

**Project FUSION -
Quantification of market participant costs for
implementing USEF interface compatibility**

SP Energy Networks



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EXECUTIVE SUMMARY

This document provides a guide to GB aggregators to identify the potential costs to meet the requirements to participate in the FUSION trial. Compliance with functional specifications of the Universal Smart Energy Framework (USEF) is the main requirement for trial participants and therefore this report analyses the costs of USEF implementation. In addition to the costs, the report further explores opportunities to reduce participation costs and the benefits associated with USEF implementation. The report is prepared by DNV GL as one of the industry partners in Project FUSION and founding partner of the USEF foundation, and further informed by DNV GL's professional experience as a leading energy sector advisory firm.

The first step in quantifying market participant costs is to identify the cost elements associated with the capabilities and functionalities specified by USEF. DNV GL then classified these cost elements in different aggregator maturity levels, allowing for the separation of the elements that are exclusively associated with USEF compliance from those elements that aggregators could develop to enhance their functionality. In the third step, DNV GL developed a survey and asked four USEF-compliant aggregators to provide an indication of the cost and effort that was associated with them implementing the USEF-specific elements. The conclusions from analysis of survey responses are as follows:

- 1. Cost of USEF participation:** the effort invested by the surveyed USEF-compliant aggregators ranged between 70 and 120 man-days for the implementation of 'USEF-specific' elements, i.e. of implementing, testing and simulating the USEF communication and learning how to use D-programmes. Less mature aggregators incurred costs to develop/improve other functionalities, which were not exclusive to USEF, such as forecasting, flexibility pricing, flexibility quantification, etc.
- 2. USEF cost saving tools:** to reduce the effort of USEF implementation, Dutch DSOs in collaboration with Project FUSION are developing two USEF software tools. This report anticipates that these tools might reduce the effort of implementation by 30 to 50 man-days; this range is based on the tool development effort estimated by the Dutch DSOs. Without considering any potential additional costs associated with the tools, the effort to implement 'USEF-specific' elements would then be reduced to a range of between 20 and 90 man-days.
- 3. USEF benefits:** aggregators identified a number of direct benefits that they experienced from implementing USEF. Among others, aggregators highlighted the value of standardisation. DNV GL quantified the value of standardisation as the avoided cost of implementing a bespoke DSO communication protocol for congestion management services (60-70 man-days as estimated by one of the surveyed aggregators) compared to the one-off cost of implementing a standard protocol. This cost can be fully or partly avoided by having the same standardised protocol for aggregators and DSOs across GB. If widely adopted by DSO and aggregators, USEF could provide this standardisation in GB and aggregators could avoid costs related to bespoke protocols. Although not widely adopted, DNV GL identifies USEF as the only standard in Europe that provides a DSO-Aggregator communication protocol and market interaction processes for congestion management services. As such, one of the main objectives of Project FUSION is to validate the suitability of the USEF standard for the GB market.

1 INTRODUCTION

1.1 Overview of Project FUSION

Project FUSION is funded under Ofgem's 2017 Network Innovation Competition (NIC), to be delivered by SP Energy Networks in partnership with seven project partners: DNV GL, Origami Energy, PassivSystems, Imperial College London (academic partner), SAC Consulting, The University of St. Andrews, and Fife Council.

Project FUSION represents a key element of SP Energy Network's transition to becoming a Distribution System Operator (DSO), taking a step towards a **clean, smart and efficient energy system**. As the electricity system changes from a centralised to a decentralised model, it enables a smarter and more flexible network to function. Project FUSION is trialling the use of commoditised local demand-side flexibility through a structured and competitive market, based on a **universal, standardised market-based framework; the Universal Smart Energy Framework (USEF)**. USEF provides a standardised framework that defines products, market roles, processes and agreements, as well as specifying data exchange, interfaces and control features. The purpose of USEF is to accelerate the transition to a smart, flexible energy system to maximise benefits for current and future customers. Section 2 provides a brief overview of USEF and Appendix A provides a glossary containing USEF definitions.

