) |

Table 5: List of areas for the update of the Generic Actor List

For Step 2, a call for participation was circulated in the Data Management WG and Regulation WG in January/February 2024. Based on the 23 answers received, a list of 16 contributors was identified and a few additional reviewers were appointed.

The Step 3 was started in February 2024. The following overall schedule is planned:

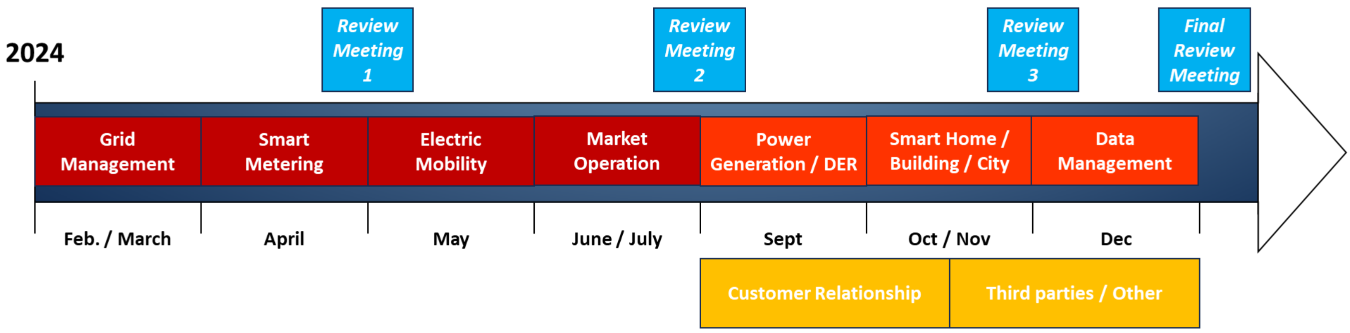



Figure 13: Overall schedule for the Generic Actor List update

As detailed in this diagram:

- Areas with priority level 3 will be treated in parallel with level 2 areas
- Review meetings with CEN/CLC/ETSI CG-SG will be planned regularly
- Intermediate releases will occur after each review meeting

A connection will also be established with the ENTSO-E / EU DSO Entity JWG to ensure consistency with the latest developments of the HEMRM and the Electricity Directive Implementing Acts.

# 3 Guidelines for Settlement Implementation

## 3.1 Settlement

Settlement in flexibility procurement processes refers to the finalisation of transactions and agreements between the parties involved in the procurement of flexibility services within the energy sector. It involves the financial and contractual aspects of acquiring flexibility resources to balance supply and demand on the energy grid. Settlement in flexibility procurement processes aligns closely with the generic business process framework established by the BRIDGE Working Group (WG). In the context of electricity grids, settlement occurs after a flexibility service provider has delivered the contracted amount of flexibility, which could include adjusting energy production or consumption levels in response to grid needs. The settlement process ensures that the provider is compensated appropriately for the services rendered. Key components of settlement in flexibility procurement processes typically include:

- **Metering and Measurement:** Accurate measurement of the flexibility provided is essential for settlement. This involves metering the relevant parameters, such as energy production and/or consumption, to determine the quantity of flexibility delivered.
- **Validation and Verification:** Before settlement occurs, there is often a validation and verification process to ensure that the flexibility services meet the requirements specified in the procurement agreement. This may involve checking the quality, accuracy, and timeliness of the provided flexibility.
- **Calculation of Payments:** Settlement involves calculating the payments owed to the flexibility service provider based on the agreed-upon terms and conditions outlined in the procurement contract. Payments may be structured based on various factors, including the quantity and quality of flexibility delivered, as well as any performance incentives or penalties.
- **Invoicing and Payment Processing:** Once the settlement calculations are completed, invoices are issued to the relevant parties, detailing the amount owed for the flexibility services. Payment processing involves the transfer of funds from the procuring entity to the flexibility service provider in accordance with the agreed-upon payment terms.
- **Reporting and Documentation:** Settlement processes often require comprehensive reporting and documentation to ensure transparency and accountability. This includes maintaining records of transactions, metering data, validation results, and payment documentation for auditing and regulatory compliance purposes.

## 3.2 Lessons Learned from EU-Funded Projects

This section presents insights gathered from various EU-funded projects regarding the implementation of the Settlement sub-process in the provision of flexibility. As the transition towards more flexible and sustainable energy systems accelerates as does the deployment of flexibility markets, the efficient settlement of transactions between market participants becomes increasingly crucial. In this context, understanding the challenges, best practices, and emerging trends in settlement processes is paramount for ensuring the smooth operation of energy markets. The feedback provided encompasses a range of perspectives and experiences from stakeholders involved in EU-funded projects:

- **Clarity in Contractual Agreements:** Clear and well-defined contractual agreements between parties involved in flexibility procurement are essential. This includes specifying terms related to pricing mechanisms, service levels, performance metrics, and settlement procedures upfront to avoid misunderstandings during the settlement process.
- **Standardisation of Data Formats:** Standardising data formats and communication protocols for reporting flexibility service delivery is crucial for streamlining the settlement process. Consistent data formats enable automated metering, validation, and reconciliation, reducing manual intervention and potential errors.
- **Automated Metering and Validation:** Implementing automated metering and validation processes helps ensure the accuracy and reliability of data used for settlement. Automated systems can detect

discrepancies or anomalies in reported data more efficiently, facilitating faster resolution and reducing the risk of disputes.

- **Transparent and Timely Reporting:** Establishing transparent and timely reporting mechanisms for flexibility service delivery enables stakeholders to track performance and monitor compliance with contractual obligations. Real-time or near-real-time reporting allows for proactive management of settlement-related issues and enhances trust between parties.
- **Robust Dispute Resolution Mechanisms:** Despite efforts to standardise processes and ensure accuracy, disputes may still arise during the settlement process. Having robust dispute resolution mechanisms in place, such as arbitration or mediation procedures, helps address disagreements promptly and fairly, minimising disruptions to ongoing operations.
- **Continuous Monitoring and Improvement:** Continuous monitoring of the settlement process is essential for identifying inefficiencies, bottlenecks, or areas for improvement. Regular evaluations and feedback loops enable stakeholders to refine procedures, enhance system performance, and adapt to evolving requirements over time.
- **Collaboration and Knowledge Sharing:** Collaboration and knowledge sharing among stakeholders involved in flexibility procurement and settlement processes are vital for promoting best practices and driving innovation. Sharing lessons learned, success stories, and challenges encountered can benefit the broader energy community and contribute to continuous improvement efforts.
- **Harmonisation of Telemetry and Time-Granularity Requirements:** Guidelines for telemetry and time-granularity requirements should be harmonised at the European level, considering the time characteristics of flexibility products to ensure, in turn, broader harmonisation of settlement processes in European flexibility markets. Real-time telemetry harmonisation, addressing factors such as data quality and granularity of measurements, is essential.
- **Attributes of Flexibility Products:** Flexibility products are characterised by attributes, including preparation time and time activations, which clearly determine the telemetry requirements. Fast flexibility products that should be activated in seconds have different time-granularity requirements than those activated in hours.
- **Independent Aggregation and Data Collection:** Enabling independent aggregation while managing the responsibilities of different actors entails complexity in data collection. Developing strategies to address this complexity is crucial for ensuring accurate and reliable settlement processes.
- **Best Practices for Verification and Compensation:** Establishing a set of best practices for verification and compensation processes is necessary. These practices should address both information exchange needs among market players (e.g., BRPs access to FSP resource information) and means of verification of actual flexibility delivery for SOs.

## 3.3 Guidelines for Settlement Implementation

### 3.3.1 Measurement and Verification

For flexibility services, measurement and verification (M&V) needs are typically more stringent compared to traditional DR programs. This is because distribution services involve the direct management and control of DER within the distribution grid. These resources, which can include solar panels, battery storage systems, electric vehicles, and demand response-enabled appliances, are located closer to end users and are often interconnected with the distribution grid. As a result, M&V processes for flexibility services require accurate and granular data collection to measure the performance of individual DER and their collective impact on grid operations. This may involve real-time monitoring of energy consumption, generation, voltage levels, frequency, and other grid parameters at the distribution level. Sophisticated metering, telemetry, and data analytics technologies are often deployed to capture and analyse this data effectively. In contrast, traditional DR programs typically focus on aggregating flexible loads or generation from a diverse portfolio of participants to provide a statistical response to grid events. The M&V requirements for these programs may be less stringent, as they rely on aggregated measurements and statistical methods to estimate overall program performance rather than individual resource performance.

Similarly, settlement processes for flexibility services tend to be more complex and detailed compared to traditional DR programs. Flexibility services involve active participation in grid operations and may require bidirectional energy flows, dynamic pricing mechanisms, and flexible contracting arrangements between SOs and DER owners. Settlement for flexibility services involves accurately quantifying the energy exchanged between the grid and individual DERs, accounting for bidirectional energy flows, time-of-use pricing, and any ancillary services provided. This requires robust billing systems, metering infrastructure, and contractual frameworks to ensure fair and transparent compensation for DER participation in grid services. In contrast, settlement for traditional DR programs may be based on predetermined payment structures, capacity commitments, or incentive-based mechanisms that do not necessarily require detailed energy accounting or bidirectional transactions.

Overall, the greater stringency of M&V requirements for distribution services reflects the evolving nature of grid operations and the increasing role of distributed energy resources in supporting grid reliability, resilience, and efficiency. As distribution systems become more dynamic and interconnected, accurate measurement, verification, and settlement processes become essential for effective grid management and DER integration.

### 3.3.2 M&V Methods

M&V methods play a critical role in the procurement of flexibility services within the energy sector. These methods are essential for ensuring the accuracy, reliability, and transparency of flexibility service delivery, as well as for verifying compliance with contractual agreements and regulatory requirements. One key aspect of M&V methods is the measurement of actual flexibility provided by market participants. This involves collecting and analysing data related to energy consumption, generation, or demand response activities in real-time or near-real-time. Advanced metering infrastructure, telemetry systems, and data analytics tools are often used to capture and process this data efficiently.

Verification of flexibility delivery entails comparing the measured performance against predefined benchmarks, targets, or service level agreements (SLAs). This verification process may involve validating the timing, duration, and magnitude of flexibility responses, as well as ensuring adherence to quality standards and operational constraints. Various methodologies for M&V exist to facilitate the provision of grid services by DERs, ranging from straightforward schemes to more intricate verification processes. This section offers an outline of five prevalent approaches, each differing in complexity, as summarised in Table 6. To determine the most suitable M&V approach(es) for verifying the performance of providers of specific grid services, several factors need to be taken into account. These encompass the nature of the service requirements in question, the positioning of the DER(s) delivering the service (Front-of-the-Meter or Behind-the-Meter), whether the service is delivered by an individual DER or an aggregation, and the availability and granularity of existing metering equipment, along with the associated data.

Table 6 Comparison of common M&V approaches (based on EPRI, «Measurment and Verification (M&V) for Distributed Energy Resources Providing Grid Services - New Complexities, Common Approaches, and Research Needs,» 2021)

| M&V Approach | Principle | Time Horizon of Assessment | Metering Requirements | Relative Complexity |
|---|---|---|---|---|
| (1) System of notifications | No explicit performance assessment or limited to receipt of basic messages. | None, or limited to receipt of basic messages. | No meter required. | Lower |
| (2) Measurements before/ after service activation | Verify that response trend is consistent with expected response. | Period of time before/ after service activation. | Meter upstream of resource providing service, with | Medium |

| | | | | |
|---|---|---|---|---|
| | | | sufficient data granularity. | |
| (3) Evaluation against comparable service providers | Compare performance of service provider against other similar service providers. | Service delivery window. | Meter upstream of resource providing service, with sufficient data granularity. | Medium |
| (4) Use of historical baselines | Compare performance of service provider against its own behaviour when not delivering service. | Service delivery window. | Meter upstream of resource providing service, with sufficient data granularity. | Higher |
| (5) Dedicated Meter | Assess DER response through dedicated metering data. | Service delivery window. | Dedicated meter required to monitor resource providing service, with sufficient data granularity. | Higher |

### 3.3.2.1 System of Notifications

According to Figure 14, this method, commonly employed in demand response (DR) programs, entails dispatching activation signals to enrolled resources, such as extensive collections of small-scale flexible loads (e.g., water heaters). Each activation signal is dispatched either directly by the entity requesting the service or through a third-party aggregator. Upon receiving an activation signal, each resource is required to engage local controls to adjust its operation. The activation signal may specify a start time and/or the desired level of response ("normal," "critical," etc.). In certain DR programs, this "open loop" notification system suffices, while in others, the resource is expected to transmit an acknowledgement message confirming receipt of the activation signal. In this initial approach, individual resources are not expected to provide detailed reports on their performance (e.g., kW reduction).

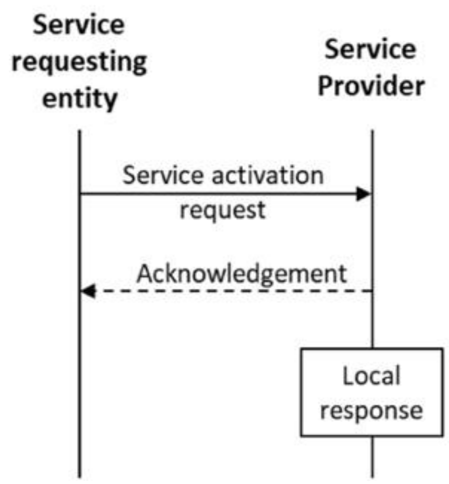



Figure 14 System of Notifications (based on EPRI, «Measurment and Verification (M&V) for Distributed Energy Resources Providing Grid Services - New Complexities, Common Approaches, and Research Needs,» 2021.)

