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Deliverable D8.7: Scalability and replicability analysis: recommendations and implementation guidelines

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Abstract

To identify barriers and opportunities, and provide policy recommendations, the FEVER project has performed a scalability and replicability analysis of the key exploitable results, as well as that of the solutions demonstrated in the demonstration/trial sites. For this purpose, Key Performance Indicators (KPIs) were identified and presented to solution developers and trial sites responsible partners for a semi-quantitative evaluation using the Likert scale (rating scale commonly used in surveys for subjective evaluations). Additionally, questions related to each KPI were asked and the outcome is herein presented. Last but not least, a collection of barriers, opportunities, challenges and success stories is included. The implemented methodology for KPI identification, figures and corresponding outcomes are herein presented. Additionally, recommendations for improvement are included. Such an analysis proved to be beneficial in providing feedback on the state of the art for interested stakeholders.

Keyword list

Scalability, Replicability, Analysis, SRA, flexibility, service provider, local flexibility market, local energy market, distribution system operator, DSO, digitalisation, digitisation, aggregator, peer-to-peer, P2P, trading, blockchain, energy communities, automation, smart grid, demand response, energy management system, flexibility, trading platform, market mechanism, industry, vehicle-to-grid, V2G, vehicle-to-home, storage, battery

Executive summary

The FEVER scalability and replicability analysis brings together the most important results of the project and analyses them in a way that they can be compared to one another, by asking solution developers to rate their solutions through the same Key Performance Indicators (KPIs). But, the FEVER solutions are most relevant when acting together, reason for which the experience of the pilots is additionally evaluated through a similar approach. Last but not least, by requesting barriers and opportunities related to market design, regulation and the stakeholder ecosystem, the most significant and challenging issues were identified and collected for the consideration of the interested readers.

Particular focus was given to KPIs with economic, regulatory and social (i.e. stakeholder) considerations. Having said that, technological KPIs are also included for the case of the individual solutions. The role of standards and interoperability was explored and included in the analysis. These have proven to be a central element of the FEVER project. Based on the existing literature, as well as on the BRIDGE scalability and replicability guidelines, KPIs were developed, identified, selected and implemented the result is presented herein.

Generally, FEVER solutions show to be advanced in their technical development, but they lag when it comes to regulatory and social indicators. Profitability seems promising, but it is often dependent on supportive regulatory frameworks. The solution's state with relation to the implementation of standards is advanced overall, and the implementation of the FlexOffer has proven useful for providing the required capability of an information standard to enable flexibility trading. Worth noting, many solution developers consider the solutions presented here as enablers for achieving the energy transformation, including those related to sector coupling.

Pilot sites have identified barriers and opportunities with relation to the specific use case implementations involved in each of the pilots. These provide insight from a perspective which is closer to that of the end users.

Given the semi-quantitative approach involved herein, exchanges with partners both for KPI development and for reaching a common understanding of the meaning of the selected KPIs and the scoring system involved have shown to be relevant elements for continuous development throughout the project. For this reason, limitations for the implementation of the methodology were developed and are described.

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1 Introduction

The project "Flexible Energy Production, Demand and Storage-based Virtual Power Plants for Electricity Markets and Resilient DSO Operation (FEVER)" started in February 2020 and is in the process of finalisation. The final phase was focused on carrying out the activities implemented on the trial sites and developing the final assessments of the solutions. In this deliverable, the scalability and replicability of the solutions is analysed. In this context, attention to the elements limiting the uptake of solutions is given. As a whole, FEVER enables different forms of local flexibility markets (LFM) to take place: going from the decentralized, blockchain-based markets, through independent, centrally operated markets, all the way to markets operated by nominated energy market operators. Numerous limitations, challenges and opportunities have been encountered from the perspective of both solution developers and of the trial sites; giving this analysis a more holistic view on the road ahead. Additionally, the applied methodology is thoroughly described and made available for other projects seeking to carry out similar analyses. Overall, the technologies developed within FEVER have a promising path ahead. However to enable flexibility to become a solution in accelerating the societal transition towards sustainability in the energy sector, both regulatory and stakeholder related factors need to be tackled.

1.1 Task 8.5: Scalability and replicability analysis: regulatory context and obstacles to innovation

This deliverable is set in Task 8.5 "Scalability and replicability analysis: regulatory context and obstacles to innovation" which aims at conducting a qualitative non-technical Scalability and Replicability Analysis (SRA) on the real-life demos in Germany, Spain and Cyprus as well as in the simulation in Greece. This analysis will assess the regulatory framework and the perspective of involved stakeholders with regards to opportunities as well as obstacles to innovation. To achieve this, existing regulations in the pilots' countries, their influence on the operation of the pilots and the consequences on business models will be mapped, and policy recommendations will be framed.

1.2 Objectives of the work reported in this deliverable

The objective of this deliverable is to identify obstacles and opportunities (from multiple perspectives) for the solutions developed within the FEVER project, as well as the FEVER ecosystem as a whole. It includes the identification of requirements for regulatory-led support, the societal challenges for solution uptake and the context of the business environment; additionally, it attempts at clarifying the potential contribution of FEVER results to the advancement of the energy system transformation.

1.3 Outline of the deliverable

The deliverable is separated into four sections:

1. Methodology: shows the outcome of the literature review and describes the approach.
2. Results: provides the results of the SRA, including figures and text-based responses.
3. Impact on pilot sites: presents a secondary SRA in which trial sites were analysed.
4. Recommendations: presents a collection of barriers and opportunities as a result of the SRA. How to read this document

Useful background information to read this document are deliverables which can be found in FEVER website (https://fever-h2020.eu/About/Deliverables),

- D1.1 - Flexibility at the distribution grid: Reference usage scenarios for market and system operation services [1]
- D1.2 - Functional and operational requirements [2]
- D1.3 - System architecture and technical specifications
- D7.3 – Pilot's validation report
- D8.5 - Report on business model assessment, market analysis, regulatory context assessment and preliminary exploitation assessment [3]

Furthermore, SG-CG/M490/K_ SGAM usage and examples [4] and Bridge guidelines [5] are recommended as background information.

2 Literature review & resulting methodology

To prepare the FEVER SRA, existing approaches of the literature were reviewed and, according to the task (T8.5) of the project, the herein presented methodology was developed and applied. This methodology has been mainly based on the BRIDGE Guidelines for implementing the prescribed methodology [5] (referred to as the BRIDGE guidelines throughout this document) of the BRIDGE Scalability and Replicability Task Force, but has also been considerably influenced by other literature, mostly due to necessary adaptations related to the commitments of the Grant Agreement. These commitments differ from the BRIDGE guidelines, mainly in that a non-technical assessment is to be pursued.

2.1 BRIDGE Guidelines

In the BRIDGE guidelines, the following four subroutines are identified:

1. Mapping of project objectives into Smart Grid Architecture Model (SGAM) architecture
2. Key Exploitable Results (KER) identification
3. Quantifiable KPIs identification
4. Results analysis, identification of limitation factors and alternative solutions

The first point of the previous numbered list is addressed in D1.3, in which a mapping of project objectives into SGAM was carried out. Given the relevance of interoperability for scalability and replicability, the SGAM interoperability layers have been deeply explored and considered for this work.

For the second sub-routine of the BRIDGE guidelines, the KERs were identified in a collaborative effort with the FEVER project partners. The proposed mapping of objectives with relation to SGAM layers and KERs was not performed (related to Table 5 of the BRIDGE guidelines), but is commented in section *5.2 Other barriers and opportunities* of this deliverable. Given the context, the project's, main actor's and High Level Use Case (HLUC) objectives have been considered and are presented in the developed methodology. The main advancements and the replicability and scalability indices proposed in the BRDIGE guidelines have been addressed and can be seen under section 2.6.1 below.

For the third subroutine, an alternative approach has been pursued. It is based on a self-conducted analysis, which is influenced by a broad literature review and exchanges with partners. Especially, members from UP and ICOM. Given the context, it does also include indicators from the BRIDGE guidelines. Instead of a quantitative approach, a semi-quantitative, Likert scale-based approach is implemented. For a technical and quantitative assessment, related indicators have been developed in the scope of D7.3. KPIs were categorised according to the KPI attributes of the BRIDGE guidelines. The KPI attributes are:

- Technical
- Economic
- Environmental
- Social
- Legal

Finally, the results analysis is shown in section 0 below. The critical parameters of subroutine #4 have been addressed. The herein addressed parameters are:

- Proprietary solutions that require the development of open standards in linking them to the various SGAM layers.
- Missing information standard
- Missing system code
- Missing market rule or mechanism

2.2 SRA Literature

The literature review, accompanied by the recommendations of the BRIDGE guidelines, brought great insight into the state of the art of SRA's in the field of smart grid / smart city implementations. A broad overview of the analysis is herein presented. A paper by Sigrist et al., 2016 [6] which has shown to be very influential in the literature, proposes the following structure (BRIDGE attributes are equivalent to areas and, more broadly, KPIs to factors) for performing an SRA:

Table 1. Summary of factors. Own depiction based on Sigris et al. [6]

Area	Scalability factors	Replicability factors
Technical	Modularity	Standardisation
	Technology evolution	Interoperability
	Interface design	Network configuration
	Software integration	
	Existing infrastructure	
Economic	Economies of scale	Macroeconomics
	Profitability	Market design
		Business model
Regulatory	Regulation	Regulation
Stakeholder acceptance	Acceptance	Acceptance

One can appreciate the "area's" resemblance to the aforementioned KPI attributes. Our usage of the information in [6] can be found in sections 2.6.2.1 to 2.6.2.3, below. This structure, including some factors, has often been encountered in the literature and approached in various ways by the reviewed projects implementing (semi-quantitative) SRA methodologies. Some of the accessed deliverables are:

Table 2. Table of references from other project SRAs

Project	Title
CLUE	D8.2 The scalability and replicability analysis of local energy community solutions [7]
Crossbow	Scalability and replicability analysis of smart grid projects: Insights from the H2020 CROSSBOW project [8]
EUniversal	D10.2 Methodology and scenarios for the EUniversal Scalability and Replicability Analysis [9]
EU-SysFlex	D10.4 Assessment of the scalability and replicability of EUSysFlex solutions [10]
integrid	D8.3 Replication Roadmap [11]
InterFLEX	D3.8 Scalability and replicability analysis (SRA) for all use cases [12]
ReFlex	Replicability Concept for Flexible Smart Grids [13]
ReUseHeat	D2.9 Scalability, replicability and modularity [14]

2.3 FEVER Objectives analysis

The objectives of FEVER were carefully defined in D1.1 and D1.2, and are herein presented for your reference. These were defined in the following ways:

- Project objectives
- Business use case objectives
- High level use case objectives
- Primary & secondary use case objectives (not presented herein)
- Objectives from the main actor's perspective (Distribution System Operator (DSO), Market Operator (MO), Energy Community)

These objectives were considered in the design of the questionnaire and in the selection of KPIs.

The FEVER's project objectives lie on three keys axes:

1. To implement flexibility measures and comprehensive flexibility aggregation, management and trading solutions, in order to provide electricity grid services, such as congestion management and overvoltage avoidance, at the distribution grid.
2. To implement enhanced monitoring and automated control of the distribution grid, by developing an innovative toolbox and implementing advanced technology that leverages flexibility form distributed resources towards providing ancillary services.
3. To implement market mechanisms and tools that support and incentivize flexibility services. These mechanisms concern different market structures and time-horizons (day-ahead and continuous trading of flexibility services, centralized and local/regional markets).

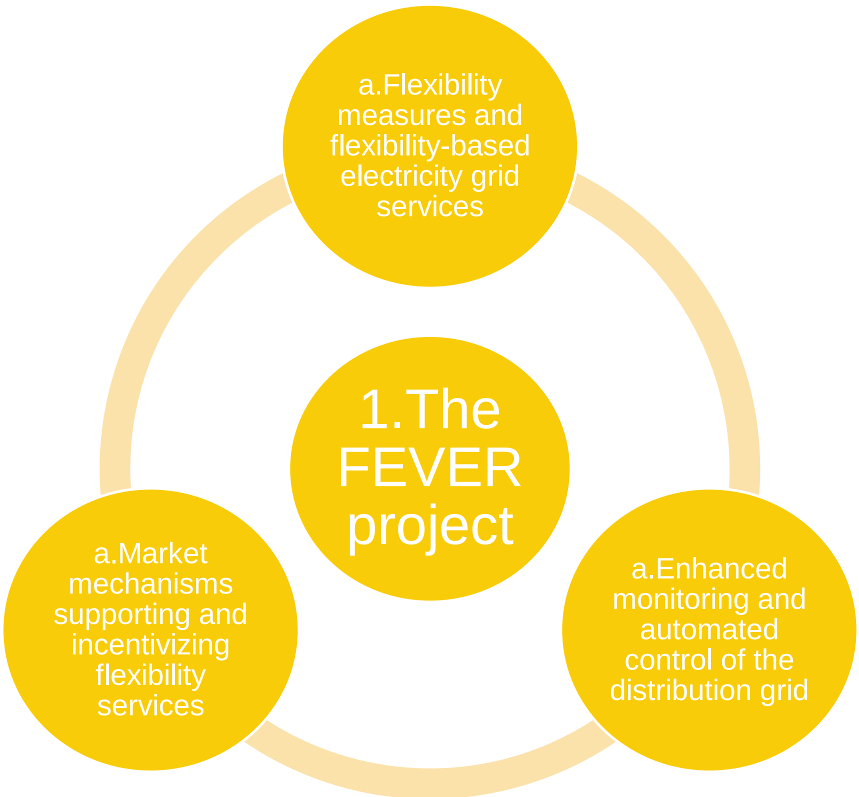

Figure 1. FEVER project objectives

Table 3. Business Use Case objectives

#	Goal	Related HLUCs
1	Minimize/delay network reinforcement costs.	**1, 2, 8, 12**
2	Increase network security and resilience.	**3, 4, 5**
3	Enhance network operational efficiency & quality of supply.	**6, 7**
4	Introducing new market mechanisms that facilitate Distributed energy resources (DER) flexibility exploitation in day-ahead and real-time balancing markets.	**9, 11**
5	Introduce new market mechanisms facilitating DER flexibility exploitation located at distribution level considering intra-day and close to real-time timeframes.	**10, 13, 14**
6	Strives for an overall system optimum with comprehensive energy supply and consumption orientation, targeting inclusion of all energy vectors. Governance policies and incentive mechanisms like special tariffs or pseudo-currencies will be explored.	**15**

Table 4. HLUCs' objectives

#	Short HLUC Name	HLUC Objectives
1	Congestion management – DER & grid flexibility	The objective of this use case is to **prevent network congestion issues at distribution level and consequently minimize/delay network reinforcement costs** by combining DSO's conventional network remedial mechanisms with DER flexibility remuneration whenever this is technically and economically viable.
2	Voltage compensation via reactive power	The objective of this use case is to **prevent voltage issues at distribution level and consequently minimize/delay network reinforcement costs** by exploiting reactive energy flexibility provided by distributed storage units.
3	Uncontrolled islanding through storage	The objective of this use case is to **enable the real-time detection and mitigation of uncontrolled islanding** based on grid, Power Electronics Device (PEDs) and DER asset monitoring data aiming to **increase the security and resilience of the distribution grid**.
4	Self-healing – DER & gid flexibility	The objective of this use case is to consider the usage of advanced and/or extend existing **grid tools for managing the network operation under critical conditions** (including extreme weather conditions) aiming to increase the security and resilience of the distribution grid.
5	Flexibility for microgrid operation	The objective of this use case is to **ensure the power security of an islanded microgrid** and increase the reliability of the distribution network.

6	DER flexibility for enhanced efficiency	The objective of this use case is the exploitation of **flexibility from distributed resources for minimizing the network technical losses and increasing network operational efficiency**. DSOs will gain financial benefits by avoiding regulated penalties for increased network losses.
7	Improved power quality and loss reduction through storage	The objective of this use case is to **enhance network operational efficiency**, in terms of technical network power losses, and to **ensure power quality of supply**.
8	Flexibility for connected microgrid	The objective of this use case is to optimize the **microgrid operation for providing flexibility services to the DSOs** via flexibility market.
9	Day-ahead market mechanism	The objective of this use case is to provide an intra-day flexibility market mechanism to exploit the flexibility sitting in distribution grid for grid operation support.
10	Intraday market mechanism	The objective of this use case is to provide a common Transmission system operator (TSO)/DSO market where a clearing platform will foster the integration of energy flexibilities located on both transmission and distribution grids into balancing electricity market considering transmission and distribution network constraints, simultaneously
11	Real-time market mechanism	The objective of this use case is to provide a common TSO/DSO market where a clearing platform will foster the integration of energy flexibilities located on both transmission and distribution grids into balancing electricity market considering transmission and distribution network constraints, simultaneously.
12	Dynamic tariffs based on flexibility	The objective of this use case is to provide the mechanism for creating **dynamic tariffs based on flexibility use** in the actual regulatory framework and **remuneration for costs for extraction of flexibilities** in the scope of equivalent or actual operative close down in the actual regulatory framework.
13	Improving flexibility through sector-coupling	The objective of this use case is to **increase** the available **flexibility** capacities within the balancing group achieved **by creating synergies among electricity, gas and transportation sectors** within a balancing group and consequently to increase BRP's portfolio and can reduce its balancing costs.
14	Regional flexibility exchange	The objective of this use case is the development of a **regional trading mechanisms** which will facilitate the trans-regional flexibility trading **among BRPs for minimizing their balancing costs**.
15	Peer-to-peer (P2P) flexibility trading	The main objective of the use case is to provide a pilot testing case for **two-level trading of energy flexibilities in closed community markets**.

Table 5. Main objectives of key business actors – the DSO's perspective

Actor	Goals from the DSO's perspective
DSO	1. Minimize/delay network reinforcement costs 2. Increase network security and resilience 3. Enhance network operational efficiency & quality of supply
FEVER MO	Develop the market framework and mechanisms enabling active & reactive power flexibility trading for grid support
Flexibility Aggregator	Offering aggregation management services to Flexibility Service Providers (FSPs)
Flexibility Service Provider	Revenues from offering flexibility services to energy stakeholders
Flexible Prosumer	Optimize flexible resource management and maximize profits

Table 6. Main objectives of key business actors – the market operator's perspective

Actor	Goals from the market operator's perspective
MO	Introduce new market mechanisms facilitating DER flexibility integration in distribution grid
System Operators (DSO/TSO)	Ensure the reliable and secure network operation
Flexibility Aggregator	Offering aggregation management services to FPSs
Flexibility Service Provider	Revenues from offering flexibility services to energy stakeholders
Flexible Prosumer	Optimize flexible resource management and maximize profits

Table 7. Main objectives of key business actors – the energy communities' perspective

Actor	Goals from the energy communities' perspective
Energy Community	1. Provide environmental, economic or social community benefits for their members or the local area. 2. Strives for an overall system optimum with comprehensive energy supply and consumption orientation, targeting inclusion of all energy vectors. 3. Explore governance policies and incentive mechanisms like special tariffs or pseudo currencies.

2.4 SGAM Mapping

The Smart Grid Architecture Model (SGAM) has received special attention for both applying and developing FEVER project overview KPI sets and KER-specific questions. As opposed to showing the graphic representation of the SGAM, which includes its zones, domains and interoperability layers, we highlight the following figure, which shows the SGAM toolbox architecture framework and, with it, SGAM's interoperability layers. This figure was very helpful in guiding the work involved in this SRA, as it graphically shows the relationships between layers and conveniently explains the layers in a form which fits our use case approach. For a closer look into the depiction of FEVER objectives into the SGAM, you may refer to D1.3.

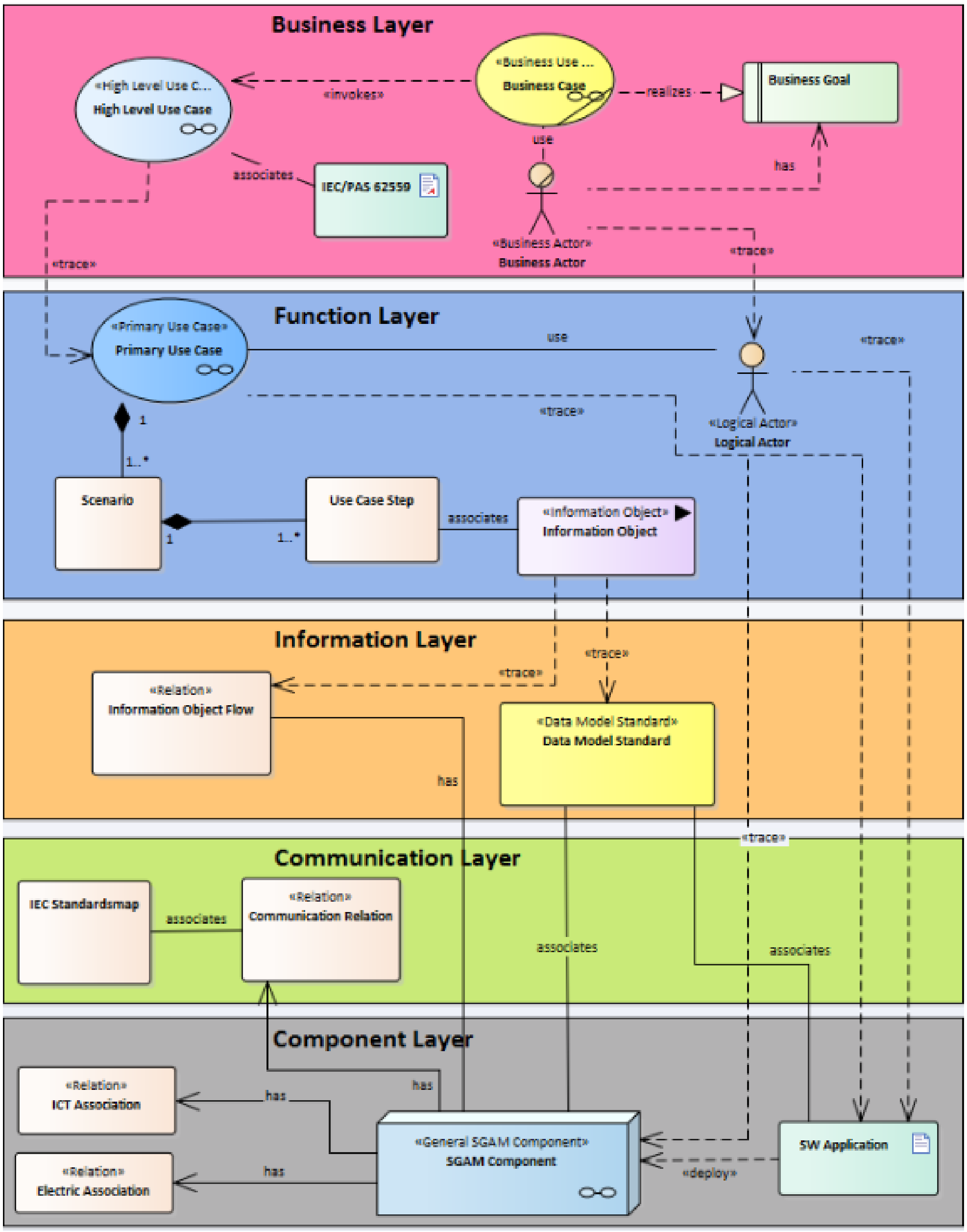

Figure 2. SGAM Toolbox Architecture Framework [15]

2.5 KER Identification

After gathering and analysing the exploitable results through D8.5, special attention has been given to those selected as KER. A grouping of FEVER's KERs can be seen in the following table:

Table 8. FEVER KERs

KER Cluster		KER
DSO Toolbox		DSO Toolbox
		Critical Event Prevention Application / Loss Reduction Application
		Algorithm for fault detection
		Algorithms for PV generation forecasting
		Algorithms for low voltage (LV) grid observability
Flexibility Management Aggregation and Trading solutions		**Flexibility Trading Platform**
		Flexibility Service Providing Agent (FSPA)
	P2P Toolbox	Flex Trading Decentralized Application (DAPP)
		FlexCoin DAPP
		Community Manager DAPP
xEMS		**Factory Energy Management System (FEMS)**
		Microgrid Operation Scheduler
DER (incl. FEVER-developed EMS)		**Vehicle-to-Grid (V2G) Charger**
Market Mechanism		**Intraday Market Mechanism (IDMM)**
Knowledge Community		**FlexCommunity**

These KERs were selected by the project partners from a list of 25 exploitable results (accessible in D8.5). The KERs analysed in this SRA are presented in blue in the table above.

Additional insight was provided by the developers of the Algorithms for low voltage grid observability (i.e. Low Voltage Grid Observability Service, part of the DSO Toolbox) and the FlexCoin and Community Manager DAPPs (i.e. FlexCoin and CM DAPPs; part of the P2P Toolbox), who evaluated their KERs separately. This input is not included in the project overview KPI sets and does not influence the scores of the *Toolboxes* themselves (i.e. it was not averaged or factored-in in any way for any Toolbox related KPI, but only presented separately).

The selected KERs satisfy a broad overview of the FEVER approach. To more easily grasp the corresponding ecosystem, you may refer to the following figure, in which the FSPA (which can be found in FSP, aggregator and energy community solutions) is not directly represented, but is a necessary building block for enabling the trading of FlexOffers:

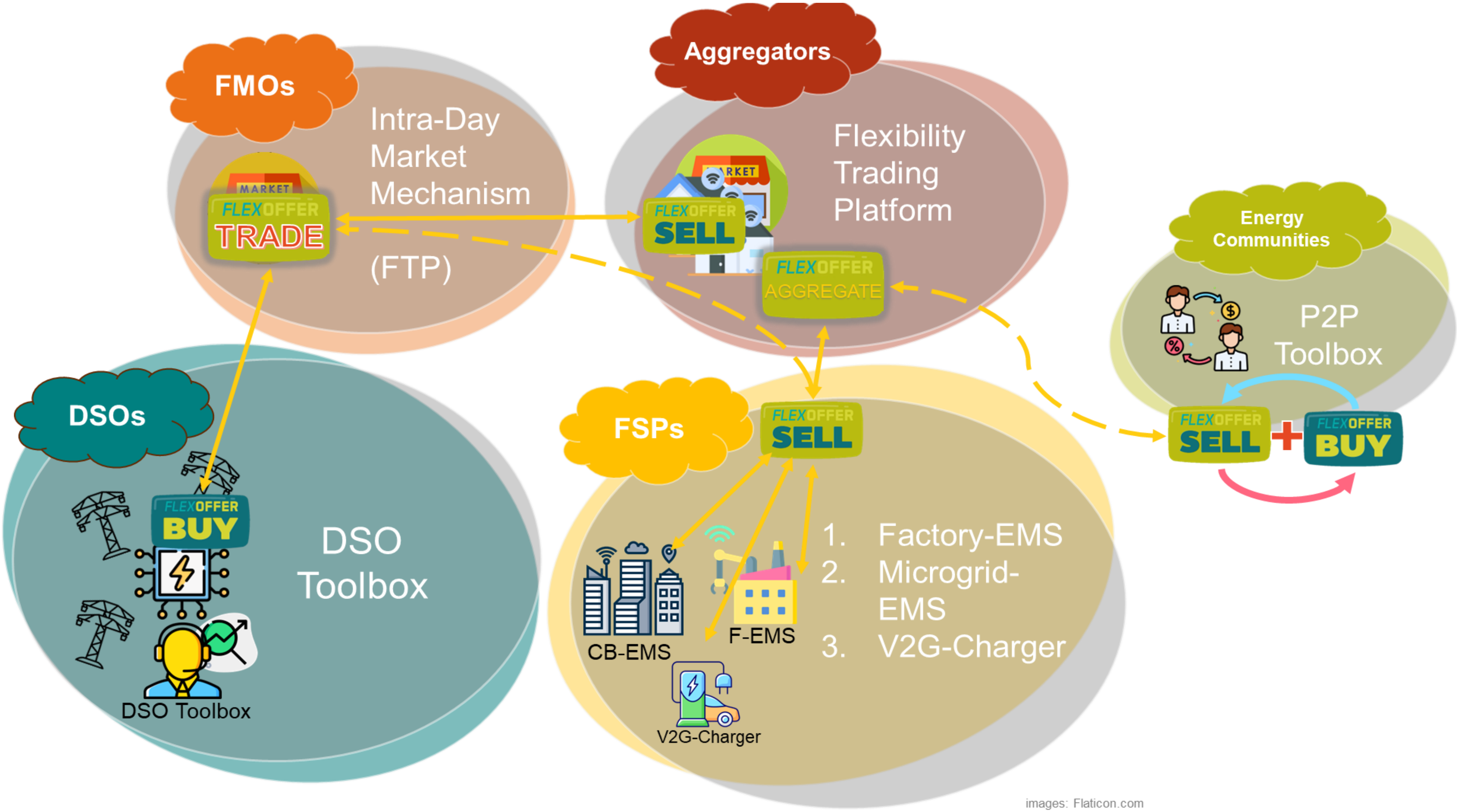

Figure 3. FEVER KER interoperability overview

2.6 KPI identification and implementation approaches

Our list of KPIs is presented and further explained in this section. The identification of relevant KPIs was mainly based on the BRIDGE guidelines, the literature review and, to some extent, on the project objectives (see section *5.2 Other barriers and opportunities* for an analysis of related limitations); as well as the experience gathered through T8.3. This was followed by discussions with project partners. Particular focus has been given to expanding the exploration of non-technical obstacles to innovation. More specifically, the focus has been given to the regulatory, social and economic attributes presented herein. The following figure presents an overarching view of the KPIs:

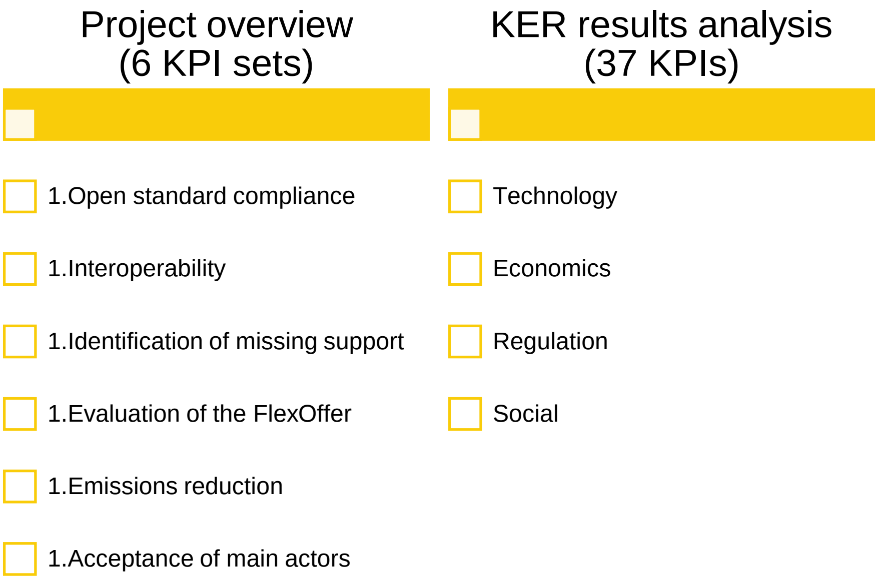

Figure 4. KPI structure

The **first section** includes replicability indices and critical parameters from the BRIDGE guidelines, followed by the FlexOffer (key element of our scalable and interoperable local flexibility trading ecosystem), environment and stakeholder ecosystem sub-sections. These results are presented through heat maps which enable for the “overview data” to be easily digested.

The **second section** (described in detail under section *2.6.2 Resulting KER analysis KPIs*) follows the aforementioned KPI attributes structure. It is separated into two main sections (which both share the same attribute structure); one for scalability and the other for replicability. Replicability is, then, separated into two sub-sections as follows:

- KER analysis
  - Scalability
  - Replicability
    - KER performance
    - External factors affecting KER replication

The KER analysis section follows a common approach (as found in the literature, e.g. in [7], [8], [14], [16], [17]) of presenting results per KER in the form of spider graphs (having said that, pizza charts and polar graphs are sometimes used with a similar visual effect and more capability for customisation). Three spider graphs per KER are considered, namely one for scalability and two for replicability (one for KER performance and one for the external factors).

2.6.1 Resulting project overview KPI sets

Due to the methodology related to this section being presented together with the results (i.e. in the results section) to facilitate their analysis, a broad overview and abstract definition for the KPIs sets related to this section is herein presented. In consequence, further detail on each KPI set is not provided in the current section. Following the resulting methodology, the KPI sets of the SRA questionnaire gather the following information (results can be found under section 3.1 below):

- **Open standard compliance:** KER's (open) standard compliance per lower SGAM layer (first three layers)
- **Interoperability:** Capability and readiness to be interoperable according to all SGAM interoperability layers
- **Identification of missing support:** Focusing on information standards, grid codes and market rules and mechanisms
- **Evaluation of the FlexOffer:** Qualities of the FO information specification, facilitating interoperability of FEVER KERs (see figure 3)
- **Emissions reduction:** Potential of KER to contribute to sectoral emissions reduction (electricity, mobility and heat)
- **Acceptance of main actors:** The relevance of selected stakeholders' acceptance for KER replication

For an easier analysis of the project overview KPI set results, the questions (and explanations) related to each metric are included under the corresponding sub-sections of the *An additional country-specific* SRA has been carried out to analyse the scalability and replicability of FEVER solutions from the perspective of the pilots, within the scope of the countries of implementation.

The methodology for the approach carried out is similar to the one related to FEVER KERs (presented in the sections above), it is also focused on the trialled use cases and the ecosystem of solutions involved therein. For reference, D7.3 presents the results and components of the trials.

The results of the trial site SRA can be found under section 4 "Impact on pilot sites".

Results and evaluation section (as well as in Annex A). This is as opposed to the following section 2.6.2., which presents the KPIs used to separately evaluate each KER, as well as their related questions. These are not presented under section 3 to avoid duplication.

2.6.2 Resulting KER analysis KPIs

In this section, the questions related to each KPI attribute and to the evaluated KPIs are presented. More specifically, KPIs are evaluated through multiple-option questions, and are grouped under attributes or even sub-attributes. KPIs may stand alone, having a single KPI per sub-attribute.

These questions may be related to the project overview KPI sets. In the cases in which they are, they may be considered as an additional evaluation of the same metric, approached from a different perspective. The following tables include the resulting questions, their descriptions and the attributes and sub-attributes to which they pertain. Each table represents a KPI attribute, either for scalability or for replicability.

It is important to note, that the results presented in the results analysis section are presented in such a way, that a high score always reflects a high scalability or replicability potential. For this reason, there are cases in which the responses were inverted (e.g. 5=1, 4=2, and so on) and may not seem compatible with the way the options are presented in the questionnaire. Additionally, this may force the observer to analyse the results in a counterintuitive way. Sometimes a low score makes a KER seem not scalable or replicable, but it may be related to elements outside of the control of the KER developers (i.e. to the exogenous context), to the role of the KER within the ecosystem, or to a lack of fit of the KPI to the KER.

2.6.2.1 Scalability related questions

Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on [6]. The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.

Table 9. SRA attributes and KPIs: Scalability - Technology

Sub-attribute	KPI	Question	Description
Modularity The factor modularity asks and studies to what extent a solution or the implementation of solutions is modular (e.g., how easy it is to add new components or whether there are limits on adding components).	**Add additional components**	Would it be possible to easily add additional components and/or increase its size (e.g. by increasing the amount of users) without affecting its performance?	Scale ranges from "considerably difficult" (score of 1), to "can be easily done" (score of 5).
	Function independence	To which extent are the components of the KER able to function independently of one another?	Scale ranges from "components are not independent" (score of 1), to "components are highly independent" (score of 5).
Technology evolution The factor technology evolution asks and determines to what extent technological advances allow increasing the solution size.	**Tech. evolution**	Can the product easily adapt to an evolving technological landscape?	e.g. higher data demand, improved communications infrastructure, cloud computing, IoT, AI, etc. Scale ranges from "no it can't" (score of 1), through "with difficulties" (3), to "yes, it can be easily adapted" (score of 5).
Interface design The factor interface design asks and studies to what extent interactions between components increase after scale-up.	**Interface design**	To which extent do interactions among components increase with size?	Score ranges from "high increase" (score of 1) to "low increase" (score of 5).
Software tools The factor software tools asks and determines to what extent the performance of software tools is affected when the	**Software tools**	Are there clear bottlenecks when it comes to the software's ability to scale-up?	i.e. are the internal and external software tools involved able to cope with an increased size? Score ranges from: 1. Unavoidable bottlenecks 2. Some difficult bottlenecks 3. Some bottlenecks

solution's size increases.			4. Bottlenecks are easy to solve 5. No bottlenecks
Existing infrastructure The factor existing infrastructure asks and studies to what extent the current infrastructure (e.g. size of transformers, line width, availability of smart meters, grid observability equipment, currently installed DERs etc.) creates limits on the maximum size of the implementation of the KER.	**Existing infrastr.**	Can a given "existing infrastructure" pose limitations to the solution's ability to scale?	e.g. size of transformers, line width, availability of smart meters, grid observability equipment, currently installed DERs etc. Score ranges from "very likely" (score of 1) to "very unlikely" (score of 5).