Project FUSION will inform wider policy development around flexibility markets and the DNO-DSO transition through the development and testing of standardised industry specifications, processes, and requirements for transparent information exchange between market participants accessing market-based flexibility services. Ultimately, Project FUSION will contribute to Distribution Network Operators and all market actors unlocking the potential and value of local network flexibility in a competitive and transparent manner. In doing so, Project FUSION aims to contribute to addressing the energy trilemma by making the energy system more secure, more affordable and more sustainable.


1.2 Background to this document

In January 2019, work package 3 (WP3) of Project FUSION commenced with a due diligence of USEF against legal, regulatory and market arrangements governing the GB energy sector. The due diligence was carried out by DNV GL and assessed the fit of USEF with the direction of reform of GB energy policy and regulation, as well as forward-looking industry initiatives like the Energy Networks Association's Open Networks (ENA ON) project, to inform the transition to a smart, flexible energy system.

The due diligence results showed that across a number of topics there is a close fit between USEF and both the current market design and the likely direction of future market design in GB. The results showed that there are several relevant and valuable innovative elements within USEF that could enrich current discussions and views on future energy market design, both broadening and deepening these views. Project FUSION subsequently sought the feedback of GB energy industry stakeholders on the merits and possible implementation of these innovative elements. The outcomes of this consultation are summarised in the FUSION Consultation report of 15 November 2019.

In addition to innovative USEF concepts, the due diligence also uncovered a small number of conflicts, which may require changes in either USEF or GB arrangements, as well as areas where GB arrangements could add to USEF. However, the due diligence did not indicate any areas that would prevent USEF from being implemented in GB, and Project FUSION's expectations are that only few modifications will be needed on USEF's side, and a limited set of recommendations to adjust current or (proposed) future arrangements in the GB energy system.

The GB Reference implementation Plan document set an implementation plan for USEF in the GB energy market, confirming clear steps for the implementation in GB of several components of USEF, based on the outcomes of the previous documents, Project FUSION Due Diligence and Public Consultation, and further informed through engagements with key stakeholders.



In addition to the GB Reference Implementation Plan, the FUSION USEF Implementation Plan document set the deployment of USEF elements in the upcoming flexibility market trial under Project FUSION. The document also provided an overview of the processes and information exchange based on the USEF Market Coordination Mechanism (MCM) that trial participants will implement.

This report is informed by previous work of Project FUSION and particularly by the GB USEF Reference Implementation Plan and the FUSION USEF Implementation Plan.

All relevant documents are available on the Reports & Publication section of the Project FUSION website.¹ In addition, Section 2 and Appendix A of this report provide a high-level introduction to USEF and a Glossary, respectively, for further reference.

1.3 Purpose of this Document

This report seeks to quantify the indicative cost range for market participants to implement the USEF interface compatibility necessary for participation in Project FUSION. Also, it goes further by quantifying the costs of aggregators becoming USEF compliant.² These costs include both the cost of becoming a USEF-compliant aggregator and the associated benefits. Further details on the implementation of the FUSION trial can be found in the FUSION USEF Implementation Plan document,³ published on the FUSION website. In addition, the communication protocol and other requirements for FUSION trial participants are set out in the FUSION Communication Protocol document.⁴

This purpose of this document is to:

1. present a brief USEF overview for context;
2. set out USEF roles and their relation to GB market participants under the FUSION context;
3. set out the methodology applied to quantify market participant costs for implementing USEF;
4. quantify those costs (and the associated benefits); and
5. provide recommendations on how to reduce these costs.

¹ <https://www.spenergynetworks.co.uk/pages/fusion.aspx>

² The focus of this report has been exclusively on quantifying this cost for participating aggregators. The cost for participating DSO's has not been addressed in this report. This is due to the associated commercial sensitivities of this analysis, particularly in light of the ongoing competitive procurement of the DSO platform at the time of writing. However, FUSION will generate learnings on the costs for participating DSO's and these will be published in due course as part of Work Package 6 – Learning Dissemination.