**Advantages**–Implementation simplicity: No specialised metering equipment is necessary for evaluating performance, and communication requirements are minimal. This method is applicable to all types of DER as long as the predetermined local response to be triggered upon receiving an activation request is specified (e.g., for a water heater, ceasing consumption until its energy content reaches a specific threshold).

**Disadvantages**–Lack of detailed performance verification: A resource that receives an activation request may only partially adjust its behaviour or not modify it at all, even after sending an acknowledgement signal confirming receipt of the request. Additionally, two resources exhibiting different performance levels would likely receive the same financial compensation since detailed performance assessment is not conducted, potentially leading to unfairness and free-riding issues.

### 3.3.2.2 Measurement Before/After Service Activation

This method, depicted in Figure 15, acknowledges that all DERs supplying a grid service are consistently linked downstream of a revenue-grade meter, either individually or alongside other co-located resources. Its objective is to use existing metering apparatus to validate that the observed "trend" in metering data immediately following service activation aligns with the anticipated response. The goal is not to conduct a thorough evaluation over the entire service delivery duration but rather to evaluate the coherence of the initial response trend.

**Advantages**–Ease of implementation: Uses existing metering infrastructure to confirm that the response trend immediately after activation aligns with anticipated behaviour; eliminates the need for comprehensive baseline calculations at the service provider level to establish historical baselines.

**Disadvantages**–Potential for manipulation: Customers might attempt to artificially boost their consumption before receiving an activation request, particularly those with low load factors; the granularity of data from existing revenue meters may be inadequate for accurately assessing the response trend, and accessing the data may be challenging; overall, performance evaluation is conducted with limited detail.

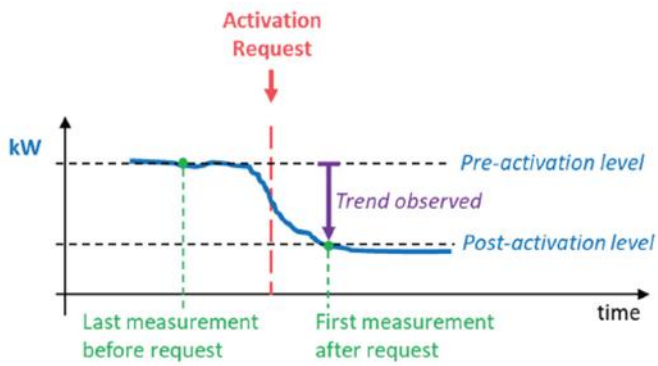



Figure 15 Measurements before/after service activation request (based on EPRI, «Measurment and Verification (M&V) for Distributed Energy Resources Providing Grid Services - New Complexities, Common Approaches, and Research Needs,» 2021)

### 3.3.2.3 Evaluation Against Comparable Service Providers

This method operates under the assumption that service providers can be categorised based on similarities, such as water heaters or AC systems of comparable sizes. It evaluates the effectiveness of each individual response by comparing it to the average response achieved by similar service providers (refer to Figure 4). This approach is especially pertinent for extensive collections of service providers with shared characteristics.

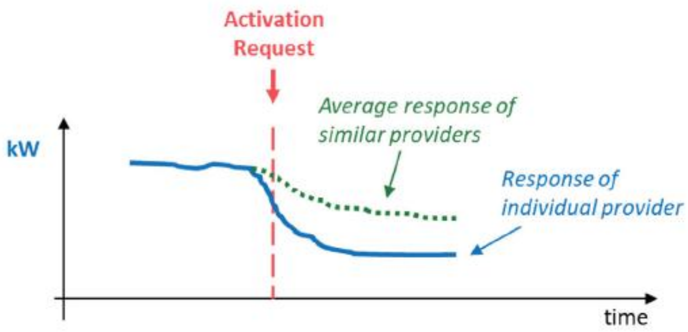



Figure 16 Performance evaluation against a group of similar providers (based on EPRI, «Measurment and Verification (M&V) for Distributed Energy Resources Providing Grid Services - New Complexities, Common Approaches, and Research Needs,» 2021)

**Advantages**–Implementation is relatively simpler compared to Approach 4 outlined below, as it doesn't necessitate historical baselines, yet it still quantifies the observed performance level; consequently, financial compensation could potentially be linked to the quantified performance level. This method also enables consideration of independent variables, such as weather-related factors, which might affect performance across a group of similar providers.

**Disadvantages**–Like Approach 2 (measurement before/after service activation), this method requires sufficiently granular metering data, which may not be available from existing meters. Additionally, it doesn't evaluate performance against what the service provider would have done if not responding to the service request, which may be desirable for certain services. Instead, it assesses how effectively the provider delivers a particular service compared to similar providers.

### 3.3.2.4 Use of Historical Baselines

This method evaluates the actual behaviour of each service provider throughout the service delivery period. It compares the observed behaviour against a baseline, which represents what the resource would have done if it weren't delivering the service. Performance is determined by the variance between 1) the actual behaviour of the resource when providing the service, and 2) the anticipated behaviour indicated by the baseline. The baseline can be established at different levels, depending on the service under consideration. For instance, it might be set at an end-user meter that measures multiple co-located resources, including the ones providing the service. Alternatively, it could be set at a meter (or sub-meters) dedicated solely to monitoring the DER(s) delivering the service.

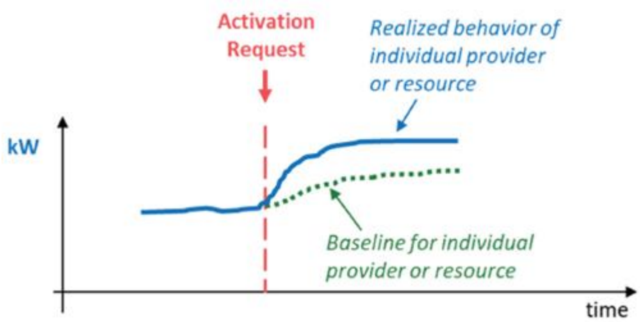



Figure 17 Performance assessment against baseline (based on EPRI, «Measurment and Verification (M&V) for Distributed Energy Resources Providing Grid Services - New Complexities, Common Approaches, and Research Needs,» 2021.)

**Advantages**—Similar to Approach 3 (evaluation against comparable service providers), this method allows for the quantification of performance and the consideration of independent factors (e.g., weather) when calculating the baseline. However, unlike Approach 3, this approach assesses the provider's response against what it would have done if it were not delivering the service.

**Disadvantages**—Sufficient granularity in the metering data is necessary, which may not be provided by existing meters. Additionally, establishing meaningful baselines can be challenging for small-size resources, particularly flexible loads with a low load factor, as their discrete behaviour is more difficult to represent using baselines.

### Dedicated Meter

This approach necessitates individual metering for each resource delivering a grid service, whether through a dedicated meter for Front-of-the-Meter (FTM) resources or a dedicated sub-meter for behind-the-meter (BTM) resources. For DERs providing a mix of grid and customer services, dedicated metering may be coupled with baseline comparisons.

**Advantages**—This method offers resource-specific metering data for every grid service provider, enabling detailed performance evaluation and providing operational advantages like load unmasking.

**Disadvantages**—Costs pose a significant challenge with this approach, encompassing expenses related to metering equipment and communication infrastructure needed for data transmission. Also, end users sometimes object to installing additional sub-metering equipment in their households/buildings, especially when these are visible. Additionally, for BTM DERs, there are concerns about potential tampering with third party-owned sub-meters, along with privacy and security issues associated with data transmission from these endpoints.

## 3.4 Baselining Methodologies

Baselining methodologies for flexibility services are essential for accurately evaluating the performance of resources providing flexibility services. These methodologies establish a reference point against which the actual behaviour of resources is compared during service delivery. One common approach involves using historical data to create historical baselines, reflecting the typical behaviour of resources when not delivering the service. Statistical methods are often employed to develop baselines based on historical data, such as averaging historical performance over a specific period or using statistical models to predict resource behaviour. Some baselining methodologies are described as follows:

- **High X of Y:** This method selects the highest value (X) from a set of historical data points (Y) within a specified time frame to establish the baseline.
- **Regression:** Regression analysis is used to model the relationship between relevant factors (such as time, weather conditions) and energy consumption, enabling the prediction of expected consumption levels.
- **Comparable Day:** The baseline is determined by comparing the energy consumption of the current day with that of similar days in the past, adjusted for relevant factors like weather conditions and day type.
- **Rolling Average:** This method calculates the baseline by averaging energy consumption over a defined historical period, such as the past few days or weeks, to smooth out short-term fluctuations.
- **Statistical Sampling:** A subset of historical data points is randomly selected to represent typical energy consumption patterns, providing a simplified baseline estimation.
- **Meter Before/Meter After:** The baseline is established by comparing energy consumption before and after a specific intervention or change, such as the activation of a demand response event.
- **Maximum Base Load:** This method sets the baseline as the maximum energy consumption observed during a specified historical period, representing the highest expected demand level.
- **Metering Generator Output:** The baseline is determined by monitoring the output of a generating source (e.g., solar panels, wind turbines) under normal operating conditions, providing a reference for expected energy production.
- **Machine Learning:** Machine learning algorithms analyse historical energy consumption data to identify patterns, trends, and anomalies, enabling the prediction of future consumption levels.

- **Control Groups:** A baseline is established by comparing the energy consumption of a group receiving the service with that of a control group not receiving the service, allowing for the isolation of the service's impact.
- **Self-declared Baseline:** Participants declare their expected energy consumption levels based on historical usage patterns or other relevant factors, providing a simple and flexible baseline estimation method.

The selection of baseline methodologies for different flexibility products in the demonstration, as well as the factors influencing this choice, is addressed in the deliverable D3.4 of the OneNet project[24]. The demonstration experience highlights that only a subset of available baselining methodologies is practically used, reflecting the complexity of decision-making in this context. Furthermore, the absence of a distinct preference for any specific methodology underscores the importance of accommodating diverse approaches, echoing the principles outlined in D3.4. The process for selecting a methodology is contingent upon various factors, including stakeholder expertise, regulatory requirements, and available resources, which aligns with the considerations discussed in the OneNet project. Moreover, the need for alternative solutions and robust verification measures to ensure accuracy and integrity, as suggested in the demonstration, corresponds to the recommendations put forth in D3.4 of the OneNet project for establishing a reliable regulatory framework for baselining. This example from the OneNet project serves as a valuable example for determining the appropriate baseline methodology to apply to various flexibility products.

Table 7 Overview of baseline methodology per product used in the OneNet demonstrators[25]

| Product | High X to Y | Comparable day | Meter before / Meter after | Self-declared FSP |
|---|---|---|---|---|
| **aFRR** | Greece | | | |
| **mFRR** | Northern Cluster, Greece | | Poland | Northern |
| **RR** | | | Poland | |
| **Corrective Local Active Power** | Northern Cluster | Spain | Slovenia | Northern Cluster, Cyprus, Spain |
| **Corrective local reactive power** | Greece | | | Cyprus |
| **Predictive short-term active power** | Northern Cluster, Greece | Spain | Poland | Northern Cluster, Spain, Poland |
| **Predictive long-term local active power** | Northern cluster | Spain | | Northern Cluster, Spain |

The conclusions extracted from the analysis presented in D3.4 of the OneNet project offer valuable insights into various aspects of baselining methodologies and their application in the context of flexibility services. As the energy sector transitions towards greater flexibility and decentralisation, understanding the intricacies of baselining

[24] OneNet, «D3.4 Regulatory and demo assessment of proposed integrated markets,» [En ligne]. Available: https://www.onenet-project.eu//wp-content/uploads/2023/09/OneNet_D3.4_V1.0.pdf.

[25] OneNet Project, «D3.4 Regulatory and demo assessment of proposed integrated markets,» 2023.

becomes increasingly crucial, particularly within the Settlement subprocess of flexibility procurement. Through a comprehensive examination of key questions surrounding baselining, informed by both literature review and OneNet demonstrator experiences, a nuanced understanding emerges regarding the principles of simplicity, accuracy, and integrity. These insights provide valuable guidance for policymakers, regulators, and industry stakeholders navigating the evolving landscape of energy markets and seeking to develop effective frameworks for the deployment of flexibility services. The following questions were analysed in the OneNet project, shedding light on critical considerations in the design and implementation of baselining methodologies[26]:

1. **Which relationship is the baseline methodology applied to?**
    a. When considering the relationship, baselining methodologies can be broadly categorised into two fields: contractual relationships between customers and intermediaries, and relationships between aggregators and system operators (SOs). Upholding principles of simplicity, accuracy, and integrity is crucial for both relationships, given the public interest in maintaining trust and reliability in the energy system.
2. **In which grid operational state is the baseline methodology used?**
    a. The choice of baseline methodology may vary depending on the operational state of the grid. While simplicity and transparency are vital during normal grid operation, accuracy and integrity become more critical during emergency states to maintain trust in the system. Balancing these requirements needs careful consideration and may require separate baselines for different operational states.
3. **Who is responsible for setting the baseline?**
    a. Four actors are typically considered for setting the baseline: the system operator (SO), independent market operator (IMO), flexible service provider (FSP), or an independent third party like the regulator. Each allocation presents trade-offs, such as simplicity versus information asymmetry. Demos often assign this responsibility to FSPs or SOs, with fallback options and monitoring measures in place to ensure accuracy and compliance.
4. **Which type of customer is baselining applied to?**
    a. Baselining methodologies are tailored to different customer types. Non-professional customers, such as households, prefer simple baselines for transparency, while professional customers, like commercial entities, prioritise accuracy without excessive complexity. This preference influences the choice of baseline methodology in OneNet demos, with a focus on simplicity and medium accuracy.
5. **Which type of DER is baselining applied to?**
    a. Baselining approaches differ for various types of DERs based on their participation and aggregation levels. While accuracy is crucial for isolated DERs in electricity markets, combined DERs require baselines that accurately reflect their contributions while maintaining simplicity. The choice between aggregated or individual baselines depends on factors like technology type and portfolio composition.
6. **Which product is baselining applied to?**
    a. Different flexibility products necessitate distinct baselining methodologies, primarily determined by product characteristics such as capacity, activation duration, and preparation time. While simplicity remains consistent across methodologies, accuracy and integrity are influenced by product-specific requirements. While demo experiences often employ a single methodology across all products, the choice is influenced by regulatory frameworks and existing tools and information.