Table 10. SRA attributes and KPIs: Scalability - Economics

Sub-attribute	KPI	Question	Description
Economies of scale The factor economy of scale asks and determines to what extent costs grow when increasing the solution's size or units of production.	**Economies of scale**	Do the costs of this KER increase through scale-up?	Score ranges from: 1. High cost increase 2. Slight increase, but still profitable 3. It remains the same / Unclear 4. Slight cost reduction 5. High cost reduction
Profitability The factor profitability asks and determines to what extent benefits grow when increasing the solution's size or the units of production.	**Profitability**	Does the profitability of this KER improve through scale-up?	i.e. are there diminishing marginal costs and increasing marginal revenues? Score ranges from: 1. Becomes unprofitable 2. Slightly worsens, but it's still profitable 3. It remains the same / Unclear 4. It improves slightly 5. Improves considerably

Table 11. SRA attributes and KPIs: Scalability - Regulation

Sub-attribute	KPI	Question	Description
Regulation The factor regulation asks and studies whether there are any regulatory barriers with respect to the size and scope of the solution.	Regulation dependent	How dependent is the demo on a favourable regulatory framework, with regards to its potential for scale-up?	Score ranges from “Very dependent” (score of 1) to “Very independent” (score of 5).

Table 12. SRA attributes and KPIs: Scalability - Social

Sub-attribute	KPI	Question	Description
Stakeholder acceptance The factor acceptance asks and determines to what extent stakeholder acceptance has been taken into account and whether any challenges are expected.	Acceptance issues	Please rate the potential emergence of acceptance issues when upscaling:	Score ranges from “No acceptance issues” (Score of 1), to “High acceptance issues” (Score of 5).
	Involvement in design	Please specify the extent to which you consider the following to be true: The end-users have been actively involved in KER design	Score ranges from “Not true” (score of 1), through “Partly true” (score of 3), to “Very true” (score of 5).
	User satisfaction	Please specify the extent to which you consider the following to be true: Users are satisfied with its design and functionality	Score ranges from “Not true” (score of 1), through “Partly true” (score of 3), to “Very true” (score of 5).
	Req. active involvement	Please specify the extent to which you consider the following to be true: Requires active end-user involvement / interaction	Score ranges from “Not true” (score of 1), through “Partly true” (score of 3), to “Very true” (score of 5).
	Enabler of DSM	Please specify the extent to which you consider the following to be true: Is an enabler of demand side participation in energy	Score ranges from “Not true” (score of 1), through “Partly true” (score of 3), to “Very true” (score of 5).

2.6.2.2 Replicability – KPIs related to KER performance

Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)

Sub-attribute	KPI	Question	Description
Integration and customisation	Integration and customisation	Does the replication of this KER necessarily require elaborate and/or time-consuming customization and integration efforts?	Scale ranges from "Will remain costly and lengthy" (score of 1), to "Can be streamlined" (score of 5).
Standards The factor standardization asks and determines to what extent a solution or the implementation of solutions is standard compliant and/or whether the solution can be easily made standard compliant.	Standard compliance	Please indicate the extent to which you consider the following is true: KER is fully standard compliant (e.g. with open, voluntary or mandatory standards)	The following rating can be inversely posed as a question as follows: Does the KER exclusively use proprietary standards? Scale ranges from "Not true" (score of 1), through "Partly true" (3), to "Completely true" (score of 5).
Interoperability The factor interoperability asks and determines to what extent a solution or the implementation of solutions and their components/functions are interoperable or even plug-and-play.	Encountered interop. issues	Were there interoperability issues in trials, with regards to this KER?	Scale ranges from "None" (score of 1), to "Many" (score of 5).

Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)

Sub-attribute	KPI	Question	Description
Market design The factor market design asks and determines to what extent a solution or the implementation of solutions depends on a given market design.	Market adaptation	Can this KER be replicated under different market designs?	Score ranges from "Hardly" (score of 1) to "Easily" (score of 5).

Business Model The factor business model asks and determines to what extent the viability of a solution or the implementation of solutions has been analysed and/or whether the solution is viable under different settings (e.g., another EU member state).	**Context adaptation**	Please indicate the extent to which you consider the following to be true: The business model is adaptable to different contexts	Score ranges from "Not true" (score of 1), through " Partly true" (score of 3), to "very true" (score of 5).
	Predictable income	Please indicate the extent to which you consider the following to be true: Income is predictable	Score ranges from "Not true" (score of 1), through " Partly true" (score of 3), to "very true" (score of 5).
	Simple CBA	Please indicate the extent to which you consider the following to be true: Cost-benefit analysis is straight forward	Score ranges from "Not true" (score of 1), through "Partly true" (score of 3), to "very true" (score of 5).

Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)

Sub-attribute	KPI	Question	Description
Regulation	**Data and cybersecurity**	Please indicate the extent to which you consider the following to be true: KER complies with data and cybersecurity standards and regulations	Score ranges from "Not true" (score of 1), through "Partly true" (score of 3), to "Very true" (score of 5).
	User Privacy	Please indicate the extent to which you consider the following to be true: KER ensures user privacy is protected	Score ranges from "Not true" (score of 1), through "Partly true" (score of 3), to "Very true" (score of 5).

Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

Sub-attribute	KPI	Question	Description
Social	**Behavioural change**	To which extent does the use of this KER imply behavioural changes from its users?	Especially with relation to users which already make use of a well-established substitute product.

Sub-attribute	KPI	Question	Description
			Score ranges from “No behavioural changes” (score of 1), through “Same changes as with most new products or services” (score of 3), to “Very likely” (score of 5).

2.6.2.3 Replicability – KPIs related to external factors

Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)

Sub-attribute	KPI	Question	Description
Network configuration The factor network configuration asks and studies to what extent a solution or the implementation of solutions depends on given resources and infrastructures (e.g., climate conditions such as temperature, wind, precipitation levels, terrain conditions, local generation mix, demographics, consumption mix and profiles, etc.).	**Grid observability**	Rate the relevance of the following factors for this solution’s replicability: The existing grid observability equipment	Scale ranges from “Irrelevant for replication” (score of 1), to “Very relevant for replication“ (score of 5).
	Smart meters	Rate the relevance of the following factors for this solution’s replicability: The smart meter roll-out	Scale ranges from “Irrelevant for replication” (score of 1), to “Very relevant for replication“ (score of 5).
	High VRES	Rate the relevance of the following factors for this solution’s replicability: A high penetration of variable renewable energy in the corresponding grid	Scale ranges from “Irrelevant for replication” (score of 1), to “Very relevant for replication“ (score of 5).
	RES Amount	Rate the relevance of the following factors for this solution’s replicability: A high number of DERs in the grid (e.g. battery systems, charging infra. PV, wind, heat pumps, etc.)	Scale ranges from “Irrelevant for replication” (score of 1), to “Very relevant for replication“ (score of 5).
	Electrification	Rate the relevance of the following factors for this solution’s replicability: A high degree of electrification of heat & transport	Scale ranges from “Irrelevant for replication” (score of 1), to “Very relevant for replication“ (score of 5).

Sub-attribute	KPI	Question	Description
	Local climate	Rate the relevance of the following factors for this solution's replicability: Local climatic factors (such as wind, temperature, precipitation, terrain)	Scale ranges from "Irrelevant for replication" (score of 1), to "Very relevant for replication" (score of 5).

Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)

Sub-attribute	KPI	Question	Description
Macroeconomics The factor macroeconomics asks and studies to what extent a solution or the implementation of solutions depends on given macro-economic factors.	**Macro barriers**	Rate the risk for macroeconomic factors to impose barriers and likelihood for these to present opportunities for replication. Risk of macroeconomic factors to impose barriers	Score ranges from "Low likelihood" (score of 1), to "High likelihood" (score of 5).
	Macro opportunities	Rate the risk for macroeconomic factors to impose barriers and likelihood for these to present opportunities for replication. Potential of macroeconomic factors to present opportunities	Score ranges from "Low likelihood" (score of 1), to "High likelihood" (score of 5).
Market design The factor market design asks and determines to what extent a solution or the implementation of solutions depends on a given market design.	**LFMs**	Is the viability of this KER highly dependent on the emergence of local or regional flexibility markets?	Score ranges from "Highly dependent" (score of 1) to "Not dependent" (score of 5).

Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)

Sub-attribute	KPI	Question	Description
Regulation	**GDPR**	Please indicate the extent to which you consider the following to be true: KER is vulnerable to General Data Protection Regulation (GDPR) non-compliance	Score ranges from “Not true” (score of 1), through “Partly true” (score of 3), to “Very true” (score of 5).
	Local frameworks	Please indicate the extent to which you consider the following to be true: KER depends on local grid balancing framework development	Score ranges from “Not true” (score of 1), through “Partly true” (score of 3), to “Very true” (score of 5).
	Regulatory barriers	Have you encountered regulatory barriers that would limit the replication of the trials which include this KER?	Score ranges from “None” (score of 1) to “Yes, numerous” (score of 5).

Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

Sub-attribute	KPI	Question	Description
Social	**Energy literacy**	To which extent do you consider energy literacy to influence stakeholder’s willingness to participate in or use this KER?	Score ranges from “High relevance” (score of 1), to “Low relevance” (score of 5).

2.7 Trial site SRA

An additional country-specific SRA has been carried out to analyse the scalability and replicability of FEVER solutions from the perspective of the pilots, within the scope of the countries of implementation.

The methodology for the approach carried out is similar to the one related to FEVER KERs (presented in the sections above), it is also focused on the trialled use cases and the ecosystem of solutions involved therein. For reference, D7.3 presents the results and components of the trials.

The results of the trial site SRA can be found under section 4 “Impact on pilot sites”.

3 Results and evaluation

This chapter includes the results of the questionnaire and their analysis. The results are based on responses from partners who are responsible for the development and implementation of the corresponding KERs.

Section 3.1 includes six sets of KPIs (i.e. groupings of indicators) and each are depicted with all KERs (only the KERs which have found the questions applicable, as opposed to N/A). In other words the first section presents figures which represent insights into the project ecosystem as a whole, from the perspective of the KERs, through indicator sets. The figures exclude the scores given to tools of a certain Toolbox (e.g. the DSO Toolbox’s Low Voltage Grid Observability Service (LVGoS) solution provided a score which is not presented in the figure), but their text based responses with relation to the analysis of the figures have been taken into consideration. The selected format for representation of the data are heat maps. These facilitate the grouped depiction of indicators and KERs, together with the scores of each indicator.

Section 0 presents the results of the evaluation of each KER. It is itself separated into two sub-sections, one for scalability and one for replicability. The sub-section on replicability presents two figures. That is, two sub-sets of indicators. One related to the KER’s performance (i.e. related to the design and development of the KER) and the other to the KER’s dependence on external factors for replicability (i.e. indicators outside of the control of developers). In addition to the scoring of indicators, text-based responses related to the indicators in the questionnaire have been directly used for the analysis of each figure. All indicators were asked for all KERs to enable comparison among them. To stick with the most common approaches found in the literature, this information is presented through spider graphs.

3.1 Project overview KPI sets

Most of the figures stem from a 1:1 representation of the values (i.e. scores) assigned by respondents through the options presented in the questionnaire (i.e. scores of 1 to 5). The only exception is presented in *Figure 5. Standards implementation results*, which was evaluated on a decimal scale from 0 to 1.

The figures of this section have three axes:

- X – Showing the **KERs** involved in the scoring of the indicator
- Y – Showing the **indicators** to be evaluated by each KER responsible partner
- Z – Showing the **labels** which represent the options/scores for indicator evaluation

Indicators are further described in tables under each sub-section.

3.1.1 Standards implementation

This indicator relates to the degree of open standards implementation for the SGAM layers found in the bottom of the figure (i.e. component, communication and information layers). Starting with a special case, this set of indicators involves a score for which respondents selected a decimal between 0 and 1 (i.e. 0, 0.1, 0.2, …1, as described in The content of the following table is the same content used to instruct the respondents on how to answer the questions related to the indicators present in the bottom of the figure. It is presented in this section to facilitate the analysis. For more information, the questionnaire can be found in Annex A of this deliverable.

Table 21). The labels (i.e. the colour bar ticks) are presented in a scale of 1 to 5 (not considering "N/A"s) for ease of analysis.

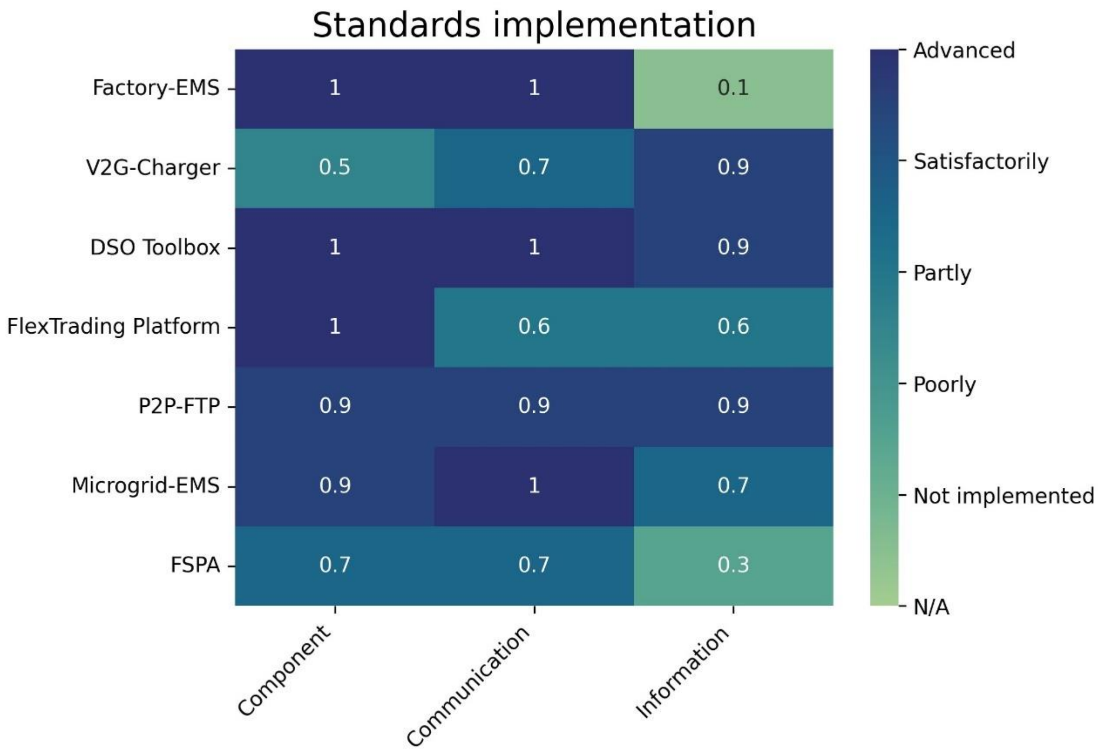

Figure 5. Standards implementation results

The content of the following table is the same content used to instruct the respondents on how to answer the questions related to the indicators present in the bottom of the figure. It is presented in this section to facilitate the analysis. For more information, the questionnaire can be found in Annex A of this deliverable.

Table 21. Standards implementation indicators

Indicator	Description
Component	If the design of the KER involves 4 component layer standards, but only 2 of them are fully defined in accessible component layer standards, the KER would have a 0.5 rating (i.e. 2 missing standards have been identified).
Communication	If the KER uses 4 communication standards (between systems or other elements), but only 2 of them are fully defined in accessible communication layer standards, the KER would have a 0.5 rating (i.e. 2 missing or underdeveloped standards have been identified).

Information	If the KER uses 4 data exchanges (between systems or other elements), but only 2 of them are fully defined in accessible information layer standards, the KER would have a 0.5 rating (i.e. 2 missing or underdeveloped standards have been identified).

Figure 5 shows that many of FEVER solutions have reached an advanced stage of development with relation to standards implementation. The following points stand out:

- The component layer has received the best average score.
- The information layer scored the lowest, highlighting the pressing need for interoperability.

Partners have provided input with relation to the following question: “In addition to the resources required for replication, does scaling up require additional resources that are based on open standards?” This input follows:

- The Flexibility Trading Platform (FTP) hasn’t been made ready to work in open markets.
- P2P-FTP: Scaling up requires more nodes and is somewhat computation heavy.
- FlexCommunity: More projects and vendors should join.
- IDMM: The Intraday Market Mechanism is currently validated in simulation environment. Demos are not yet available. For an implementation of Technical Readiness Level (TRL) higher than 5, all standards (i.e. component, communication and information standards) that were defined in D1.3 should be taken into consideration and deployed as accessible and/or open standards.
- The FEMS
    - consists of three components (persistence layer, business logic, user interface & communication components). The components are standard layer components.
    - communicates with the FSPA. The component is integrated with communication (HTTP) and information standard is based on propriety solution following CIM directions.

3.1.2 Interoperability per SGAM layer

For the following figure, the labels in the colour bar are the possible answers to the rating request indicated as the: “Capability of solution’s x-layer to be implemented according to different standards“. The labels were presented to respondents under another “option name”. These were changed in the following graph for ease of representation. Said option names follow (Label -> Name):

- **Interoperability Profile (IOP) ready**: Yes, in all relevant cases
- **Partly capable**: Different standards are partially implemented
- **Can be done with ease**: Different standards can be easily implemented
- **Difficult**: Difficulty in working according to different standards
- **Restricted**: Restricted to one set of standards

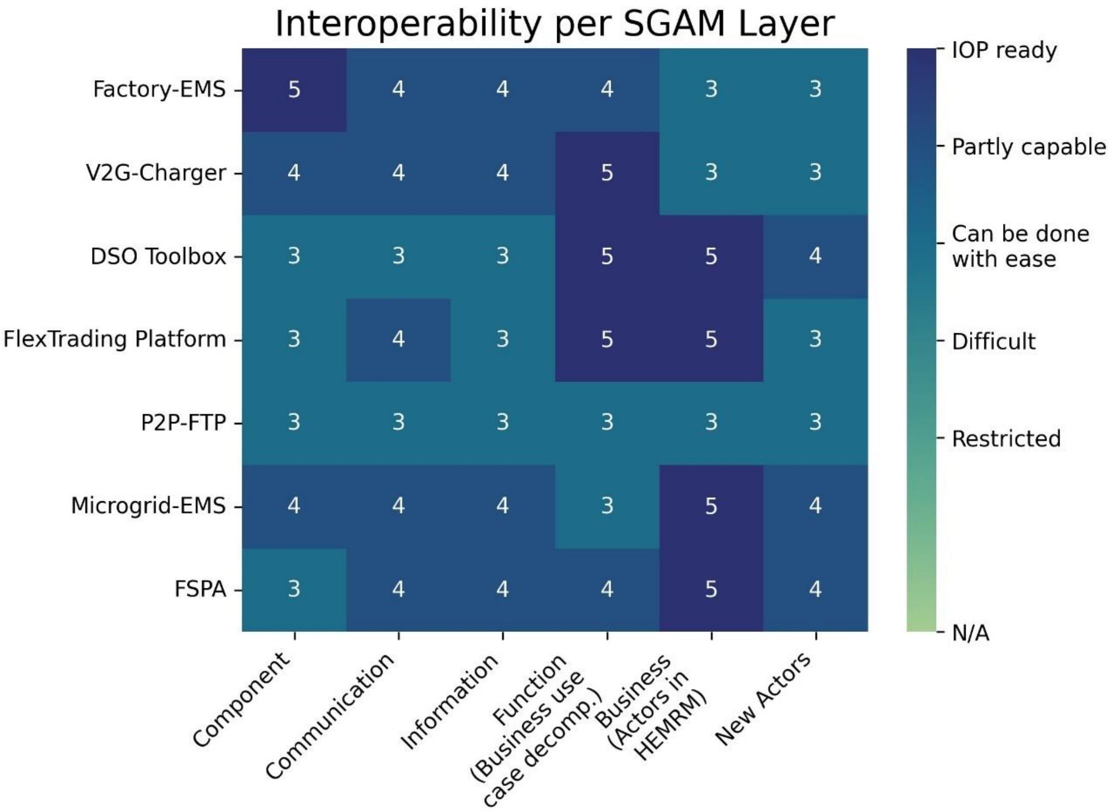

Figure 6. Interoperability per SGAM layer results

The content of the following table is the same content used to instruct the respondents on how to answer the questions related to the indicators present in the bottom of the figure. It is presented in this section to facilitate the analysis of the previous figure. The questionnaire can be found in the Annex A of this deliverable.

Table 22. Interoperability per SGAM layer indicators

Indicator	Description
Component	Please rate: Capability of solution's component layer to be implemented according to different standards. The emphasis of the component layer is the physical distribution of all participating components in the smart grid context. This includes system and device actors, power system equipment (typically located at process and field level), protection and telecontrol devices, network infrastructure (wired / wireless communication connections, routers, switches, servers) and any kind of computers.
Communication	Please rate: Capability of solution's communication layer to be implemented according to different standards. The emphasis of the communication layer is to describe protocols and mechanisms for the interoperable exchange of information between components in the context of the underlying use case, function or service and related information objects or data models.
Information	Please rate: Capability of the solution's information layer to be implemented according to different standards. The information layer describes the information that is being used and exchanged between functions, services and components. It contains information objects and

Indicator	Description
	the underlying canonical data models. These information objects and canonical data models represent the common semantics for functions and services in order to allow an interoperable information exchange via communication means.
Function (Business use case decomp.)	Please rate: Related business use cases have been decomposed to thoroughly describe functionality. The function layer describes system use cases, functions and services including their relationships from an architectural viewpoint. The functions are represented independent from actors and physical implementations in applications, systems and components. The functions are derived by extracting the use case functionality that is independent from actors.
Business (Actors in HEMRM)	Please rate: Related roles and responsibilities of involved actors are described in the HEMRM (Harmonized Electricity Market Role Model). The business layer represents the business view on the information exchange related to smart grids. It involves regulatory and economic (market) structures (using harmonized roles and responsibilities) and policies, business models and use cases, and business portfolios (products and services) of market parties involved. Also business capabilities, use cases and business processes can be represented in this layer.
New actors	Please rate: Related roles and responsibilities of NEW actors have been fully defined. Also Business Layer related.

Figure 6 shows that FEVER solutions can all be made interoperable, although some of them face higher difficulties than others. The following points stand out:

- The DSO toolbox and the FTP are interoperability-ready in both the functional and business layers (according to the proposed questions).
- Being partly capable is still a high score in terms of IOP. Different standards being implemented could mean that the most relevant/popular ones were implemented or that only certain markets have been addressed.
- The information layer interoperability was mostly found to be easy to implement; contrasting to some extent with the previous Figure 5. This is likely due to the implementation of the FlexOffer, which sits in the information layer, and its possible consideration as a de facto standard by some respondents, and as an "inaccessible standard" by others.
- When comparing Figures 5 and 6, one can see that even if some KERs have (mostly) implemented open standards, this doesn't mean they have been made fully interoperable. As an example, the DSO's responses show this case quite clearly.
- The P2P-FTP can be made interoperable in all layers with ease.
- None of the solutions has interoperability restrictions in any SGAM layer.

Through the additional input provided by the KER responsible partners, we gathered certain elements for further consideration:

- LVGoS: efficient communication is crucial in this service, so replicability with different standards has to be evaluated carefully.
- P2P-FTP: the roles and responsibilities related to energy communities and energy sharing are still in development.
- FlexCommunity: The FlexOffer's integration with existing initiatives like IEC TC57 will have to be clarified.

Additionally, partners have identified proprietary solutions that require the development of open standards as follows:

- DSO Toolbox: the integration with Supervisory Control and Data Acquisition (SCADA) solutions of the DSO and the involved proprietary information models. Weather forecast service providers.
- P2P-FTP: FlexShape's Aggregator-as-a-Service.
- Microgrid-EMS: IEC 61970 and IEC 62325.

3.1.3 Missing support

The following figure refers to the identification of missing information standards, grid codes or market rules and mechanisms to support the FEVER project's solutions and its ecosystem. Results equal to -1 mean "not applicable".

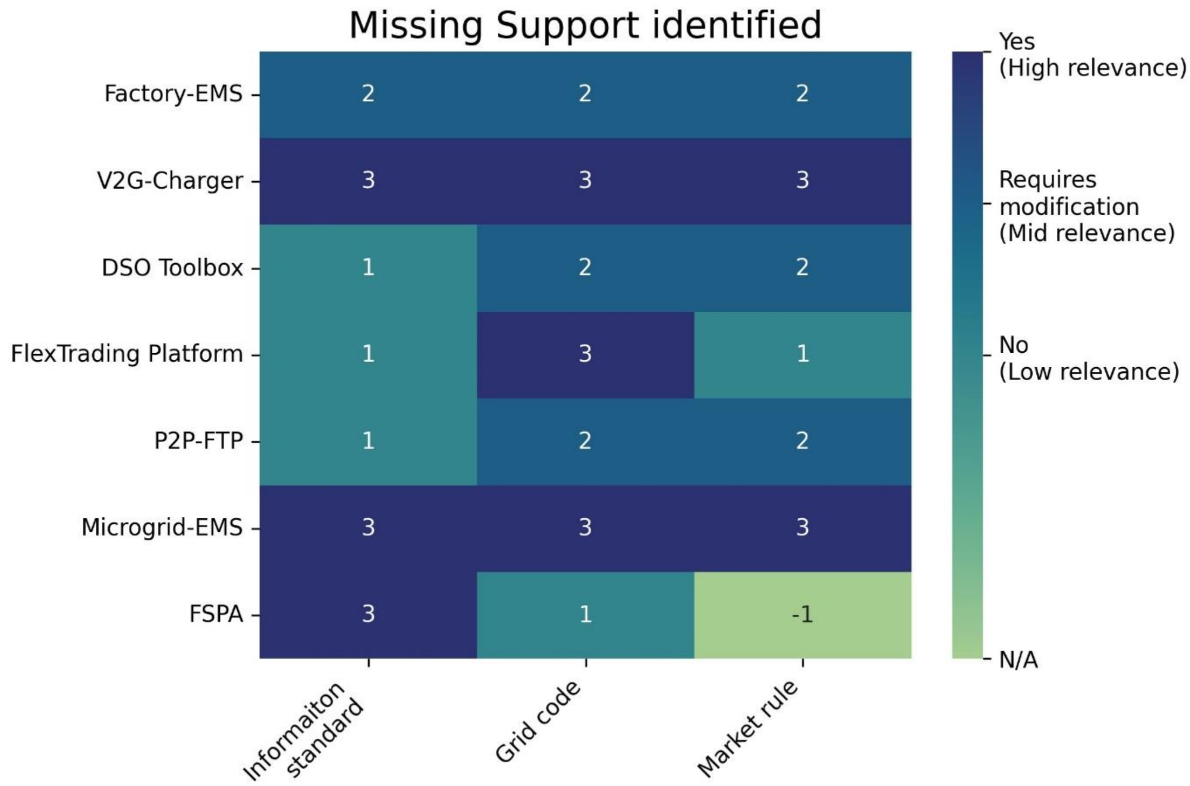

Figure 7. Missing support identified results

The content of the following table is the same content used to instruct the respondents on how to answer the questions related to the indicators present in the bottom of the figure. It is presented in this section to facilitate the analysis of the previous figure. The questionnaire can be found in the Annex A of this deliverable.

Table 23. Missing support identified indicators

Indicator	Description
Information standard	Have you identified any missing information standards?
Grid code	Have you identified any missing grid connection codes?
Market rule	Have you identified any missing market rules or market mechanisms?

Figure 7 shows that FEVER solution developers have identified multiple missing support opportunities as well as requirements for modification of the existing information standards, grid codes and/or market rules or mechanisms. The following points stand out:

- The Microgrid-EMS developers find missing support under all indicators, with a high relevance.
- Market rules don't apply to the FTP, and grid codes are missing to support its implementation.
- Grid codes and market rules require modifications from end-to-end. Meaning, there is (at least) requirement of modifications from the perspective of DER, EMS, DSO Toolbox and FTP (for the case of the P2P-FTP).

Partners have provided additional input with relation to the indicators.

- FTP: Since no demonstrator includes direct market integration, there is no connection code to external market.
- P2P-FTP: Modifications required for energy communities and energy sharing.
- FlexCommunity:
  - FlexOffer is not yet an information standard.
  - Grid connection codes have to be modified to enable more flexibility.
  - Rules for LFMs need development.

3.1.4 FlexOffer capabilities

The following figure depicts the FlexOffer evaluation results (FlexOffer may be understood as an energy and flexibility information protocol which facilitates, but it is not limited to, the formation of citizen-centred, local and sector-coupled energy markets in such a way that these remain compatible with the HEMRM) and its implementation within the project.

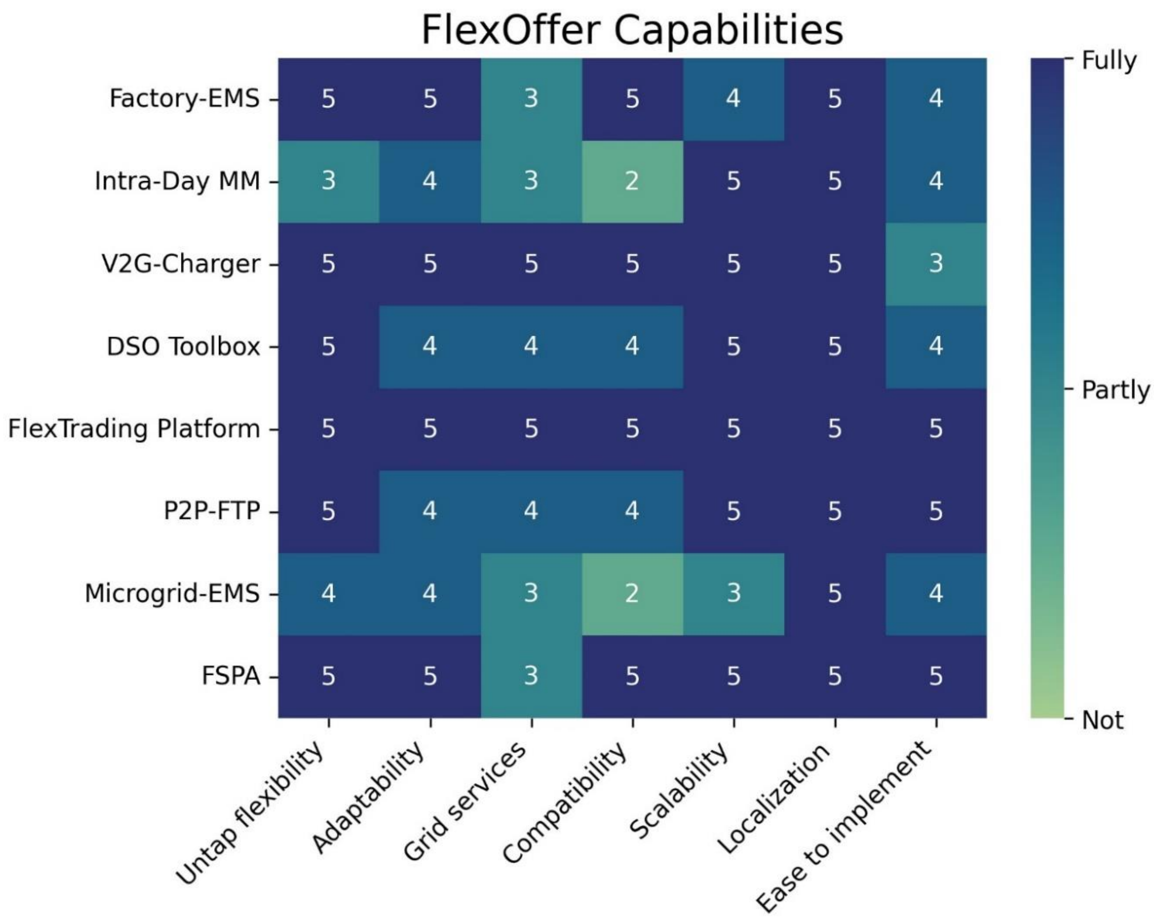

Figure 8. FlexOffer capabilities results

The content of the following table is the same content used to instruct the respondents on how to answer the questions related to the indicators present in the bottom of the figure. It is presented in this section to facilitate the analysis of the previous figure. For additional details, the questionnaire can be found in the Annex A of this deliverable.

Table 24. FlexOffer capabilities indicators

Indicator	Description
Untap flexibility	According to your experience, rate the capability of the FlexOffer to untap different types of flexibility.
Adaptability	According to your experience, rate the capability of the FlexOffer to facilitate the required functionality.
Grid services	According to your experience, rate the capability of the FlexOffer to enable grid service provision.
Compatibility	According to your experience, rate the FlexOffer's compatibility with your market model.
Scalability	According to your experience, rate the capability of the FlexOffer to scale.
Localisation	According to your experience, rate the capability of the FlexOffer for localized use of flexibility.
Ease to implement	Please, rate the ease of implementation of the FlexOffer in this product.

Figure 8 shows that the FlexOffer has facilitated many relevant elements of energy system flexibility, as well as showing where the most relevant areas for further development may be found (i.e. adaptability, grid services and compatibility). The ease of implementation also has potential for improvement, as can be seen in the comments from respondents, below.

Through the additional input provided by the KER responsible partners, we have identified certain elements for further consideration:

- FlexOffer implementation requires support in the following forms:
  - Documentation
  - Open Application Programming Interfaces (API) documentation
  - To provide open source parsers and error handling
  - Open source implementations / tools
  - Webinars
  - An online interactive tool that generates different offers based on users inputs and generates (one or more) schedules that could be assigned to that offer.
  - To promote the FlexOffer to achieve more vendors offering products based on FlexOffers.
- Necessary FlexOffer extensions for:
  - Ancillary services
  - Reactive power products
  - Bids for asset portfolios
  - Enhancement for short time scale system services (aFRR, mFRR)
  - Enabling the adjustment of the FlexOffer
- Additional remarks or features:
  - The flexibility can be fully used locally in FEMS at peak levelling.

- While FOs can help with the uptake of flexibility services, they are not compatible in the current type of bid offers used in HeNEx's wholesale markets.
- The FlexOffer's capabilities should be assessed in collaboration with the FlexOffer User group.

3.1.5 Environmental

The following figure depicts the result of questions related to the potential for each KER to contribute to sectoral emissions reductions, having each sector as an individual indicator.

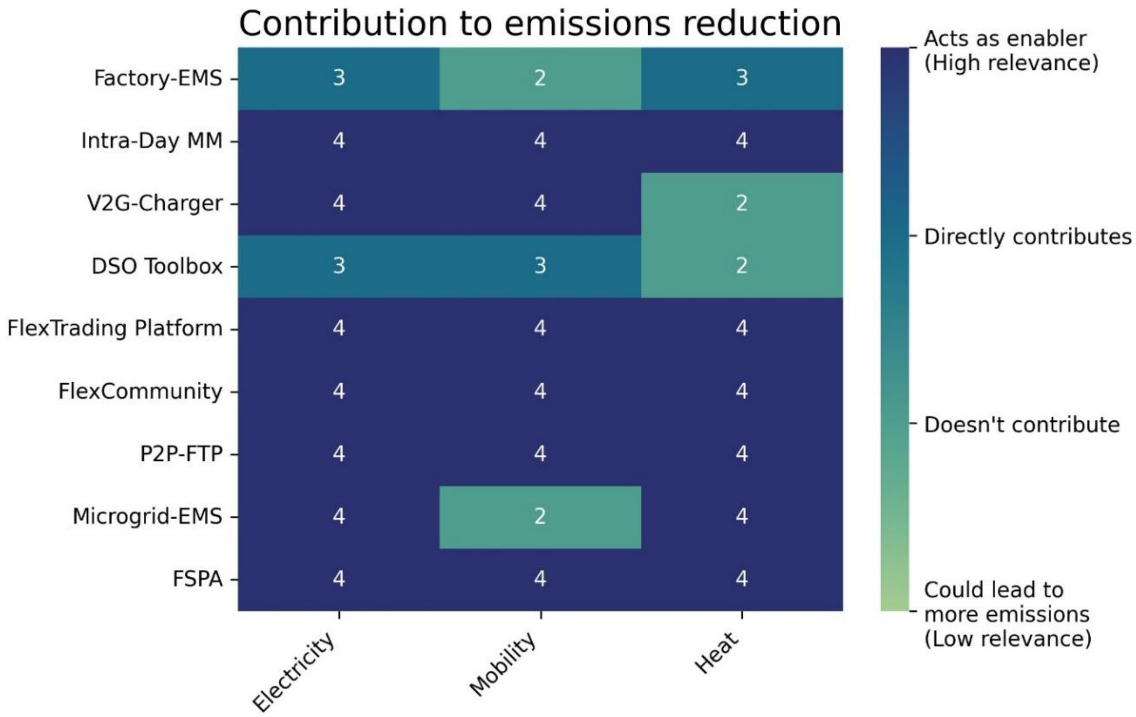

Figure 9. Contribution to emissions reduction – results

The content of the following table is the same content used to instruct the respondents on how to answer the questions related to the indicators present in the bottom of the figure. It is presented in this section to facilitate the analysis of the previous figure. For additional details, the questionnaire can be found in the Annex A of this deliverable.