³ https://www.spenergynetworks.co.uk/userfiles/file/FUSION_USEF_Implementation_Plan.pdf

⁴ When available, this document can be found in the FUSION website: <https://www.spenergynetworks.co.uk/pages/fusion.aspx>

2 USEF OVERVIEW

The USEF framework aims to facilitate effective coordination across all different actors involved in the electricity market by providing a common standardised roles-model and market design while describing communication requirements and interactions between market roles. USEF turns flexible energy use into a tradeable commodity, which is available for all energy market participants to optimise the use of resources and is separated from (but in coordination with) the traditional electricity supply chain. USEF focuses on explicit demand-side flexibility, in which prosumers are contracted by the aggregator to provide specific flexibility services using Active Demand and Supply (ADS) assets. USEF acknowledges but does not provide detailed considerations for implicit demand-side flexibility or peer-to-peer energy trading.

To facilitate the transition towards a cost-effective and scalable model, USEF provides the essential tools and mechanisms which redefine existing energy market roles, add new roles and specify interactions and communications between them. In addition, the USEF standard ensures that all technologies and projects will be compatible and connectable to the energy system, facilitating project interconnection, hence fostering innovation and accelerating the smart energy transition. By delivering a common standard to build on, USEF connects people, technologies, projects and energy markets in a cost-effective manner. Its market-based mechanism defines the rules required to optimise the whole system, ensuring that energy is produced, delivered and managed at lowest cost for the whole system and effectively for the end-user.

The USEF framework provides:

- a **standardised common framework** designed to be implemented on top of current energy markets such as wholesale, retail and capacity markets.
- a description of the **flexibility value chain** (FVC) involving new and existing market players and giving a central role to the aggregator in facilitating flexibility transactions.
- a **roles model** and an **interaction model** to enable the implementation of different business models and interactions between actors.
- a market design described by the **Market Coordination Mechanism (MCM)** which sets out the phases and interaction requirements for flexibility transactions. The MCM provides all stakeholders with equal access to a smart energy system. To this end, it facilitates the delivery of value propositions (i.e. marketable services) to various market parties without imposing limitations on the diversity and customisation of those propositions.
- detailed **communication and market access requirements** taking into consideration privacy and cyber security issues.

For more information, all USEF documents are freely available on the USEF Website.⁵ Relevant publications for this report are:

- *USEF: The framework explained.*⁶ This document outlines the vision of the USEF Foundation and USEF's approach to the flexibility market design, with a high-level description of the structure, market roles, tools and rules.
- *USEF Flexibility Trading Protocol (UFTP) Specifications.*⁷ This document provides the detailed communication protocol between DSO and Aggregator.

⁵ <https://www.usef.energy/>

⁶ USEF: The framework explained https://www.usef.energy/download-the-framework/#popup_overlay2

⁷ USEF Flexibility Trading Protocol https://www.usef.energy/download-the-framework/#popup_overlay1

3 USEF ROLES AND MARKET PARTICIPANTS

Table 1 lists the USEF roles that will be performed during the FUSION trial and how they relate to GB market participants. The colour coding describes whether the USEF role fully matches, partially matches, or does not match the GB arrangements.


Capitalised words indicate USEF terminology. For example, the term "Aggregator" refers to the USEF role, whereas the term "aggregator" refers to the GB market party.