DERs, including heat pumps, PV/wind, back-up generation, combined heat and power, or storage/batteries, offer diverse participation possibilities in flexibility markets. They can operate independently or be combined with demand reduction actions of an active consumer behind the main meter. Alternatively, they may be aggregated into a larger portfolio managed by an aggregator. Baseline methodologies for isolated DERs vary in terms of simplicity, accuracy, and integrity, depending on the DER type. For combined DERs, accuracy is crucial to avoid over- or under-incentivisation, especially when both demand reduction and generation assets are involved. Submetering is advocated to improve accuracy, particularly for combined DERs, enabling better performance quantification and supplier accountability. Aggregated baselines may be calculated for the same or different types of DERs, each

[26] OneNet Project, «D3.4 Regulatory and demo assessment of proposed integrated markets,» 2023.

requiring tailored methodologies. Simpler baseline approaches may enhance accuracy when aggregating DERs of the same type, while transparent and consistent calculation methods are vital for integrity, especially in aggregated baselines, to prevent manipulation and ensure fairness and reliability.

Assessing selected baseline methodologies in accordance with the type of DER against the baselining principles of accuracy (A), simplicity (S), integrity (I), and efficacy (E) draws upon the research conducted within the CoordiNet project as outlined in deliverable D2.1[27]. This assessment involves scrutinising different baseline approaches to determine their effectiveness in accurately quantifying the contribution of DERs (accuracy), minimising complexity for market participants (simplicity), ensuring the reliability and robustness of baseline calculations (integrity), and ultimately achieving the desired outcomes of flexibility provision and grid stability (efficacy).

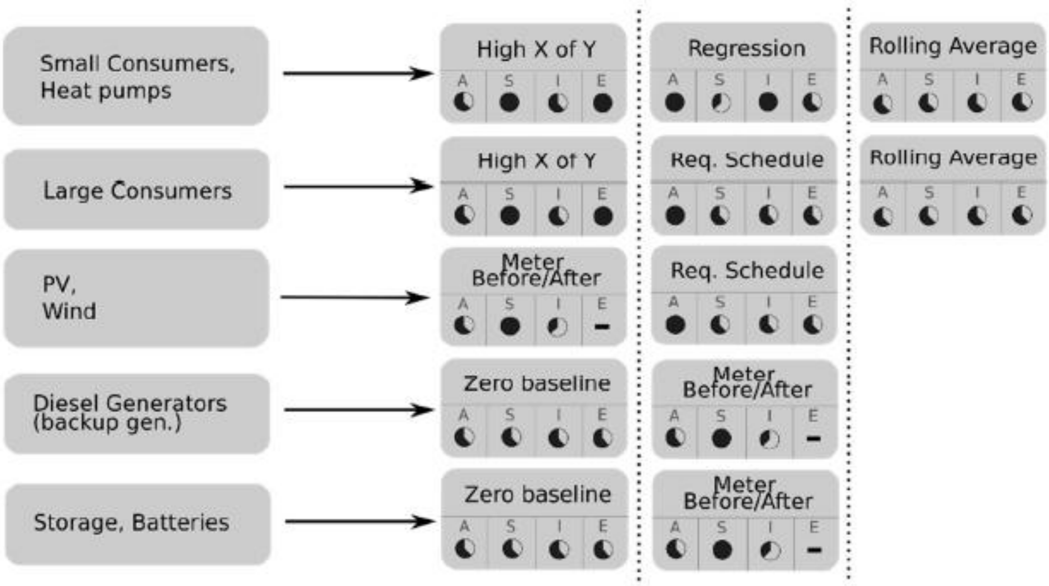



Figure 18 Baseline decision framework adopted in the CoordiNet project[28]

## 3.5 Data Requirements

There are two categories of metering data that are integral to the M&V process. Firstly, there is revenue-grade meter data, which has conventionally been used for retrospective verification and settlement purposes. Secondly, there is real-time operational data, the use of which depends on factors such as the nature of the flexibility service, the available metering resolution, and the frequency of data streaming to the entity requiring the service. For instance, operational data can be employed to promptly identify instances where a DER service provider fails to fulfil their contractual commitments, allowing for immediate action to be taken if necessary. Both types of metering data may originate from a single or multiple metering infrastructures.

DERs are typically smaller than traditional resources, which can result in higher costs for conventional metering and telemetry solutions when applied to DER projects. Additionally, DERs often deliver services to multiple entities, such as DSOs and TSOs, introducing new challenges in terms of "accounting" for these services. This is in contrast to conventional resources, which typically operate within a single service domain. Moreover, geographically dispersed DERs may offer services as part of an aggregated group, unlike conventional resources that are usually

[27] CoordiNet, «D2.1 Markets for DSO and TSO procurement of innovative grid services: Specifications of the architecture, operation and clearing algorithms,» 2021.
[28] CoordiNet, «D2.1 Markets for DSO and TSO procurement of innovative grid services: Specifications of the architecture, operation and clearing algorithms,» 2021.

standalone assets. However, despite these differences, the fundamental objective of M&V remains consistent: to ensure that each service provider adheres to the service requirements outlined in their contracts.

The positioning of DERs on the grid, whether they are "behind-the-meter" (BTM) or "front-of-the-meter" (FTM), is crucial for effective M&V planning, especially in the context of settlement processes. BTM DERs are situated on the customer's side of the electricity meter, allowing on-site energy consumption without metering, while FTM DERs deliver energy off-site, necessitating metered passage through the end-user meter. This distinction significantly impacts settlement procedures, with BTM resources typically operating under retail tariffs and FTM resources subject to retail or wholesale tariffs, depending on various factors such as DER type and service offerings.

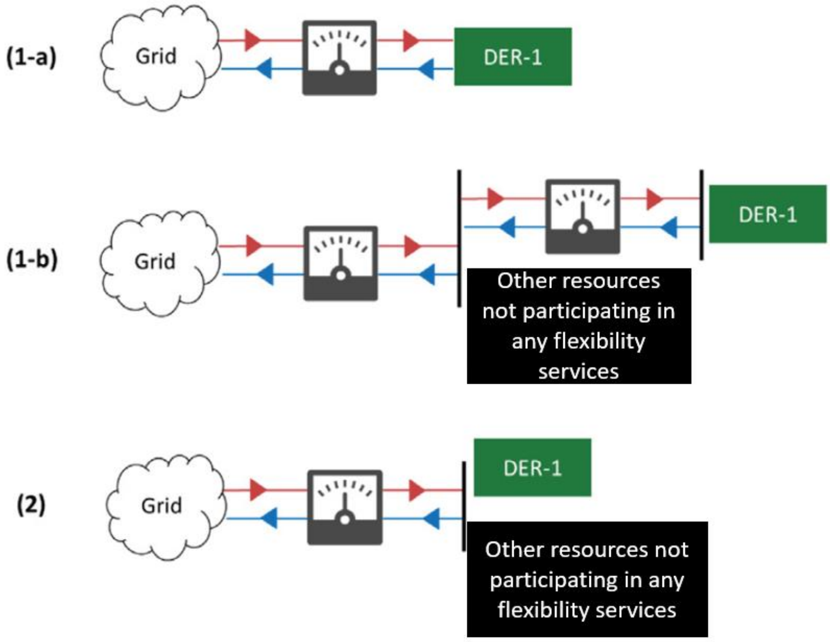



Figure 19 *Metering configurations: dedicated meter (1-a) or sub-meter (1-b), vs. meter shared between participating and non-participating resources (2)*

The majority of prevalent M&V methodologies outlined in Table 6 rely on metering data to evaluate the effectiveness of the grid services rendered. These data configurations can generally be classified into two primary categories. In the first category, DERs delivering grid services are equipped with their own dedicated metering infrastructure (Configuration 1-a in Figure 19) or sub-meter (Configuration 1-b in Figure 19). Alternatively, in the second category, DERs are metered alongside loads and other resources that may not provide the same grid services or may offer different ones (Configuration 2 in Figure 19). Configuration 1-a is typically used for FTM DERs engaged in grid services provision, while Configuration 1-b becomes pertinent when individual metering of BTM DERs is mandated within the M&V framework. Configuration 2 is commonly observed in M&V methodologies employed in demand response (DR) programs; whose baseline establishment relies on data obtained from the existing end-user meter.

In addition to DER location and data granularity, the aggregation of DERs and the potential for submetering play crucial roles in M&V planning, particularly concerning settlement processes. Aggregating DERs allows for the collective assessment of multiple distributed resources, providing a comprehensive view of their combined impact on the grid. This aggregation can streamline settlement procedures by consolidating data from various sources and simplifying the calculation of payments or credits for grid services. Submetering offers a valuable tool for M&V, enabling the isolation and measurement of specific components within a larger system. Submetering allows for the precise monitoring of individual DERs or subsets of DERs, facilitating accurate assessment of their performance and contribution to grid services. By submetering, the granularity of data collection can be enhanced, providing detailed insights into the operation and efficiency of each DER unit.

The granularity of data required varies across different flexibility services, reflecting the diverse operational needs and objectives of each service. For instance, services involving real-time response to grid conditions, such as frequency regulation or voltage support, demand highly granular data with rapid sampling rates to capture fluctuations in supply and demand. On the other hand, services focused on longer-term optimisation, such as capacity provision or energy arbitrage, may require less frequent data sampling but still necessitate detailed information on energy consumption and generation patterns. Furthermore, the granularity of data may differ based on the specific characteristics of the flexibility service and the underlying technologies involved. For example, services using fast-responding resources like battery storage or fast-acting demand response may require sub-second granularity to capture rapid changes in output or consumption. In contrast, services relying on slower-responding resources such as thermal storage or distributed generation may tolerate coarser data granularity but still require sufficient resolution to capture relevant operational parameters.

As an illustrative example, the identification of needs for explicit DR in the ACCEPT project is presented below:

- **Quantify delivered flexibility**
    - Power and energy consumption data from eligible prosumers and district level assets respectively
    - Data granularity – 15 minutes
    - Flexibility provided period (specific hours during the day)
    - Power/energy from controllable loads (i.e. dhw,hvac)
    - Power/energy from building-level PVs (generation)
    - Power/energy from district-level PVs (generation)
- **Quantify procured flexibility**
    - Data granularity – 15 minutes
    - Baseline power/energy from each consumer (W/kWh)
    - Actual power/energy from each consumer (W/kWh)
- **Flexibility sold**
    - Data granularity – 15 minutes
    - Quantify delivered flexibility
    - Remuneration price in €/kWh based on the SLAs
- **SC2[29] – flexibility fee calculation**
    - Data granularity – 15 minutes
    - Quantify procured flexibility (W/kWh)
    - Price in €/kWh specified by the provider
- **SP3[29] – flexibility fee validation**
    - Data granularity – 15 minutes
    - Flexibility fee calculated (€/kWh)
    - Dynamic pricing factors (such as Electricity Market Prices, Network Constraints, Weather Conditions, etc.)
- **SP4[29] – settle flex**
    - Data granularity – 15 minutes
    - Flexibility fee validation (€/kWh)
    - Actual Consumption and Generation Data (W/kWh)
    - Baseline Consumption and Generation Data (W/kWh)
    - Flexibility Fee Rates (€/kWh)
    - Dynamic Pricing Data (€/kWh)

## 3.6 Settlement subprocess

The Settlement generic subprocess is detailed in Annexe 1 (§3.6), together with a comparative analysis with projects implementing the settlement (performed last year).