Table 25. Contribution to emissions reduction – indicators

Indicator	Description
Electricity	Does this KER enable its users to achieve electricity GHG emissions reductions?
Mobility	Does this KER enable its users to achieve reduction of emissions in mobility?
Heat	Does this KER enable its users to achieve a carbon footprint reduction for heating?
Relevance	Please rate this question's relevance for scalability and replicability

It is worth noting, that respondents view many of the developed KERs as having an enabling quality throughout the ecosystem. Enabling the low-carbon transformation is a strong argument in favour of scalability and replicability. The environmental attribute should be deconstructed further, and its linkages to other attributes established.

Partners have provided further insight with relation to the following question: Does this KER enable its users to achieve a reduction in GHG emissions?

- The IDMM helps address operational challenges in the distribution system caused by increased DER integration and enables the participation of distribution system DERs in the ID market, offering new revenue streams for them. Since DERs play a crucial role in decarbonizing the energy mix, the IDMM serves as an enabler for the decarbonization of the energy sector.
- The FlexOffer enables all sectors to offer, trade, and activate their flexibility in a uniform way.
- The P2P-FTP (i.e. P2P Toolbox) enables users, e.g. energy community members, to buy renewable electricity from their peers for residential, EV and heating.
- The FTP does not directly reduce GHG emissions, but with optimal assignment of consumption (and production) flexibility it can maximise the use of RES and as such it is an enabler for sector decarbonisation.

Additionally,

- The LVGoS does not contribute in a direct way. It does however indirectly. Indicating how an additional option could have been included in the questionnaire, for enabling partners to contribute to the analysis more adequately and precisely.

3.1.6 Stakeholder Acceptance

The following figure presents the results to the question: how important is the acceptance of specific x-stakeholder for the replication of this KER? In other words, each KER responsible partner weighed the relevance of the role which different stakeholders play in the replication of their own KERs. The stakeholders presented are the same as those defined as the main actors in FEVER, excluding the prosumer.

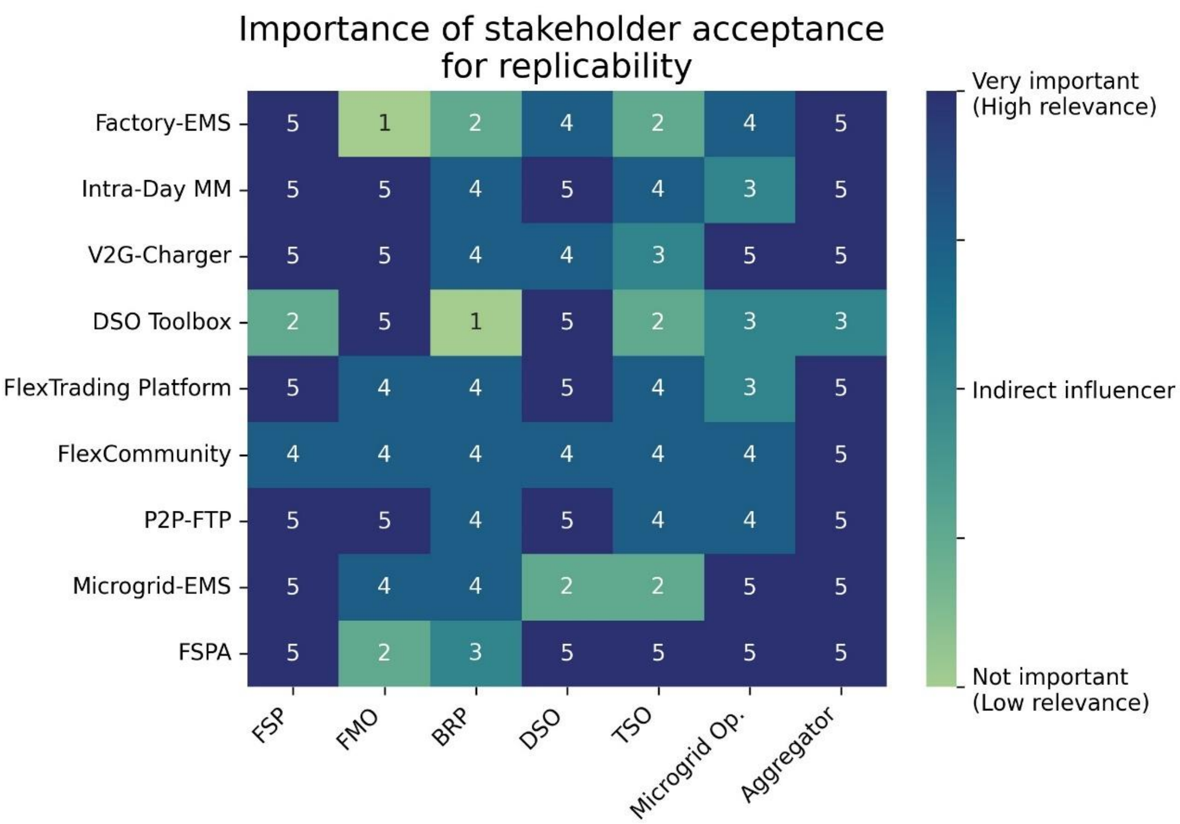

Figure 10. Importance of stakeholder acceptance for replicability – results

For each of the stakeholders presented in the bottom axis of the previous figure, the question: “How important is this stakeholder’s acceptance for the replication of this KER?”, was asked. For additional details, the questionnaire can be found in the Annex A of this deliverable.

KER Results Analysis

All the figures in this section stem from a 1:1 representation of the values (i.e. scores) assigned by respondents through the options presented in the questionnaire (i.e. scores of 1 to 5).

The figures of this section have two axes:

- X – Showing the **indicators** to be evaluated by each KER responsible partner.
- Y – Showing the **scores** assigned to each indicator by each KER responsible partner.

Indicators are presented in detail in section *2.6.2 - Resulting KER analysis KPIs*. The detailed description is excluded from this section to avoid replication of the corresponding tables.

To facilitate the interpretation of the spider graphs, the following points should be considered:

- Each spider graph corresponds to one single KER.
- The higher the score, the more scalable or replicable the KER is according to the indicator.
- Each indicator includes two evaluation metrics:
    - Indicator: the score of the indicator itself.
    - Relevance: the perceived relevance of the indicator for scalability/replicability.
- Sometimes a bad score doesn’t reflect a non-scalable or replicable KER, but reflects upon the high dependence on a certain factor which may have not been fully addressed either by the developers or by the exogenous environment.
- The bigger the difference between the indicator and its relevance, the more immediate the need for attention to the KPI.
- N/A scores are shown with a score of 0. This doesn’t mean the KER received “the worst score” for said indicator. Instead, it could mean that the question wasn’t clear, or that the indicator simply doesn’t apply.

Each section corresponds to a single KER. It first presents the main achievements, followed by a scalability sub-section; after which the replicability sub-section is presented. Each sub-section also presents additional information related to the indicators, as provided by the respondents. Some sections have more information than others.

The three following figures present an average of the scores of each indicator for all KERs. The average scores exclude both the toolbox components, to avoid biasing of the FEVER ecosystem in favour of the toolboxes, and the FlexCommunity, due to its non-technical nature (the solution has social and knowledge related purposes instead of directly-related technical functionalities). Additionally, N/A responses have been excluded from the calculations.

This is followed by three tables which contain information for the adequate interpretation of the scores assigned to the KPIs by respondents.

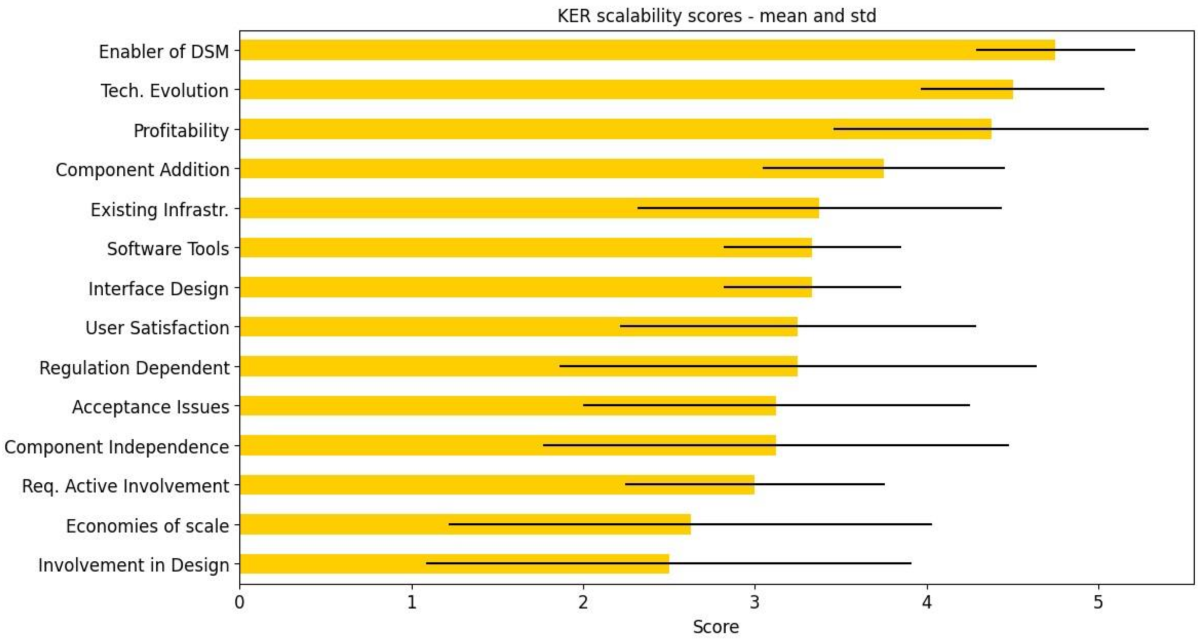

Figure 11. KER scalability scores – mean and std

Some points worth noting:

- Starting from the bottom, the figure above shows how FEVER KERs could benefit from user involvement in their design.
- There are expected rising costs due to scale-up.
- In spite of the automation qualities, the required active involvement from users has a score of three. This may indicate to the need to involve more users in testing the solutions. In replicability, energy literacy is a relevant factor. This KPI may be influenced by energy literacy.
- From component independence to existing infrastructure, the average score is in the middle of the scale. Having said that, some KPIs show a large standard deviation, for which more tailored attention could be given for the specific KERs forming the herewith presented values.
- Component addition shows how it is generally easy to add new components, potentially increasing the KERs functionality and enabling its adaptation to an evolving technological landscape.
- The profitability is expected to increase through scale-up. Having said that, regulation dependence does show a large standard deviation.
- KERs are generally able to keep up with an evolving technological landscape and are enablers of demand side management.

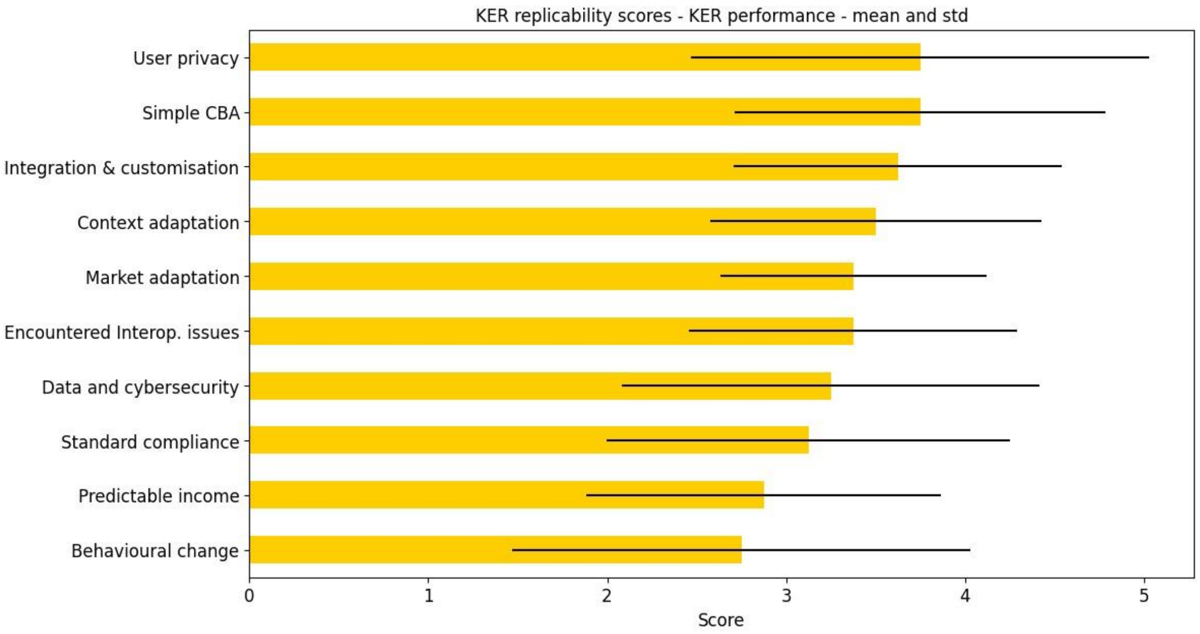

Figure 12. KER replicability scores – KER performance – mean and std

Some points worth noting:

- Starting from the bottom of the figure, behavioural change is presented as the biggest limiting KPI for replicability.
- The income of the KERs is not quite predictable.
- From compliance with standards (KPI which can be appreciated in more detail in the previous sections) to market adaptation, KPIs are below an average score of 3.5.
- KERs show a consistent standard deviation of around 1.
- Most KERs don't show high integration and customisation efforts, probably due to standardisation.
- Although income is not so predictable, the CBA of each KER seems manageable.
- No KPI has a score higher than 4, with the highest two being 3.75.
- User privacy has received the highest score. Considering social KPIs having the lowest score of this and the previous figures, KER developers show an effort to provide technical security for KER users.

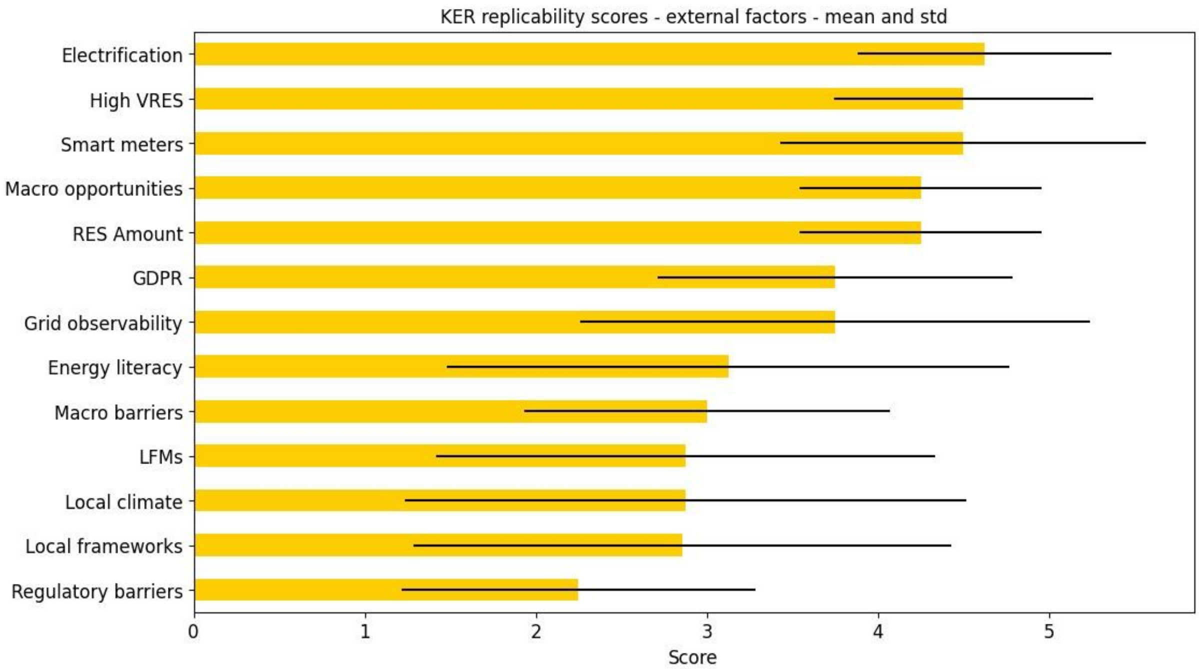

Figure 13. KER replicability scores – external factors – mean and std

Some points worth noting:

- Starting from the bottom of the figure, the lowest score is found under regulatory barriers, showing how regulation is an important impediment for KER replicability and widespread adoption.
- Local framework development is indeed necessary for many KERs to be replicable.
- Local climate is a KPI which has proven to be confusing for respondents, and probably too broad to reflect something meaningful. It should be posed differently, to more specifically address demand elements leading to high energy consumption (the reason being, that aspects related to generation have been better addressed through other network configuration related KPIs).
- Local flexibility markets (LFMs), together with local framework development, would be beneficial for the uptake of FEVER KERs.
- While macroeconomic barriers may very well pose challenges for replication, the opportunities are ranked considerably higher.
- Energy literacy, together with local climate, has one of the highest standard deviations. This may be due to the role of certain KERs within the FEVER ecosystem. Some have higher degrees of interaction with users than others.
- Aside from risks to GDPR non-compliance, as well as to the encountered macro-opportunities, what makes most of these KERs highly replicable is their design and compatibility with the development of the electricity network. As can be seen under the description of KPIs, four of the highest average scores are related to KPIs under the network configuration sub-attribute.

To facilitate the interpretation of the following figures, the three following tables include an explanation of an adequate interpretation of indicator scores. These tables include KPIs in order of appearance on the figures; clockwise, starting from the top.

Table 26. KPI interpretation – scalability

KPI	Interpretation	Explanation
Component addition	High score = high scalability	It enables product development without hindering performance.

KPI	Interpretation	Explanation
Component independence	High score = high scalability	It avoids causing chain reactions in growth of component relationships due to changes in design.
Tech. evolution	High score = high scalability	It enables product adaptation to contextual changes.
Interface design	High score = low increase = high scalability	It avoids exponential increase in data exchanges due to scale-up
Software tools	High score = high scalability	It denotes the lack of bottlenecks in data exchanges due to limitations of specific building blocks of the KER.
Existing infrastr.	High score = unlikely limitations = high scalability	It denotes the lack of influence from the grid infrastructure on the KER's scalability.
Economies of scale	High score = high scalability	It represents the expected cost reductions after scale-up.
Profitability	High score = high scalability	It represents increasing profits after scale-up.
Regulation dependent	High score = high scalability	It represents independence from regulatory framework.
Acceptance issues	High score = no acceptance issues = high scalability	It represents the potential emergence of acceptance issues.
Involvement in design	High score = high scalability	It represents user involvement in KER design.
User satisfaction	High score = high scalability	It represents user satisfaction with product design and functionality. No involvement (previous KPI), would lead to N/A.
Req. active involvement	High score = no involvement = high scalability	It represents the requirement of active involvement from users for product functionality.
Enabler of DSM	High score = high scalability	It specifies the KER's potential for enabling demand side management of energy consumption.

Table 27. KPI interpretation – replicability – KER performance

KPI	Interpretation	Explanation
Integration & customisation	High score = low I&C requirements = high replicability	It denotes the need to adapt the product to the customer's premises or local context.
Standard compliance	High score = high replicability	It specifies the KER's use of open standards.

KPI	Interpretation	Explanation
Encountered interop. Issues	High score = low issues = high replicability	It provides a broad account of the interoperability issues encountered in product development.
Market adaptation	High score = high replicability	It denotes the ease with which the KER can be replicated under different market designs.
Context adaptation	High score = high replicability	It denotes the KER's business model to be adaptable to different contexts or locations.
Predictable income	High score = high replicability	It denotes the predictability of the KER's income streams.
Simple CBA	High score = high replicability	It denotes the simplicity with which the cost-benefit analysis of the KER can be performed.
Data and cybersecurity	High score = high replicability	It denotes the KER's compliance with data and cybersecurity standards and regulations.
User privacy	High score = high replicability	It denotes the extent to which the KER's design ensures user privacy protection.
Behavioural change	High score = no changes = high replicability	It denotes the extent to which the usage of the KER implies behavioural changes from users.

Table 28. KPI interpretation – replicability – external factors

KPI	Interpretation	Explanation
Grid observability	High score = high opportunity = high replicability	It denotes the opportunity which the existence of grid observability equipment provides to the KER's replicability.
Smart meters	High score = high replicability	It denotes the opportunity which a high smart metering deployment rate provides to the KER's replicability.
High VRES	High score = high replicability	It denotes the opportunity which a high penetration of variable renewable energy provides to the KER's replicability.
RES amount	High score = high replicability	It denotes the opportunity which a high number of DERs provides to the KER's replicability.
Electrification	High score = high replicability	It denotes the opportunity which a high electrification rate (of heating and mobility) provides for KER replicability.
Local climate	High score = high replicability	It denotes the opportunity which local climate conditions may provide to the KER.

KPI	Interpretation	Explanation
Macro barriers	High score = low barriers = high replicability	It denotes the extent to which macroeconomic factors may bring about barriers which could limit the KER's replicability.
Macro opportunities	High score = high opportunities = high replicability	It denotes the extent to which macroeconomic factors may bring about opportunities which could potentiate the KER's replicability.
LFMs	High score = low dependence on LFMs = high replicability	It denotes the KER's dependence on the emergence of LFMs for KER replicability.
GDPR	High score = low vulnerability = high replicability	It represents the KER's vulnerability to GDPR non-compliance.
Local frameworks	High score = low dependence = high replicability	It denotes the KER's dependence on the development of local grid balancing frameworks.
Regulatory barriers	High score = no barriers = high replicability	It broadly specifies the amount of encountered regulatory barriers which would limit the replication of the KER.
Energy literacy	High score = low influence = high replicability	It specifies the influence of energy literacy on user's willingness to participate in KER implementation.

3.1.7 DSO Toolbox

Achieved a TRL of 7, demonstrating many of the functionalities of the solution in at least one pilot, e.g. detection of congestion, activation of flexibility, etc. There were functionalities that were not possible to demonstrate in full scale due to malfunction of equipment (i.e. battery), such as the self-healing operation, or due to unavailability of data.

3.1.7.1 Scalability

The development of this KER has fully considered scalability in its design. It consists of a microservice based architecture (enabling easy upscaling), which follows a multitenant approach and enables its offering through SaaS.

The **most relevant regulatory barriers** identified for scale-up are:

- Insufficient/non-existent remuneration schemes for flexibility providers
- The limited existence of operational flexibility markets

The **most relevant regulatory opportunities** identified for scale-up are:

- New grid network code on flexibility

The **most relevant obstacles** for scale-up related to the **stakeholder ecosystem** are:

- Knowledge of future market trends related to flexibility (given the current immaturity of most markets)

The **most relevant opportunities** for scale-up related to the **stakeholder ecosystem** are:

- New business opportunities through market transformation, increased energy cost due to crisis

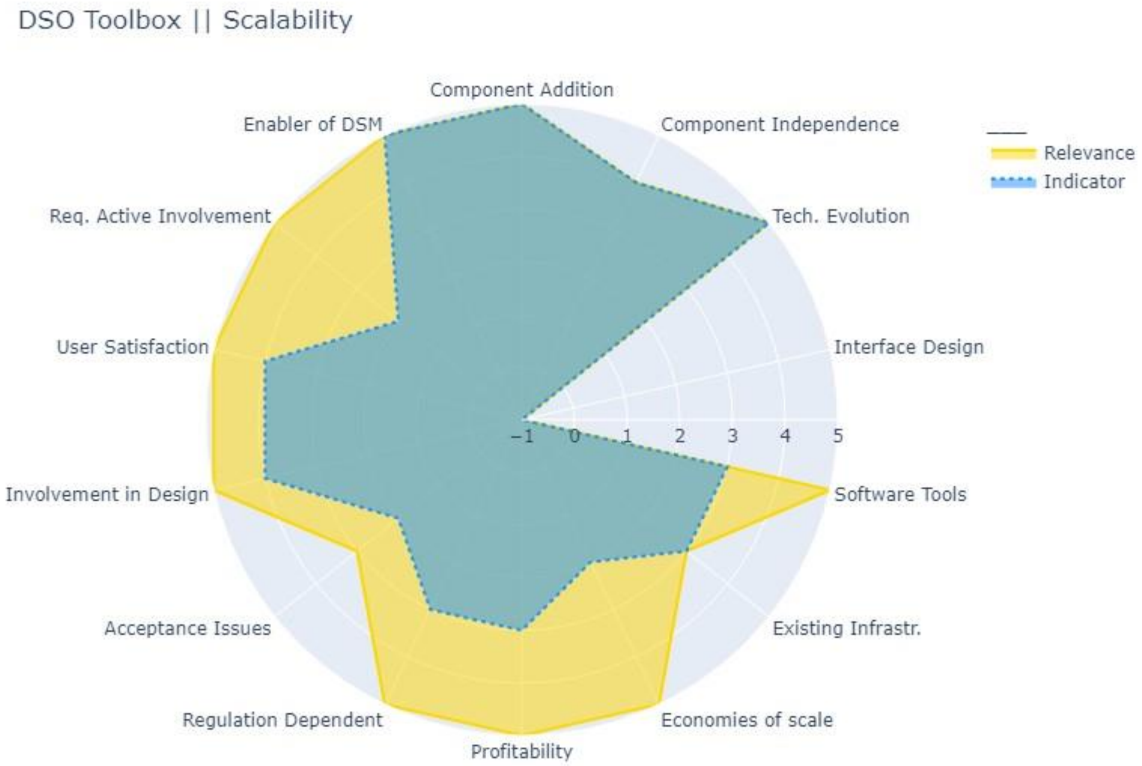

Figure 14. DSO Toolbox - Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Please indicate main challenges in **adding new components**:
    - Different processes can be modelled in the DSO Toolbox, whilst existing components of the processes can be replaced. In terms of UI, a modular approach was followed in the design, enabling different type of notification for events of interest, enabling easy addition of new type of grid events. The use of a canonical data model based on CIM also facilitate the integration of new components. Challenges would relate mainly on the proper definition of the business function of the component rather than the technological side.
- Please describe **dependencies among components**:
    - The are different business applications enabled by the DSO Toolbox. Many of them can operate independently, but most of them need forecast data for their operation.

- Can the product easily adapt to an **evolving technological landscape**? Please elaborate:
  - SOA approach and microservice architecture, facilitates adaptation in the evolving tech. landscape.
- Please describe the effect of scale-up on **interactions among components**:
  - Question not clear.
- Please provide information about the identified **software bottlenecks**:
  - Increase of size of the pilot or the number of pilot areas could introduce delays of computation. Vertical and horizontal scaling needs to be introduce in this case.
- Can a given "**existing infrastructure**" pose limitations to the solution's ability to scale? Regarding the existing infrastructure, please indicate the main barriers you'd expect to encounter:
  - Same as above.

3.1.7.2 Replicability

This KER:

- Sometimes KER uses nationally, instead of internationally recognized standards.
- Is involved in developing new standards by demonstrating FlexOffer implementation.
- No missing standards have been identified.

The most relevant **qualities of a favourable market design** for the KER's replicability are:

- Local

The most relevant **limitations of** current **market designs** are:

- Bid size
- Product design

The **most relevant regulatory barriers** for the replication of this KER are:

- Absence of local markets and of the DSO as "purchaser" of flexibility

The **biggest opportunities for replication** regarding the **regulatory framework** are:

- The consideration of localised flexibility bids

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Does the replication of this KER necessarily require elaborate and/or time-consuming **customization and integration efforts**?
  - New grid model and data need to be provided to train tailor made models.
- To which extent does the use of this KER imply **behavioural changes** from its users?
  - Flexibility concept and modern active management is a prerequisite for the use of the solution.

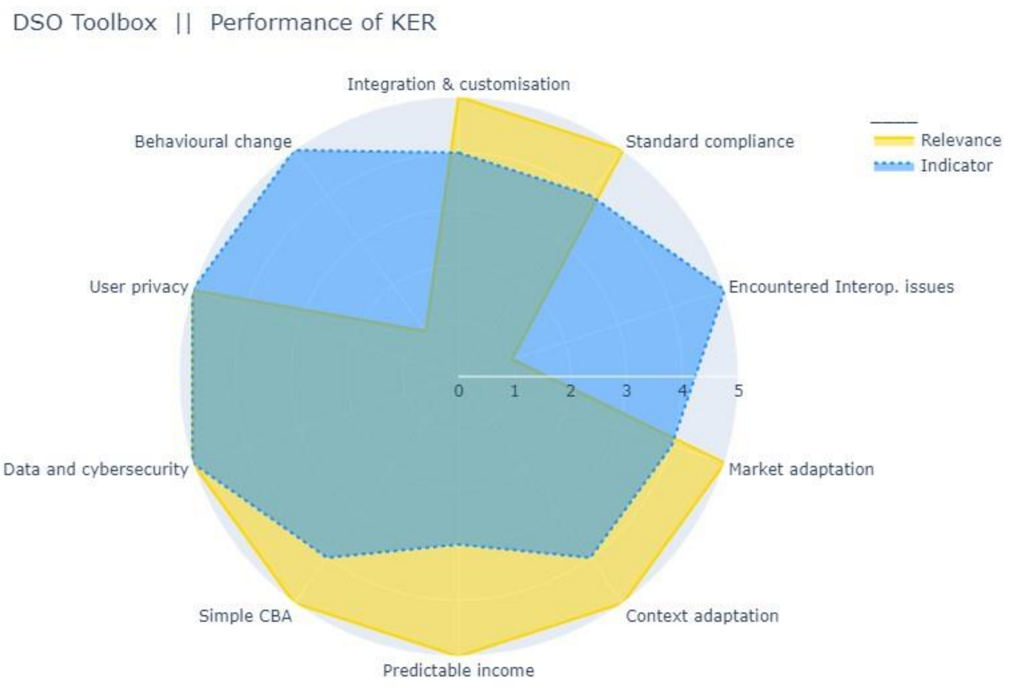

Figure 15. DSO Toolbox – Replicability – Performance of KER

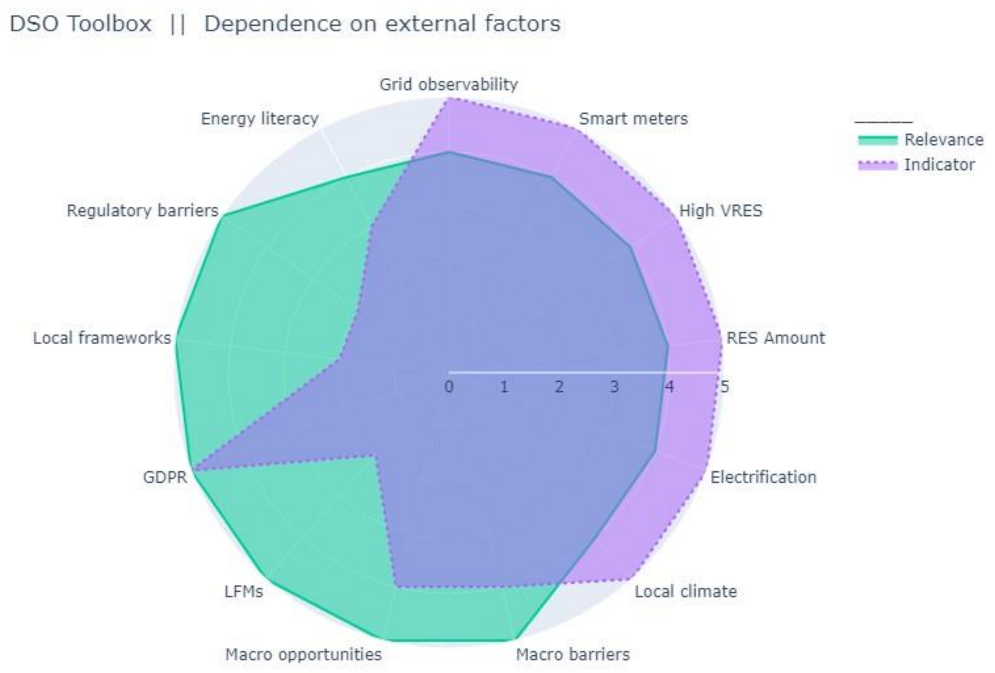

Figure 16. DSO Toolbox – Replicability – Dependence on external factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- To which extent do you consider **energy literacy** to influence stakeholder's willingness to participate in or use this KER?
  - End-users are technical operator of DSO's control centre

3.1.8 Low Voltage Grid Observability Service (part of DSO Toolbox)

This submission is intended for only a part of the KER under analyses (DSO Toolbox) and it is related to the Grid Observability Service (GOS) only. The KER's main achievements are:

- The GOS provides local grid observability to the DSOs in LV power grid areas, that are normally unobservable.
- It performs a low cost, low effort and (potentially) real-time state estimation of the downstream LV grid with a low number of available measurements by means of an AI-powered algorithm trained on simulation-generated synthetic grid data.
- The technology leverages the use of a power grid digital twin, and it is based on open-source software libraries and tools.

3.1.8.1 Scalability

To ensure scalability in KER design, the technology has been fully based on open standards and is lightweight. Different types of hardware can be used and easily purchased. Upfront investment is really low compared to other solutions. It can be quickly reproduced in other pilot grids with low effort and low investment.

The **most relevant obstacle** for scale-up **related to the stakeholder ecosystem** is:

- Acceptance for DSO to rely on AI based algorithms for LV grid monitoring and management

The **most relevant opportunity** for scale-up related to the **stakeholder ecosystem** is:

- Acceptance for DSO to rely on AI based algorithms for LV grid monitoring and management

Showing how sometimes the existence of an obstacle also brings an opportunity for development.

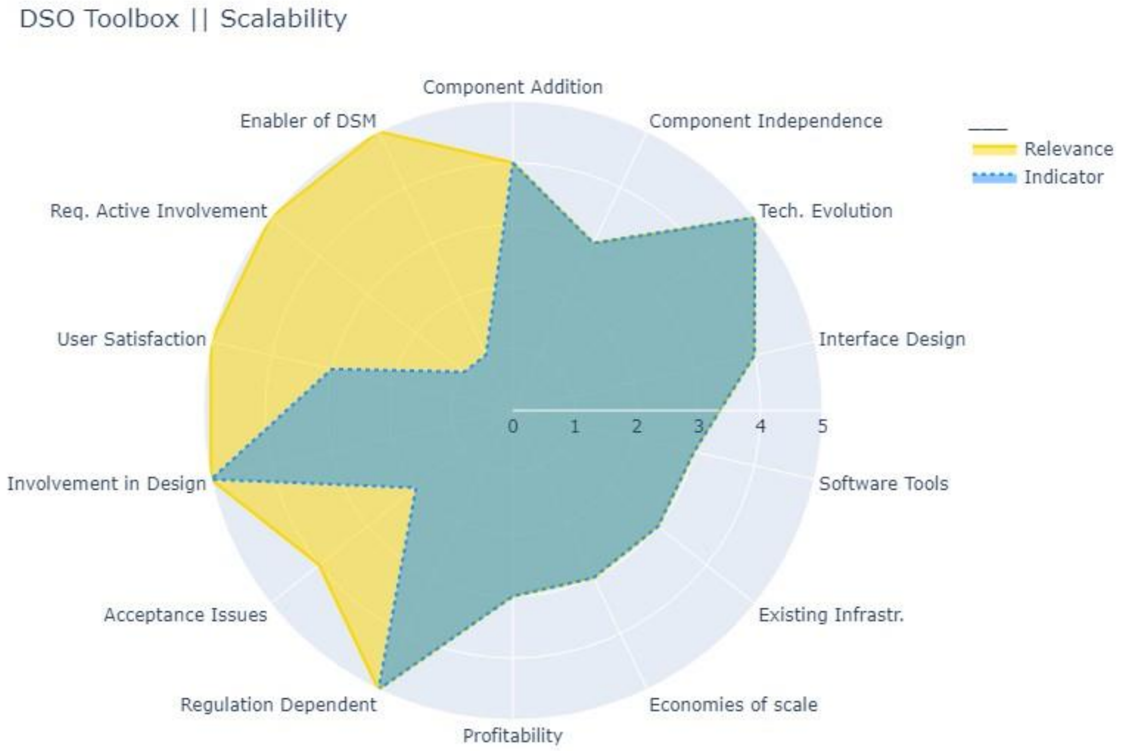

Figure 17. Low Voltage Grid Observability Service (DSO Toolbox) – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Please indicate main challenges in adding **additional components**:
  - Integration with DSO legacy systems (SCADA)
- Please describe **dependencies among components**:
  - At its essence the KER is composed by a measuring hardware, a computing hardware and UI software for visualization. They work independently but the operation of the service works in cascade\series. If one stops, everything stops.
- Can the product easily adapt to an evolving technological landscape (i.e. **tech. evolution**)? Please elaborate:
  - It is based on cutting edge AI technologies

- Please describe the effect of scale-up on interactions among components (i.e. **interface design**):
    - Scaling up the technology does not mean make it bigger but only make more devices of the same size with the same scope to be deployed in different LV grids. A sort of plug-and-play service.
- Please provide information about the identified software bottlenecks (i.e. **software tools**):
    - communication could be a bottleneck, as well as data preparation and visualization in the user interface.
- Can a given "**existing infrastructure**" pose limitations to the solution's ability to scale? If so, please indicate the main barriers you'd expect to encounter:
    - Communication speed, large amount of data and the required servers to store it.