Table 1 USEF roles in FUSION trial

Legend:

Role exists in USEF and GB the arrangements but with slightly different responsibilities or names
Role matches USEF and GB arrangements
Role is exclusive to USEF

USEF Role included in the FUSION trial	Relation to GB market participants
Distribution System Operator (DSO) <i>Role responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area.</i>	This role will be performed by SPEN.
Active Demand Supply (ADS) <i>Energy consuming or producing devices that can be actively controlled.</i>	This role refers to the flexible assets that are managed by the Aggregator.
Aggregator <i>A service provider that contracts, monitors, aggregates, dispatches and remunerates flexible assets at the customer side. Aggregators buy flexibility from Prosumers and sell it to Flexibility Service Providers.</i>	The USEF <i>role definition</i> for Aggregator differs from the <i>market party</i> aggregator. In FUSION, the Aggregator role can be performed by any party that manages a portfolio of flexible assets, for example, aggregators or suppliers.
Constraint Management Service Provider (CMSP) <i>A provider of constraints management services to a DSO or the ESO.</i>	This role provides flexibility to the DSO for constraint management. The CMSP in USEF is market facing, unlike the Aggregator who interacts with the Prosumers. In the FUSION trial, the CMSP role can be performed by any market party that offers flexibility services, for example, aggregators.
Common Reference Operator (CRO) <i>Role responsible for operating the Common Reference. The Common Reference as a repository which contains detailed information on network congestion points, their associated connections and active aggregators in the electricity network.</i>	This role will be performed by SPEN.
Meter Data Company (MDC) <i>Role designating a company responsible for the acquisition and validation of meter data and to facilitate the flexibility</i>	This role will be performed by SPEN.



<i>and balancing settlement processes by making accurate and valid data available to market agents.</i>	
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Throughout this report, the term aggregator will encompass the roles of Aggregator and Constraint Management Service Provider (CMSP).

4 METHODOLOGY

This section describes the methodology to quantify the costs for participating in the FUSION trial. All interested aggregators must be USEF-compliant to offer flexibility services in the trial. Therefore, the quantification is mainly based on the experience of USEF-compliant aggregators and their costs to implement USEF.

Aggregators should meet a list of requirements to be USEF-compliant that goes beyond the implementation of a standardised message protocol. DNV GL has developed a high-level list of costs of the activities that aggregators should perform to provide DSO flexibility services through a market-based and USEF-complaint interaction. The high-level costs list consists of the following elements:


1. **USEF communication protocol:**⁸ The implementation, testing and simulation of USEF Flexibility Trading Protocol (UFTP).
2. Long-term, day-ahead and intra-day forecasting: The capability to forecast the demand/generation and available capacity of flexible assets per Settlement Periods (SP).
3. **D-programmes:** The capability to translate forecasts to the D-programme structure and the capability to use D-programmes as a baseline to quantify delivered flexibility.
4. Flexibility delivery quantification: The capability to quantify and justify the delivered flexibility.
5. Flexibility pricing: The capability to assign a price to the offered flexibility.
6. Portfolio optimisation: The capability to optimise the portfolio of assets attending the Prosumer needs.
7. Monitoring: The capability to monitor available capacity and performance of the portfolio of assets.
8. Dispatch: The capability to activate/dispatch flexible assets upon request.
9. Aggregation at congestion point level: The capability to identify and aggregate the assets connected to the congestion points.
10. Local sub-metering: Installation of local submetering if required by the specific service.
11. Value stacking: The capability to participate in different services/markets with a portfolio of assets

Albeit that all these elements are needed to participate in a USEF mechanism, it should be noted that many of these elements would be required if an aggregator participated in a bespoke DSO congestion management mechanism that is built upon the same principles as USEF (market-based, transparent, scalable, suitable for value stacking and future proof). Therefore, USEF-specific elements and non-USEF specific elements should be distinguished. USEF-specific elements are the **USEF communication protocol** and **D-programmes**. The remaining elements, although necessary for USEF compliancy, can be classified as non-USEF-specific. This categorisation shows that the costs will strongly depend on the maturity level of the aggregator prior to implementing USEF. For example, some aggregators may have already implemented several of the listed elements as part of their business as usual aggregation services.