[29] See Figure 27. Business process diagram for the settlement subprocess

# 4 Conclusion and Perspectives

## 4.1 Main Findings and Recommendations

This section describes the main findings and recommendations regarding the Reference Framework.

| Topic | Usability Survey – Standards Mapping |
|---|---|
| **Findings** | The survey on standards conducted in 2020 and 2021, identifying relevant standards for each interface of the GBPs, was considered useful by project participating in the survey. |
| **Recommendation** | A new survey on the use of standards used by different projects, in the context of the Reference Framework, could provide useful insights, enabling faster alignment among stakeholders. |

| Topic | Usability Survey – Extension |
|---|---|
| **Findings** | Most of the use cases seem aligned with the projects' work, but there are cases where no alignment was indicated. These cases could be further investigated, enabling a more generic definition of the business processes. In terms of the level of granularity of the GBP analysis, the general assessment was positive, but room for improvement was indicated in the comments section, with some indicating more steps, whilst other indicting fewer. Finally, a list of suggestions for the extension of the GPB set was provided from projects. |
| **Recommendation** | The Reference Framework could benefit from the modelling of new use cases, stemming from the current work of the projects, whereas the misalignment of the current GBP can be further investigated to increase the generality of the Reference Framework. Furthermore, link with other frameworks indicated by the projects can be further investigated.<br><br>The consistency of the Reference Framework with ENTSO-E / EU DSO Entity JWG activities (in particular in TF2) should be ensured via a coordination effort. |

| Topic | Generic Actor List |
|---|---|
| **Findings** | Use-case definition needs to be harmonised to enable cross-project comparison and support interoperability. Several items of a use-case definition could be based on reference libraries: actors, functions, information exchanged, …<br>A Generic Actor List was established in 2012 by CEN/CLC/ETSI, but it now needs to be updated with the latest sources, including the IEC Interface Reference Model (IEC 61968) and the Harmonised Electricity Market Role Model (HEMRM). |

| Topic | Generic Actor List |
|---|---|
| Recommendation | Gather relevant expects from projects to analyse the current Generic Actor List and the new available sources and then update the list. It should be clustered to enable experts to contribute where they are the most knowledgeable. At the end, the updated list should be submitted to the CEN/CLC/ETSI Coordination Group on Smart Grids (CG-SG) for review and approval. |

| Topic | Settlement – Baseline methodologies |
|---|---|
| Findings | In examining the provision of flexibility services to both TSOs and DSOs developed in the scope of EU-funded projects, it becomes evident that baselining methodologies must be adaptable to various flexibility products and grid conditions. Different flexibility products may require tailored approaches to baseline calculation, considering factors such as granularity, accuracy, and simplicity. Furthermore, the provision of flexibility services to TSOs and DSOs necessitates clear regulatory guidelines, effective coordination mechanisms, and standardised baseline methodologies to ensure interoperability and transparency across the grid. |
| Recommendation | Stakeholders should prioritise developing standardised baseline methodologies that balance accuracy and simplicity. Regulatory bodies should establish clear guidelines for market access, compensation mechanisms and operational protocols. Collaboration among flexibility service providers, TSOs, and DSOs is essential to streamline communication, data exchange, and market participation. Continuous review and improvement of baseline methodologies are necessary to adapt to evolving grid conditions and stakeholder feedback, ensuring the effectiveness and reliability of flexibility services. |

| Topic | Settlement – Protocols for real-time data exchange & granularity requirements |
|---|---|
| Findings | The analysis of data needs for real-time monitoring and granularity in the context of DER aggregation revealed varying requirements across flexibility services and grid operators. Real-time data exchange is crucial for efficient operation of flexibility markets, but the specific data needs differ depending on the type of service and grid operation scenario. Similarly, granularity requirements vary, with some services necessitating high-resolution data while others can operate with lower granularity. |
| Recommendation | To address these findings, stakeholders should collaborate to establish standardised protocols for real-time data exchange and granularity requirements. This includes defining minimum standards for data transmission frequency and resolution based on the specific needs of each flexibility service and grid operation scenario. Additionally, stakeholders should invest in technologies that facilitate secure and efficient data exchange, such as advanced metering infrastructure and data management systems. Moreover, clear guidelines should be developed for |

| Topic | Settlement – Protocols for real-time data exchange & granularity requirements |
|---|---|
| | aggregating DERs, including data reporting requirements and compensation mechanisms, to ensure transparency and interoperability in flexibility markets. |

| Topic | Settlement – Data collection, validation & exchange among stakeholders |
|---|---|
| **Findings** | The assessment of data roles in the settlement process highlighted the critical importance of accurate and timely data for ensuring transparent and efficient settlement procedures. Real-time data plays a crucial role in verifying the performance of flexibility services and determining appropriate compensation for service providers. Additionally, the granularity of data required varies depending on the type of flexibility service and the level of aggregation involved. |
| **Recommendation** | To enhance the data roles in the settlement process, it is recommended to establish clear standards and protocols for data collection, validation, and exchange among relevant stakeholders. This includes setting minimum requirements for data accuracy, frequency, and resolution to ensure reliable settlement calculations. Moreover, stakeholders should invest in advanced metering and monitoring technologies to improve data quality and granularity, enabling more precise settlement procedures. Additionally, collaboration between grid operators, service providers, and regulatory authorities is essential to address data interoperability issues and establish common data formats and interfaces for seamless data exchange. By implementing these recommendations, stakeholders can streamline the settlement process and enhance the overall efficiency and transparency of flexibility markets. |

| Topic | Settlement – Notification mechanisms |
|---|---|
| **Findings** | The analysis revealed several areas where the settlement process lacks adequate attention, including the notification of differences between delivered and ordered flexibility volumes, settling non-delivered supply volumes, compensating for imbalances, and ensuring validated measured data for the quantification and settlement of flexibility services. These gaps can lead to discrepancies in settlement calculations, challenges in accurately compensating service providers, and potential inefficiencies in the overall flexibility market operation. |
| **Recommendation** | To address these shortcomings, it is recommended to implement robust notification mechanisms that promptly alert stakeholders to any discrepancies between ordered and delivered flexibility volumes. Additionally, mechanisms should be established to settle non-delivered supply volumes fairly and transparently, taking into account factors such as contractual obligations and operational constraints. Compensating for imbalances should be done accurately and promptly, with clear guidelines for determining liability and appropriate compensation levels. Furthermore, efforts should be made to ensure the availability of validated measured data, including implementing data validation processes and establishing standards for data quality assurance. By addressing these recommendations, the settlement process can become more reliable, |

| Topic | Settlement – Notification mechanisms |
|---|---|
| | transparent, and efficient, leading to improved market performance and stakeholder satisfaction. |

## 4.2 Perspective and next steps

The activities of the Action #3 should be continued in 2024 and beyond.

Based on the recommendations, several actions have been identified:

1. Further improve the Reference Framework: align GBPs with project use cases, extend the list of GBPs, improve alignment with other frameworks.
2. Reinforce the Reference Framework to support practical implementation: use-case harmonisation (incl. Generic Actor List), list of relevant protocols/standards, …
3. Follow up on the application of the settlement guidelines to current and future projects.
4. Share this report with relevant parties such as ENTSO-E / EU DSO Entity JWG (in particular the team in charge of the Demand-Response Implementing Act) and CEN/CLC/ETSO CG-SG.

A detailed plan will be set out to achieve most of these actions by the BRIDGE General Assembly of 2025.

# 5 Annex 1: Reference Framework

In this chapter, the Reference Framework is described. As defined in §1.2, it is made of generic business processes, functions and interfaces.

## 5.1 Definition of Terms

### 5.1.1 Flexibility

For the sake of clarity in the following discussion, the terms and relations used in the latter context are defined.

The first term to be defined is the flexibility itself. According to[30] 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 adding some details related to the relations between system components and the implementation of flexibility, which might in the end limit the generality of the definition. But what is more important is that it also defines parameters to describe the flexibility. Such parameters are important in order to be able to define the flexibility offer (or request) and its respective value, but also to verify that the flexibility was indeed released.

Thus, to summarise, 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)."*

### 5.1.2 Flexibility Stakeholders

We can further define a set of generic stakeholders related to providing and consuming flexibility. These can be as follows:

**Flexibility Provider** – is a party able and willing to adapt or modify its energy-related behaviour in exchange for some compensation. This party operates in its own name and doesn't represent anyone else. It can be a private and small energy grid stakeholder, but it can also be an 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 on the energy grid. Examples of flexibility consumers are TSOs, DSOs, BRPs and other energy grid stakeholders that may require the change of energy grid parameters.

**Flexibility Service Provider (incl. aggregator)** – is a party that doesn't usually offer flexibility on its own, but rather it represents the individual flexibility providers to help 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.

[30] Smart Grid Task Force, «Regulatory Recommendations for the Deployment of Flexibility: EU SGTF-EG3 Report,» 2015.

**Flexibility Facilitator** – is a party that represents one or several flexibility consumers to help 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 all 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 in order 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.

### 5.1.3 Energy Services Stakeholders

In addition, we define a set of stakeholders related to energy services:

**Energy Service Company** – Based on the HEMRM[31], a party offering energy-related services to the party connected to grid, but not directly active in the energy value chain or the physical infrastructure itself. The energy service company (ESCO) may provide insight services as well as energy management services.

**Energy Supplier** – Based on the HEMRM, an energy supplier supplies electricity to or takes electricity from a party connected to the grid at an accounting point.

**P2P Market Operator** – Responsible for the maintenance and operation of a peer to peer (P2P) energy market, including management of participants (peers).

**Electrical Vehicle Charge Point Operator (EV CPO)** – Owner/operator/manager of EV charging infrastructure.

## Generic Business Processes

### 5.1.4 GBP1 – Flexibility for SOs through Open Market

The GBP 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 stakeholders 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.

[31] ebIX, EFET, ENTSO-E, «Harmonised Electricity Market Role Model,» [En ligne]. Available: https://www.ebix.org/artikel/role_model.

- Prosumer, the flexibility provider, who offers flexibility to the market via the aggregator (function P1), activated taking care modelled preferences and constraints (function P2) and properly remunerated or penalised (function S).

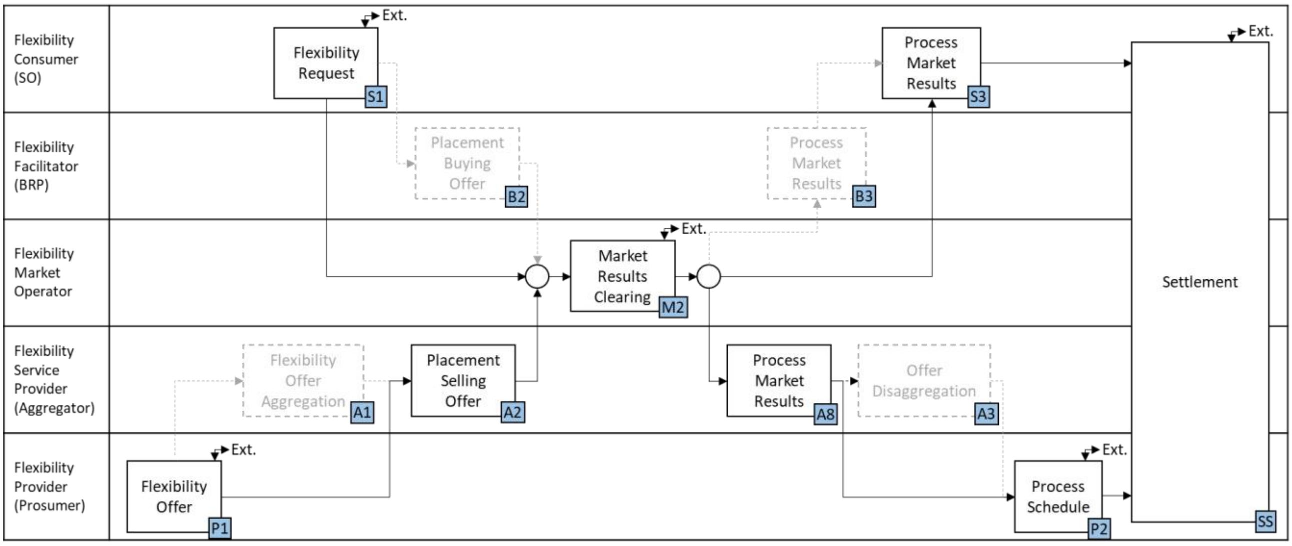



Figure 20 Business process diagram – GBP1 “SO flexibility through open market”

## 5.1.5 GBP2 – Flexibility for SO via Prior Bilateral Agreement

The SO (i.e. DSO or TSO) business process for flexibility via prior bilateral agreement (Figure 21) is quite different from the one described above, even though flexibility is offered to the SO in this case as well. The purpose of this case is to provide near real-time flexibility activation after an SO request, in particular for the SO to deal with an emerging network congestion/load balancing problem. Flexibility is not expected to be delivered through a market; therefore, no market operator is involved in order to simplify and speed up the process. Priority must be given due to the emergency status. Therefore, if 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 involved in this process are the SO, the flexibility providers (prosumers) and the flexibility service provider (prosumers, aggregator). 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 set out 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 flexibility service provider, 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 determined 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 flexibility service provider based on the bilateral agreement. The amount of flexibility that will be provided to SO is calculated dynamically by the flexibility service provider.
- During runtime, flexibility providers provide the information on the availability of flexibility (directly or through an 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. This is to enable the evaluation of the availability of flexibility at a specific time and classify it according to the different needs of the SO (immediate actions in the event of time-critical emergencies and planning to compensate for predicted 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 set 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 established, which is discussed in further detail in section 5.1.9. The established Settlement subprocess is common for all GBPs.