3.1.8.2 Replicability

This KER:

- Doesn't make use of nationally, instead of internationally recognized standards.
- Is not involved in testing and/or developing new standards.
- Hasn't identified any missing standards.

The biggest **regulatory barrier** for replication is:

- GDPR and privacy matters are jeopardizing the creation of a proper grid model.

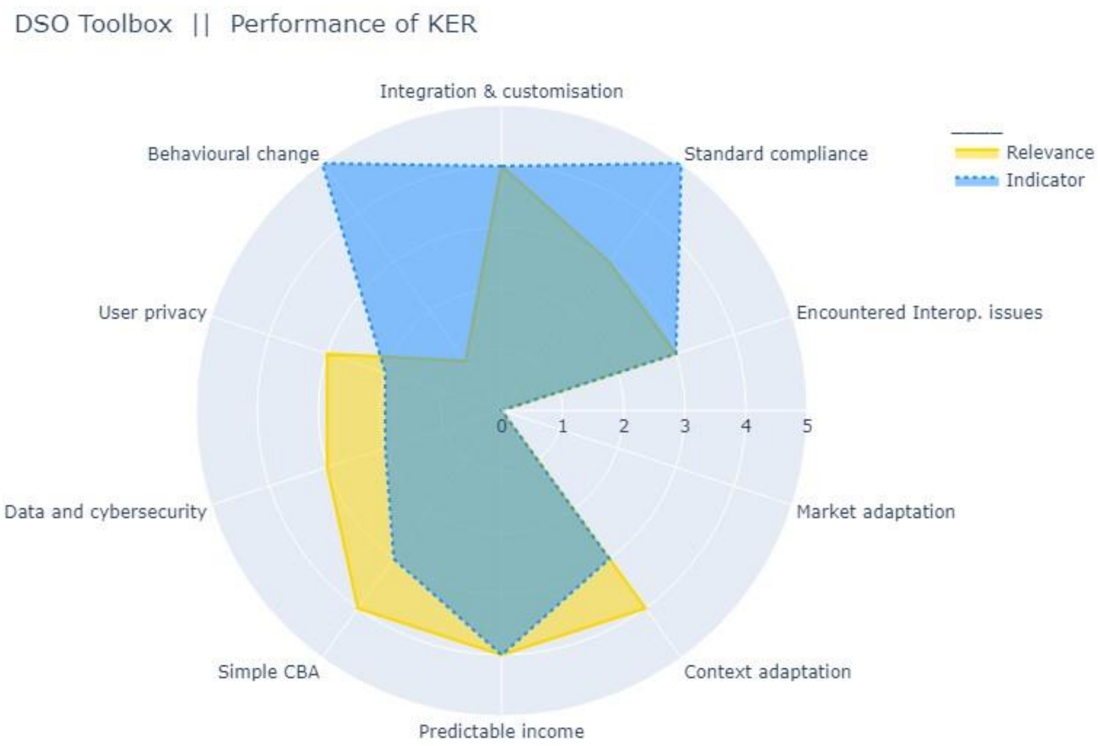

Figure 18. Low Voltage Grid Observability Service (DSO Toolbox) – Replicability – KER Performance

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Does the replication of this KER necessarily require elaborate and/or time-consuming **customization and integration efforts**?
    - Replicability can and should be streamlined.
- Please indicate the extent to which you consider the **simplicity of CBA** to be true**:**
    - Business model is very simple so far. New opportunities could be explored in the future.

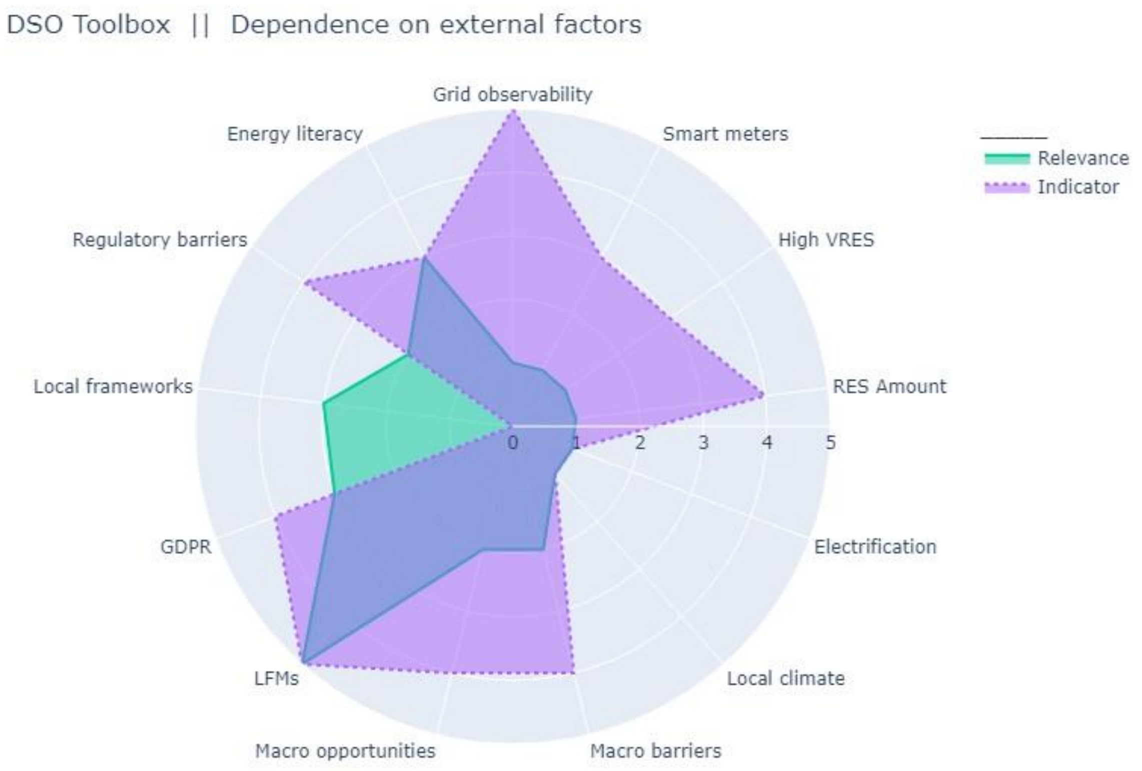

Figure 19. Low Voltage Grid Observability Service (DSO Toolbox) – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- How relevant do you consider the factor **network configuration** for KER replicability? Please provide further insight:
    - It can be replicated in any LV network with any type of load and generation.
- Please provide information on the most relevant **macroeconomic risks and opportunities** identified:
    - If price of measuring equipment rises, the technology could be a promising alternative.

- To which extent do you consider **energy literacy** to influence stakeholder’s willingness to participate in or use this KER?
    - "Digital literacy" would be more relevant, rather than energy literacy.

3.1.9 Flexibility Trading Platform

The Flexibility Trading Platform has reached TRL7.

3.1.9.1 Scalability

This KER fully considered scalability in its design.

The most relevant **regulatory barrier** identified for scale-up is:

- Prosumer's financial settlement

The most relevant **opportunity** identified related to the **regulation**, for scale-up, is:

- Large scale optimisation

The most relevant **obstacle** for scale-up related to the **stakeholder ecosystem** is:

- Integration into existing IT environments

The most relevant **opportunity** for scale-up related to the **stakeholder ecosystem** is:

- Provision of system services

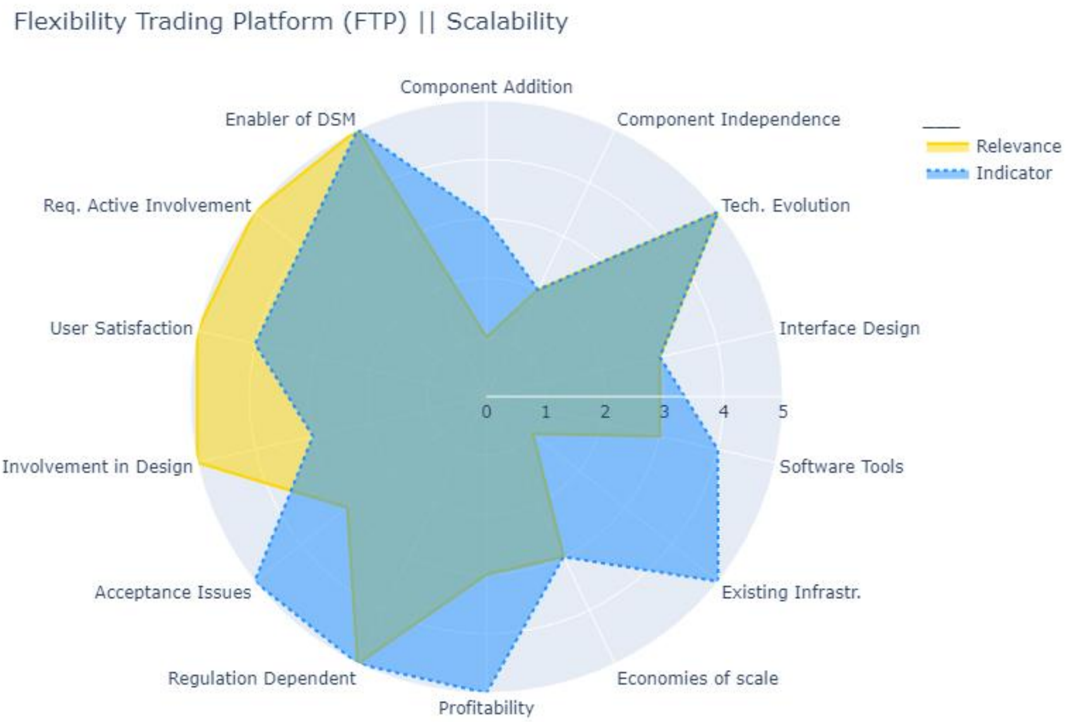

Figure 20. Flexibility Trading Platform – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Are there **clear bottlenecks** when it comes to the **software**'s ability to scale-up? Please provide information about the identified software bottlenecks:
    - Increased number of Flexibility Offers

3.1.9.2 Replicability

This KER:

- Doesn't make use of nationally, instead of internationally recognized standards
- This KER is involved in testing and/or developing new standards
- No missing standards have been identified

The **most relevant quality of** a **favourable market design** for the KER's replicability is:

- Offering of the real-time market or balancing markets.

The **most relevant limitation** of current **market designs**, on the KER's replicability is:

- Low volume and low price volatility.

The **biggest regulatory barrier** for replication is:

- Legality of the user to provide profitable services.

The **biggest opportunity** for replication **regarding the regulatory framework** is:

- Introduction of the flexibility market.

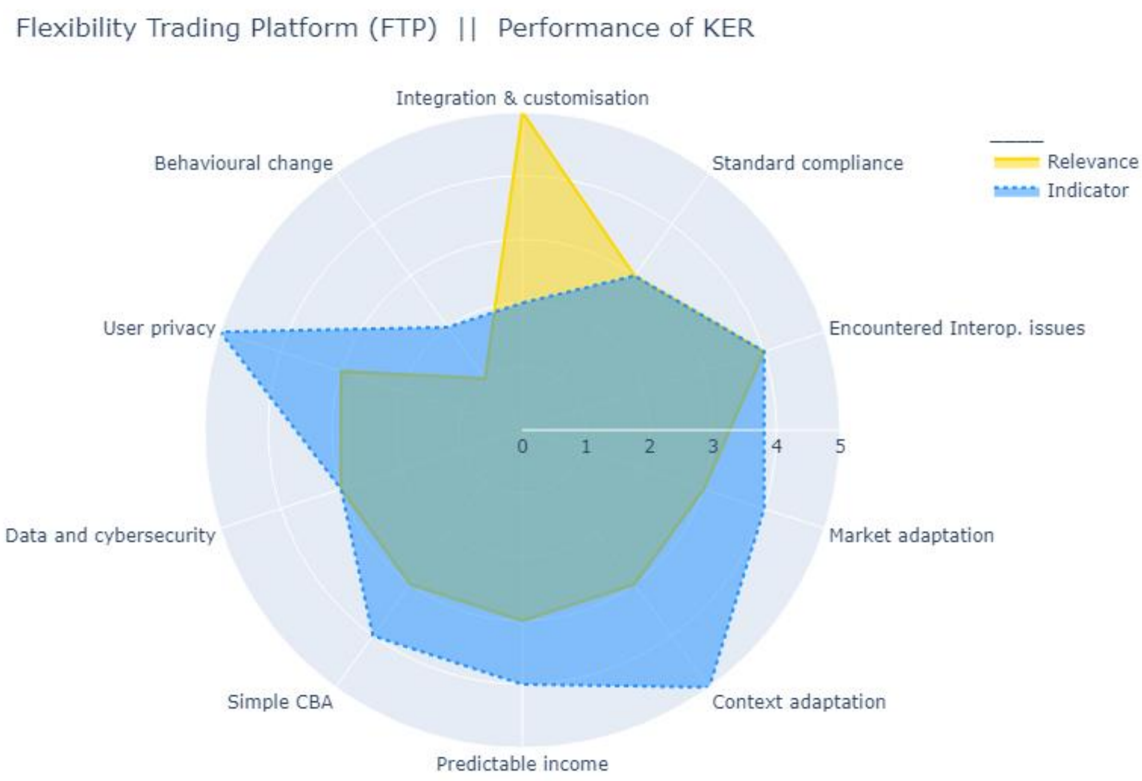

Figure 21- Flexibility Trading Platform – Replicability – Performance of KER

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

Every **integration** requires **customization** at entry of prosumers, reporting and KPI presentation.

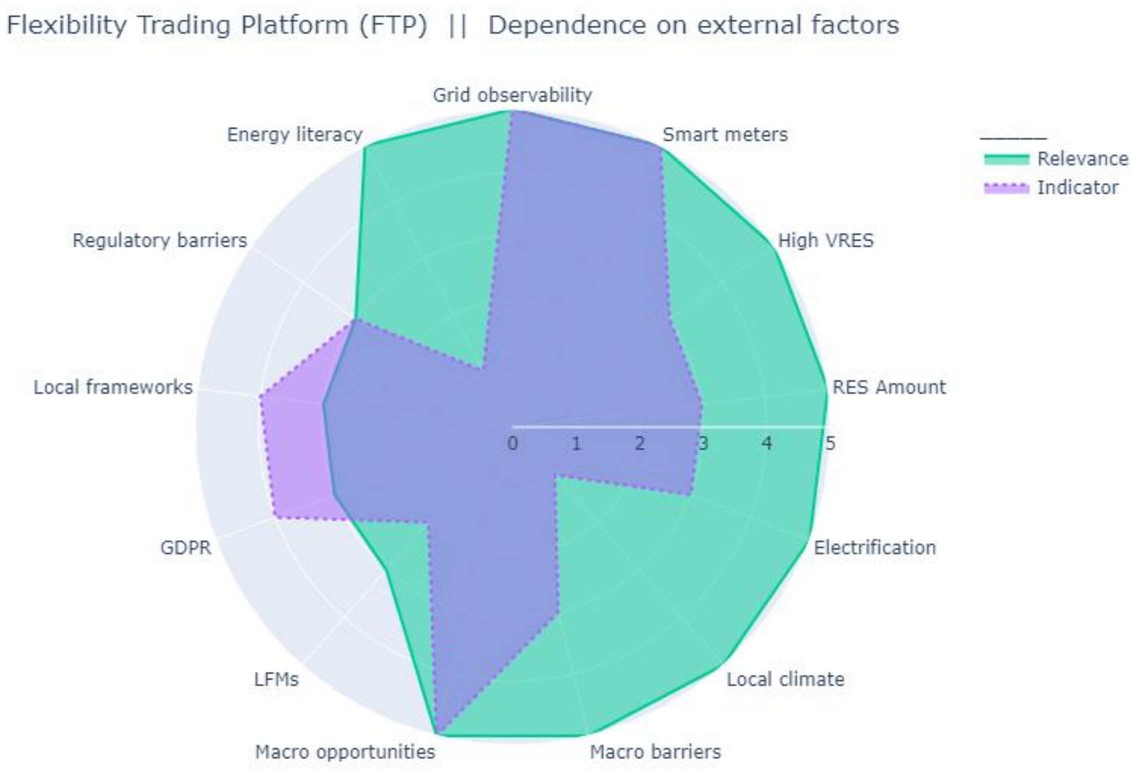

Figure 22. Flexibility Trading Platform – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- **Smart meters** are important for adaptation evaluation.
- **Electrification** of heat and transport is important to provide flexibility, however this has indirect influence on the product.
- **Macro barriers** have influence on replicability since the phenomena reduces the investments in advanced features and reduces the market influence (provides various incentives and other marker barriers).
- **Energy literacy** is highly important at usage of this product.

3.1.10 P2P Toolbox

The P2P-FTP enables basic identity, pseudo-currency and flexibility trading activities. It is based on blockchain technology. It has reached TRL7.

3.1.10.1 Scalability

This product was partly designed with scalability in mind. The blockchain technology has some issues with scalability, in return for its transparency.

The most relevant **regulatory barrier** identified for scale-up is:

- National regulations for energy communities and energy sharing

The most relevant **opportunity** related to **regulation** for scale-up is:

- Energy communities as a local driver

The most relevant **obstacle** for scale-up related to the **stakeholder ecosystem** is:

- Complexity of set-up and operation

The most relevant **opportunity** for scale-up related to the **stakeholder ecosystem** is:

- Energy communities as local drivers

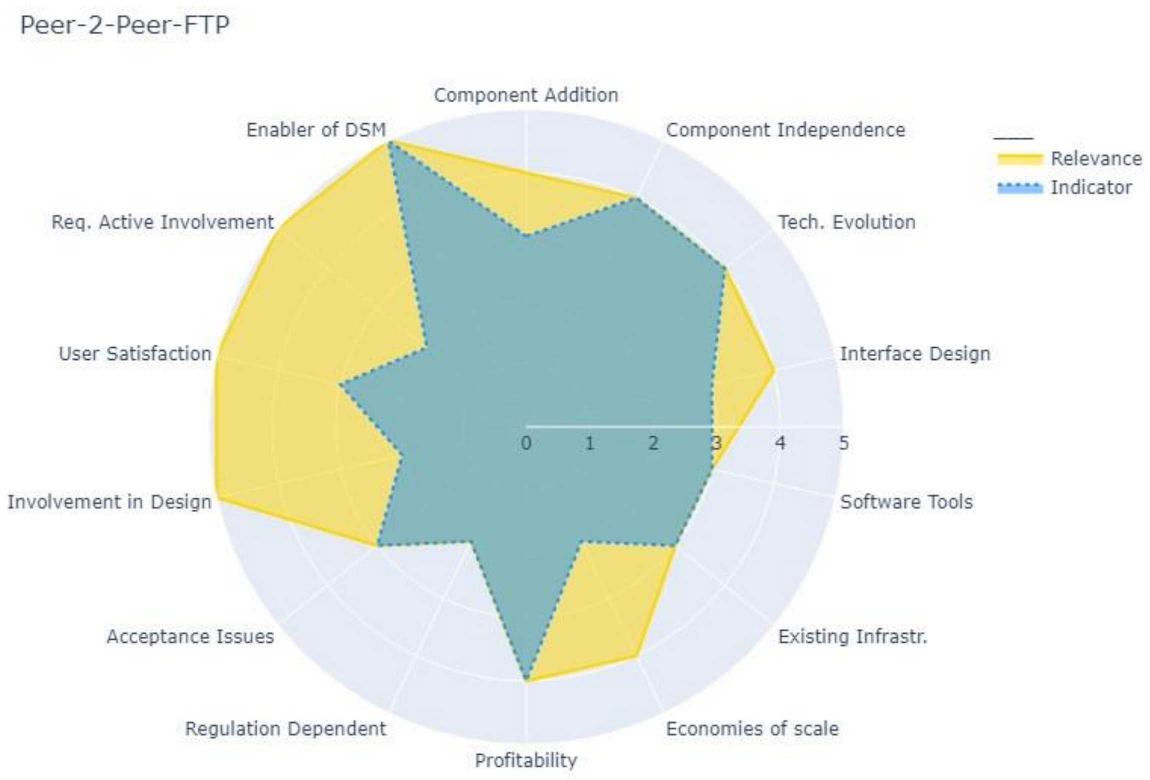

Figure 23. P2P Toolbox – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise,

many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Please indicate main challenges in **adding new components**:
    - The blockchain technology makes adding new components harder.
- Please describe **dependencies among components**:
    - All three components are need to work together.
- Can the product easily adapt to an **evolving technological landscape**? Please elaborate:
    - The blockchain technology makes this possible but nontrivial.
- Please provide information about the identified **software bottlenecks**:
    - The blockchain technology has some bottlenecks which have been previously mentioned.
- Regarding the **existing infrastructure**, please indicate the main barriers you'd expect to encounter, for this solution's ability to scale-up?
    - The blockchain technology could have a problem with many thousands of devices
- Do the **costs** of this KER **increase** through scale-up?
    - The need for more blockchain nodes leads to increasing cost.
- Please rate the **potential emergence of acceptance issues** when upscaling:
    - Privacy and transparency issues could emerge.

3.1.10.2 Replicability

This KER:

- Doesn't make use of nationally, instead of internationally recognized standards
- Is involved in testing and/or developing new standards
- Has identified missing standards: Formal standard for flexibility

The most relevant **qualities of a favourable market design** for replicability are:

- Small bid sizes
- Technology neutrality
- Not requiring symmetric bids

The most relevant **limitations of current market designs**, for replicability are:

- Too high bid sizes
- Technology requirements
- requiring symmetric bids

The biggest **regulatory barriers** for replication is:

- Local regulations for energy communities and energy sharing are inadequate.

The biggest **opportunity** for replication, regarding **regulation** is:

- Energy communities as drivers

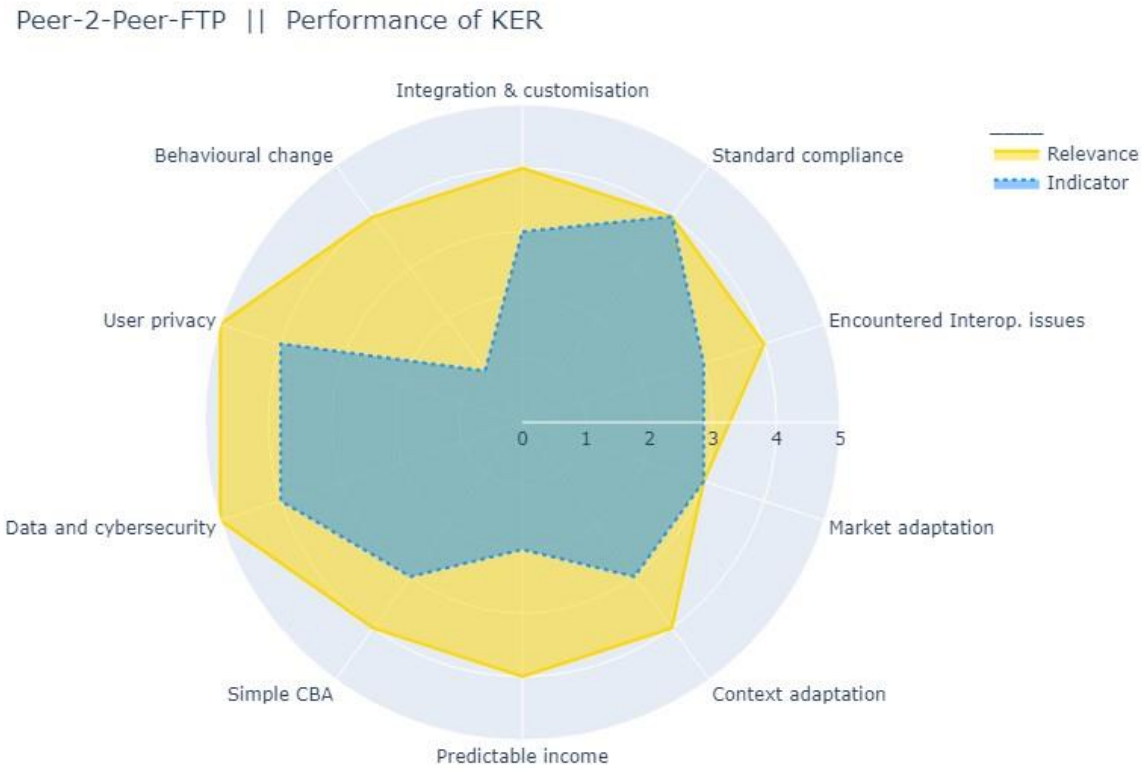

Figure 24. P2P Toolbox – Replicability – Performance of KER

A detailed description of the indicators can be found in the following tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Does the replication of this KER necessarily require elaborate and/or time-consuming **customization and integration efforts**?
  - It has to be customized for local regulations and context.
- Were there **interoperability issues in trials**, with regards to this KER?
  - There were issues integrating the components and operating the blockchain nodes.
- Can this KER be replicated under **different market designs**?
  - Because local regulations for energy communities and energy sharing differ, it would require adaptation.
- Comments on the business model:
  - Business model is yet unclear
- Does the use of this KER imply **behavioural changes** from its users?
  - Yes, buying and selling energy and flexibility in this way is very different from the traditional model.

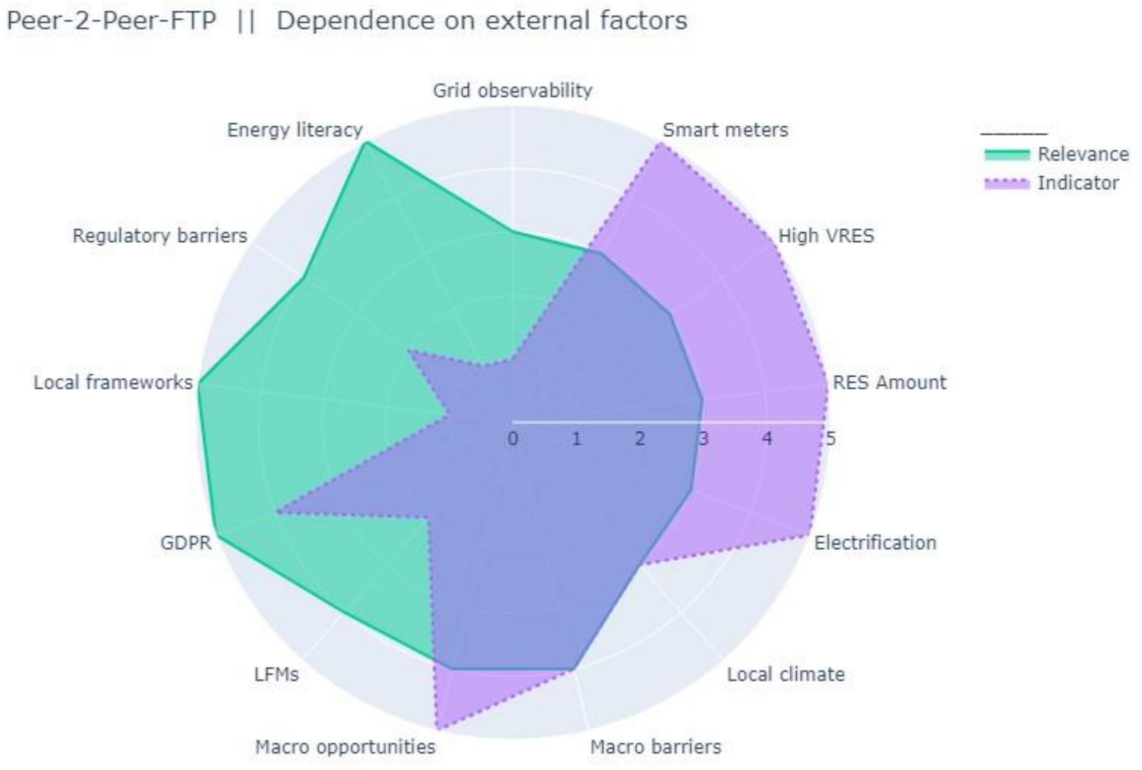

Figure 25. P2P Toolbox – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Relating to the factor **network configuration**, please provide insight,
  - Local regulations and user acceptance have to support it.
- Relating to the potential for **macroeconomic** factors to impose **barriers** and the likelihood for these to present **opportunities** for replication, please provide information on the risks and opportunities identified:
  - The 2022 energy crisis made a very good business case.
- Relating to the dependence on the emergence of **local or regional flexibility markets**, please provide information:
  - The emergence will make the business case much stronger.
- To which extent do you consider **energy literacy** to influence stakeholder's willingness to participate in or use this KER?
  - The platform enables users, e.g., energy community members, to buy renewable electricity from their peers for residential, EV and heating.

3.1.11 FlexCoin and Community Management DAPPs (part of P2P Toolbox)

The main advancement of these P2P-Toolbox components is the integration of the first settlement platform (HLF, FlexCoin), enabling much easier integration than other settlement platforms. The main difference is which API is called and the schema of data exchanged with that API.

3.1.11.1 Scalability

This KER was partly designed with scalability in mind. As it is relatively easy to add prosumers to the system, it would require much more hardware resources in case the product is used by millions.

The most relevant **regulatory barriers** identified for scale-up are:

- Germany not allowing prosumers to trade energy among themselves.
- Limitations on exchanging energy between neighbouring DSOs.

The most relevant **obstacle** for scale-up related to the **stakeholder ecosystem**:

- Consumers not being keen to load shifting.

The most relevant **opportunity** for scale-up related to the **stakeholder ecosystem**:

- Stabilisation of the grid with assets that are not traditionally used for this purpose.

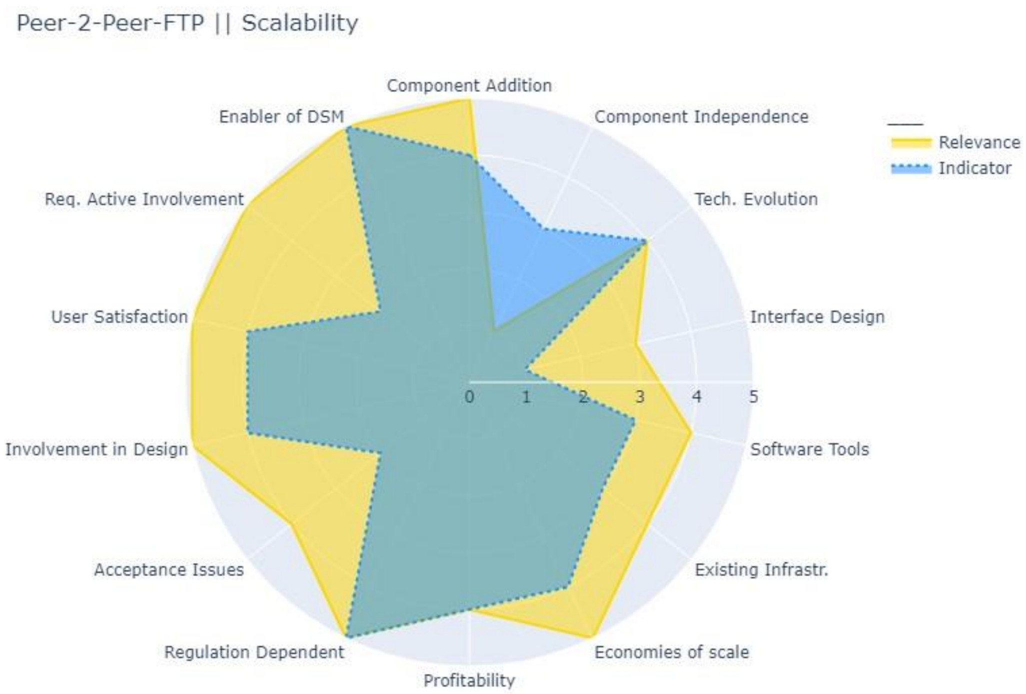

Figure 26. FlexCoin and CM DAPPs(part of P2P Toolbox) – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Please rate the **potential emergence of acceptance issues** when upscaling:
    - Consumers are not keen to shift their consumption as frequently shifting consumption also means rescheduling tasks that depend on energy consumption.

3.1.11.2 Replicability

This KER:

- Doesn’t make use of nationally, instead of internationally recognized standards
- Is not involved in testing and/or developing new standards
- Has not identified any missing standards

The most relevant quality of a **favourable market design** for replicability is:

- Allowing small consumers and small producers to participate in ancillary services.

The most relevant **limitation** of current **market designs** on replicability is:

- The benefits for prosumers are not so clear.

The biggest **regulatory barrier** for replication is:

- Consumers are not allowed to trade energy among themselves.

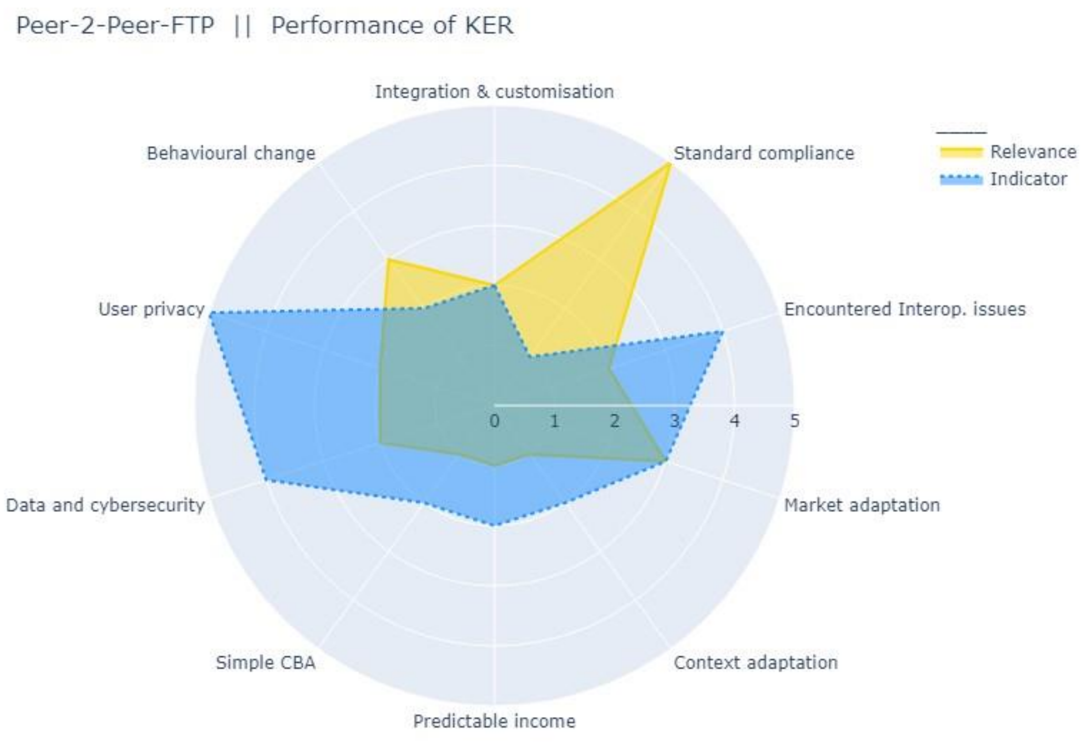

Figure 27. FlexCoin and CM DAPPs (part of P2P Toolbox) – Replicability – Performance of KER

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Does the replication of this KER necessarily require elaborate and/or time-consuming **customization and integration efforts**?
    - The deployed server-side services wouldn't require much work, but each prosumer still has to be integrated separately.