To visualize this, DNV GL created a small *maturity model*. DNV GL broke down the high-level cost element list (*listed earlier in section 4*) in three complexity levels: Low (L), Medium (M) and High (H). DNV GL grouped the cost-elements to develop different *aggregator maturity levels* for aggregators providing flexibility services to a DSO. Figure 1 shows the relation between the maturity level and the cost and complexity to become USEF-compliant. In Figure 1, the X-axis shows 5 aggregator maturity levels (1-5)⁹ with corresponding aggregator capabilities. The Y-axis reflects the

⁸ USEF Flexibility Trading Protocol https://www.usef.energy/download-the-framework/#popup_overlay1

⁹ This classification was developed solely to support the quantification analysis and do not have any implications outside of this study.



complexity of the processes associated with each maturity level and the relative costs associated with achieving each respective maturity level from scratch.

The aggregator capabilities reflected within each ascending maturity level are cumulative. This means that each level assumes the implementation of the elements of the less mature levels.¹⁰

1. Level 1 represents the most basic aggregator, where the DSO directly controls the assets of the aggregator's customers.
2. Level 2 represents an aggregator that performs the dispatch of a portfolio of flexible assets fully dedicated to the DSO. Apart from managing customer relations, Level 2 aggregator is able to monitor and quantify the flexibility which is delivered from a small and homogeneous portfolio of assets.
3. Level 3 represents an aggregator that has a dedicated portfolio delivering flexibility to a DSO. In addition to Level 2 capabilities, Level 3 aggregator is also able to perform forecasts, flexibility pricing, portfolio optimisation and more complex flexibility delivery quantification.
4. Level 4 represents an aggregator that offers flexibility to a DSO through a market-based interaction. Level 4 capabilities are more complex than less mature levels. In addition, Level 4 aggregator is able to aggregate at congestion point level, has value stacking capabilities and has enabled an advanced, yet bespoke communication protocol to interact with the DSO.
5. Level 5 represents a USEF-compliant aggregator. The differences between Level 4 and Level 5, are that the communication protocol in Level 5 is the UFTP (USEF Flexibility Trading Protocol) and that the aggregator uses D-programmes for both, the forecasting and baselining. Δ USEF symbolises the cost of implementing a market-based interaction based on USEF.

Although levels 4 and 5 are similar, we still need to apply different maturity levels to distinguish the costs of implementing the USEF standard from all costs that are realised to participate in a non-standardized, yet fully developed and market-based congestion management mechanism, alongside other market activities. This implies that the *bespoke communication protocol implementation* in level 4 is not a requirement for level 5. In other words, the aggregator does not need to implement a bespoke DSO communication protocol to move from level 3 to level 5. On the other side an aggregator in level 4 (who has already implemented a bespoke communication protocol) would need to incur the cost of implementing the USEF communication protocol to become USEF compliant and reach level 5.

¹⁰ Note, that in this exercise we provide a minimum complexity requirement per level. The cost associated to further increasing quality or complexity of the different elements is out of the scope of the study.