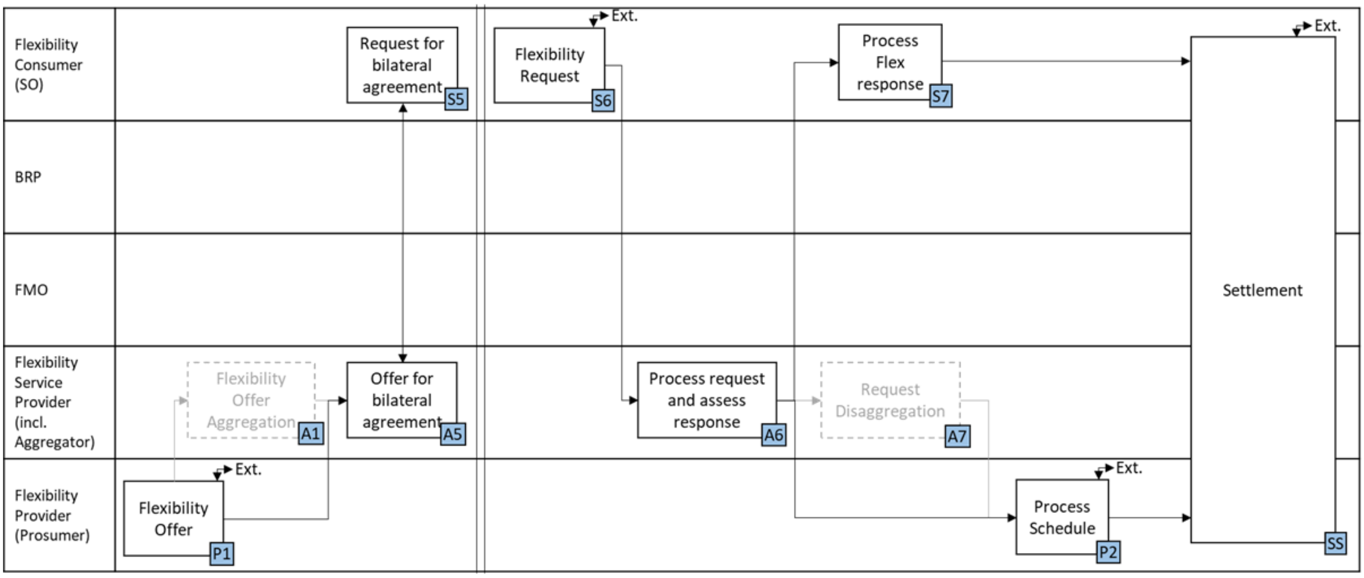



Figure 21. Business process diagram for GBP2 "SO flexibility via prior bilateral agreement"

### 5.1.6 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 costs 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 going into 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 borne by existing bundled roles in the energy market, like energy suppliers with variable prices, aggregators.

It is worth emphasising that the BRP sets out its optimisation strategy by undertaking the role 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 that the market settlement is undertaken by the BRP. Market settlement is analysed further in section 5.1.9, entitled 'Settlement Subprocess', and is common across all GBPs, incl. GBP3.

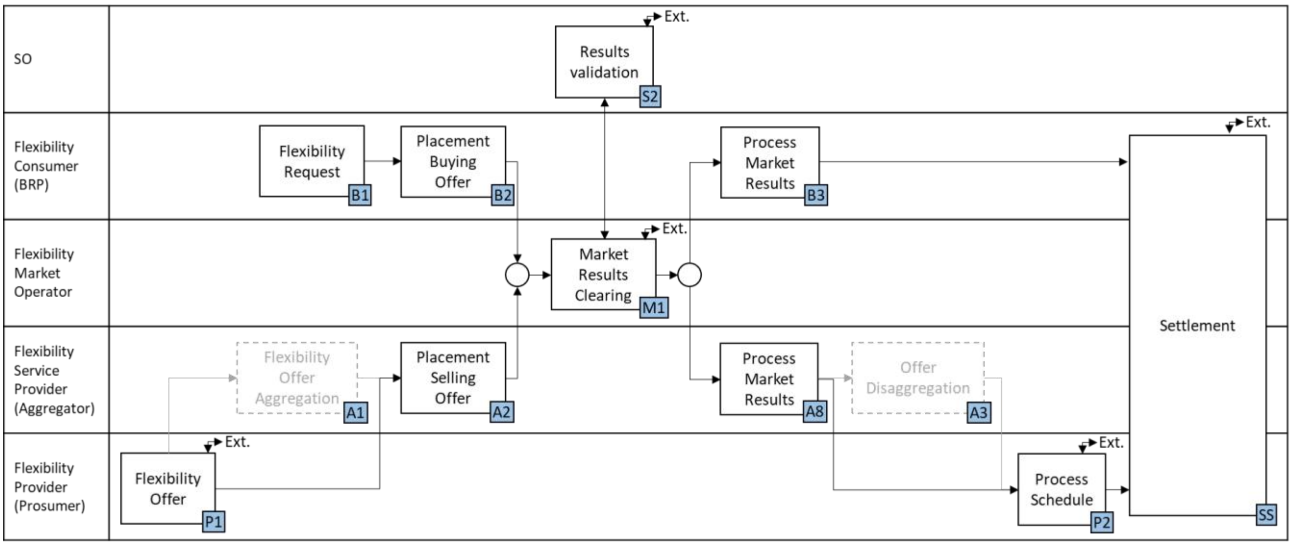



Figure 22: Business process diagram for GBP3 “BRP portfolio optimisation”

### 5.1.7 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. make consumption 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 of the goal and of the participation to the market, there are some actions related to the internal optimisation within the energy community as shown in the Figure 23. If the optimisation process is not managed 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.

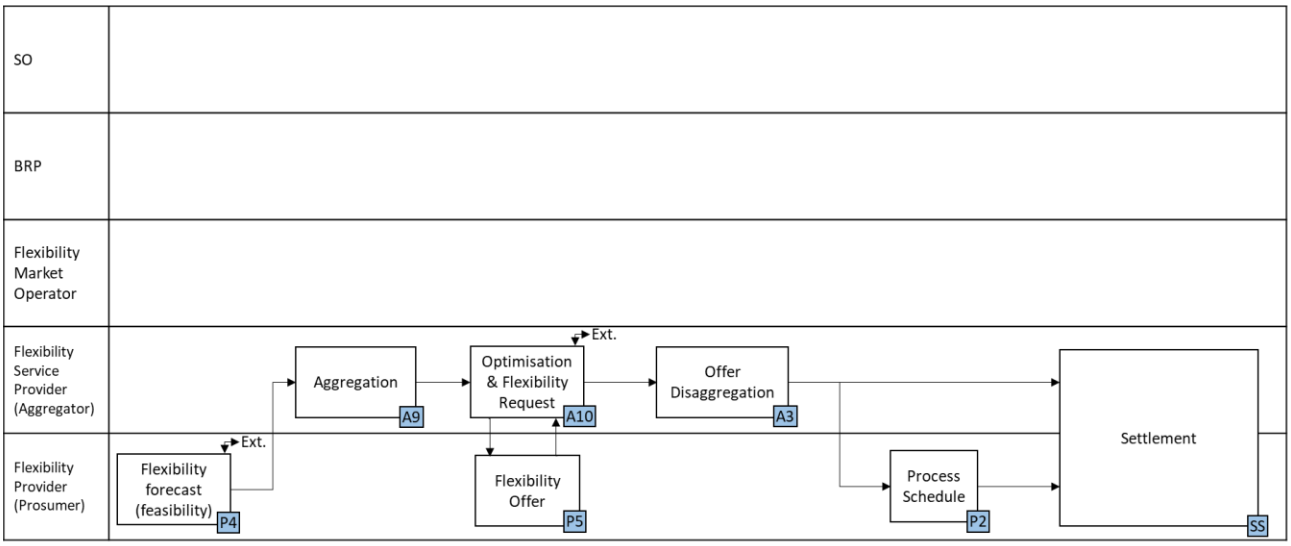



Figure 23. Business process diagram for GBP4 "Energy community optimisation"

### 5.1.8 GBP5 – Implicit Flexibility Using Dynamic Steering Signals

The flexibility offering and buying can be performed implicitly. 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 implementations. In the basic approach the flexibility consumer takes the risk of being exploited by the flexibility 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. This scenario 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:

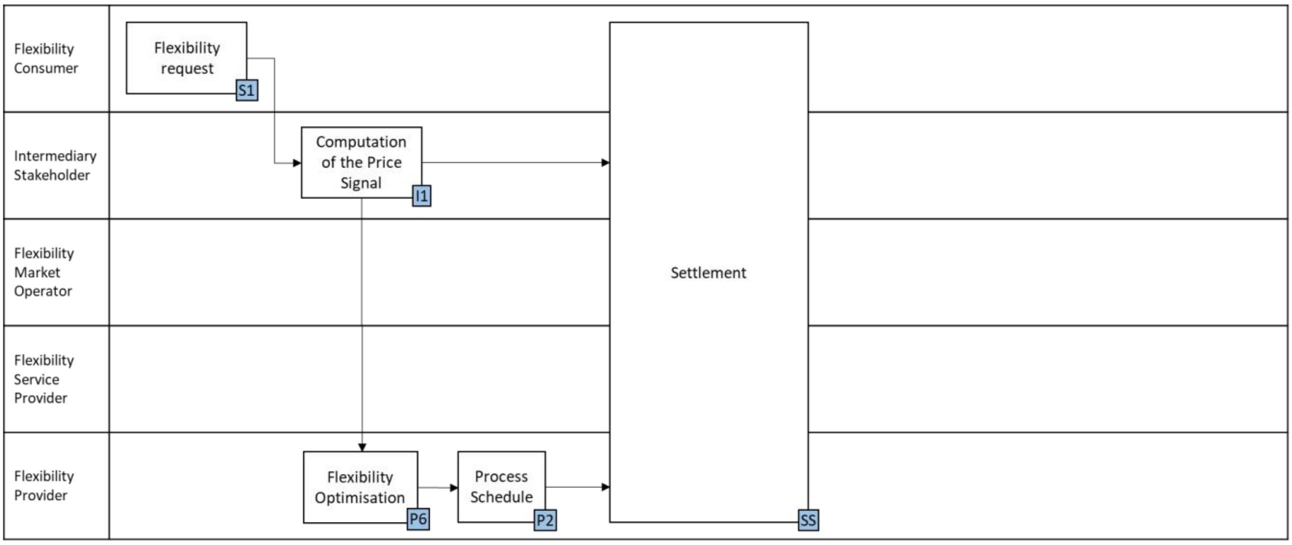



Figure 24. Tentative business process diagram for GBP5 "Implicit flexibility using dynamic steering signals" (“price signal” scenario)

### 5.1.9 GBP6 – Energy Monitoring and Energy Management

A key enabler of the energy transition is the management of energy at individual premises level, through energy monitoring and optimisation of an asset’s operation in respect to the end-consumer preferences, local production, as well as considering external factors such as energy prices, CO2 equivalent of the energy generation mix, weather conditions and forecasts, etc. Such solutions can be offered by ESCOs, who provide the infrastructure and/or support the prosumer in achieving an efficient operation of its premises.

The aim of this GBP is to model the feedback to the prosumer with regards to energy monitoring and management based on detailed energy and external data. The form of the feedback can range from actions that need to be applied manually by the end user to automatic operation that are transparently applied to home appliances with dedicated control signals.

Furthermore, the ESCO can perform these operations on a prosumer basis or for a group of prosumers in a larger context involving aggregation and extended processing.

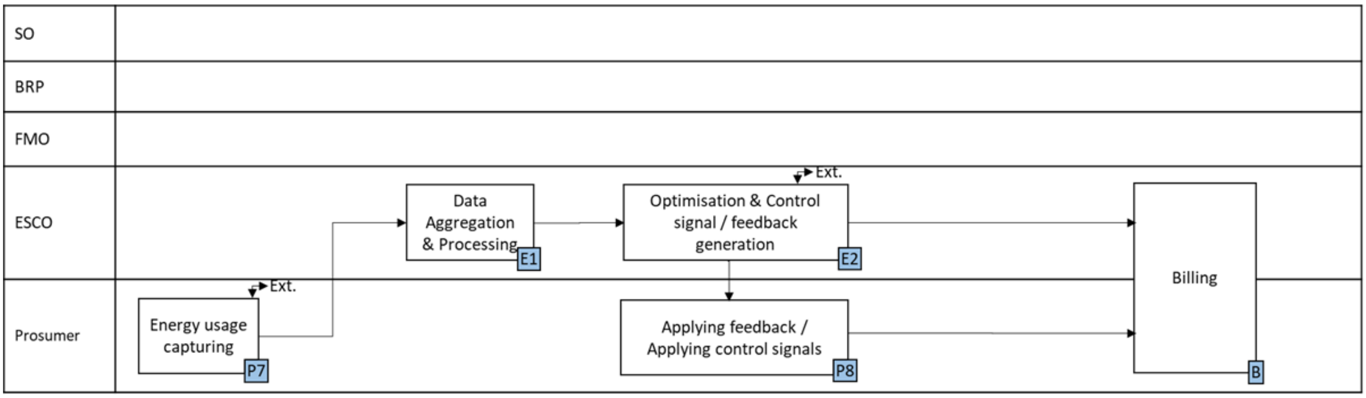



Figure 25. Energy Monitoring and Management GBP

## 5.1.10 GBP7 – P2P Trading in Energy Communities

Extending the description provided in GBP 4, this GBP aims to describe the trading of energy among peers / members of an energy community. This can be enabled via a local energy market (aka P2P market), which is managed by an operator, responsible for its maintenance, monitoring of transactions as well as for the management of participants. The following diagram depicts the different sub-processes/ functions of each stakeholder in the P2P trading lifecycle.