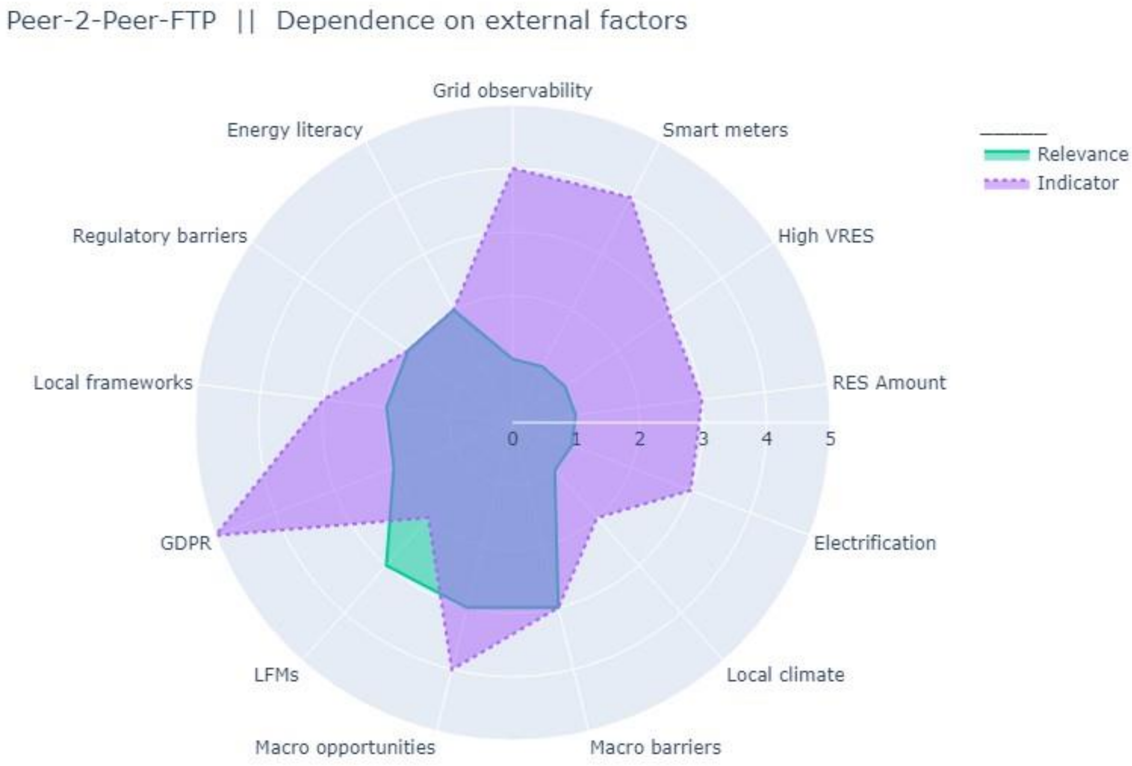

Figure 28. FlexCoin and CM DAPPs(part of P2P Toolbox) – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

3.1.12 Intra-Day Market Mechanism

The IDMM is a tool for market-based DSO flexibility procurement. This tool offers advantages to both DSOs, by providing them with new tools for congestion management, as well as to flexibility aggregators and owners of flexibility assets located in the distribution system, by granting them access to the market, and creating opportunities for profit maximisation through electricity trading. In terms of design and technical excellence, the KER's primary advancements include:

a) accurate representation of AC network characteristics
b) access to both active and reactive power trading
c) minimum information exchange between the DSO and MO using AC sensitivities

3.1.12.1 Scalability

This product was fully designed with scalability in mind. The IDMM as well as all FEVER market mechanisms (day ahead and real-time) have been designed to be scalable to networks of real size. The IDMM has been validated in networks of 1000 buses and the results are presented in D4.3.

For scale-up, the most relevant **regulatory barriers** are:

- Adaptation in short-term and balancing markets (e.g. increase time and/or locational granularity)

- Provide incentives to DSOs to investigate solutions for the operation and planning of their networks beyond classic network expansion.

The most relevant **opportunities** for scale-up related to **regulation** are:

- Regulatory framework for demand-side participation in the markets has been put in place in many European countries.
- Incentives for DERs installation are evident in many European countries
- The EU Internal Electricity Market Directive highlights the need for market based flexibility procurement by the DSOs.

The most relevant **obstacles** for scale-up related to the **stakeholder ecosystem** are:

- Technological challenges such as accurate baseline prediction.
- Coordination between DSO-TSO.

The most relevant **opportunities** for scale-up related to the **stakeholder ecosystem** is:

- New revenue streams for market parties and technology providers.

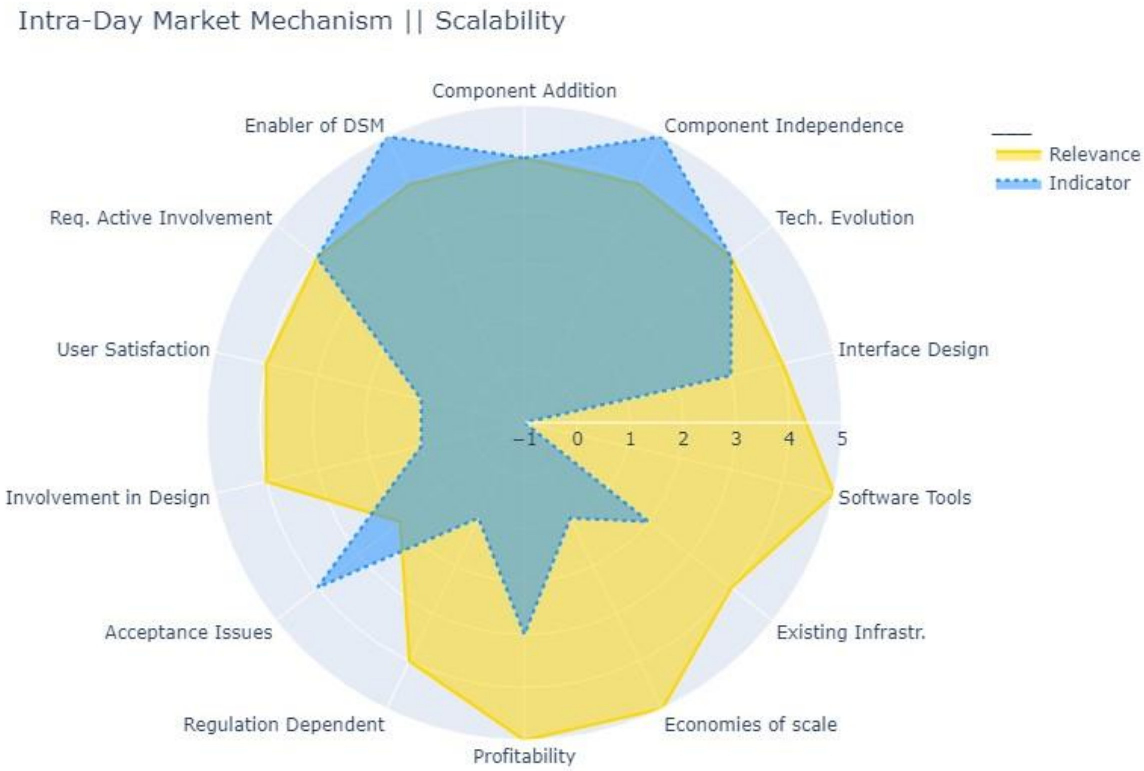

Figure 29. Intra-day Market Mechanism – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation

- Table 12. SRA attributes and KPIs: Scalability - Social

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Please indicate main challenges in **adding new components**:
  - Modification in models to include three phase transformers
- Please describe **dependencies among components**:
  - Independent modules have been developed to process input data, run power flow, run network and market feasibility checks.
- Can the product easily adapt to an **evolving technological landscape**? Please elaborate:
  - The IDM is currently a simulation model. New technologies will mainly affect the KERs demonstration in operational environment.
- Please describe the effect of scale-up on **interactions among components**:
  - Scaling up will not affect existing interaction among components, but will create new needs for interaction.
- Please provide information about the identified **software bottlenecks**:
  - To be evaluated in a future stage.
- Can a given "**existing infrastructure**" pose limitations to the solution's ability to scale? Please indicate the main barriers for this solution's ability to scale-up?
  - The availability of technologies like smart meters, currently installed DERs, and network monitoring tools may affect the solutions ability to scale up.
- Do the **costs** of this KER **increase** through scale-up?
  - Scaling up will result in new costs related to IT infrastructure, ex. servers and operation costs.
- Does the **profitability** of this KER **improve** through scale-up?
  - We have not conducted yet a break even analysis.
- Please rate the **potential emergence of acceptance issues** when upscaling:
  - Although we haven't investigated stakeholders feedback on the proposed IDM, we think that if the neccessary tools and incentives are provided to the market participants, the tool would be widely accepted by the relevant stakeholders.

3.1.12.2 Replicability

This KER:

- Doesn't make use of nationally, instead of internationally recognized standards
- Is not involved in testing and/or developing new standards
- No missing standards have been identified

The most relevant **qualities of** a **favourable market design** for replicability are:

- Co-optimising energy and reserve procurement both in day-ahead and shorter-term energy markets.
- Reform wholesale-market bidding formats to incorporate increased detail in the representation of generation and demand characteristics.
- Increased time and locational granularity.

The most relevant **limitations** of current **market designs**, for the KER's replicability are:

- Small assets cannot participate in the market.
- Integration of LFMs with wholesale markets.

The biggest **regulatory barriers** for replication are:

- Data ownership and data privacy provisions.

The biggest **opportunity** for replication of this KER, regarding the **regulatory framework,** is:

- Regulation on DSO revenue models.

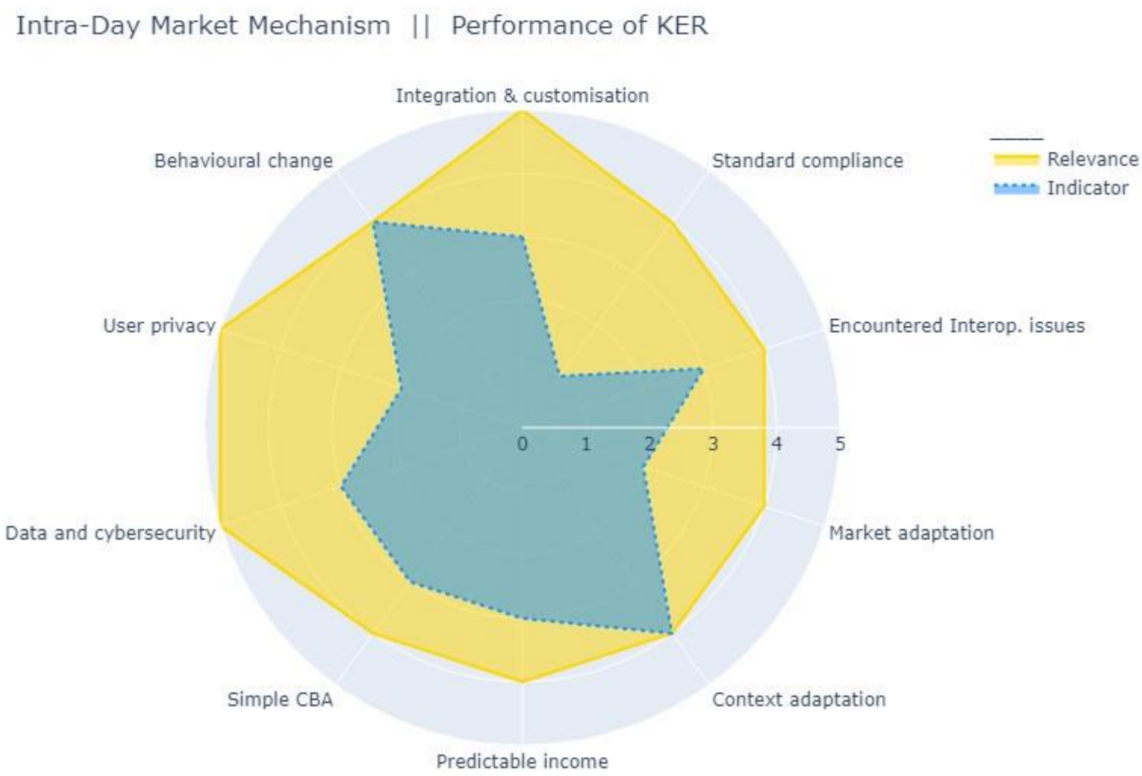

Figure 30. Intra-day Market Mechanism – Replicability – KER **Performance**

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Were there **interoperability issues**, with regards to this KER?
  - We haven't dealt with interoperability issues yet.
- Can this KER be replicated under **different market designs**?
  - The implementation of the IDM is highly related to the market design. Co-optimisation of resources between the energy and reserves markets is required.
- Please elaborate on the **predictability of income and simplicity of the CBA**:
  - The cost benefit analysis highly depends on external parameters, like forecasts for DER integration, other regulatory provisions etc, and could have a lot of uncertainty.

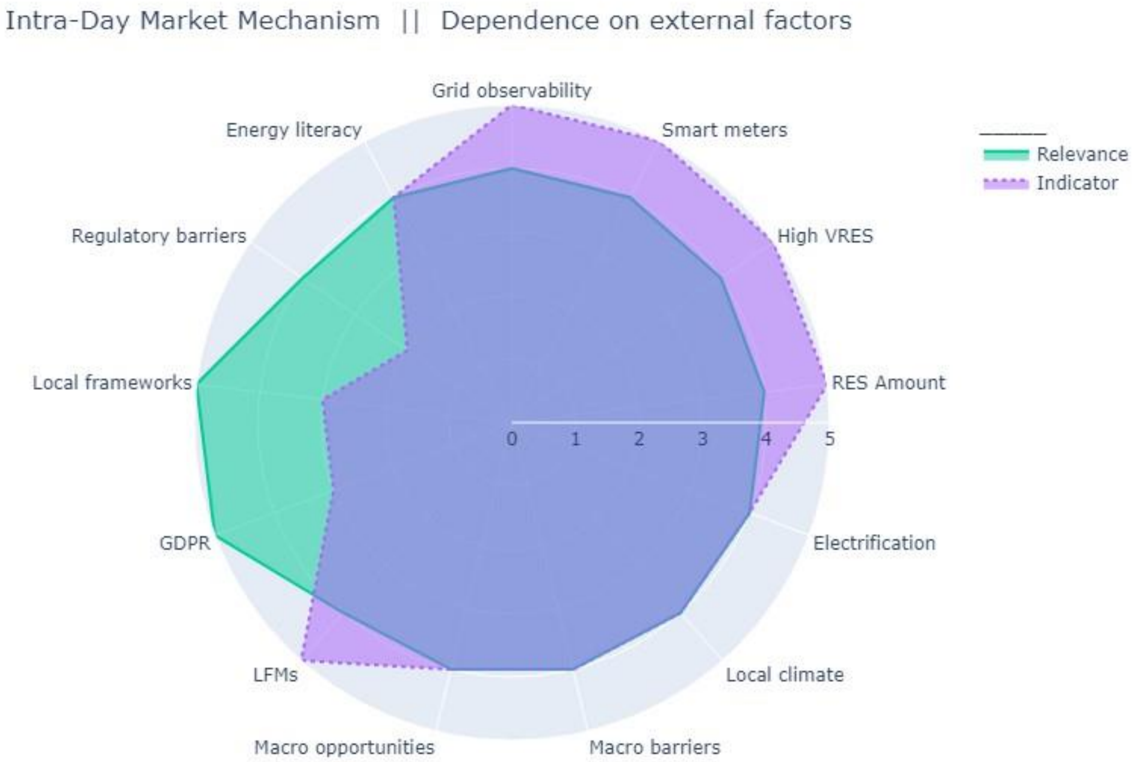

Figure 31. Intra-day Market Mechanism – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- Please provide insight for the relevance of the factor **network configuration** for KER replicability:
  - The local generation mix and consumption mix and profiles could affect the implementation of the IDM.
- Please provide information on the most relevant **macroeconomic risks and opportunities** identified:
  - Electricity and gas prices, depending on their value, could serve as risks or opportunities. Interest rates and/or inflation may have an impact on DERs investments.
- Please, provide information about the KER's dependency on **LFMs**:
  - The IDMM is a local energy market.

3.1.13 Factory Energy Management System

The main advancement of the FEMS is having gone from TRL 7 to TRL 8.

3.1.13.1 Scalability

This product was partly designed with scalability in mind.

The most relevant **opportunities** related to **regulation** for the scale-up of this KER are:

- More energy flexibility communities
- Potential grid stability
- Cost reductions

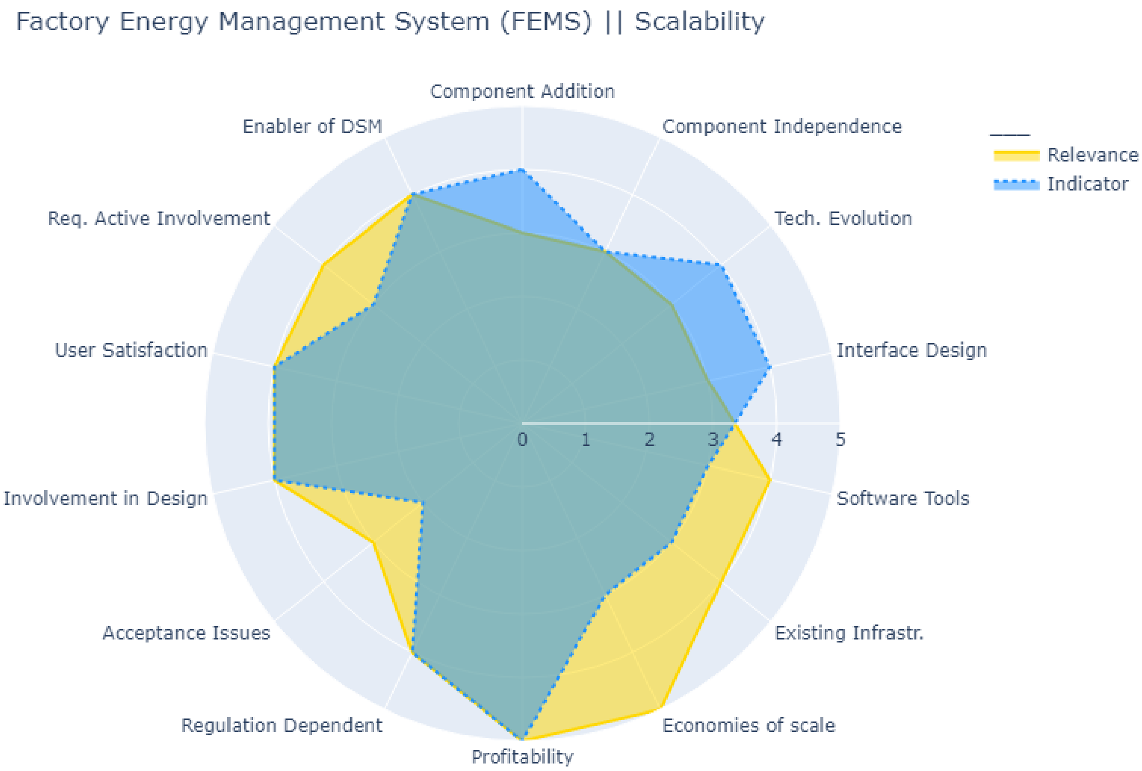

Figure 32. Factory Energy Management System – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

3.1.13.2 Replicability

This KER:

- Doesn't make use of nationally, instead of internationally recognized standards
- This KER is involved in testing and/or developing new standards
- Missing standards have been identified.

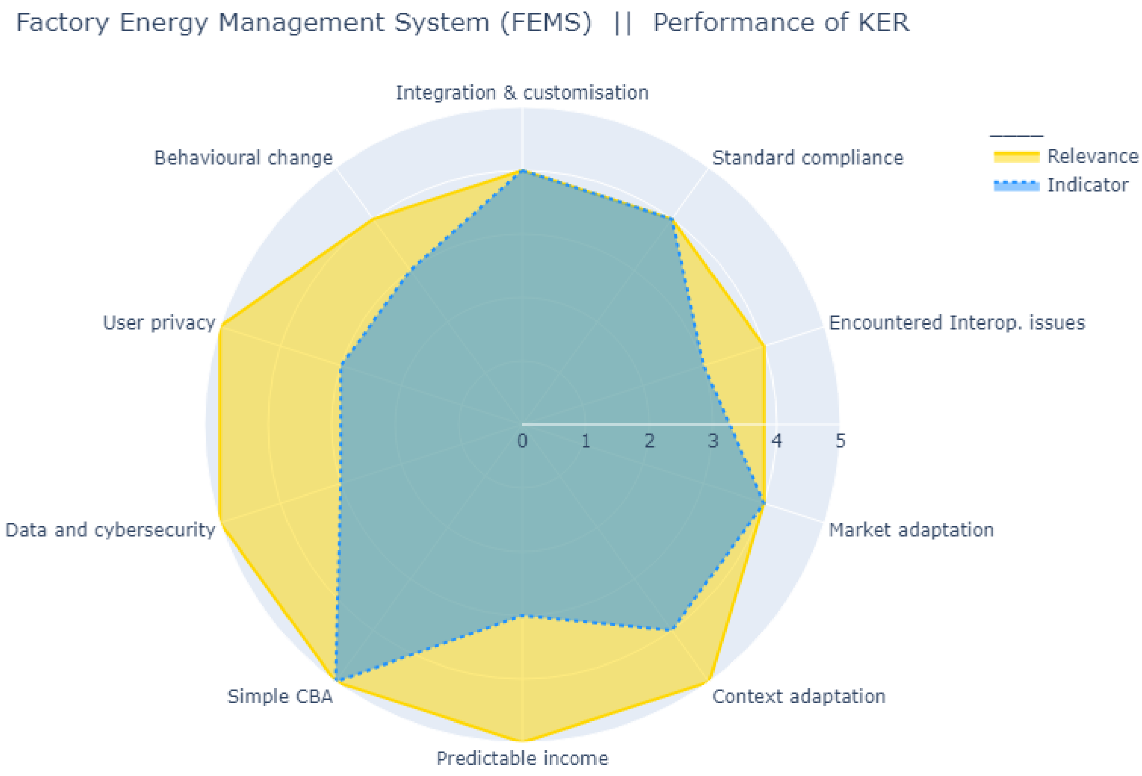

Figure 33. Factory Energy Management System – Replicability – KER Performance

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- **Cost benefit analysis** is straight forward because investment costs are known and the incomes can be controlled by the prosumer setting the price.
- The FEMS is fully automated solution therefore doesn't require direct **behavioural changes**, however through its usage it implicitly influences the customer habits by expanding it energy literacy.
- The FEMS's business model accepts various **contexts** – becide the market trading, it can also be used through bi-lateral contracts and direct control.

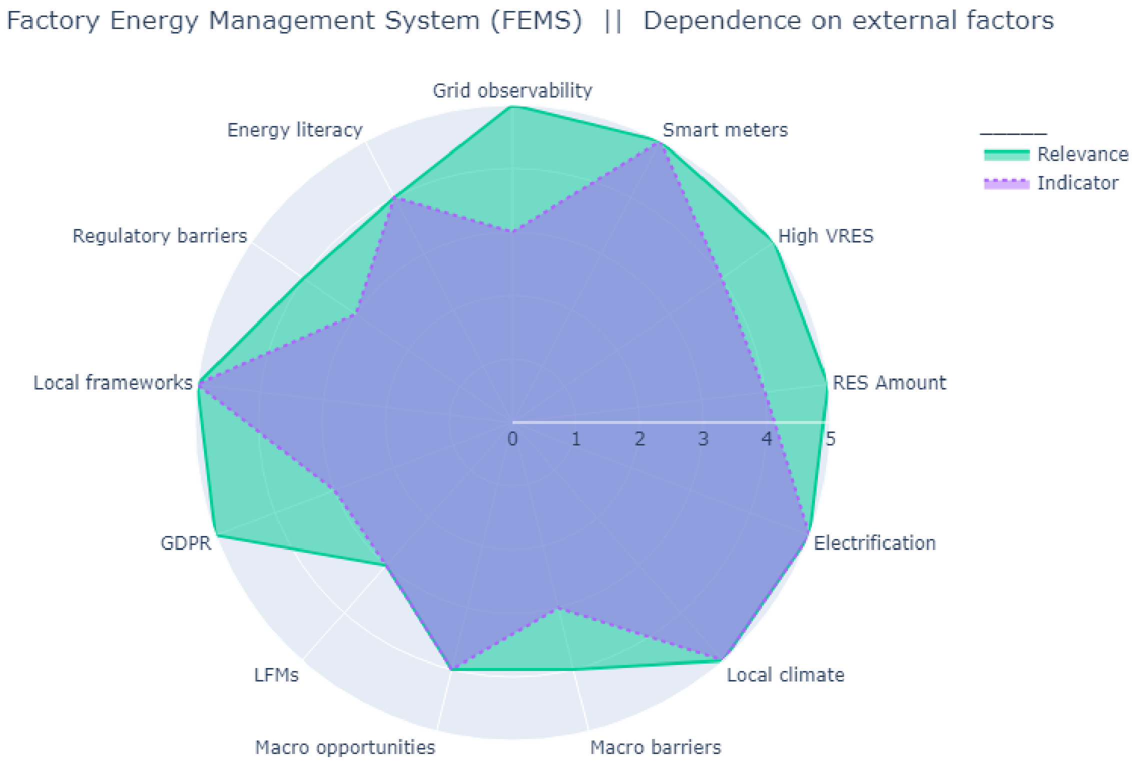

Figure 34. Factory Energy Management System – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

Additional input has been provided with relation to the indicators presented in the previous figure. The provided input for each indicator, including the corresponding request for input, follows:

- **Grid observability** is very important for the scenario performance, however indirectly involved in this product.
- **Smart meters** are important for adaptation evaluation.
- **Electrification** of heat and transport is important to provide and control flexibility.
- **Macro barriers** has influence on replicability since the phenomena reduces the investments in advances features and reduces the market influence (provides various incentives and other marker barriers).
- KER does has not high dependence on **local balancing framework** since it set-up separate control communication with dedicated high level/external component

3.1.14 Micro-Grid Energy Management System

During the project period, the Microgrid-EMS reached a TRL of 7 since it was evaluated using real-life data and buildings from the microgrid of UCY.

3.1.14.1 Scalability

This product was fully designed with scalability in mind.

The most relevant **regulatory barriers** for scale-up are:

- No specific regulatory framework.
- Unwillingness of adopting this specific technology.

The most relevant **opportunities** related to **regulation** for scale are:

- The product can be added to already existing Building Energy Management System (BEMS)/FEMS.
- The product can work as a stand-alone solution.

The most relevant **obstacle** for scale-up related to the **stakeholder ecosystem** is:

- Flexibility and adaptability of the users.

The most relevant **opportunity** for scale-up related to the **stakeholder ecosystem** is:

- BEMS architecture and limitations.

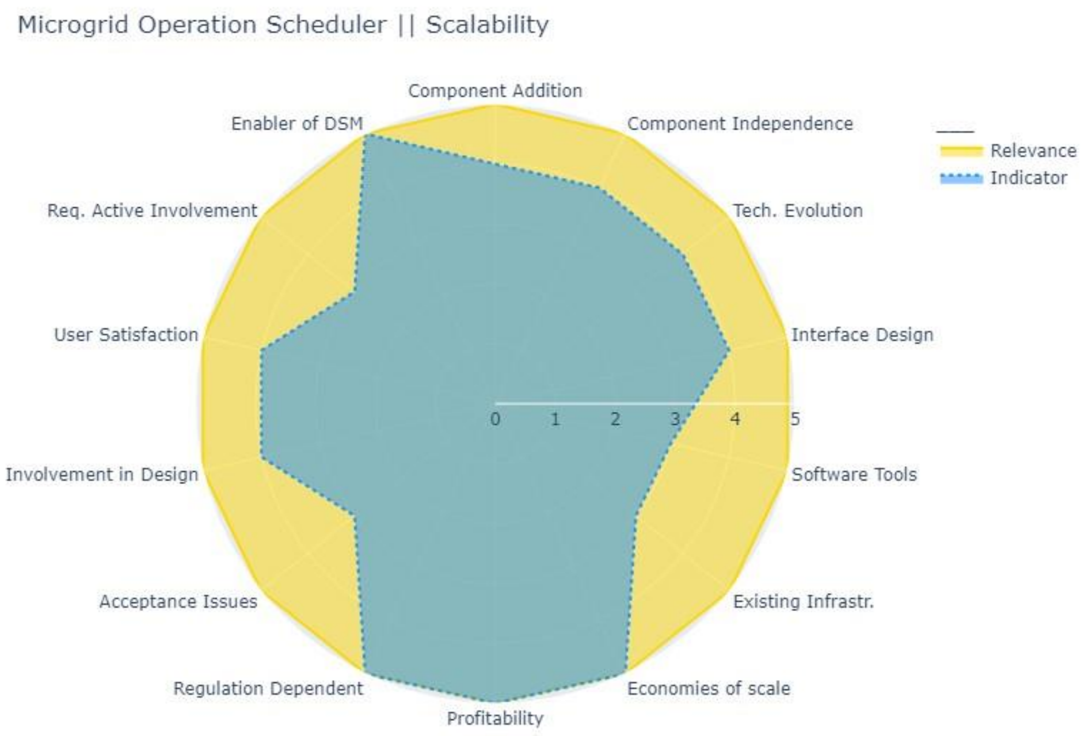

Figure 35. Microgrid Energy Management System – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.

- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

3.1.14.2 Replicability

This KER:

- Sometimes uses national instead of internationally recognised standards.
- Is not involved in the development of new standards.
- Hasn’t identified any missing standards.

The most relevant **quality of** a **favourable market design** for the KER’s replicability is:

- Fully interactive day-ahead, intraday and balancing markets should be existing.

The most relevant **quality of** current **market designs**, which poses **limitations** on replicability is:

- The connection between the local and wholesale electricity markets.

The biggest **regulatory barrier** for the replication of the trial(s) related to this KER is:

- The flexibility regulatory framework is not established.

The biggest **opportunity for replication**, regarding the **regulatory framework** is:

- Since the regulatory framework is not fully established, there is potential for advocacy.

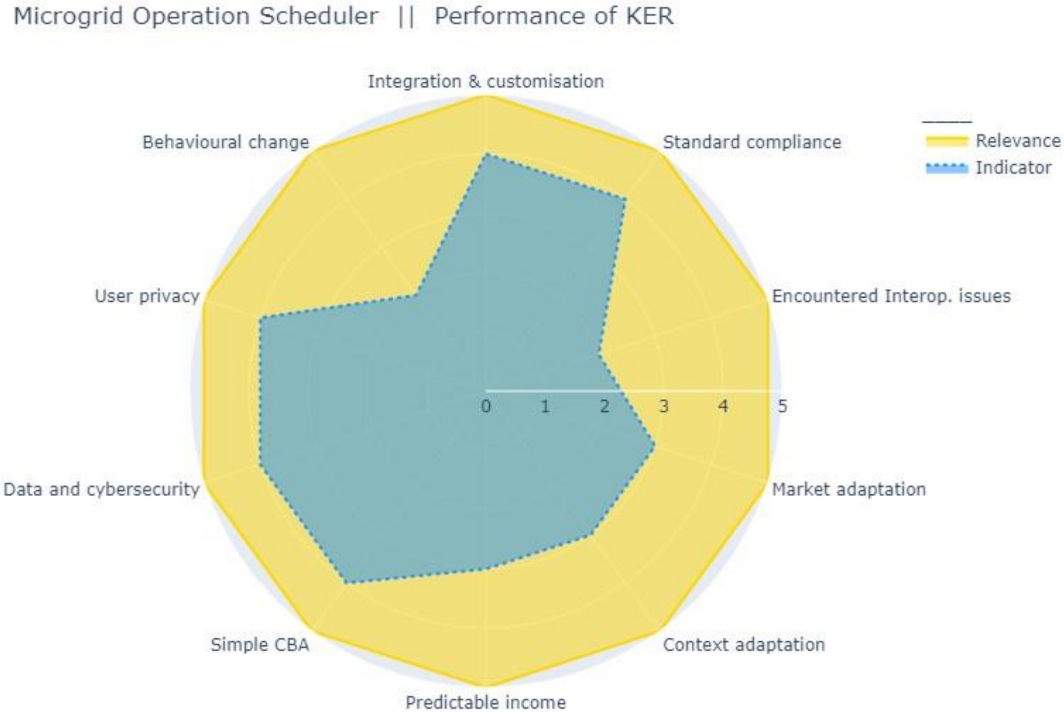

Figure 36. Microgrid Energy Management System – Replicability – KER Performance

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

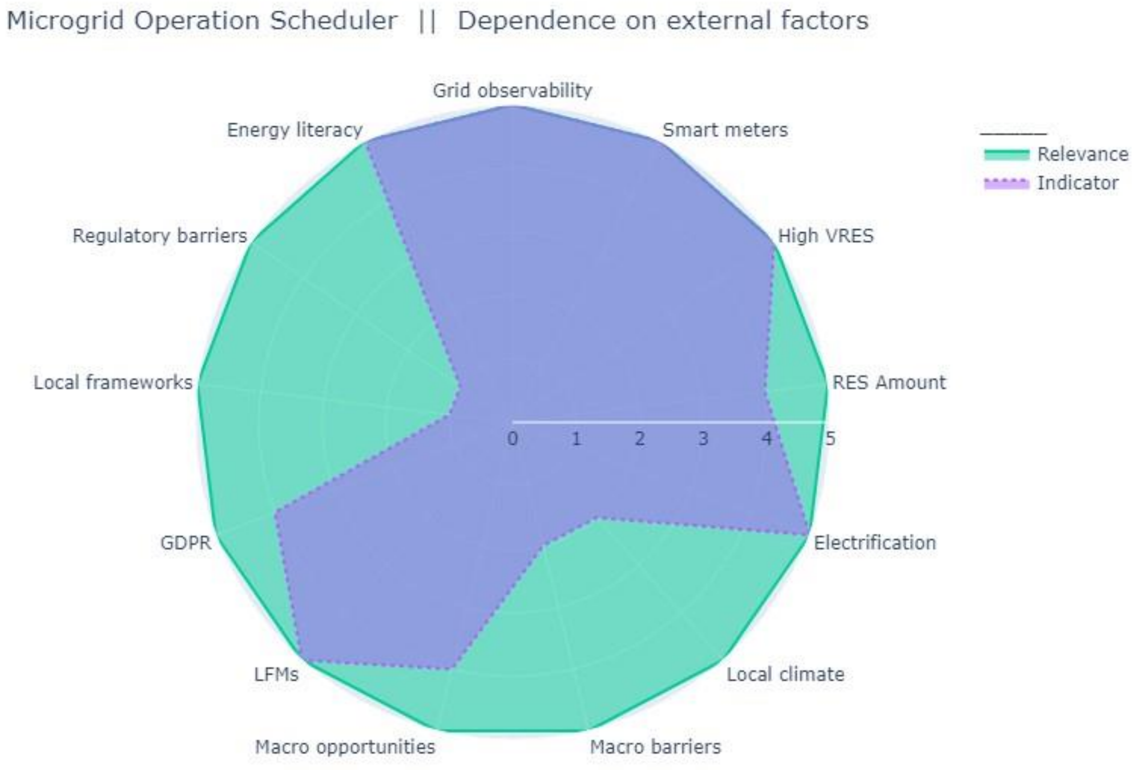

Figure 37. Microgrid Energy Management System – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

3.1.15 V2G-Charger

Main achievement is reaching a TRL7, as the charger will have been tested in two pilots (operational level).

The V2G-Charger was analysed separately, from the development of its EMS. This may be reflected in some of the responses found herein.

3.1.15.1 Scalability

This product was not designed with scalability in mind.

The most relevant **regulatory barrier** for scale-up is:

- The regulatory framework of energy aggregators.