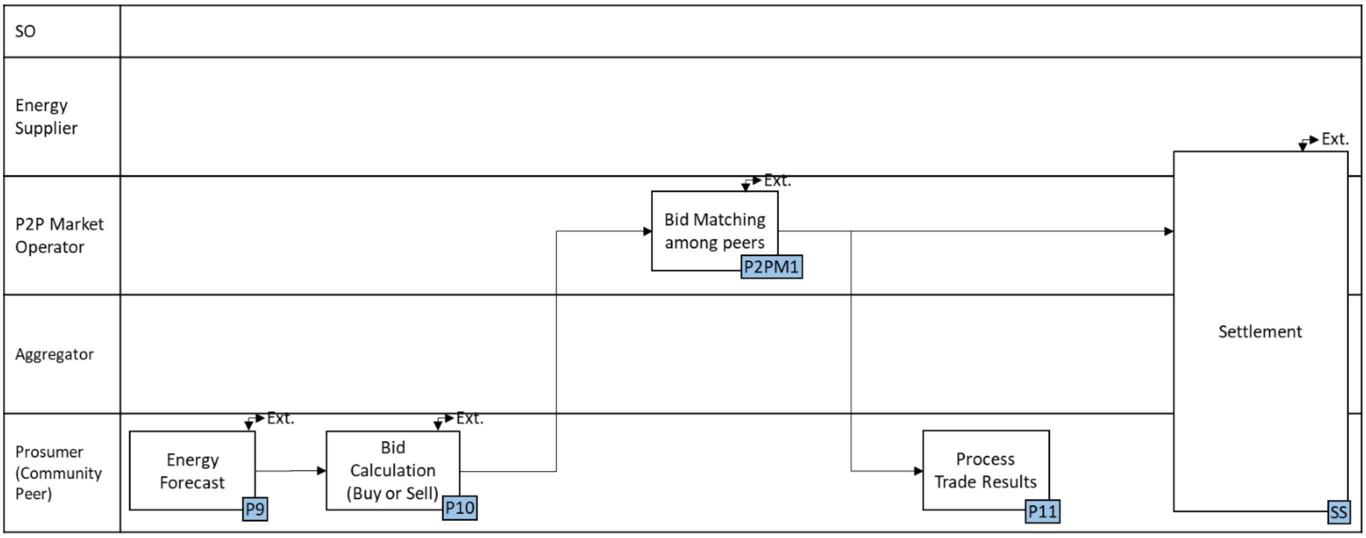



Figure 26. P2P Trading in energy community GBP

## 5.1.11 Settlement Subprocess

### 5.1.11.1 Generic Process

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 flexibility provided, 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.

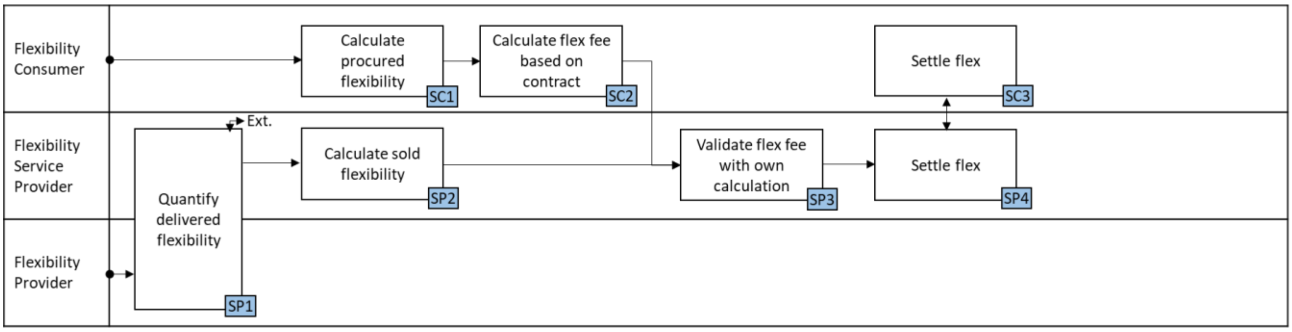



Figure 27. Business process diagram for the settlement subprocess

### 5.1.11.2 Comparative Analysis with Projects Implementing the Settlement

This year, feedback was collected on implementing the settlement in order to understand how the different projects are approaching it and to see if they are considering a similar sub-process to the one depicted in Figure 27.

For that purpose, 7 projects (PARITY, ACCEPT, OneNet -Northern Demo Cluster, X-Flex, Platone, BRIGHT and IANOS) have shared how they are implementing the Settlement subprocess of the flexibility procurement. Based on their feedback, this section provides an in-depth analysis of the approaches followed by different projects implementing the Settlement subprocess. It then goes on to briefly explain each project concerning the settlement Subprocess.

#### 5.1.11.2.1 PARITY

In PARITY's local energy market / local flexibility market, settlement is done automatically with a software component (named Oracle) which runs per prosumer. It communicates with the blockchain platform and checks the rules that are set out within the smart contracts (these rules are referred to as Service Level Agreements). It calculates the sold flexibility by directly accessing the corresponding measurement data, i.e. power consumption and production, per consumer or prosumer involved. According to this description, this project adopts the sequence diagram presented in Figure 27. Business process diagram for the settlement subprocess.

For the delivery of aggregated flexibility to the DSO or external markets (e.g. ancillary services market), the Aggregator Toolset, which is a software component that assumes the role of the aggregator within the PARITY framework, acts as the aggregated flexibility provider and performs the settlement and remuneration. It then distributes the corresponding tokens of the energy/flexibility transaction to each participating prosumer.

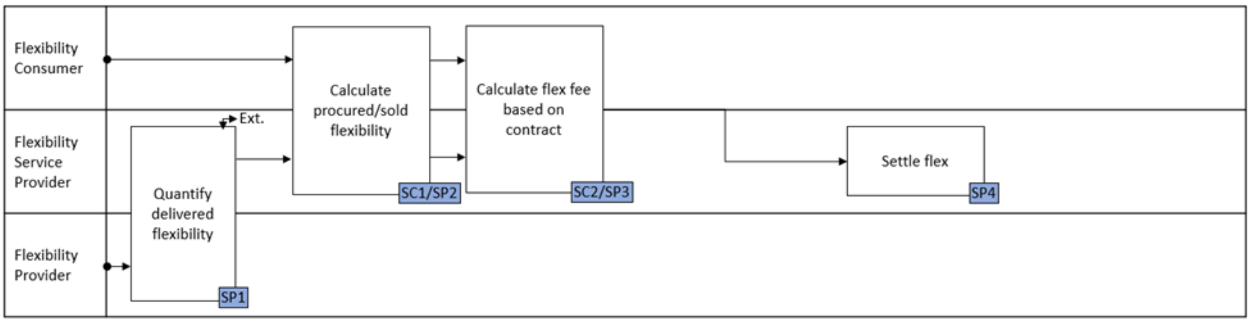



Figure 28 Business process diagram for the Settlement subprocess in the PARITY project

#### 5.1.11.2.2 ACCEPT

Within the ACCEPT project, the flexibility provider's role is assumed by the prosumer/ consumer (in this case, this is an energy community member). The main scenarios under which the prosumer/consumer is asked to provide flexibility to a third party are:

i. the P2P trading scenario among members of the same energy community,
ii. the explicit demand response scenario, and
iii. the implicit (i.e., price-based) demand response scenario. In all three scenarios, the settlement process, based on the outputs of which the prosumer/consumer is remunerated for their provided flexibility, is carried out automatically by a software component called P2P Exchange Platform.

The P2P Exchange Platform performs the remuneration based on consumption measurements gathered from the consumer/prosumer (this is the external input depicted in the GBP diagram of Figure 27) and a set of rules agreed between the consumer/prosumer and the flexibility service provider (within ACCEPT, this role could be assumed by either an ESCO, a retailer or an aggregator, based on the scenario implemented at any given time). The consumption measurements, post-flexibility provision, are compared to the previously calculated baseline consumption of the user to estimate the delivered flexibility (verification of response estimation) of the prosumer/consumer.

It should be noted that the set of rules mentioned before, referred to as Service Level Agreements, are included in smart contracts between the flex service provider and the flex provider. Among those rules, for the i) and iii) scenarios, the remuneration price for the flexibility provision is calculated based on a P2P trading mechanism which is executed on a Smart Contract. For the ii) scenario, the price is provided by the flex service provider on a day-ahead basis (this price is calculated by the flex service provider, here the retailer, with inputs from the DSO and the wholesale market, and the demand elasticity calculated by a relevant ACCEPT software component).

The flexibility service provider has in turn a bilateral agreement with the flexibility consumer (in our case, this is the DSO, whose functions are performed by a software component called ACCEPT System Emulator), where the commercial terms under which flexibility is procured and then settled are described (i.e., the price per kWh that the flexibility consumer is willing to pay for procuring flexibility). How the agreement between the two parties was achieved (either through a tender or through the energy flex market) is beyond the project's scope. Once all flexibility providers send their verification of response (i.e., their provided flexibility calculated based on the baseline consumption and the measured actual consumption) to the flexibility service provider, the latter aggregates these responses to calculate the actual sold flexibility. The remuneration is then carried out by the DSO to the community, which then distributes the revenue to the participating members according to the bilateral agreements.

It should be noted that the set of rules mentioned before, referred to as Service Level Agreements, are included in Smart Contracts between the flex service provider and the flex provider. Among those rules, for the i) and iii) scenarios, the remuneration price for the flexibility provision is calculated based on a P2P trading mechanism which is executed on a Smart Contract. For the second scenario, the price is provided by the flex service provider on a day-ahead basis (this price is calculated by the flex service provider, here the retailer, with inputs from the DSO and the wholesale market, and the demand elasticity calculated by a relevant ACCEPT software component).

The flexibility service provider has, in turn, a bilateral agreement with the flexibility consumer (in this case, this is the DSO, whose functions are performed by a software component called ACCEPT System Emulator), where the commercial terms under which flexibility is procured and then settled are described (i.e., the price per kWh that the flexibility consumer is willing to pay for procuring flexibility). How the agreement between the two parties was achieved (either through a tender or through the energy flex market) is the project's scope. Once all flexibility providers send their verification of response (i.e., their provided flexibility calculated based on the baseline consumption and the measured actual consumption) to the flexibility service provider, the latter aggregates these responses to calculate the actual sold flexibility. The remuneration is then carried out by the DSO to the community, which then distributes the revenues to the participating members according to the bilateral agreements. Therefore, the business process diagram adopted in the ACCEPT projects is adapted from Figure 27 and depicted in Figure 29.

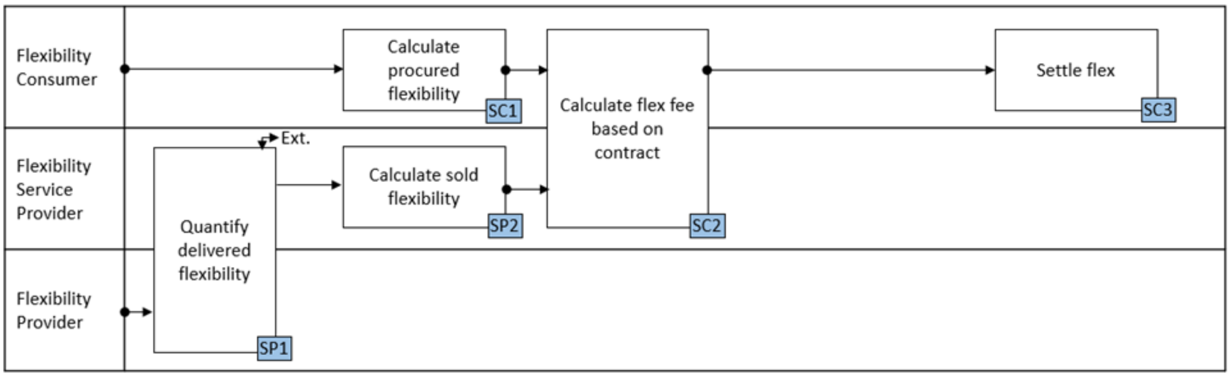



Figure 29 Business process diagram for the Settlement subprocess in the ACCEPT project

#### 5.1.11.2.3 X-FLEX

In the XFLEX project, no BRP role and thus the market clearing is performed at the MO level. The overall settlement process is centralised as the MO is responsible for the market clearing and thus the settlement of the amount of the flex offered by flex providers (aggregators) to the flex consumers (SOs). Therefore (SC1= SP2) and (SC2=SP3) performed towards the valuation of the flexibility offered by the flex service provider to the system operator and then the remuneration for the provided flexibility (based on the financial terms defined in the offer).

The remuneration is performed based on flexibility availability and use. Different scenarios are examined in XFLEX project taking into account the settlement parameters for both availability and use. The flex settlement approach applies also at the level of flexibility provider (consumer/flexibility asset owner) and flexibility service provider (aggregator). In that case, the aggregator is responsible for the settlement of flexibility offered. The approach is similar to what was presented in GBP definition. More specifically:

- **SC1:** Flex service provider is responsible for the calculation of the flex offered (vs flex potential) from the different flex providers;
- **SC2=SP3:** Flex service provider get from the MO the information about flex offered to SO and validate the amount of flex provided. Then the settlement disaggregation to flex providers is performed on the basis of the contractual terms agreed between flex service provided and flex providers;
- **SP4/SC3**: is performed by default by both entities (flex service provider AND flex provider) to perform the flexibility settlement validation;

Taking into account the explanation described above for the X-Flex project, the sequence diagram for the Settlement subprocess in the X-Flex project is represented below.

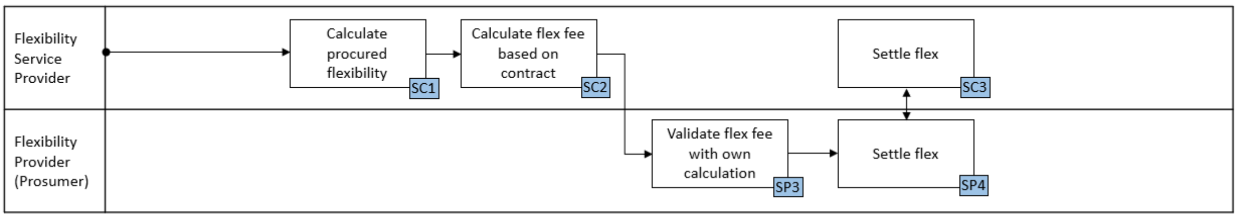



Figure 30 Business process diagram for the Settlement subprocess in the X-Flex project

#### 5.1.11.2.4 Platone

The settlement process in the Italian use case of the Platone Project is implemented by the Platone Market Platform, which is also in charge of collecting the flexibility requests and offers, matching them and providing the market results for the flexibility activation. The settlement process is divided into two phases: validation and remuneration. In order to validate the flexibility provided by the resources, the market platform acquires the certified measurements (using blockchain) from the shared customer database at the end of the activation phase.

The Platone Market Platform is able to calculate the settlement for each resource and to enable the remuneration process through the smart contract and Platone tokens, using blockchain technology. More in detail, the Platone Market Platform implements two different smart contracts for the settlement remuneration:

- Settlement agreement, a dynamic smart contract able to manage multiple agreements between the aggregator and its own customers. This smart contract is used for the settlement management.
- Platone token, an ERC-20 based token is used for the payment of the flexibility provisioning to the end customers. Each customer has its own wallet linked to its own point of delivery (PoD) and Platone tokens are provided to the customer wallet at the end of the settlement phase.

Below is a step-by-step sequence diagram for the settlement process:

1) Market platform receives measurements for market data verification and settlement.
2) Market platform verifies on the blockchain services layer the agreement between aggregator and customer
3) Market platform performs settlement based on measurement, market outcomes and agreements.
4) Market platform assigns the Platone tokens to the respective customers.
5) Market platform shares the settlement data to all the market participants (with specific access permission)
6) Aggregator, TSO, and DSO can visualise all the data via web user interface (UI).

#### 5.1.11.2.5 OneNet (Northern Cluster)

In turn, for the Northern Cluster of the OneNet project, the settlement process is conducted in a component called the flexibility register (FR). The Northern Demonstrator implemented a software system for the needs of the demo. The FR receives information about the trades made on the market (for congestion management) and does first the verification process. In this process the metering data is compared to either schedules (plans) sent by the flexibility service provider, or alternatively the FR calculates a baseline from based on historical data. These results are then communicated to relevant parties.

The verification process quantifies the delivered flexibility and the settlement process uses this information to conclude financial and imbalance settlement done partly outside of the FR. The sequence diagram for the use case can be found in Figure 2.7. The objective of this use case is to quantify the delivered flexibility volumes and support the financial and imbalance settlement based on the results in the context of OneNet Northern Demonstrator scope. This is one of the FR’s core functionalities.

This process also includes the calculation of a baseline, which is conducted by the FR based on historical metering data. The Northern Demonstrator concept presented two alternatives for establishing the reference value for metering data of resources, against which the behaviour of the resources is evaluated in the verification process. These two are the baseline calculated by the FR and schedules sent by the FSP operating the respective resources. In this demo cluster, an optimisation model for SOs is also implemented to procure flexibility together for congestion management. It is reported that in this case doing the financial settlement is not trivial.

#### 5.1.11.2.6 BRIGHT

In the BRIGHT project, demand response (DR) programs are implemented at the community level using peer-to-peer flexibility trading to determine the DR signals.

The implementation is done on top of the blockchain energy ledger that stores, in a tamper-proof manner, the energy (and non-energy) information collected by smart devices. The DR signals are injected into the blockchain self-enforcing smart contracts managing the community's flexible entities. The smart contracts enable to programmatically define the expected energy flexibility to be delivered by each local prosumer as well as the associated remuneration. The commitments for energy flexibility delivery are saved in blockchain as transactions for each flexible entity participant. They will be processed and compared to the real-time monitored values during delivery time.

The DR programs settlement is based on the monitored data to activate the appropriate financial remuneration for the community flexibility providers. During flexibility delivery, energy transactions are generated and stored in the blockchain based on the energy data monitoring gathered from the smart meters associated with each flexible entity. The new data triggers the execution of smart contracts that are associated with the flexibility entities. The smart contracts check and compare the monitoring data with the corresponding commitments, and based on these values, the actual settlement is generated.

The payments represent the transfer of tokens associated with energy flexibility delivery.

#### 5.1.11.2.7 IANOS

In the IANOS project the application of a P2P market platform enables prosumers in a local network to directly trade energy with each other, by avoiding RES curtailment and future grid transport costs.

The settlement process is implemented using smart contracts by considering both the energy and financial aspects of trading management and the energy data acquired by smart meters.

During delivery based on the energy, monitoring data gathered from the smart meters associated with each prosumer energy transactions is generated and stored in the blockchain. The new data triggers the execution of the smart contracts associated with the prosumers. The smart contract checks and compares the monitoring with the corresponding commitments and the actual settlement is made based on these values. Fungible tokens based on ERC-20 standard are exploited as a payment for the purchase of energy between prosumers.

# Functions and Interfaces

This section describes the functions and interfaces used in the generic business processes. To easily compare with the previous version of the Reference Framework[32], all the changes and additions are marked in red.

## 5.1.12 Functions

### 5.1.12.1 Summary of relevant functions per Generic Business Process

| Function | GBP1 | GBP2 | GBP3 | GBP4 | GBP5 | GBP6 | GBP7 |
|---|---|---|---|---|---|---|---|
| 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 | | ✓ | | | | | |

[32] BRIDGE, «Interoperability of flexibility assets - Version 2.0,» 2022. [En ligne]. Available: https://op.europa.eu/en/publication-detail/-/publication/a00be176-ac1f-11ed-b508-01aa75ed71a1/language-en.

| Function | GBP1 | GBP2 | GBP3 | GBP4 | GBP5 | GBP6 | GBP7 |
|---|---|---|---|---|---|---|---|
| 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~~ | | | | | | | |
| 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) | | | | ✓ | | | |

| Function | GBP1 | GBP2 | GBP3 | GBP4 | GBP5 | GBP6 | GBP7 |
|---|---|---|---|---|---|---|---|
| P6 / Flexibility optimisation | | | | | ✓ | | |
| P7 / Energy usage capturing | | | | | | ✓ | |
| P8 / Applying the feedback | | | | | | ✓ | |
| P9 / Energy Forecast | | | | | | | ✓ |
| P10 / Bid Calculation | | | | | | | ✓ |
| P11 / Process Trading Result | | | | | | | ✓ |
| I1 / Computation of Price Signal | | | | | ✓ | | |
| E1 / Data Aggregation & Processing | | | | | | ✓ | |
| E2 / Optimisation & Control signal / feedback generation | | | | | | ✓ | |
| P2PM1 / Bid Matching among peers | | | | | | | ✓ |
| B / Billing | | | | | | ✓ | |
| SS / Settlement subprocess:<br>• SP1 / Quantify delivered flexibility<br>• SP2 / Calculate sold flexibility<br>• SP3 / Validate flex fee with own calculation<br>• SP4 / Settle flex<br>• SC1 / Calculate procured flexibility<br>• SC2 / Calculate flex fee based on contract<br>• SC3 / Settle flex | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |

### 5.1.12.2 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 | |

| S1 / Flexibility Request | |
|---|---|
| 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<br><br>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<br><br>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<br><br>Amount of energy<br><br>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<br><br>Flexibility transaction/agreement |
| External required data | |
| Decomposition into functions/subfunctions | |

### 5.1.12.3 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 |

| B2 / Placement of Buying Offer | |
|---|---|
| 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<br><br>Flexibility transaction/agreement |
| External required data | |
| Decomposition into functions/subfunctions | |

| ~~B4 / Process Settlement~~ |
|---|
| *Deprecated* |

### 5.1.12.4 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 Flexibility Consumer<br><br>Selling offer(s) from Flexibility Service Provider<br><br>Validated Results |

| M1 / Market Results Clearing (BRP) | |
|---|---|
| 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 Flexibility Consumer<br><br>Selling offer(s) from Flexibility Service Provider |
| Outputs | Flexibility order(s) |
| External required data | Flexibility pool |
| Decomposition into functions/subfunctions | |

#### 5.1.12.5 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 (incl. consumers, prosumers, electric vehicle charging point operators, etc.) |
| 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 |

| A5 / Offer for Bilateral Agreement | |
|---|---|
| Inputs | Aggregated flexibility (calculated from previous step ) |
| Outputs | Min/Max amount of flexibility that can be used after a Flexibility Consumer flexibility request<br><br>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 | |

| A7 / Request disaggregation | |
|---|---|
| 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.<br><br>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) |
| 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<br><br>Flexibility offer per flexibility provider (prosumer) |
| Outputs | Flexibility request to each prosumer<br><br>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 | |

### 5.1.12.6 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.<br><br>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 |

| P1 / Flexibility offer | |
|---|---|
| | patterns, types of devices, set-points preferences, weather data (including forecasts), calendar, state of charge (SoC), etc. |
| Decomposition into functions/subfunctions | 1 Calculation of flexibility per controllable, flexible asset<br>2 Aggregated flexibility at the level of the flexibility provider<br><br>The calculation of the flexibility per controllable, flexible asset may require an extra step for the creation of certain profiles (e.g., EV charging profile, occupancy profile, thermal comfort profiling, etc.). |

| 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<br><br>Flexibility transaction/agreement |
| External required data | • Control of assets – specific setpoints<br>• Response from controllable assets |
| Decomposition into functions/subfunctions | 1 Create process schedule per asset<br>2 'Translation' of process schedule to specific control actions/asset setpoints |

| ~~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.) and available EV infrastructure.<br><br>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 / profiling data (e.g., occupancy profiling, thermal comfort profiling, thermal building profile, etc.) / data from EV infrastructure (e.g., SoC, EV charging pattern, etc.) |
| Outputs | Prosumer-level flexibility forecast |
| External required data | Metering and sensor IoT data, weather data (including forecasts), data from EV infrastructure |
| Decomposition into functions/subfunctions | 1 Calculation of available flexibility per asset<br>2 Aggregation of asset-level flexibility forecasts into provider-level flexibility forecast |

| 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 flexibility provider (incl. prosumers, consumers, EV charging points operators, etc.) |
| 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 | |

| P7 / Energy usage capturing | |
|---|---|
| Description | This function is realised at the prosumer household and covers the collection of energy usage data and any data related to energy usage. This can cover the summarized usage, but also the energy usage of individual appliances as well as other data collected by relevant sensors. There might also be a diversity in the temporal resolution of the data. |
| Inputs | • Smart Meter data<br>• Appliance status (on/off, mode of operation)<br>• Appliance Schedule<br>• Temperature/Humidity/Occupancy/Luminance Sensor data |
| Outputs | Energy usage and related data (diverse temporal and spatial resolutions possible) |
| External required data | External data that can influence the energy monitoring (weather, time, etc.) |
| Decomposition into functions/subfunctions | |

| P8 / Applying the Feedback | |
|---|---|
| Description | The prosumer receives the feedback that covers the suggestions on how to improve the energy usage and can apply these to improve efficiency |

| P8 / Applying the Feedback | |
|---|---|
| | in the household. This feedback can be applied manually by the end user or in automated manner. |
| Inputs | • Energy related feedback<br>• Appliance operation schedule |
| Outputs | Steering signals to control the appliances |
| External required data | |
| Decomposition into functions/subfunctions | |

| P9 / Energy Forecasting | |
|---|---|
| Description | Execution of energy forecasting algorithms at the level of the prosumer in order to identify the energy to be exported or imported from other peer of the energy community or from the contracted retailer. |
| Inputs | Energy Data (data on energy demand and generation – if available) |
| Outputs | Forecasts |
| External required data | Weather Historic and Forecast Data |
| Decomposition into functions/subfunctions | |

| P10 / Bid Calculation | |
|---|---|
| Description | Based on the energy forecasts and the prosumer's preference the energy to be exported or imported from other peer of the energy community or from the contracted retailer is identified. |
| Inputs | Forecast Data, Prosumer Preferences |
| Outputs | Bid |
| External required data | |

| P10 / Bid Calculation | |
|---|---|
| Decomposition into functions/subfunctions | |

| P11 / Process Trading Result | |
|---|---|
| Description | The outcome of the trading mechanism is communicated in this step. |
| Inputs | Traded Quantity/Price |
| Outputs | |
| External required data | |
| Decomposition into functions/subfunctions | |

### 5.1.12.7 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 | |

### 5.1.12.8 E functions

| E1 / Data Aggregation & Processing | |
|---|---|
| Description | If needed to consider the prosumer (or many prosumers) in a larger context their energy usage data can be aggregated and all the data |

| E1 / Data Aggregation & Processing | |
|---|---|
| | related to their energy usage (sensor data, IoT data) can be processed for the main optimisation. |
| Inputs | Energy usage and related data from the prosumers |
| Outputs | Aggregated and pre-processed data |
| External required data | |
| Decomposition into functions/subfunctions | |

| E2 / Optimisation & Control signal / feedback generation | |
|---|---|
| Description | The energy usage and related data are here processed, and optimisation processes are executed. This might involve also training of Digital Twins. The output of these is a summary that covers the improvement suggestions (feedback) or directly applicable steering signals that can be executed on the appliances within the households. |
| Inputs | The pre-processed or aggregated energy usage and related data from the monitored prosumers. |
| Outputs | The feedback (suggestion on the energy usage change) or direct steering signals to be applied on the appliances |
| External required data | The optimisation process may use external data on energy price, CO2 generation, weather, etc., as additional drivers. |
| Decomposition into functions/subfunctions | |