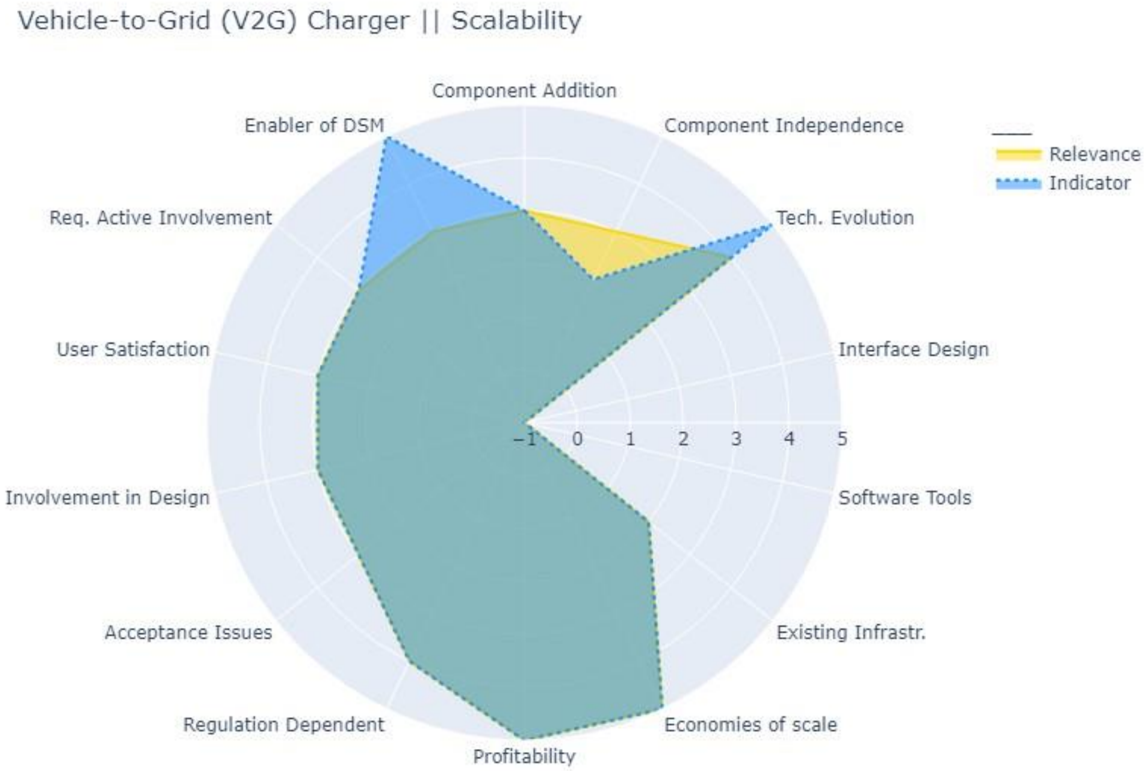

Figure 38. V2G-Charger – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

The provided input for each indicator, including the corresponding request for input, follows:

- Can the product easily adapt to an **evolving technological landscape**? Please elaborate:
  - The EV market will expand in the following years.
- Please rate the **potential emergence of acceptance issues** when upscaling:
  - EV drivers agree on the possibility of charging/discharging the car depending on their needs but car manufacturers are a bit reluctant considering the battery state-of-health.

3.1.15.2 Replicability

The most relevant **quality of** current **market designs**, which pose **limitations** on the KER's replicability

- Charge protocols, specially CCS

The biggest **regulatory barrier** for the replication of the trial(s) related to this KER is:

- The slow progress on P2P business model and energy communities

The biggest **opportunity** for the replication of this KER, regarding the **regulatory framework** is:

- Offer V2G as a flexibility service in energy communities.

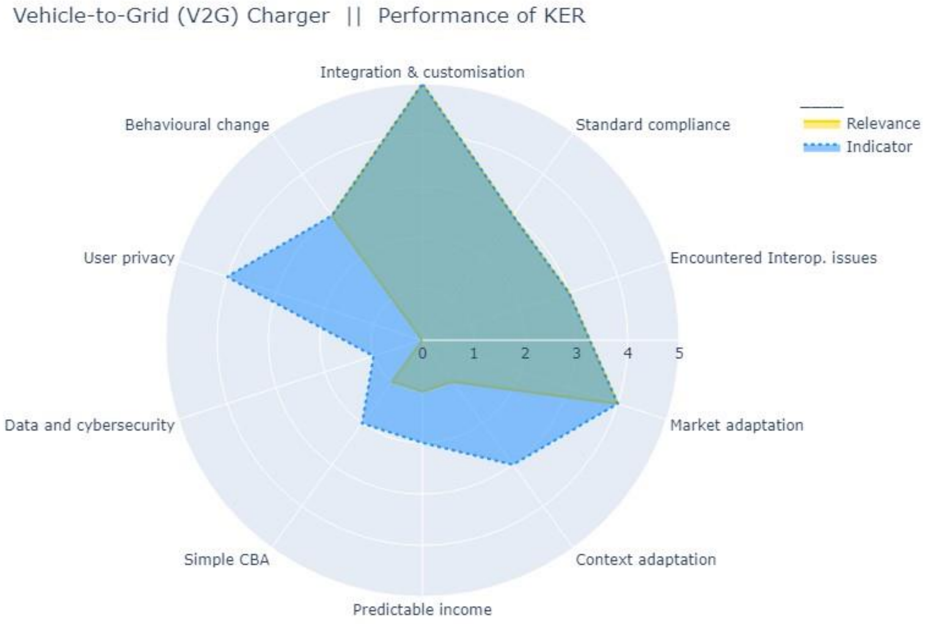

Figure 39. V2G-Charger – Replicability – KER Performance

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

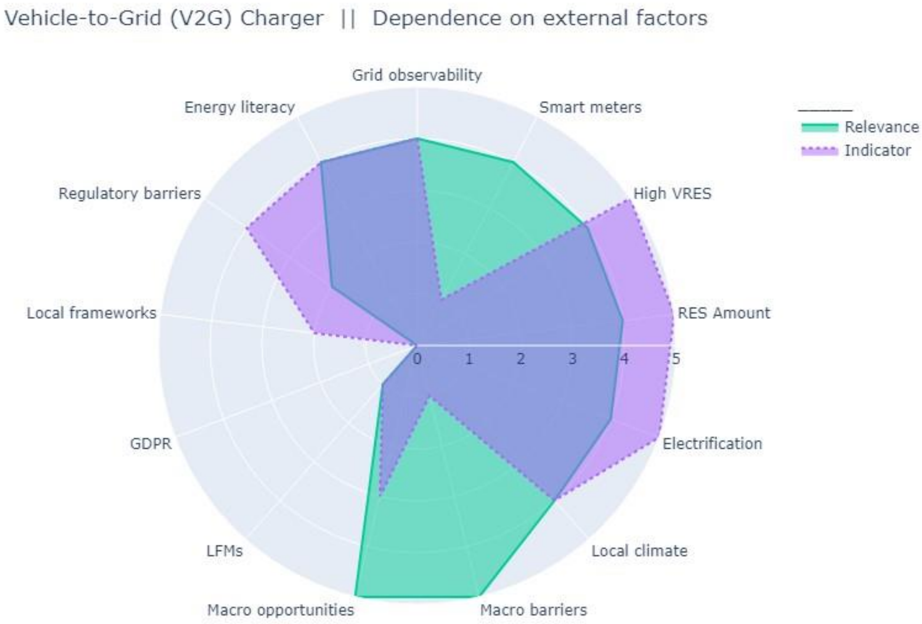

Figure 40. V2G-Charger – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

3.1.16 Flexibility Service Providing Agent

Achieved TRL 8. The KER transforms the description of the EMS adaptation capacity into the FlexOffer form and assigns the price for adaptation. It has advanced functionality of monitoring the prosumer's flexibility and its assignment, priority and device aggregation.

3.1.16.1 Scalability

This KER was fully designed with scalability in mind.

The most relevant **regulatory barrier** for scale-up is:

- Support for the flexibility business model.

The most relevant **opportunity** related to **regulation** for scale-up is:

- Regulatory support for energy communities.

The most relevant **obstacle** for scale-up related to the **stakeholder ecosystem** is:

- No actual barrier since it can be implemented in the cloud form.

The most relevant **opportunity** for scale-up related to the **stakeholder ecosystem** is:

- The product can be implemented either in hardware form or in the cloud.

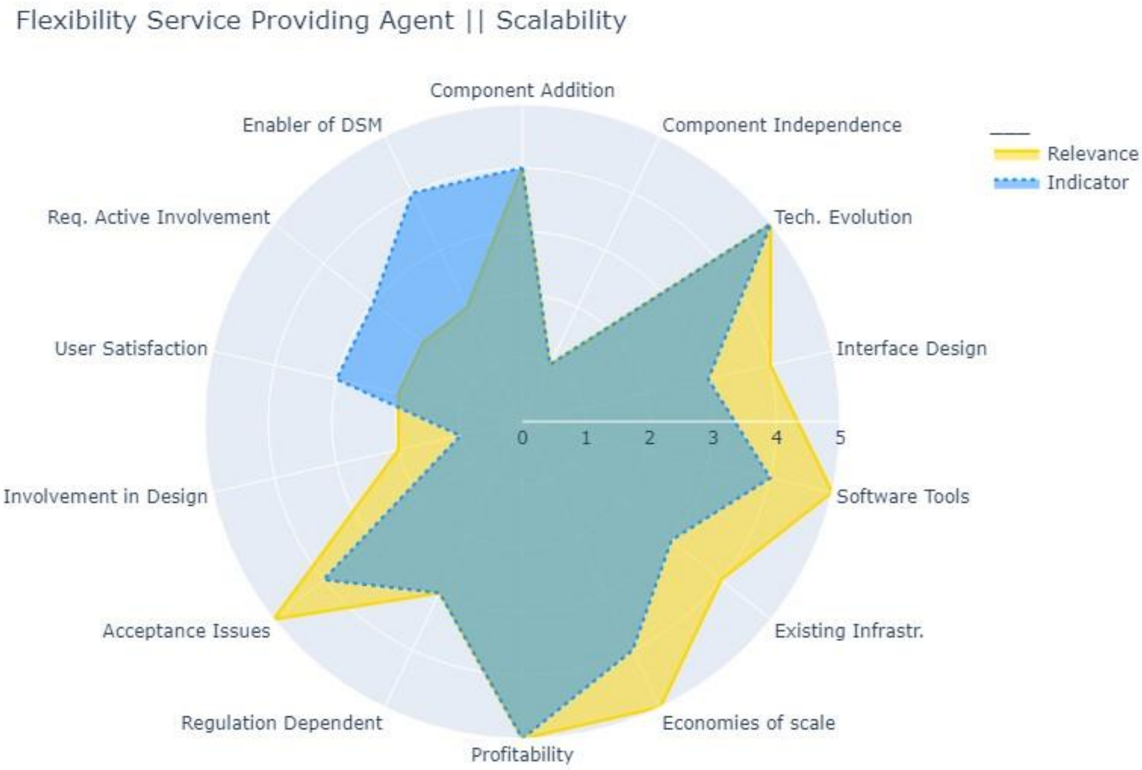

Figure 41. Flexibility Service Providing Agent – Scalability

A detailed description of the indicators can be found under tables:

- Various sub-attribute descriptions, especially for those within the technology attributes (both for scalability and replicability), as well as related KPIs are based on . The reference also includes KPI descriptions, which were also included in the questionnaire as additional information and for respondents to more easily grasp the meaning and objective of each question. Otherwise, many of the questions have been formulated by BAUM and/or adapted from the references referred to in the methodology.
- Table 9. SRA attributes and KPIs: Scalability - Technology
- Table 10. SRA attributes and KPIs: Scalability - Economics
- Table 11. SRA attributes and KPIs: Scalability - Regulation
- Table 12. SRA attributes and KPIs: Scalability - Social

3.1.16.2 Replicability

The most relevant **quality of** a **favourable market design** for the KER's replicability.

- Supports direct trading.

The most relevant **quality of** current **market designs**, which pose **limitations** on the KER's replicability

- Minimum bid sizes
- Unclear price signals
- Lack of standardisation
- Lack of awareness

The biggest **regulatory barrier** for the replication of the trial(s) related to this KER is:

- Commercialisation of system services.

The biggest **opportunity** for the replication of this KER, regarding the **regulatory framework** is:

- The roll-out of local flexibility markets which are compatible with the FlexOffer.

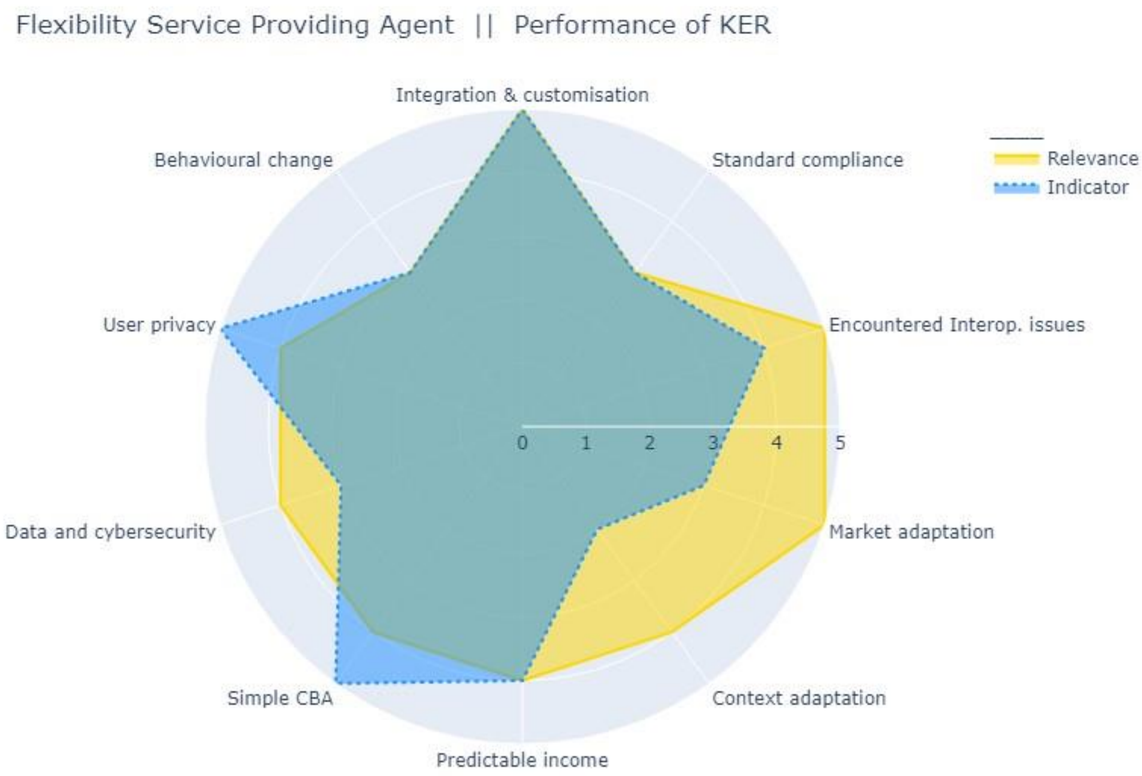

Figure 42. Flexibility Service Providing Agent – Replicability – KER Performance

A detailed description of the indicators can be found under tables:

- Table 13. SRA attributes and KPIs: Replicability – Technology (KER Performance)
- Table 14. SRA attributes and KPIs: Replicability – Economics (KER Performance)
- Table 15. SRA attributes and KPIs: Replicability – Regulation (KER Performance)
- Table 16. SRA attributes and KPIs: Replicability – Social (KER Performance)

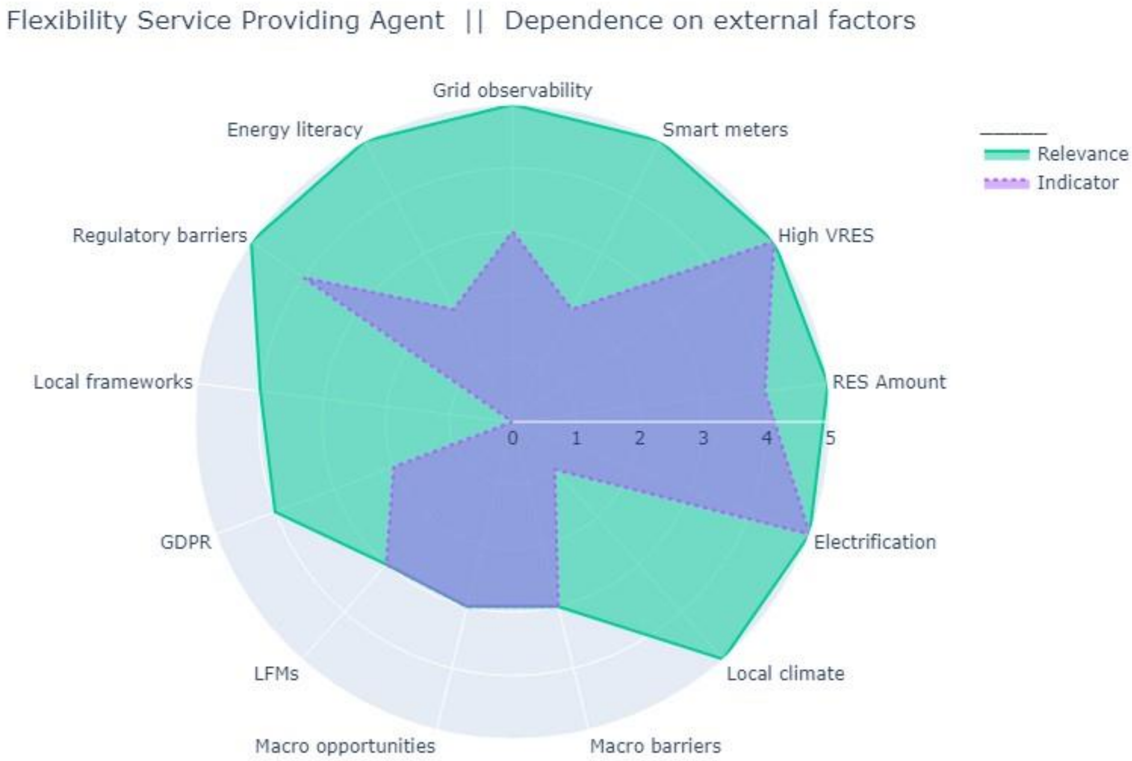

Figure 43. Flexibility Service Providing Agent – Replicability – External factors

A detailed description of the indicators can be found under tables:

- Table 17. SRA attributes and KPIs: Replicability – Technology (external factors)
- Table 18. SRA attributes and KPIs: Replicability – Economics (external factors)
- Table 19. SRA attributes and KPIs: Replicability – Regulation (external factors)
- Table 20. SRA attributes and KPIs: Replicability – Social (external factors)

4 Impact on pilot sites

This trial site SRA can be understood as an additional source of information, to be able to respond to questions specifically related to the pilots. It strives to show that the trial site managers, the technology providers and developers share a common vision and understanding of the potential of the solutions involved.

In the same way as with the KER SRA, this SRA has been evaluated using a Likert-scale from 1 to 5, adapting the options (for respondents to select from) to the questions posed in the questionnaire. Said questions and their corresponding KPIs can be found in the table below. The questionnaire can be found in Annex B.

These SRAs (one for each pilot site) were sometimes responded by one pilot site responsible partner, and sometimes by multiple partners. For the cases where it was responded by multiple partners, the values are obtained from the average value of each. It is these averages which are shown in the following figures. After each figure, a table with additional comments from the respondents is presented.

An explanation of the involved KPIs can be found in the following table:

Table 29. Pilot site SRA KPIs & questions

Attribute	KPI	Question
Business	Market structure	Does the current electricity market structure create barriers that limit an up-scaled version of the trialled solution?
	Business case clear	Is the business case clear, predictable and justifiable to those expected to bear the costs?
	Economic viability of services	Are the currently proposed services economically viable? (i.e. Is the Cost-Benefit ratio > 1?)
	Superiority to alternatives	Is the superior effectiveness to other alternatives clearly established?
	DSO network adaptability	Can solutions adapt to different types of distribution networks? (e.g. urban/rural, high/low number of points of interconnection, different network topologies, etc)
	Scale-up capacity	Is the project able to scale-up if its size (e.g. in terms of amount of participants, provided flexibility) were increased?
Regulation	Untap flexibility	Is the current regulatory framework enabling or limiting consumers to untap their flexibility? (e.g. Flex products and services, rules for aggregation (baseline methodology), tariff design, market process, smart appliances, net metering)
	Market access	Does the current regulatory framework enable or limit market access for the actors involved in the implementation of the trialled solutions? (e.g. aggregator, micro-grid operator)
	Flexibility coordination and integration	Does the current regulatory framework enable or limit flexibility market coordination and integration? (e.g. TSO-DSO coordination, local market design, value stacking, flex in network planning,...)
	Sector coupling synergies	Does the current regulatory framework enable or limit the exploitation of potential synergies coming from increased sector coupling? (e.g. service provision by E-mobility, integration with heat, household and industry)

Attribute	KPI	Question
	Data, interoperability, cybersecurity	Are the trialled solutions compliant with current regulations and standards related to access to data, interoperability and cybersecurity?
	DSO Digitalisation	Are current regulatory frameworks sufficiently supporting DSOs to embrace digitalisation?
	Energy community service provision	Does the current regulatory framework enable or limit service provision by energy communities? (e.g. grid services and associated products, energy community and system operator, financing models, etc...)
Social	Solution complexity	Are solutions highly complex in their implementation? (do they required an integrated package approach to implementation, or can they be easily implemented component-by-component?)
	Stakeholder acceptance	Do you foresee stakeholders' acceptance problems upon deploying your technical solution? (including DSOs, TSOs, regulators, manufacturers, NGOs, aggregators, end customers, etc)
	Stakeholder industrialisation	Do you foresee a willingness of different groups of stakeholders to participate in the industrialisation of your innovative solution? (stakeholders related to the industrial ecosystem of the solutions)
	Urgent need	Do potential target groups feel that the trialled solution addresses an urgent need?
	Privacy risk	Does the solution cause a risk of privacy for its potential users?
	Ease-of-use	To which extent are solutions easy to use for potential end-users? (e.g. do they require high level of IT or energy education?)
	User interaction	Does the solution require a high level of user interaction?

4.1 Germany

Additional barriers and opportunities	
Business barriers or opportunities	Low end user incentives

With four respondents, Germany has the largest input from the four evaluated trial sites.

4.1.1 Economic indicators

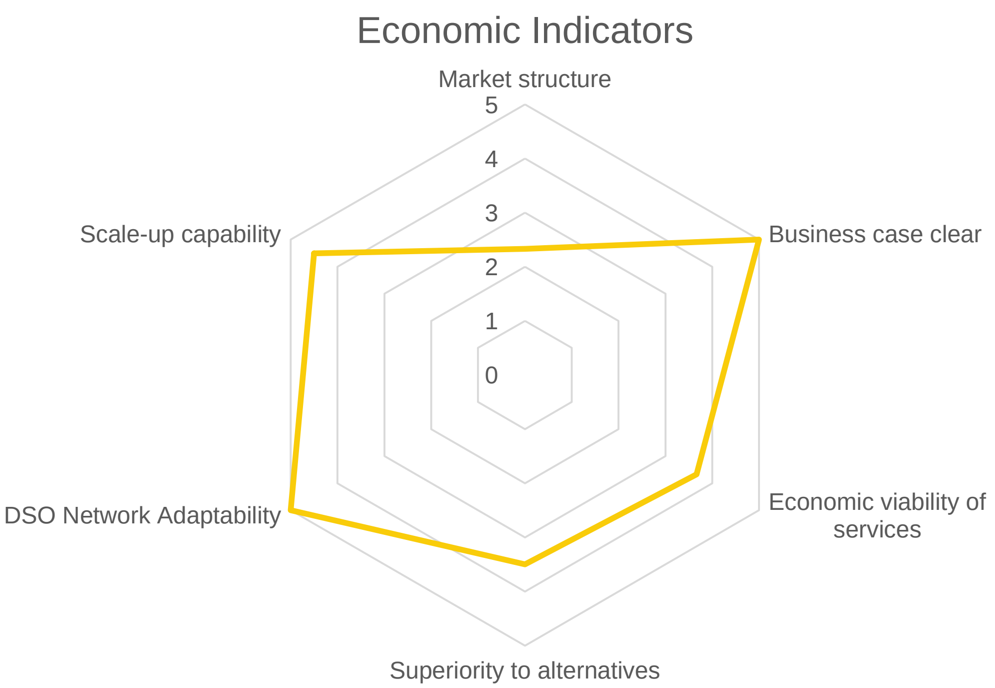

Figure 44. Germany – Pilot SRA – Economic indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- Please provide an explanation.
- Why (not)? What are the barriers and/or opportunities?
- Why (not)? For which stakeholder's business case?
- Why (not)? For which target group?

The information provided can be found in the following table:

Table 30. Germany – Pilot SRA – Additional input for economic KPIs

KPIs	Additional input related to each KPI
Market structure	• Missing regulatory framework for flexibility exchange / trade. • Energy Community is still not allowed in Germany. • Depends on the metering infrastructure of the trial sites or the possible areas.

KPIs	Additional input related to each KPI
Business case clear	• For local energy distributor, who avoids the network congestion and provides the balancing service to the upper level. • All stakeholders involved are aware of the constraints, remunerations and costs. • Exchange of energy and the related costs/earnings, which can be exchanged between the parties.
Economic viability of services	• Not analysed in the project. • Earnings are expected.
Superiority to alternatives	• Advanced algorithms provide technical/economic optimisation. • Not clear, still implementing HLUCs.
DSO network Adaptability	• It structures the prosumers in the form which reflects the network topology. • In Germany, the public utilities are in charge of the entire surrounding areas. • If the infrastructure is sufficient, the solutions could be provided in every area.
Scale-up capability	• It only requires participant-related equipment and corresponding equipment configuration, for them to be included into the solution. • Public awareness and engagement is very high due to rising energy costs. • Energy communities are still not allowed in Germany (considering the demo is related to P2P trading).

4.1.2 Regulation

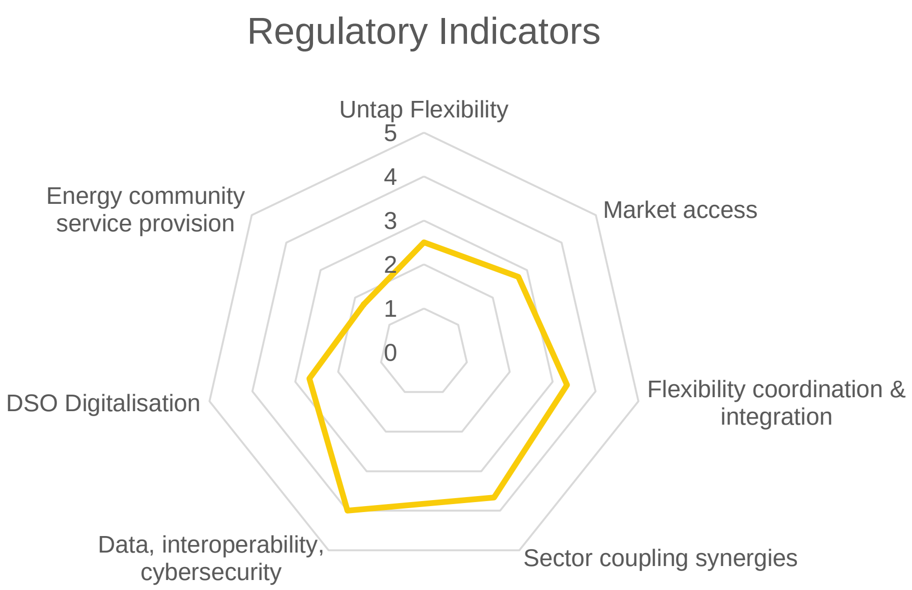

Figure 45. Germany – Pilot SRA – Regulatory indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- What are the enabling/limiting factors? What are the related regulations?
- Why? What are the related regulations and standards?

The information provided can be found in the following table:

Table 31. Germany – Pilot SRA – Additional input for regulation KPIs

KPIs	Additional input related to each KPI
Untap flexibility	• Supporting regulation is still missing. • Limiting factors regarding Energy Communities and Smart-Meter roll-out. • Obstacles arising from the design of regulations for electricity trading, in the design of the balancing power market, distortions of the electricity price due to the design of subsidy regimes, subsidy mechanism for renewable energies and CHP, privileged treatment of own consumption, system of grid charges, obstacles to grid-serving flexibility in the system of incentive regulation.
Market access	• Aggregation already occurs. The "copper-plate" allows aggregation also over longer distances. • Limiting factors regarding Energy Communities and Smart-Meter-Rollout.
Flexibility market coordination and integration	• EU regulations dictate that the TSO coordinates all activities. However, the unbundling rule and further actions (such as RD2.0) allow local market design to some extent.
Sector-coupling synergies	• Sector-coupling is a very desirable action in Germany as it aims at grid operation efficiency. • Good Smart-Meter-Infrastructure and possibilities like Smart-Grid or tenant electricity enable sector-coupling synergies
Data, interoperability, cybersecurity	• All implemented solutions must follow standards such as IEC 62351, etc.
DSO Digitalisation	• Related regulation is the "Act on Metering Point Operation and Data Communication in Smart Energy Networks" (Messstellenbetriebsgesetz - MsbG). It has new definitions for "Smart meter". • Digitalisation in Germany is not always implemented easily. User acceptance and strict data privacy laws can make it difficult.
Energy community service provision	• Energy communities are not fully legislated. • There is missing regulation to enable the wider scale adoption of the trial. • Energy Community (as trialled) is still not allowed in Germany. • A license for trading power is required and obtaining it is not easy. • No regulatory framework in Germany for energy communities within the RED II directive.

4.1.3 Social

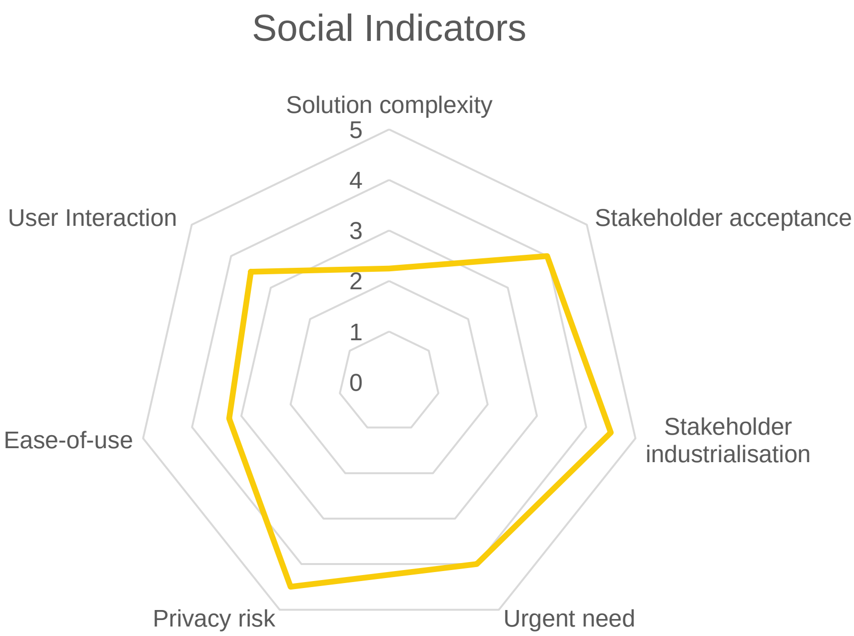

Figure 46. Germany – Pilot SRA – Social indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- Why (not)? From which stakeholders?
- Please provide an explanation. Why (not)? Which target groups?
- Please provide an explanation. Why (not)? Which part(s) of the solution?

The information provided can be found in the following table:

Table 32. Germany – Pilot SRA – Additional input for social KPIs

KPIs	Additional input related to each KPI
Solution complexity	• It is possible to only integrate the needed components. • We don´t have a user´s guide for the solutions. Furthermore, for clients and many colleagues, it is essential to have a translation. • Many data and system interfaces have high technical standards regarding remote control. In addition, there are high safety requirements like ISMS for utilities within the control centre.
Stakeholder acceptance	• Minor problems may occurred during adaptation to the characteristics of specific stakeholders. • User engagement process was undertaken and this aspect is always investigated.

KPIs	Additional input related to each KPI
Stakeholder industrialisation	• Possibilities to generate some additional earnings due to flexible maintenance / asset using of industrial clients. • Better grid operation for DSO.
Urgent need	• The user expressed the needs to actively control its network. • To save money.
Privacy risk	• No high risk. The data are anonymized. • GDPR was part of the prerequisites for the solution providers to refer to. • Regarding the ISMS and GDPR, the risks are not very high. • EMSs have privacy risks.
Ease-of-use	• For the field experts it is easy to be used. • Most solutions are not customer related, but for DSOs. • All can use. Elements can be installed easily. • Sometimes a little bit more technical and IT specific knowledge. In addition a higher knowledge for the topics within the energy market is relevant.
User interaction	• The solution is automated. • Users can decide, to some extent, the time when they are available to provide the flexibility services.

4.1.4 Analysis of results

As can be appreciated in the figures, the most relevant barriers to scalability and replication in the German pilot are:

- Economic
  - The formulation of a supportive market framework for flexibilities and energy communities
  - Availability of metering infrastructure
- Regulatory
  - Support for enabling end-users to untap flexibility
  - Support for the formation of energy communities
  - Support for DSO digitalisation
- Social
  - Solution complexity

These outcomes come to show that many of the elements proved to have a high score, and that most support is required from regulation. Additionally, support for stakeholders to tackle the complexity of the proposed solution, for example through materials and tools to improve energy literacy, could enable the acceleration of solution uptake.

4.2 Spain

Additional barriers and opportunities	
Additional business barriers or opportunities	Current regulation does not remunerate DSOs for the use of software, but instead remunerates grid infrastructure investments. However, the EU directive 2019/944 established the need of developing a new framework that rewards flexibility. In this context, the Spanish Institute for the Diversification and Saving of Energy (IDAE) is currently working on the IREMEL project, which aims to define the regulatory modifications needed to unlock LFMs in Spain.
Additional social barriers or opportunities	• Social barriers: energy poverty • Social opportunities: the predicted increase in EVs

Two responses were provided for the Spanish trial site SRA.

4.2.1 Economic indicators

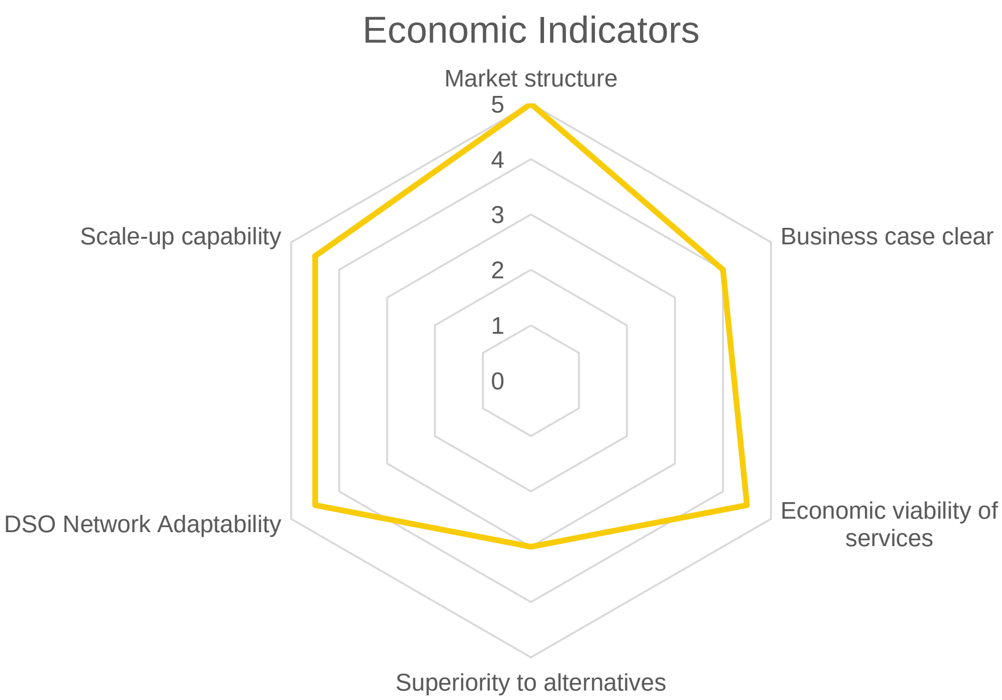

Figure 47. Spain – Pilot SRA – Economic indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- Please provide an explanation.
- Why (not)? What are the barriers and/or opportunities?
- Why (not)? For which stakeholder's business case?
- Why (not)? For which target group?

The information provided can be found in the following table:

Table 33. Spain – Pilot SRA – Additional input for economic KPIs

KPIs	Additional input related to each KPI
Market structure	If flexibility provision reaches 1MW it should be OK.
Business case clear	The costs are carried by the TSO (REE in Spain).
Economic viability of services	• It is yet to be assessed by the DSO. • We have no data to confirm this, but it could be economically feasible for the DSOs (this evaluation is out of the scope of the project). The same happens for the prosumers who provide flexibility. The solution with a higher potential to be economically feasible is the V2G charger.
Superiority of alternatives	Effectiveness is not tested yet. No comparison has been made.
DSO network adaptability	• Developed tools are applied to radial distribution networks. • UPC services (UPC participated in the development of multiple DSO toolbox tools) can be adapted to any type of power grid.
Scale-up capability	• There is no limit on the application of developed tools. • The burden to scale-up would be carried by INEA's solutions (FTP), to be able to handle more market participants.

4.2.2 Regulation

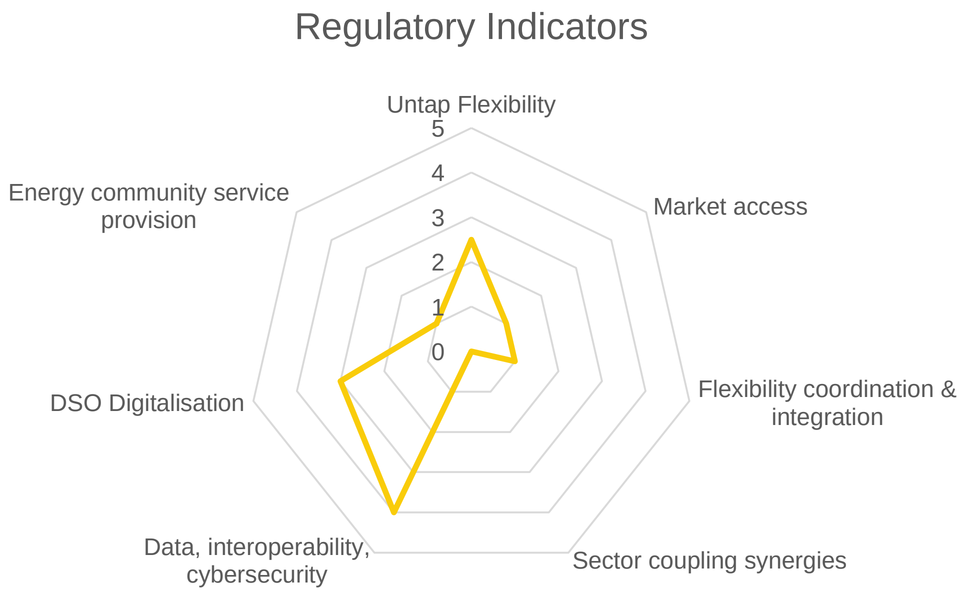

Figure 48. Spain – Pilot SRA – Regulatory indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- What are the enabling/limiting factors? What are the related regulations?
- Why? What are the related regulations and standards?

The information provided can be found in the following table:

Table 34. Spain – Pilot SRA – Additional input for regulation KPIs

KPIs	Additional input related to each KPI
Untap flexibility	• The aggregator role and its definition at a regulatory level is unclear. • From the point of view of the DSO Toolbox apps, it is limiting since the cooperation/integration of DSO within the Spanish TSO does not exist. In the energy system, most flexibility is traded at a high voltage (transmission system), which requires a minimum of 1MW to enter the market, which does not apply in FEVER. • From the point of view of the prosumers it is also limiting, as the amount of power that can be extracted from the flexible devices is below 1MW.
Market access	We do not have an aggregator role, hence it is not applicable in FEVER. However, in case of having an aggregator we could access the market (if we could reach 1MW).
Flexibility coordination and integration	• In Spain there are no local markets, or local energy communities (that we know of). • TSO-DSO coordination unclear.
Data, interoperability, cybersecurity	• Use of RESTful web services. • All messages follow the data interchange format JSON according to RFC 8259, and the timestamps follow the ISO 8601. • All of the communication are encrypted, applications use authentication mechanisms and in general best practices are followed
DSO Digitalisation	Unclear. CNMC (Comisión Nacional de los Mercados y la Competencia) is the Spanish electricity markets regulator. An Information System for Distribution Network Operators (SIORD) is currently being developed in Spain to establish a common, simple and standard platform for all the DSOs in the national territory (https://www.aseme.org/events/siord-sistema-informacion-operadores-red-distribucion-aseme).
Energy community service provision	Not regulated at this stage.

4.2.3 Social

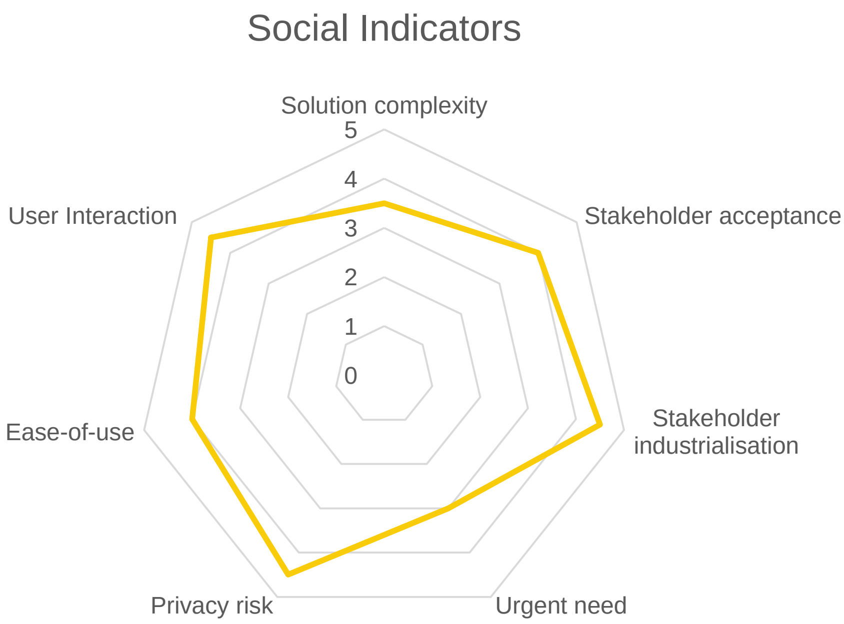

Figure 49. Spain – Pilot SRA – Social indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- Why (not)? From which stakeholders?
- Please provide an explanation. Why (not)? Which target groups?
- Please provide an explanation. Why (not)? Which part(s) of the solution?

The information provided can be found in the following table:

Table 35. Spain – Pilot SRA – Additional input for social KPIs

KPIs	Additional input related to each KPI
Solution complexity	• Tools are developed as a suite of web services. Interoperability is guaranteed by the use of APIs. • Both the DSO toolbox apps and the xEMS require an intermediary integration structure.
Stakeholder acceptance	• No problems are expected. • To implement the services deployed by UPC, we need to adapt to the regulations currently being developed. We can only assume that there would be some adaptations, and therefore, acceptance problems.
Stakeholder industrialisation	• Potential stakeholders interested in our tools: DSO, Data Management System providers, aggregators, Energy Service Companies (ESCOs), facility managers. • UPC services are mostly tied to DSOs, which some of them are already working with similar solutions.

KPIs	Additional input related to each KPI
Urgent need	• There is no urgency nowadays, although the problems solved by our solutions will increase in the near future, making it a future urgency. • Needed by DSOs, TSOs, MOs, aggregators, etc.
Privacy risk	• All communications are securitized by "Basic Auth" and tokens. In this project latest TLS protocols are used. • The anonymity of data was respected in the operation and development of all services.
Ease-of-use	• Simple user interface, both from ICOM (DSO Toolbox) and INEA (FTP and FEMS).
User interaction	• After an initial set-up, it is an automated solution. • DSOs and prosumers should interact now and then with the two above-mentioned interfaces.

4.2.4 Analysis of results

As can be appreciated in the figures, the most relevant barriers to scalability and replication in the Spanish pilot are:

- Economic
  - Superiority to alternatives
- Regulatory
  - Support for enabling end-users to untap flexibility
  - Support for the formation of energy communities
  - Support for market access
  - Support for flexibility coordination and integration
  - Support for DSO digitalisation
- Social
  - Solution complexity
  - Not perceived as an urgent need

These outcomes show that, similarly to Germany, more support is required from regulation. While sector-coupling synergies were considered as not applicable, only regulation on data, interoperability and cybersecurity received a high score. This indicator was followed by DSO digitalisation, which received a score of 3 (neither limiting nor supporting). Aside from the aforementioned in indicators, all others received scores below 3, leading to the need to revise regulations for potential solutions or clarification for their intended use.

Additionally, while the complexity of the proposed solution is seen as a barrier for stakeholders, an even bigger one is the perception from stakeholders towards the need of the proposed solution. Considering that the Spanish pilot is focusing on the industrial sector, there is a potential perception from industry to not require flexibility in their processes (as proposed in FEVER), but instead turn to the use of alternative solutions; linking this social indicator to the poorly scoring economic indicator on superiority to alternatives.

4.3 Cyprus

Additional barriers and opportunities	
Additional regulatory barriers or opportunities	The Competitive Market of Cyprus, which will be available from Q2 2024 and onwards, will enable the smooth integration of all the solutions

One response provided for the Cyprus trial site SRA.

4.3.1 Economic indicators

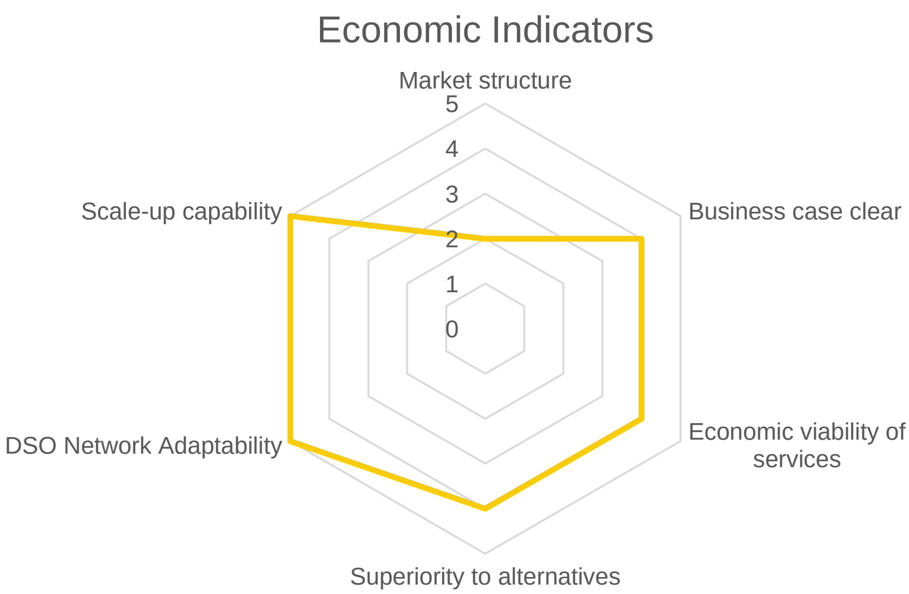

Figure 50. Cyprus – Pilot SRA – Economic indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- Please provide an explanation.
- Why (not)? What are the barriers and/or opportunities?
- Why (not)? For which stakeholder's business case?
- Why (not)? For which target group?

The information provided can be found in the following table:

Table 36. Cyprus – Pilot SRA – Additional input for economic KPIs

KPIs	Additional input related to each KPI
Market structure	The electricity market of Cyprus is currently under a transitional period that partly enables the trialled solutions to be tested.
Business case clear	The stakeholder is the University of Cyprus, therefore, the structure and the business case is fully clear.

4.3.2 Regulation

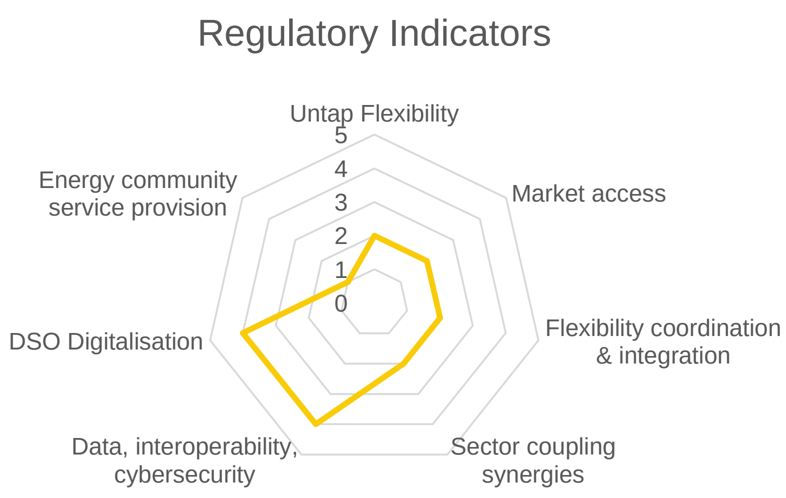

Figure 51. Cyprus – Pilot SRA – Regulatory indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- What are the enabling/limiting factors? What are the related regulations?
- Why? What are the related regulations and standards?

The information provided can be found in the following table:

Table 37. Cyprus – Pilot SRA – Additional input for regulatory KPIs

KPIs	Additional input related to each KPI
Untap flexibility	The current regulatory framework in Cyprus is limiting the consumers to untap their flexibility. The regulatory framework is in Greek and no translation exists at this point. However, on the new market of Cyprus (day-ahead) this will be possible (https://www.cera.org.cy/en-gb/ilektrismos/details/market-rules).
Market access	The current regulatory framework is very limited with regards to the actors involved in the market.
Flexibility coordination & integration	Flexibility trading is not allow under the current framework.
Sector-coupling synergies	The current regulatory framework is very limited with regards to the services that can be implemented within the electricity network.
Data, interoperability and cybersecurity	The current regulations and standards can be found here: https://dsa.cy/en/legislation/ec-security-legislation.
DSO Digitalisation	The electricity market of Cyprus is currently under a transitional period that enables the stakeholders (including DSOs) to enhance the digitalisation of their services.
Energy community service provision	No regulatory framework exists for energy communities.

4.3.3 Social

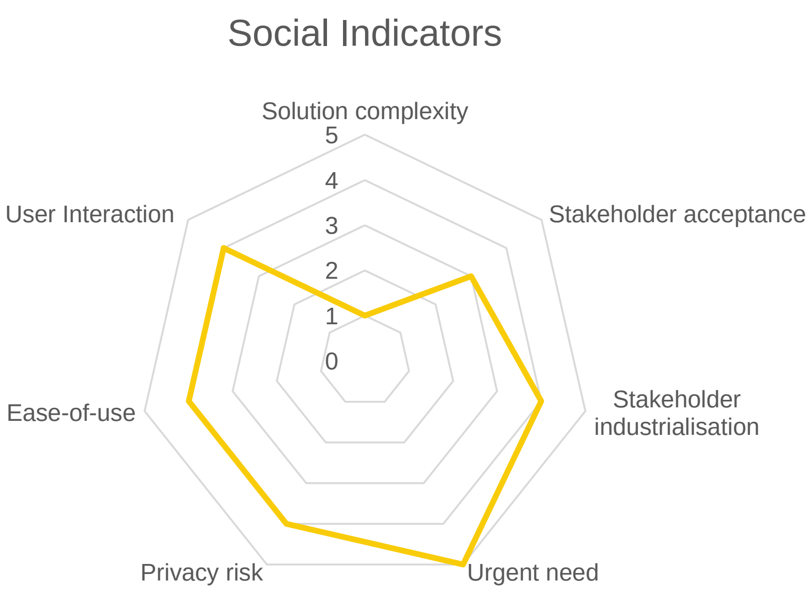

Figure 52. Cyprus – Pilot SRA – Social indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- Why (not)? From which stakeholders?
- Please provide an explanation. Why (not)? Which target groups?
- Please provide an explanation. Why (not)? Which part(s) of the solution?

The information provided can be found in the following table:

Table 38. Cyprus – Pilot SRA – Additional input for social KPIs

KPIs	Additional input related to each KPI
Stakeholder acceptance	Some acceptance issues might arise from network operators (e.g. DSO, TSO, etc.).
Stakeholder industrialisation	Since the electricity markets in general require innovative solutions, the willingness will be high especially from network operators.
Urgent need	Battery and microgrid management is relevant at the spot market level and, therefore, such tools increase the productivity of the network in general.
User interaction	The idea is to create a semi-autonomous system that will require minimum user interaction. However, the occasional evaluation of the systems is mandatory to ensure the efficiency, accuracy and stability of the solutions.

4.3.4 Analysis of results

With results very similar to those of Germany for social and economic indicators, and to Spain for regulatory indicators, the most relevant barriers to scalability and replication in the Cyprian pilot are:

- Economic

- Market structure
- Regulatory
  - Support for energy community service provision
  - Support for enabling end-users to untap flexibility
  - Support for market access
  - Support for flexibility coordination and integration
  - Support for sector coupling synergies
- Social
  - Solution complexity

The focus on microgrids in the Cyprian pilot is important to consider while analysing the results. Again, most support is required from regulation. Additionally, support for stakeholders to tackle the complexity of the proposed solution could accelerate the uptake.

4.4 Greece

Two responses were provided for the Greek demonstrator, which has been simulating the operation of different market mechanisms using data from other trial sites.

4.4.1 Economic indicators

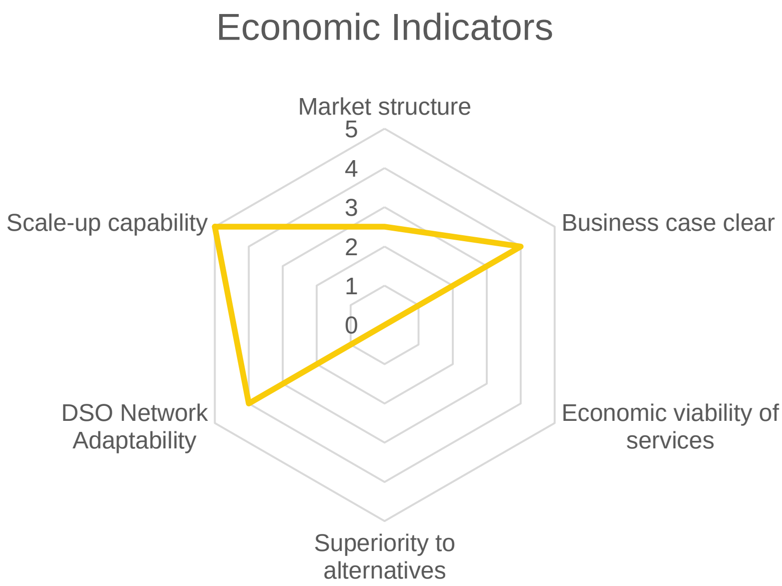

Figure 53. Greece – Pilot SRA – Economic indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- Please provide an explanation.
- Why (not)? What are the barriers and/or opportunities?
- Why (not)? For which stakeholder's business case?
- Why (not)? For which target group?

The information provided can be found in the following table:

Table 39. Greece – Pilot SRA – Additional input for economic KPIs

KPIs	Additional input related to each KPI

Market structure	• Limited smart meter deployment. • The market structure itself is not a barrier for the operation of LFMs. However, incentives should be given to participants for their participation in LFMs.
Business case clear	The business model canvas is currently finalized (can be found under D8.6) and could provide a good guidance to interested parties.
Economic viability of services	N/A
Superiority to alternatives	N/A
DSO network adaptability	Simulations for different networks of different sizes have been successfully executed. Scalability analysis regarding pilot sites is underway.
Scale-up capability	Simulations for different networks of different sizes have been successfully executed.

4.4.2 Regulation

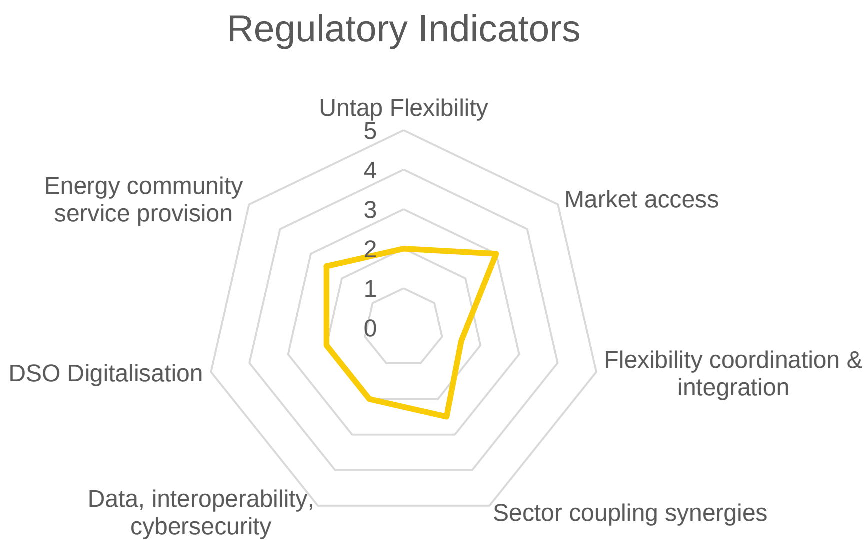

Figure 54. Greece – Pilot SRA – Regulatory indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- What are the enabling/limiting factors? What are the related regulations?
- Why? What are the related regulations and standards?

The information provided can be found in the following table:

Table 40. Greece – Pilot SRA – Additional input for regulatory KPIs

KPIs	Additional input related to each KPI
Untap flexibility	• The current legislation allows participation of demand response assets in the balancing market through aggregators. However, limited actual transactions have happened so far in the market. • Smart meters are not yet installed. • Market is not mature enough for demand response participation of small participants in the wholesale market. • Law 4986/2022 (Government Gazette A 204 - 28.10.2022) Incorporation of Directive (EU) 2019/944 of the Council and of the Council of 5 June 2019 on common rules for the internal electricity market and the amendment of Directive 2012/ 27/EU and other urgent provisions.
Market access	• Same as above. • A new law ("Law 4986/2022 (Government Gazette A 204 - 28.10.2022) Incorporation of Directive (EU) 2019/944 of the Council and of the Council of 5 June 2019 on common rules for the internal electricity market and the amendment of Directive 2012/ 27/EU and other urgent provisions.") foresees the participation of demand response in the market. Participation of demand response in the balancing market is limited to participants with capacity >1MW. Changes in the spot markets (Day Ahead and Intraday markets) on demand response participation will soon be in force.
Flexibility coordination & integration	• Demand response can be provided only in the balancing market. Local markets are part of the current legislation. Flexibility of demand response and storage can be considered for future grid planning operation. • Article 44 of "Law 4986/2022 (Government Gazette A 204 - 28.10.2022) Incorporation of Directive (EU) 2019/944 of the Council and of the Council of 5 June 2019 on common rules for the internal electricity market and the amendment of Directive 2012/ 27/EU and other urgent provisions", foresees the market based flexibility procurement by the DSO. • Coordination mechanisms between the Greek TSO and DSO were established within the framework of the Horizon 2020 research program CoordiNET, but are not yet incorporated in the legislation.
Sector-coupling synergies	• Electromobility is promoted under the provisions of "Law 4710/2020 - Promotion of electromobility and other provisions", but the share of electric cars is still limited. • Charge point operator and EV Aggregator role are described in the current legislation. • No legislation to promote synergies and sector coupling is in place.
Data, interoperability and cybersecurity	• Articles 30 & 32 of "Law 4986/2022" specifically addresses data access and security for smart grids. In parallel, relevant provisions can be found in the country's general data protection laws.

KPIs	Additional input related to each KPI
DSO Digitalisation	• Flexibility can be considered in grid planning, but not in active grid management through demand response or storage (only for production from DER). • Article 17 of "Law 4986/2022" specifies that the DSO is responsible for the digitization of the system, but no regulation is currently in force to support DSOs digitalization.
Energy community service provision	• Greece was one of the front runners in the regulation for energy communities. We are currently refactoring the regulation towards v2. • Law 4513/2018 defines the roles and scope of an energy community, as well as presents key provisions for their establishment. No further reference to issues related to energy communities (like the interaction with the system operator or financing models) is made.

4.4.3 Social

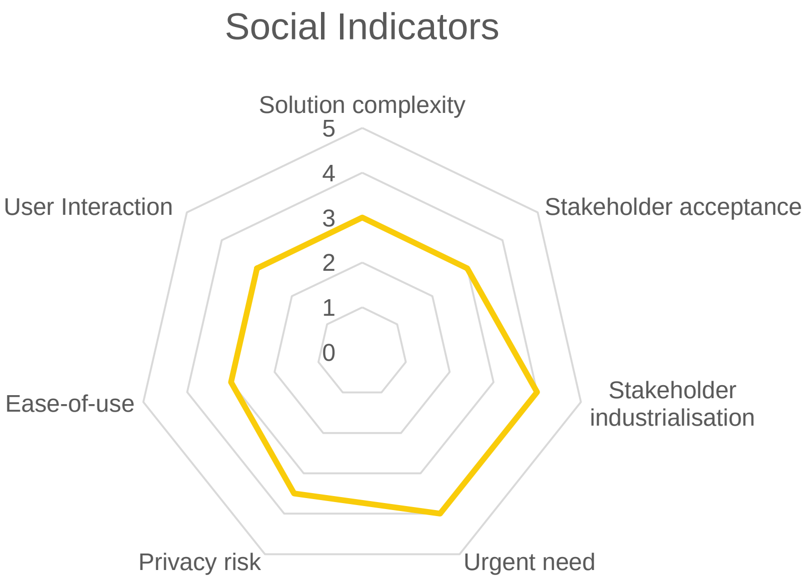

Figure 55. Greece – Pilot SRA – Social indicators

After providing the scores for each KPI, respondents were asked to provide additional information, e.g. in the following ways:

- Why (not)? From which stakeholders?
- Please provide an explanation. Why (not)? Which target groups?
- Please provide an explanation. Why (not)? Which part(s) of the solution?

The information provided can be found in the following table:

Table 41. Greece – Pilot SRA – Additional input for social KPIs

KPIs	Additional input related to each KPI
Solution complexity	• We follow a modular approach in FEVER, so not all components need to be deployed. • Solutions development and implementation require experience in system modelling. User interfaces are developed for easy simulations execution by the users.
Stakeholder acceptance	• Solution requires the engagement of both TSO & DSO, as well as the approval of the regulator.
Stakeholder industrialisation	• Initial discussion for the technical implementation of a trading platform has raised a lot of interest to stakeholders.
Urgent need	• Congestions are typical in areas with high RES production penetrations. FEVER solutions can mitigate such problems.
Privacy risk	• For DSO, there is limited to no risk. • The trading platform will handle DSO data and financial information of market participants.
Ease-of-use	• For the DSO Toolbox, usability tests have been introduced in the design. • The users need to have energy education to decide on their optimal bidding strategy. Apart from that, the goal is to make a platform that can be easily used by the end users.
User interaction	• DSO toolbox can operate in automatic mode. • Users will need to interact with the platform for bidding and for flexibility request submission, as well as to check status of trades.

4.4.4 Analysis of results

As can be appreciated in the figures, the most relevant barriers to scalability and replication in the Greek use cases are:

- Economic
    - Market structure
- Regulatory
    - Support for enabling end-users to untap flexibility
    - Support for market access
    - Support for flexibility coordination and integration
    - Support for sector coupling synergies
    - Support for data, interoperability and cybersecurity
    - Support for DSO digitalisation
    - Support for enabling energy communities to provide flexibility services

With regards to the market structure, the deployment of smart meters and the introduction of incentives are identified as the main limitations. Smart meters are a basic requirement due to the need for metering data for the provision of flexibility services. Similarly, incentives are necessary for consumers to be interested in providing said services. The economic viability of services, as well as the superiority of alternatives are both considered to be not applicable for the case of Greece. Rating which is likely related to the position of HEnEx as a MO and the lack of an economic evaluation of grid expansion vs. flexibility.

Profound insight has been provided by respondents with relation to the regulatory indicators. While the regulatory framework does enable LFMs to take place (to a considerable extent), the maturity of the market is low, and some elements which may enable for it to reach maturity are lacking in regulation, as well as on the side of DER (e.g. EVs) and smart meter deployment. Having said that, entry into force of some of these regulatory elements is soon to occur (e.g. TSO-DSO coordination mechanisms). The promotion of sector coupling and DSO digitalisation are still not in place from the side of legislation.

On the social side, indicators are mostly neutrally rated (score = 3). Aside from those, industrial stakeholder seem to be interested in participating in the uptake of the solutions, and the stakeholder ecosystem perceives an urgent need for their deployment. Thus presenting an opportunity for Greece to further engage in the development of FEVER solutions.

5 Recommendations

In this section, a compilation of barriers, obstacles, limitations, opportunities and qualities (qualities of current market designs posing limitations to, and those qualities favouring replication); related to regulation, the involved stakeholder ecosystem and of a favourable market design; are presented under section 5.1 for ease of analysis.

Additionally, points for improvement and recommendations for other SRAs are presented under section 5.2. These are mostly related to the usage of project, actor and use case objectives for the identification of KPIs; and can be seen as a compliment to the BRIDGE guidelines.

5.1 Recommendations for policy

In this section, a compilation of barriers, obstacles, limitations, opportunities and qualities related to regulation, the involved stakeholder ecosystem and of a favourable market design are presented for ease of analysis.

Table 42. Regulation, market design and the stakeholder ecosystem supporting FEVER

Description	Barriers / obstacles / limitations	Opportunities / qualities
Most relevant **regulatory** barriers and opportunities identified for scale-up of FEVER KERs	1. Remuneration schemes for flexibility providers 2. The existence of operational flexibility markets 3. Prosumer's financial settlement 4. National regulations for energy communities and energy sharing 5. Germany not allowing prosumers to trade energy among themselves. 6. Limitations on exchanging energy between neighbouring DSOs. 7. Adaptation in short-term and balancing markets (e.g. increase time and/or locational granularity) 8. Provide incentives to DSOs to investigate solutions for the operation and planning of their networks beyond classic network expansion. 9. No specific regulatory framework. 10. Unwillingness of adopting this specific technology. 11. The regulatory framework of energy aggregators. 12. Support for the flexibility business model.	1. New grid network code on flexibility 2. Large scale optimisation 3. Energy communities as a local driver 4. Regulatory framework for demand-side participation in the markets has been put in place in many European countries. 5. Incentives for DERs installation are evident in many European countries 6. The EU IEMD highlights the need for market based flexibility procurement by the DSOs. 7. More energy flexibility communities 8. Potential grid stability 9. Cost reductions 10. The product can be added to already existing BEMS/FEMS. 11. The product can work as a stand-alone solution. 12. Regulatory support for energy communities.
Most relevant obstacles and opportunities for scale-up related to the **stakeholder** ecosystem	1. Knowledge of future market trends related to flexibility (given the current immaturity of most markets) 2. Acceptance for DSO to rely on AI based algorithms for LV grid monitoring and management 3. Integration into existing IT environments 4. Complexity of set-up and operation 5. Consumers not being keen to load shifting. 6. Technological challenges such as accurate baseline prediction. 7. Coordination between DSO-TSO. 8. Flexibility and adaptability of the users.	1. New business opportunities through market transformation, increased energy cost due to crisis 2. Acceptance for DSO to rely on AI based algorithms for LV grid monitoring and management 3. Provision of system services 4. Energy communities as local drivers 5. Stabilisation of the grid with assets that are not traditionally used for this purpose. 6. New revenue streams for market parties and technology providers. 7. BEMS architecture and limitations. 8. The product can be implemented either in hardware form or in the cloud.

Description	Barriers / obstacles / limitations	Opportunities / qualities
Most relevant qualities and limitations of a favourable **market design** for replication	1. Bid size 2. Product design 3. Low volume and low price volatility. 4. Too high bid sizes 5. Technology requirements 6. Requiring symmetric bids 7. The benefits for prosumers are not so clear. 8. Small assets cannot participate in the market. 9. Integration of LFMs with wholesale markets. 10. The connection between the local and wholesale electricity markets. 11. Charge protocols, specially CCS	1. Local 2. Offering of the real-time or balancing markets 3. Small bid sizes 4. Technology neutrality 5. Not requiring symmetric bids 6. Allowing small consumers and small producers to participate in ancillary services. 7. Co-optimising energy and reserve procurement both in day-ahead and shorter-term energy markets. 8. Reform wholesale-market bidding formats to incorporate increased detail in the representation of generation and demand characteristics. 9. Increased time and locational granularity. 10. Fully interactive day-ahead, intraday and balancing markets should be existing. 11. Offer V2G as a flexibility service in energy communities. 12. Supports direct trading.
Most relevant **regulatory** barriers and opportunities for replication	1. Absence of local markets and of the DSO as "purchaser" of flexibility 2. GDPR and privacy matters are jeopardizing the creation of a proper grid model. 3. Legality of the user to provide profitable services. 4. Local regulations for energy communities and energy sharing are inadequate. 5. Consumers are not allowed to trade energy among themselves. 6. Data ownership and data privacy provisions. 7. The flexibility regulatory framework is not established. 8. The slow progress on P2P business model and energy communities 9. Commercialisation of system services.	1. The consideration of localised flexibility bids 2. Introduction of the flexibility market. 3. Energy communities as drivers 4. Regulation on DSO revenue models. 5. Since the regulatory framework is not fully established, there is potential for advocacy. 6. The roll-out of local flexibility markets which are compatible with the FlexOffer specification.

5.2 Other barriers and opportunities

To better identify the existence of missing open standards, both component and communication layer standards could have been assessed under the section on missing support, as presented in Figure 7. Missing support identified results, thus complementing the two figures: Figure 5. Standards implementation results and Figure 6. Interoperability per SGAM layer results.

For more valuable insight, instead of evaluating stakeholder acceptance as done in section 3.1.6 Stakeholder Acceptance, this could be done through indicators evaluating the stakeholder ecosystem, for example, through the objectives developed from the perspective of specific stakeholders (e.g. DSO, MOs and energy communities as present in

Table 5 to Table 7). Stakeholder acceptance is a very broad topic which can be decomposed into more specific indicators, instead of the broader one of "acceptance".

A closer look into the Environmental dimension would be beneficial.

The proposed mapping of objectives under the BRIDGE guidelines related to SGAM layers, objectives and KERs was not performed (related to Table 5 of the BRIDGE guidelines) due to matters related to the recent crises (supply chain disruptions affecting the pilots, communication difficulties and changes in roles and responsibilities related to specific tasks). To carry out this detailed analysis it is found useful to develop relationships among KERs and interoperability layers together with multi-perspective, multi-use case objectives (as proposed in [5]), from an early stage in the project. KERs may be involved in multiple layers, leading to the possibility of one "objectives' data column" to be described for each KER, as present as the KER may be in every interoperability layer. This, related to its development in the project and its functionality within the project's scope. As one can see in section *2.3 FEVER Objectives analysis*, not only project objectives, but also use case objectives and objectives from the main actor's perspective may be relevant. The corresponding analysis could be constrained to the depth of the objectives' analysis of each project. Additionally, each KER may be found in different layers. Each KER might satisfy one or more of the objectives. The KER is not present in a certain layer if its development and functionality within the project is not relevant to that layer, considering the actor's role in utilising or interacting with each KER. Such a table would bring high detail to the project's distribution within the SGAM interoperability layers and is useful for use case analysis. A possible way to build this is in the example table shown below. The cells which are filled-out may be used as a source for the identification of indicators. For this reason, and to avoid the excessive definition of indicators, a periodic revision of the table, or grouping areas of the table, could be useful as visual and conceptual tools to identify and collaboratively select relevant indicators for evaluation.

Other considerations for improving the approach:

- A closer look into ICT network configuration should have been implemented in the KER SRA.
- Instead of the local climate KPI, a closer evaluation of demand response technologies and their influencing factors could be assessed.