### 5.1.12.9 P2PM functions

| P2PM1 / Bid Matching among peers | |
|---|---|
| Description | Based on the energy forecasts and the prosumer's preference the energy to be exported or imported from other peer of the energy community or from the contracted retailer is identified. |

| P2PM1 / Bid Matching among peers | |
|---|---|
| Inputs | Bids |
| Outputs | Traded Quantities/Prices |
| External required data | |
| Decomposition into functions/subfunctions | |

### 5.1.12.10 Billing function

| B / Billing | |
|---|---|
| Description | In this process the service provider gets the payment for the service, the results are evaluated, and their value is defined. |
| Inputs | Energy Usage data |
| Outputs | |
| External required data | |
| Decomposition into functions/subfunctions | |

### 5.1.12.11 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 |
| Outputs | Delivered flexibility (how much, when, …) |
| External required data | Metering data |

| SP1 / Quantify delivered flexibility | |
|---|---|
| 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<br><br>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<br><br>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 | |

## 5.1.13 Arrows (information flows)

### 5.1.13.1 Summary of Relevant Interfaces per Generic Business Process

| Interface | GBP 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| P1 → A1 | (✓) | (✓) | (✓) | | | | |
| A1 → A2 | (✓) | | (✓) | | | | |
| P1 → A2 | ✓ | | ✓ | | | | |
| A1 → A5 | | (✓) | | | | | |
| P1 → A5 | | ✓ | | | | | |
| A2 → M2 | ✓ | | | | | | |

| Interface | GBP 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 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 | | | | | ✓ | | |
| P2PM1 → SS | | | | | | | ✓ |
| S1 ↔ Ext | ✓ | | | | | | |
| S2 ↔ Ext | | | ✓ | | | | |
| S6 ↔ Ext | | ✓ | | | | | |
| M1 ↔ Ext | | | ✓ | | | | |
| M2 ↔ Ext | ✓ | | | | | | |
| ~~A4 ↔ Ext~~ | | | | | | | |
| P1 ↔ Ext | ✓ | ✓ | ✓ | | | | |
| P2 ↔ Ext | ✓ | ✓ | ✓ | | | | |
| P4 ↔ Ext | | | | ✓ | | | |
| P7 ↔ Ext | | | | | | ✓ | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A2 → M1 | | | ✓ | | | | |
| B1 → B2 | | | ✓ | | | | |
| B2 → M1 | | | ✓ | | | | |
| M1 ↔ S2 | | | ✓ | | | | |
| P7 → E1 | | | | | | ✓ | |
| E1 → E2 | | | | | | ✓ | |
| E2 → P8 | | | | | | ✓ | |
| P8 → B | | | | | | ✓ | |
| P9 → P10 | | | | | | | ✓ |
| P10 → P2M1 | | | | | | | ✓ |
| P2PM1 → P11 | | | | | | | ✓ |
| P9 ↔ Ext | | | | | | | ✓ |
| P10 ↔ Ext | | | | | | | ✓ |
| P11 ↔ Ext | | | | | | | ✓ |
| A10 ↔ Ext | | | | ✓ | | | |
| SP1 → SP2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| SP2 → SP3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| SC1 → SC2 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| SC2 → SP3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| SP3 → SP4 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| SP4 ↔ SC3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |
| SP1 ↔ Ext | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ |

#### 5.1.13.2 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<br><br>Flexibility Service Provider |
| List of exchanged data | Flexibility offer (what, when, where, how much, …)<br><br>Could be: |

| P1 → A2 | |
|---|---|
| | • 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).<br>• *Granularity* of the timeseries, its *length* (horizon) and *unit* is also contained in message description.<br>• Location: geographical (latitude and longitude) or grid-related (substation ID or connection point)<br>• Communication endpoints for central EMS (or individual assets)<br><br>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, …) |

<u>Option 2: no aggregation</u>

| P1 → A2 | |
|---|---|
| Purpose | Inform Flexibility Service Provider about possible flexibility on Flexibility Provider side for the next hour/day/… |
| Involved roles | Flexibility Provider<br><br>Flexibility Service Provider |
| List of exchanged data | Flexibility offer (what, when, where, how much, …)<br><br>Could be:<br><br>• 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). |

| P1 → A2 | |
|---|---|
| | • *Granularity* of the timeseries, its *length* (horizon) and *unit* is also contained in message description.<br>• Location: geographical (latitude and longitude) or grid-related (substation ID or connection point)<br>• Communication endpoints for central EMS (or individual assets)<br><br>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. |

## 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<br><br>Flexibility Service Provider |
| List of exchanged data | Flexibility offer (what, when, where, how much, …)<br><br>Could be:<br><br>• 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).<br>• *Granularity* of the timeseries, its *length* (horizon) and *unit* is also contained in message description.<br>• Location: geographical (latitude and longitude) or grid-related (substation ID or connection point)<br>• Communication endpoints for central EMS (or individual assets)<br><br>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 |

| P1 → A5 | |
|---|---|
| | 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). |
| 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<br><br>Flexibility Service Provider |
| List of exchanged data | Flexibility offer (what, when, where, how much, …)<br><br>Could be:<br><br>• 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).<br>• *Granularity* of the timeseries, its *length* (horizon) and *unit* is also contained in message description.<br>• Location: geographical (latitude and longitude) or grid-related (substation ID or connection point)<br>• Communication endpoints for central EMS (or individual assets)<br><br>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 |

| P1 → A5 | |
|---|---|
| | 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<br><br>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<br><br>Flexibility Facilitator |
| List of exchanged data | Flexibility request (what, when, where, how much, …) |
| **B2 → M2** | |
| Purpose | Place flexibility request |
| Involved roles | Flexibility Facilitator<br><br>MO |
| List of exchanged data | Flexibility request (what, when, where, how much, …) |

**S1 → M2**

Option 2: direct

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

**M2 → S3**

Option 1: through Flexibility Facilitator

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

| M2 → S3 |
|---|

Option 2: direct

| M2 → S3 | |
|---|---|
| Purpose | Inform about flexibility transaction/agreement |
| Involved roles | MO<br><br>Flexibility Consumer |
| List of exchanged data | Flexibility order (what, when, where, how much, …) |

| M2 → A8 | |
|---|---|
| Purpose | Inform about flexibility transaction/agreement |
| Involved roles | MO<br><br>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, …) |

| A8 → P2 | |
|---|---|

| A3 → P2 | |
|---|---|
| Purpose | Inform about flexibility activation to be scheduled (disaggregated) |
| Involved roles | Flexibility Service Provider<br><br>Flexibility Provider |
| List of exchanged data | Flexibility order (what, when, where, how much, …) |

Option 2: no aggregation

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

| A5 → S5 | |
|---|---|
| Purpose | Bid/offer for bilateral agreement (iterative phase)<br><br>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<br><br>Flexibility Service Provider |
| List of exchanged data | Imbalance Settlement period and its duration. Hourly table of flexibility and corresponding offer<br><br>request/bid for flexibility in specific slot(s) of time<br><br>Validation/refusal message<br><br>Reconsider offers until all the forecasted energy requirement is safely satisfied.<br><br>Lead time; Time before the (recurring) flexibility option expires.<br><br>Problematic point (node)<br><br>Remuneration scheme<br><br>Others:<br><br>• Maximum number of activations<br>• Minimum time between activation<br>• Penalties for deviation from contract |

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

| A6 → S7 | |
|---|---|
| Purpose | Flexibility response |
| Involved roles | Flexibility Consumer<br>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<br>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 |

| A6 → P2 | |
|---|---|
| | 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<br>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<br>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<br><br>MO |
| List of exchanged data | Flexibility offers and offer results (what, when, where, how much, …)<br><br>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<br><br>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<br><br>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<br><br>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<br><br>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<br><br>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<br><br>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 |

| P7 → E1 | |
|---|---|
| Purpose | Share all the data necessary to provide the prosumer with feedback |
| Involved roles | |
| List of exchanged data | Energy usage data, data related to energy usage (many options possible, including sensor data and IoT data) |

| E1 → E2 | |
|---|---|
| Purpose | Provide necessary near real-time and historical data to train the necessary models used by the optimisation engine of the ESCo. |
| Involved roles | Prosumer and ESCo |

| | |
|---|---|
| List of exchanged data | 1 Metering data (total consumption, consumption of individual appliances)<br>2 Sensoring data (indoor temperature, occupancy, humidity, luminance, etc.)<br>3 Weather data<br>4 Monitoring data (appliances status (on/off), appliances mode of operation) |

| E2 → P8 | |
|---|---|
| Purpose | Send optimised operational schedule to the prosumer for achieving the desired goal (e.g., save energy, save money from energy bills, maximise their self-consumption, etc.) |
| Involved roles | Prosumer, ESCo |
| List of exchanged data | 1 Recommendations on optimum operation of controllable appliances for implementation of manual actions by the prosumer<br>2 Control signals to gateway of prosumer for automatic implementation of optimal operational schedule by applicable controllable devices. |

| E2 → B | |
|---|---|
| Purpose | Estimate of the process results from the ESCO |
| Involved roles | ESCO |
| List of exchanged data | To be defined how these results are estimated |

| P8 → B | |
|---|---|
| Purpose | Process results from the prosumer |
| Involved roles | Prosumer |
| List of exchanged data | To be defined how these results are provided |

| P9 → P10 |
|---|

| | |
|---|---|
| Purpose | Realise the actual needs of the prosumer (to either buy energy to cover demand or sell surplus generation). Should flexibility be considered, the purpose is to realise the needs of the prosumer while respecting their comfort and convenience and achieving certain optimisation goals, such as maximising the consumption of local generation. |
| Involved roles | Prosumer |
| List of exchanged data | 1 Demand forecast or flexibility forecast (baseline demand forecast plus upwards/downwards available flexibility)<br>2 Generation forecast |

| P10 → P2PM1 | |
|---|---|
| Purpose | Realise the available generation, as well as the total demand at community/local market level. Realise the needs of each prosumer within the community/local market (incl. energy needs and needs relating to comfort and convenience). |
| Involved roles | Prosumer, P2P Market Operator |
| List of exchanged data | 1 Selling bid: Prosumer-level generation surplus<br>2 Buying bid: Prosumer-level demand needs |

| P2PM1 → P11 | |
|---|---|
| Purpose | Provide result of trading |
| Involved roles | P2P Market Operator, Prosumer |
| List of exchanged data | Traded Quantity/Price |

| 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<br><br>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<br><br>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<br>Flexibility Consumer |
| List of exchanged data | Price signals |

| P2PM1 → SS | |
|---|---|
| Purpose | Trade settlement |
| Involved roles | P2P Market Operator |
| List of exchanged data | Traded Quantity/Price |

### 5.1.13.3 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 |

| S2 ↔ Ext | |
|---|---|
| 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 |

| P1 ⟷ Ext | |
|---|---|
| | 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 |

| P7 ⟷ Ext | |
|---|---|
| Purpose | Gather all necessary prosumer-level data required by the ESCo for optimising the operation / use of household appliances of the prosumer |
| Involved roles | Prosumer |
| List of exchanged data | 1 Total consumption<br>2 Consumption of individual (controllable) appliances<br>3 Status and mode of operation of individual (controllable) appliances<br>4 Indoor ambient conditions |

| P9 ⟷ Ext |
|---|

| | |
|---|---|
| Purpose | Calculate the energy demand and energy generation (where applicable) forecasts required for understanding the bid needs of a prosumer. |
| Involved roles | Prosumer |
| List of exchanged data | 1. Energy measurements (generation and consumption)<br>2. Weather conditions |

| **P10 ⟷ Ext** | |
|---|---|
| Purpose | Retrieve energy price data from the market enabling the proper calculation of the bids. |
| Involved roles | Prosumer |
| List of exchanged data | Energy Prices |

| **P11 ⟷ Ext** | |
|---|---|
| Purpose | Decide on the P2P transactions to take place among peers of the community/local energy market based on prosumer-level needs and energy prices. |
| Involved roles | P2P Market Operator |
| List of exchanged data | 1. Energy Prices for local energy market<br>2. Grid energy prices |

| **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 |

### 5.1.13.4 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<br><br>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<br><br>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<br><br>Flexibility Service Provider |
| List of exchanged data | Flexibility transaction data<br><br>Payment information |

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

**GETTING IN TOUCH WITH THE EU**

## In person

All over the European Union there are hundreds of Europe Direct centres. You can find the address of the centre nearest you online (european-union.europa.eu/contact-eu/meet-us_en).

## On the phone or in writing

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
- at the following standard number: +32 22999696,
- via the following form: european-union.europa.eu/contact-eu/write-us_en.

**FINDING INFORMATION ABOUT THE EU**

## Online

Information about the European Union in all the official languages of the EU is available on the Europa website (europa.eu).

## EU publications

You can view or order EU publications at op.europa.eu/en/publications. Multiple copies of free publications can be obtained by contacting Europe Direct or your local documentation centre (european-union.europa.eu/contact-eu/meet-us_en).

## EU law and related documents

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex (eur-lex.europa.eu).

## Open data from the EU

The portal data.europa.eu provides access to open datasets from the EU institutions, bodies and agencies. These can be downloaded and reused for free, for both commercial and non-commercial purposes. The portal also provides access to a wealth of datasets from European countries.

Publications Office of the European Union

The Service Contract (n. CINEA/2023/OP/0001/SI2.901723) supports BRIDGE activities, funded by the EU.