Table 43. An example table could look like this, for two sets of objectives

	Project Objectives (O- #...)			Actor's Objectives			KERs
	O-1	O-2	O-3	O-4	O-5	O-6	
IOP Layer 1 (IOP-L1)	KER 1 in IOP-L1 for objective O-1						**KER 1**
	KER 2 in IOP-L1 for objective O-1						**KER 2**
	KER 4 in IOP-L1 for objective O-1						**KER 4**
IOP Layer 2 (IOP-L2)				KER 1 in IOP-L2 for objective O-4			**KER 1**
					KER 2 in IOP-L2 for objective O-5		**KER 2**
						KER 3 in IOP-L2 for objective O-6	**KER 3**
IOP Layer 3 (...)	…			...			…
IOP Layer 4							
IOP Layer 5							

Table 44. An example table could look like this, for use case objectives

	BUC Objectives			HLUC Objectives…			KERs
	O-7	O-8	O-9	O-10	O-11	O-12…	
IOP Layer 1 (IOP-L1)							**KER 1**
							KER 2
							KER 4
IOP Layer 2 (IOP-L2)							**KER 1**
							KER 2
							KER 5
IOP Layer 3 (...)	…			…			…
IOP Layer 4							
IOP Layer 5							

Finally, it is found useful to carry out the analysis from the beginning of the project, making periodic revisions (e.g. every 6 months) as the project evolves and new challenges are encountered / tackled. An optional extension to the approach could be to include information related to the already existing standards and procedures, which support the implementation of a certain KER within the project's scope, considering its interactions with external systems, leading to an exhaustive analysis of project objectives and clarity on the technological ecosystems supporting the project's technologies / ambitions. The latter point, meaning that not only the development of the KER and its functionality within the project's scope would be covered, but also the supporting technologies and ecosystems (i.e. more cells would be filled for each KER, namely where supporting technologies are involved with the KER, as well as when the KER is indirectly influenced by other objectives). Weights or, more so categories, could be useful.

6 Conclusion

The SRA proves to be a useful tool for the identification of barriers and opportunities for the scale-up of solutions, both from the technological perspective, as well as from regulatory, economic and social perspectives. Following the learnings from multiple projects, particularly through the contributions of the BRIDGE initiative, has enabled for us to more adequately perform this analysis and produce the necessary results, leading to useful policy recommendations. Additionally, analysing technical elements, such as the implementation of standards and the evaluation of specific tools implemented throughout the project, has shed light on the contribution this project can bring to society.

While the implementation of a semi-quantitative analysis doesn't necessarily lead to concrete results, such as those stemming from purely quantitative analyses, it does provide for a subjective view from the partners involved in the project through data. This data enables for the interested reader to obtain a broad picture of the developed results, as well as their limitations, success stories and their potential for improvement.

To be able to achieve a transition to sustainability in such a way that the burden on society is eased, automated solutions which enable for consumers to change their consumption practices and/or enable for them to become active participants in the construction of a sustainable energy system, have been identified as valuable for the whole society. From regulators, contributing with the development of new regulations in support of these solutions, to industry and consumers, who have manifested their interest in utilising and developing these same solutions. In other words, the path ahead has been set, but it is not an easy one, and it is imperative to tread it with care.

7 List of tables

8 List of figures

9 List of references

[1] I. K. V. A. N. I. I. L. K. N. A. e. a. Evangelos Karfopoulos, “D1.1 - Flexibility at the distribution grid: Reference usage scenarios for market and system operation services,” 2020.

[2] V. A. I. L. N. I. C. P. P. B. M. K. e. a. Isidoros Kokos, “D1.2 - Functional and operational requirements,” 2020.

[3] I. L. I. K. N. I. M.-I. B. S. T. A. B. A. N. G. Č. J. M. R. P. P. G. F. d. R. G. P. e. a. Rita Dornmair, “D8.5 – Report on business models assessment, market analysis, regulatory context assessment and preliminary exploitation assessment,” 2022.

[4] C.-C.-E. S. G. C. Group, “SG-CG/M490/K_ SGAM usage and examples - SGAM User Manual - Applying, testing & refining the Smart Grid Architecture Model (SGAM) Version 3.0.,” CENELEC, Brussels, Belgium, 2014.

[5] D. f. Energy, “Guidelines for implementing the prescribed technology,” *Publications Office of the European Union,* 2023.

[6] L. Sigrist, K. May, A. Morch, P. Verboven, P. Vingerhoets and L. Rouco, “On Scalability and Replicability of Smart Grid Projects—A Case Study.,” *Energies,* 2016.

[7] M. S. L. A. Ying Yang, “D8.2 The scalability and replicability analysis of local energy community solutions,” 2023.

[8] N. A. I. G. J. R. I. M. E. P. C. M. S. M. Despoina I. Makrygiorgou, “Scalability and replicability analysis of smart grid projects: Insights from the H2020 CROSSBOW project,” frontiers, 2023.

[9] R. C. A. E. B. L. M. Orlando Valarezo, “EUniversal - D10.2 Methodology and scenarios for the EUniversal Scalability and Replicability Analysis,” 2022.

[10] C. C. (. M. S. (. P. H. (. D. O. O. (. S. T. (. C. M. (. G. I. &. N. D. C. (. G. V. (. Robert Soler (EDF), “EU-SysFlex - D10.4 Assessment of the scalability and replicability of EUSysFlex solutions,” 2022.

[11] S. P. M. A. R. C. M. P. M. R. C. L. L. Barbara Herndler, “integrid - D8.3 Replication Roadmap,” 2020.

[12] F. Kupzog, “D3.8 Scalability and replicability analysis (SRA) for all use cases,” 2019.

[13] P. H. E. K. N. L. J. S. Xiubei Ge, “ReFlex - Replicability Concept for Flexible Smart-Grids,” 2019.

[14] K. L. Daniela Leonte, “ReUseHeat - D2.9 Scalability, replicability and modularity,” 2020.

[15] S. Wilker, M. Meisel and T. Sauter, “"Smart grid architecture model standardization and the applicability of domain language specific modeling tools",” *2017 IEEE 26th International Symposium on Industrial Electronics (ISIE),* pp. pp. 152-157, 2017.

[16] L. S. P. V. A. M. P. V. L. R. Kristof May, “Improving Scalability and Replicability of Smart Grid Projects,” CIRED - 23rd International Conference on Electricity Distribution, Lyon, 2015.

[17] C. D. E. Z. S. P. a. V. V. Georgios Fotis, “Scalability and Replicability for Smart Grid Innovation Projects and the Improvement of Renewable Energy Sources Exploitation: The FLEXITRANSTORE Case,” MDPI, Basel, Switzerland, 2022.

[18] B. C. GmbH, “FlexCommunity,” [Online]. Available: https://flex-community.eu/.

[19] R. J. B. B. H. C. K. B.-V. R. F. L. A. A. M. D. R. F. C. J. V. S. J. R. A. G. S. H. T. M. S. e. a. Sergio Potenciano Menci, “Functional Scalability and Replicability Analysis for Smart Grid Functions: The InteGrid Project Approach,” 2021.

10 List of abbreviations

Abbreviation	Term
AC	Alternative current
AI	Artificial Intelligence
API	Application Programming Interfaces
BEMS	Building Energy Management System
BRS	Balance Responsible Party
CBA	Cost-benefit analysis
DAPP	Decentralized Application
DER	Distributed Energy Resources
DSM	Demand side management
DSO	Distribution System Operator
EMS	Energy management system
ESCO	Energy service company
EU	European Union
EV	Electrical vehicle
FEMS	Factory energy management system
FMO	Flexibility Market Operator
FSP	Flexibility Service Provider
FSPA	Flexibility Service Providing Agent
FTP	Flexibility Trading Platform
GDPR	General Data Protection Regulation
GHG	Greenhouse gas
GOS	Grid Observability Service
HEMRM	Harmonized Electricity Market Role Model
HLUC	High Level Use Case
ICT	Information and communications technology
IDMM	Intraday Market Mechanism
IOP	Interoperability Profile
IT	Information Technology
KER	Key Exploitable Result
KPI	Key Performance Indicator
LFM	Local flexibility markets
Low Voltage	LV
LVGoS	Low Voltage Grid Observability Service
MO	Market operator
P2P	Peer-to-peer

PED	Power Electronics Device
PV	Photovoltaic
SCADA	Supervisory Control and Data Acquisition
SGAM	Smart Grid Architecture Model
SRA	Scalability and Replicability AnalysiICTs
TRL	Technical Readiness Level
TSO	Transmission System Operator
V2G	Vehicle-to-Grid
VRES	Variable renewable energy sources

Annex A KER SRA

FEVER-SRA-KERs → base 03.01.2024, 16:21

Page 01

Dear respondent,

To prepare this scalability and replicability (S&R) questionnaire, both the BRDIGE guidelines and the approaches found in the literature were used as a basis. **Special focus is given to the gathering of non-technical barriers and opportunities for replicability and scalability**. For this reason, please provide as many as you find relevant.

Different types of questions will be encountered.

- **First**, there will be **introductory questions**, which attempt at **painting a general image** about the KERs, thus contributing to building a narrative about the project (e.g. about standardisation, interoperability and the FlexOffer).
- **Secondly**, **ranking questions** will be found. These **are at the heart of the SRA** and will be used to compare the KERs' scalability and replicability potentials.
- **Finally**, there will be questions which relate to **information gathering**. These mostly are a way for you to give an explanation to the rankings, but also include questions which directly request to specify barriers and opportunities for scalability and/or replicability.

The S&R questionnaire is mainly divided into environmental, technical, economic, regulatory and social-related questions, which broadly define the sections of the questionnaire. Additionally, a section to BRIDGE's recommendation for analysis of replicability indeces and one for the FlexOffer have been added.

The SRA **questionnaire can be saved** using the "Pause the Interview" button in the bottom left of the page at every stage. This will lead to a page which allows for you to return to the questionnaire, as well as to save a link that opens the questionnaire at the stage where it was left at, or the option of having an e-mail sent to you with a link to the (partly filled-out) questionnaire. This can be **useful for collaboration** (e.g. in case you consider a partner can be better suited to respond some questions or sections, if you have any questions or need clarification). After which, said partner can do the same and send the updated link back to you. **We recommend to use the generated link** (instead of the e-mail option), as the e-mails can often land in the Spam/Junk e-mail folder.

(For you to be able to evaluate the **question's relevance** to either scalability or replicability, we have included the option to do so. This will be found as a rating from Low to High. You will find this option **under parantheses and in red**, for each of the "rating" type of questions. For these type of questions, low will be on the left side and high on the right. Always.)

Thank you in advance!

Good riddance

1. Please, select the KER you'd like to evaluate.

In case you want to participate and don't find your KER in the list, you may specify it under "Other:"

[Please choose]

Page 02

Replicability Indices

(Standardisation & Interoperability)

2. Please provide a short description of the KER's main advancements:

e.g. with relation to the TRL level reached during the project.

3. Please rate your KER according to the indicated replicability indices.

Open standards: For example, if the KER uses 4 standards, but only 2 of them are open, the KER would have a 0.5 rating. Score of 1 meaning the KER uses only open standards.

Component standards For example, if the design of the KER involves 4 component layer standards, but only 2 of them are fully defined in accessible component layer standards, the KER would have a 0.5 rating (i.e. 2 missing standards have been identified).

Communication standard For example, if the KER uses 4 communication standards (between systems or other elements), but only 2 of them are fully defined in accessible communication layer standards, the KER would have a 0.5 rating (i.e. 2 missing or underdeveloped standards have been identified).

Information standards: For example, if the KER uses 4 data exchanges (between systems or other elements), but only 2 of them are fully defined in accessible information layer standards, the KER would have a 0.5 rating (i.e. 2 missing or underdeveloped standards have been identified).

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	N/A
Open standard implementation	○	○	○	○	○	○	○	○	○	○	○	○
Component standards	○	○	○	○	○	○	○	○	○	○	○	○
Communication standards	○	○	○	○	○	○	○	○	○	○	○	○
Information standards	○	○	○	○	○	○	○	○	○	○	○	○

In addition to the resources required for replication (referred to in the current replicability index question), does scaling up require additional resources that are based on open standards?

4. According to the specified SGAM Interoperability layers, is this KER ready to be replicated using different standards?

The emphasis of the **component layer** is the physical distribution of all participating components in the smart grid context. This includes system and device actors, power system equipment (typically located at process and field level), protection and telecontrol devices, network infrastructure (wired / wireless communication connections, routers, switches, servers) and any kind of computers.

The emphasis of the **communication layer** is to describe protocols and mechanisms for the interoperable exchange of information between components in the context of the underlying use case, function or service and related information objects or data models.

The **information layer** describes the information that is being used and exchanged between functions, services and components. It contains information objects and the underlying canonical data models. These information objects and canonical data models represent the common semantics for functions and services in order to allow an interoperable information exchange via communication means.

	Restricted to one set of standards (Low)	Difficulty in working according to different standards	Different standards can be easily implemented	Different standards are partially implemented	Yes, in all relevant cases (High)	N/A
Component - Capability to be implemented according to different standards	○	○	○	○	○	○
Communication - Capability to be implemented according to different standards	○	○	○	○	○	○
Information - Capability to be implemented according to different standards	○	○	○	○	○	○
(Please rate this question's relevance for demo replicability)	○	○	○	○	○	○

Welcome to provide any related information you find relevant (be advised, this is always an option):

5. According to the specified SGAM Interoperability layers, is this KER ready to be replicated?

The function layer describes system use cases, functions and services including their relationships from an architectural viewpoint. The functions are represented independent from actors and physical implementations in applications, systems and components. The functions are derived by extracting the use case functionality that is independent from actors.

The business layer represents the business view on the information exchange related to smart grids. It involves regulatory and economic (market) structures (using harmonized roles and responsibilities) and policies, business models and use cases, and business portfolios (products and services) of market parties involved. Also business capabilities, use cases and business processes can be represented in this layer

HEMRM – Harmonized Electricity Market Role Model

	Not at all (Low)		Partly		Fully (High)	N/A
Function - Related business use cases have been decomposed to throroughly describe functionality	○	○	○	○	○	○
Business - Related the roles and responsibilities of involved actors are described in the HEMRM	○	○	○	○	○	○
Business - Related roles and responsibilities of NEW actors have been fully defined	○	○	○	○	○	○
(Please rate this question's relevance for demo replicability)	○	○	○	○	○	○

Welcome to provide any related information you find relevant:

6. Have you identified any missing information standards, grid connection codes, market rules or market mechanims?

	No (Low)	Requires modifications	Yes (High)	N/A
Missing informaiton standard	○	○	○	○
Missing grid connection code	○	○	○	○
Missing market rule or mechanism	○	○	○	○
(Please rate this question's relevance for demo replicability)	○	○	○	○

Welcome to provide any related information you find relevant:

7. Have you identified any proprietary solutions that require the development of open standards in linking them to the various SGAM layers?

Page 03

Environment

8. Does this KER enable its users to achieve a reduction in GHG emissions?

	Could lead to more emissions (Low)	Doesn't contribute	Directly contributes	Acts as enabler for sector decarbonizatic (High)
Electricity GHG emissions reductions	○	○	○	○
Reduction of emissions in mobility	○	○	○	○
Carbon footprint reduction of heating	○	○	○	○
(Please rate this question's relevance for scalability and replicability)	○	○	○	○

Please provide insight regarding your answer to the previous question:

Page 04

9. Did you gain any experience with the FlexOffer specification in the development of this KER?

○ No
○ Yes

Page 05

FlexOffer

10. According to your experience, rate the capability of the FlexOffer to deliver the following:

	None		Partly		Fully
FlexOffer capability to untap different types of flexibility	○	○	○	○	○
FlexOffer capability to facilitate the required functionality	○	○	○	○	○
FlexOffer capability to enable grid service provision	○	○	○	○	○
FlexOffer compatibility with your market model	○	○	○	○	○
FlexOffer capability to scale	○	○	○	○	○
FlexOffer capability for localized use of flexibility	○	○	○	○	○

Please elaborate on your previous answer:

11. Please rate the ease of implementation of the FlexOffer in this product.

	Very challenging				Very straight forward
FlexOffer ease of implementation	○	○	○	○	○

Please elaborate on your previous answer:

12. What could be done to improve the FlexOffer implementation experience?

Page 06
SC

Scalability - Technology

Scalability can be defined as the ability of a system to change its scale in order to meet growing volumes of demand.

A more restrictive formulation defines scalability then as the ability of a system to maintain its performance (i.e., relative performance) and function, and retain all its desired properties when its scale is increased without having a corresponding increase in the system's complexity.

13. Was this product designed with scalability in mind?

	No	Partly	Fully
The product was designed with scalability in mind	○	○	○

Please elaborate on your previous answer:

Modularity

The factor modularity asks and studies to what extent a solution or the implementation of solutions is modular (e.g., how easy it is to add new components or whether there are limits on adding components).

14. Would it be possible to easily add additional components and/or increase its size (e.g. by increasing the amount of users) without affecting its performance?

	Considerably difficult (Low)				Can be easily done (High)
Ease of adding new components	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○

Please indicate what the the main challenges for adding new components to KER:

15. To which extent are the components of the KER able to function independently of one another?

	Components are NOT independent (Low)				Components are highly independent (High)
Component interdependency or independency	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○

Please describe the identified (in)dependencies among components:

Technology Evolution

The factor technology evolution asks and determines to what extent technological advances allow increasing the solution size.

16. Can the product easily adapt to an evolving technological landscape?

e.g. higher data demand, improved communications infrastructure, cloud computing, IoT, AI, etc.

	No, it can't (Low)		With difficulties		Yes, it can easily be adapted (High)
The product can easily adapt to an evolving technological landscape	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○

Please elaborate on your previous answer:

Interface design

The factor interface design asks and studies to what extent interactions between components increase after scale-up.

17. To which extent do interactions among components increase with size?

	High increase (Low)				Low increase (High)	N/A
Impact of scale-up on component interaction	○	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○	○

Please describe the effect of scale-up on interactions among components:

Software Tools

The factor software tools asks and determines to what extent the performance of software tools is affected when the solution's size increases.

18. Are there clear bottlenecks when it comes to the software's ability to scale-up?

i.e. are the internal and external software tools involved able to cope with an increased size?

	Unavoidable bottlenecks (Low)	Some difficult bottlnecks	Some bottlnecks	Bottlnecks are easy to solve	No bottlenecks (High)	N/A
Software bottlenecks (both internal and external software tools)	○	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○	○

Please provide information about the identified software bottlenecks:

Existing Infrastructure

The factor existing infrastructure asks and studies to what extent the current infrastructure (e.g. size of transformers, line width, availability of smart meters, grid observability equipment, currently installed DERs etc.) creates limits on the maximum size of the implementation of the KER.

19. Can a given "existing infrastructure" pose limitations to the solution's ability to scale?

e.g. size of transformers, line width, availability of smart meters, grid observability equipment, currently installed DERs etc.

	Very likely (Low)				Unlikely (High)	N/A
Potential impact of existing infrastructure on scale-up	○	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○	○

Regarding the existing infrastructure, please indicate the main barriers you'd expect to encounter, for this solution's ability to scale-up?

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Scalability - Economics

Scalability can be defined as the ability of a system to change its scale in order to meet growing volumes of demand.

A more restrictive formulation defines scalability then as the ability of a system to maintain its performance (i.e., relative performance) and function, and retain all its desired properties when its scale is increased without having a corresponding increase in the system's complexity.

Economies of scale

The factor economy of scale asks and determines to what extent costs grow when increasing the solution's size or units of production

.

20. Do the costs of this KER increase through scale-up?

	High cost increase (Low)	Slight increase, but still profitable	It remains the same / Unclear	Slight cost reduction	High cost reduction (High)
Economies of scale	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○

Please, provide information on your answer to the previous question (especially if "unclear"):

Profitability

The factor profitability asks and determines to what extent benefits grow when increasing the solution's size or the units of production.

21. Does the profitability of this KER improve through scale-up?

i.e. are there diminishing marginal costs and increasing marginal revenues?

	Becomes unprofitable (Low)	Slightly worsens, but it's still profitable	It remains the same / Unclear	It improves slightly	Improves considerably (High)
Profitability	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○

Please, provide information on your answer to the previous question (especially if "unclear"):

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Scalability - Regulation

Scalability can be defined as the ability of a system to change its scale in order to meet growing volumes of demand.

A more restrictive formulation defines scalability then as the ability of a system to maintain its performance (i.e., relative performance) and function, and retain all its desired properties when its scale is increased without having a corresponding increase in the system's complexity.

Regulation

The factor regulation asks and studies whether there are any regulatory barriers with respect to the size and scope of the solution.

22. How dependent is the demo on a favourable regulatory framework, with regards to its potential for scale-up?

	Very dependent (Low)				Very Independent (High)
Dependence on a favourable regulatory framework	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○

23. Please provide the most relevant regulatory barriers that have been identified for the scale-up of this solution:

	Barriers for scale-up
01	
02	

24. Please provide the most relevant opportunities encountered in the current regulatory framework for the scale-up of this solution:

	Opportunities for scale-up
01	
02	

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Scalability - Social

Scalability can be defined as the ability of a system to change its scale in order to meet growing volumes of demand.

A more restrictive formulation defines scalability then as the ability of a system to maintain its performance (i.e., relative performance) and function, and retain all its desired properties when its scale is increased without having a corresponding increase in the system's complexity.

Stakeholder Acceptance

The factor acceptance asks and determines to what extent stakeholder acceptance has been taken into account and whether any challenges are expected.

25. Please rate the potential emergence of acceptance issues when upscaling:

	No acceptance issues (Low)				High acceptance issues (High)
Potential emergence of acceptance issues	○	○	○	○	○
(Please rate this question's relevance for scalability)	○	○	○	○	○

Welcome to provide further insight to the previous question:

26. Please specify the extent to which you consider the following to be true:

	Not true (Low)		Prtly true		Very true (High)
The end-users have been actively involved in KER design	○	○	○	○	○
Users are satisfied with its design and functionality	○	○	○	○	○
Requires active end-user involvement/interaction	○	○	○	○	○
Is an enabler of demand side participation in energy	○	○	○	○	○
(Please rate this question's relevance for demo scalability)	○	○	○	○	○

Welcome to provide further insight to the previous question:

27. Please provide the most relevant obstacles for scale-up related to the stakeholder ecosystem:

	Barriers for scale-up
01	
02	

28. Please provide the most relevant opportunities for scale-up related to the stakeholder ecosystem:

	Opportunities for scale-up
01	
02	

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Replicability

From this point forward, questions will be related to replicability!

Replicability - Technology

Replicability denotes the property of a system that allows it to be duplicated at another location or time; and it depends on the expected change of boundary conditions (i.e. regulation, weather, etc).

29. Does the replication of this KER necessarily require elaborate and/or time-consuming customization and integration efforts?

	Will remain costly and lengthy (Low)				Can be streamlined (High)	N/A
Required customization and integration efforts	○	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○	○

This information could be related to why you would expect for customization and integration efforts to be reduced in the future; why you'd think they will be difficult to overcome; or about the barriers and opportunities to overcome them.

Standards

The factor standardization asks and determines to what extent a solution or the implementation of solutions is standard compliant and/or whether the solution can be easily made standard compliant.

30. Please indicate the extent to which you consider the following to be true:

The following rating can be inversely posed as a question as follows: Does the KER exclusively use proprietary standards?

	Not true (Low)		Partly true		Completely true (High)
KER is fully standard compliant (e.g. with open, voluntary or mandatory standards)	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○

31. Please, answer the following questions:

	No	Yes
Are there cases in which this KER makes use of nationally, instead of internationally recognized standards?	○	○
Is this KER involved in testing and/or developing new standards?	○	○
Have you identified any missing standards?	○	○

In case you answered "yes" to any of the previous two questions, please provide the corresponding information:

Interoperability

The factor interoperability asks and determines to what extent a solution or the implementation of solutions and their components/functions are interoperable or even plug-and-play.

32. Were there interoperability issues in trials, with regards to this KER?

	None (Low)				Many (High)
Interoperability issues encountered	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○

Please provide insight, regarding your answer for the previous question:

Network configuration

The factor network configuration asks and studies to what extent a solution or the implementation of solutions depends on given resources and infrastructures (e.g., climate conditions such as temperature, wind, precipitation levels, terrain conditions, local generation mix, demographics, consumption mix and profiles, etc.).

33. How relevant do you consider the factor network configuration for KER replicability?

	Low				High
Relevance of network configuration for replicability	○	○	○	○	○

Please provide insight, regarding your answer for the previous question:

34. Rate the relevance of the following factors for this solution's replicability:

	Irrelevant for replication (Low)				Very relevant for replication (High)	N/A
The existing grid observability equipment	○	○	○	○	○	○
The smart meter roll-out	○	○	○	○	○	○
A high penetration of variable renewable energy in the corresponding grid	○	○	○	○	○	○
A high number of DERs in the grid (e.g. battery systems, charging infra. PV, wind, heat pumps, etc.)	○	○	○	○	○	○
A high degree of electrification of heat & transport	○	○	○	○	○	○
Local climatic factors (such as wind, temperature, precipitation, terrain)	○	○	○	○	○	○

Please indicate other replicability-relevant factors related to the network configuration, and/or give any additional information to the previous ratings:

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Replicability - Economics

Replicability denotes the property of a system that allows it to be duplicated at another location or time; and it depends on the expected change of boundary conditions (i.e. regulation, weather, etc).

Macroeconomics

The factor macroeconomics asks and studies to what extent a solution or the implementation of solutions depends on given macro-economic factors.

35. Rate the risk for macroeconomic factors to impose barriers and likelihood for these to present opportunities for replication.

e.g. carbon costs, interest rates, inflation, electricity prices, gas prices, raw material prices, etc.

	Low likelyhood (Low)				High likelyhood (High)
Risk of macroeconomic factors to impose barriers	○	○	○	○	○
Potential of macroeconomic factors to present opportunities	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○

Please provide information on the most relevant macroeconomic risks and opportunities identified:

Market Design

The factor market design asks and determines to what extent a solution or the implementation of solutions depends on a given market design.

36. Can this KER be replicated under different market designs?

	Hardly (Low)				Easily (High)	N/A
KER replication under different market designs	○	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○	○

Please, provide information on its implications:

37. Is the viability of this KER highly dependent on the emergence of local or regional flexibility markets?

	Highly dependent (Low)				Not dependent (High)
KER's dependency on the emergence of local flexibility markets	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○

Please, provide information about the KER's dependency on local flexibility markets:

38. Please, indicate the most relevant qualities of a favourable market design for the KER's replicability.

39. Please, indicate the most relevant qualities of current market designs, which pose limitations on the KER's replicability.

i.e. the market design barriers.

Business model

The factor business model asks and determines to what extent the viability of a solution or the implementation of solutions has been analyzed and/or whether the solution is viable under different settings (e.g., another EU member state).

40. Please indicate the extent to which you consider the following to be true:

	Not true (Low)		Partly true		Very true (High)
The business model is adaptable to different contexts	○	○	○	○	○
Income is predictable	○	○	○	○	○
Cost-benefit analysis is straight forward	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○

Please, elaborate on your previous answer:

Replicability - Regulation

Replicability denotes the property of a system that allows it to be duplicated at another location or time; and it depends on the expected change of boundary conditions (i.e. regulation, weather, etc).

41. Please indicate the extent to which you consider the following to be true:

	Not true (Low)		Partly true		Very true (High)	N/A
KER complies with data and cybersecurity standards and regulations	○	○	○	○	○	○
KER is vulnerable to GDPR non-compliance	○	○	○	○	○	○
KER ensures user privacy is protected	○	○	○	○	○	○
KER depends on local grid balancing framework development	○	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○	○

42. Have you encountered regulatory barriers that would limit the replication of the trials which include this KER?

	None (Low)				Yes, numerous (High)
Regulatory barriers for replication	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○

43. What are the biggest regulatory barriers for the replication of the trial(s) related to this KER?

44. What are the biggest opportunities for the replication of the trial(s) related to this KER, regarding the regulatory framework?

Replicabtility - Social

Replicability denotes the property of a system that allows it to be duplicated at another location or time; and it depends on the expected change of boundary conditions (i.e. regulation, weather, etc).

45. To which extent does the use of this KER imply behavioural changes from its users?

Specially with relation to users which already make use of a well-established substitute product.

	No behavioural changes (Low)		Same changes as with most new products or services		Considerable changes required (High)
Behavioural changes from KER users	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○

Welcome to provide additional information:

46. To which extent do you consider energy literacy to influence stakeholder's willingness to participate in or use this KER?

	High relevance (Low)				Low relevance (High)
Influence of energy literacy on acceptance	○	○	○	○	○
(Please rate this question's relevance for replicability)	○	○	○	○	○

Welcome to provide additional information:

47. For the specified FEVER business actors, how important is stakeholder acceptance for the replication of this KER?

	Very important (Low)		Indirectly influences potential for replication		Not important (High)
FSP – Flexibility Service Provider	○	○	○	○	○
FMO – Flexibility Market Operator	○	○	○	○	○
BRP – Balance Responsible Party	○	○	○	○	○
DSO – Distribution System Operator	○	○	○	○	○
TSO – Transmission System Operator	○	○	○	○	○
Microgrid Operator	○	○	○	○	○
Flexibility Aggregator	○	○	○	○	○
(Please rate this question’s relevance for replicability)	○	○	○	○	○

Welcome to provide additional information:

Last Page

Thank you for completing this questionnaire!

We would like to thank you very much for helping us.

Your answers were transmitted, you may close the browser window or tab now.

Carlos Ayon Mac Gregor, B.A.U.M. Consult GmbH

Annex B FEVER Scalability and Replicability Analysis Questionaire

FEVER Scalability and Replicability Analysis

Welcome!

Non-technical barriers for the implementation of FEVER's solutions.

Regulatory, social and economic obstacles to innovation.

* Erforderlich

Scalability and Replicability Analysis

The objective of this SRA is to perform a non-technical analysis on the implementation of FEVER solutions in their correspon-ding pilot countries. By addressing non-technical challenges and opportunities, we'll be able to contribute to the development of regulations and provide valuable information to the overarching knowledge community.

- If there are questions which are out of the scope of the trial, you may specify and these will not be considered for the country's evaluation.
- If the answers vary depending on the solution(s) considered, please provide more detailed information in the free text options.

Thank you for your contribution!

1. Please enter your Name and Organisation *

2. Please select the country/pilot site you want to evaluate. *

- ◯ Cyprus
- ◯ Germany
- ◯ Spain
- ◯ Greece

Regulatory Analysis

The objective of this section is the mapping of current regulations and identification of regulatory barriers related to the piloted solutions. Please respond according to the the country selected in the previous section.

3. Is the current regulatory framework enabling or limiting consumers to **untap their flexibility**? (e.g. Flex products and services, rules for aggregation (baseline methodology), tariff design, market processes, smart appliances, sub-metering) *

- ◯ Fully enabling
- ◯ Enabling
- ◯ Neither enabling nor limiting
- ◯ Limiting
- ◯ Fully limiting
- ◯ Not applicable to trial site / I don't know

4. What are the enabling/limiting factors? What are the related regulations?
*

5. Does the current regulatory framework enable or limit **market access** for the actors involved in the implementation of the trialled solutions? (e.g. aggregator, micro-grid operator) *

- Fully enabling
- Enabling
- Neither enabling nor limiting
- Limiting
- Fully limiting
- Not applicable to trial site / I don't know

6. What are the enabling/limiting factors? What are the related regulations?
*

7. Does the current regulatory framework enable or limit **flexibility market coordination and integration**? (e.g. TSO-DSO coordination, local market design, value stacking, flex in network planning, inc-dec gaming) *

- Fully enabling
- Enabling
- Neither enabling nor limiting
- Limiting
- Fully limiting
- Not applicable to trial site / I don't know

8. What are the enabling/limiting factors? What are the related regulations? *

9. Does the current regulatory framework enable or limit the exploitation of **potential synergies coming from increased sector coupling**? (e.g. service provision by E-mobility, integration with heat, sector integration at household and industrial levels) *

- Fully enabling
- Enabling
- Neither enabling nor limiting
- Limiting
- Fully limiting
- Not applicable to trial site / I don't know

10. What are the enabling/limiting factors? What are the related regulations? *

11. Are the trialled solutions compliant with current regulations and standards related to **access to data, interoperability and cybersecurity**? *

- Fully compliant
- Compliant
- Neither compliant nor non-compliant
- Non-compliant
- Fully non-compliant
- Not applicable to trial site / I don't know

12. Why? What are the related regulations and standards?
*

13. Are current regulatory frameworks sufficiently supporting **DSOs to embrace digitalisation**?
*

- ◯ Fully enabling
- ◯ Enabling
- ◯ Neither enabling nor limiting
- ◯ Limiting
- ◯ Fully limiting
- ◯ Not applicable to trial site / I don't know

14. What are the enabling/limiting factors? What are the related regulations?
*

15. Does the current regulatory framework enable or limit **service provision by energy communities**? (e.g. grid services and associated products, energy community and system operator, financing models, community purpose guidance, etc.) *

- ◯ Fully enabling
- ◯ Enabling
- ◯ Neither enabling nor limiting
- ◯ Limiting
- ◯ Fully limiting
- ◯ Not applicable to trial site / I don't know

16. What are the enabling/limiting factors? What are the related regulations? *

Business analysis

17. Does the current **electricity market** structure create **barriers** that limit an up-scaled version of the trialled solution? *

- ◯ Yes
- ◯ Partly yes
- ◯ Neither yes or no
- ◯ Partly no
- ◯ No
- ◯ Not applicable to trial site / I don't know

18. Please provide an explanation. Why (not)? What are the barriers?

19. Is the **business case clear, predictable and justifiable** to those expected to bear the costs?
*

- Yes
- Partly yes
- Neither yes or no
- Partly no
- No
- Not applicable to trial site / I don't know

20. Please provide an explanation. Why (not)? For which stakeholder's business case?

21. Are the currently proposed services **economically viable**? (i.e. Is the Cost-Benefit ratio > 1?)
*

- Yes
- Partly yes
- Neither yes or no
- Partly no
- No
- Not applicable to trial site / I don't know

22. Please provide an explanation. Why (not)?

23. Is the **superior effectiveness** to other alternatives clearly established? *

- Very clearly
- Clearly
- Neither clear nor unclear
- Unclear
- Very unclear
- Not applicable to trial site / I don't know

24. Please provide an explanation. Why (not)?

25. Can solutions **adapt to different types of distribution networks**? (e.g. urban/rural, high/low number of points of interconnection, different network topologies, etc) *

- Yes
- Partly yes
- Neither yes or no
- Partly no
- No
- Not applicable to trial site / I don't know

26. Please provide an explanation. Why (not)? What are the barriers?

27. Is the project **able to scale-up** if its size (e.g. in terms of amount of participants, provided flexibility) were increased? *

- Yes
- Partly yes
- Neither yes or no
- Partly no
- No
- Not applicable to trial site / I don't know

28. Please provide an explanation. Why (not)? What are the most relevant barriers and/or opportunities.

29. Are solutions highly complex in their implementation? (do they required an integrated package approach to implementation, or can they be easily implemented component-by-component?) *

- Yes
- Partly yes
- Neither yes or no
- Partly no
- No
- Not applicable to trial site / I don't know

30. Please provide an explanation. Why (not)? What are the opportunities to improve the offering?

Social Analysis

31. Do you **foresee stakeholders'acceptance** problems upon deploying your technical **solution?** (including DSOs, TSOs, regulators, manufacturers, NGOs, aggregators, end customers, etc) *

- ◯ High acceptance problems
- ◯ Acceptance problems
- ◯ Moderate acceptance problems
- ◯ Minor acceptance problems
- ◯ No acceptance problems
- ◯ Not applicable to trialled solution / I don't know

32. Why (not)? From which stakeholders?

33. Do you foresee a willingness of **different groups of stakeholders to participate in the industrialisation** of your innovative solution? (stakeholders related to the industrial ecosystem of the solutions) *

- Yes
- Partly yes
- Neither yes or no
- Partly no
- No
- Not applicable to trial site / I don't know

34. Please provide an explanation. Why (not)? From which stakeholders?

35. Do potential target groups feel that the trialled solution **addresses an urgent need**? *

- Yes
- Partly yes
- Neither yes or no
- Partly no
- No
- Not applicable to trial site / I don't know

36. Please provide an explanation. Why (not)? Which target groups?

37. Does the solution cause a **risk of privacy** for its potential users? *

- Very high risk
- High risk
- Moderate risk
- Low risk
- Very low risk
- Not applicable to trial site / I don't know

38. Please provide an explanation. Why (not)? Which part(s) of the solution?

39. To which extent are solutions **easy to use** for potential end-users? (e.g. do they require high level of IT or energy education?) *

- Very easy
- Easy
- Neither easy nor hard
- Hard to use
- Very hard to use
- Not applicable to trial site / I don't know

40. Please provide an explanation. Why (not)? Which part(s) of the solution?

41. Does the solution require a high level of **user interaction**? *

- ◯ Yes
- ◯ Frequently
- ◯ Moderately
- ◯ Occasionally
- ◯ No
- ◯ Not applicable to trial site / I don't know

42. Please provide an explanation. Why (not)? Which part(s) of the solution?

Additional remarks

In case we're missing a relevant barrier or opportunity, please let us know.

43. Please identify additional regulatory barriers or opportunities you'd like for us to consider.

44. Please identify additional business barriers or opportunities you'd like for us to consider.

45. Please identify additional social barriers or opportunities you'd like for us to consider.