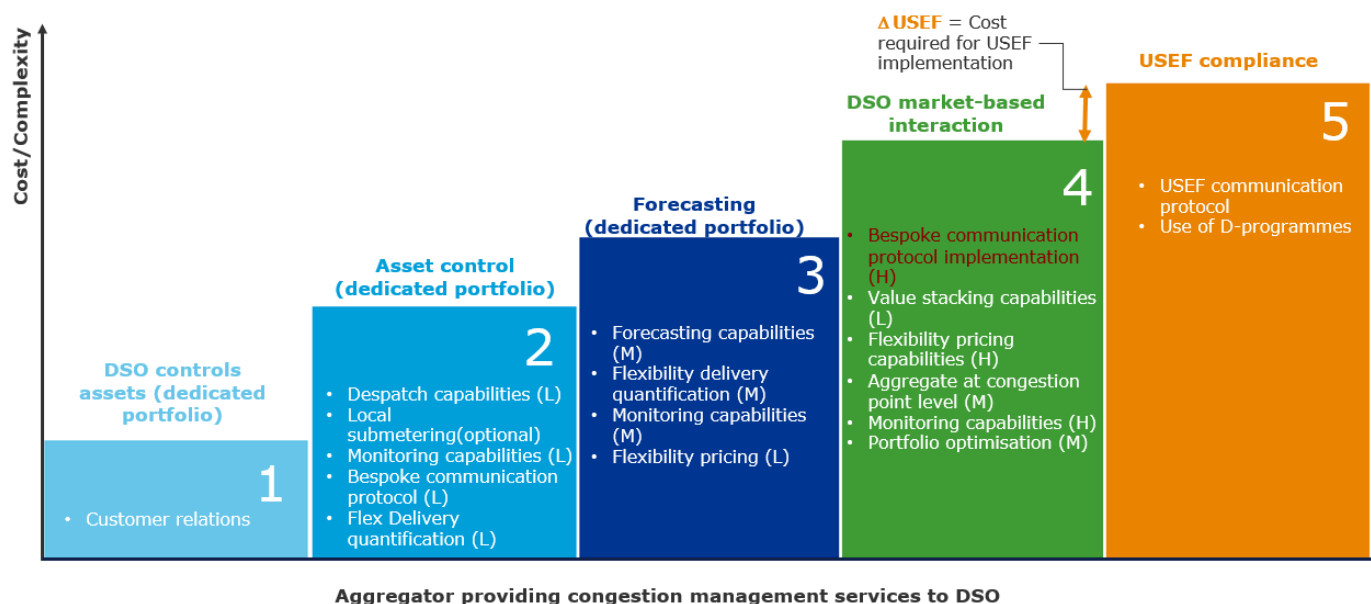


Figure 1 Cost/complexity scale for different aggregator maturity level

To get an estimation of the cost resulting from USEF implementation, ΔUSEF , we have developed a survey¹¹ (Appendix B) for aggregators that have already implemented USEF. Primarily, the questions aimed to:

1. Identify the aggregator's maturity level and capabilities **before** USEF implementation; and
2. Quantify the effort invested by the aggregator to become USEF compliant.

In addition to calculating the cost of implementing USEF, we also sought to:

3. Discover the benefits that the USEF implementation brought to USEF-compliant aggregators; and
4. Collect suggestions on how the USEF costs can be brought down.

Following the survey, we quantified the cost per aggregator maturity level, subject to the previous level of the USEF aggregators participating in the survey. Finally, we quantified the saving associated to two USEF tools and will be used to estimate the total cost of implementing USEF.

In order to gauge the costs of non-USEF-compliant (GB) aggregators achieving USEF compliance, Project Partners originally planned to include these aggregators in the survey to ascertain their existing maturity level. However, given the commercial sensitivity of the responses to such a survey, the aim of the exercise shifted to focus not on surveying GB aggregators per se, but rather introducing them to the survey questions so that they could use them internally within their organisations to position themselves on the determine cost of participation based on their maturity level.

5 COST BENEFIT ASSESSMENT

5.1 Quantification of costs

The quantification of costs is based on the experience of existing USEF-compliant aggregators. Four USEF-compliant aggregators, that will remain anonymous, participated in a survey, which was prepared by DNV GL. These aggregators had different original maturity levels, ranging from level 2 to level 4, prior to becoming USEF-compliant. As such, they had to adopt a variety of functionalities/capabilities which were both USEF-specific and non-USEF-specific.

Figure 2 illustrates the cost range (in man-days) to enable the elements described in Section 4. The costs which are exclusively associated to USEF are the **USEF communication protocol** implementation (including testing and simulation) and the use of **D-programmes**. The costs for USEF communication protocol elements and the use of D-programmes range from 50 to 100 and 1 to 20 man-days of work respectively. The remaining elements and their associated costs represented enhancements made by the aggregators to increase their maturity level that were not exclusively USEF-driven.

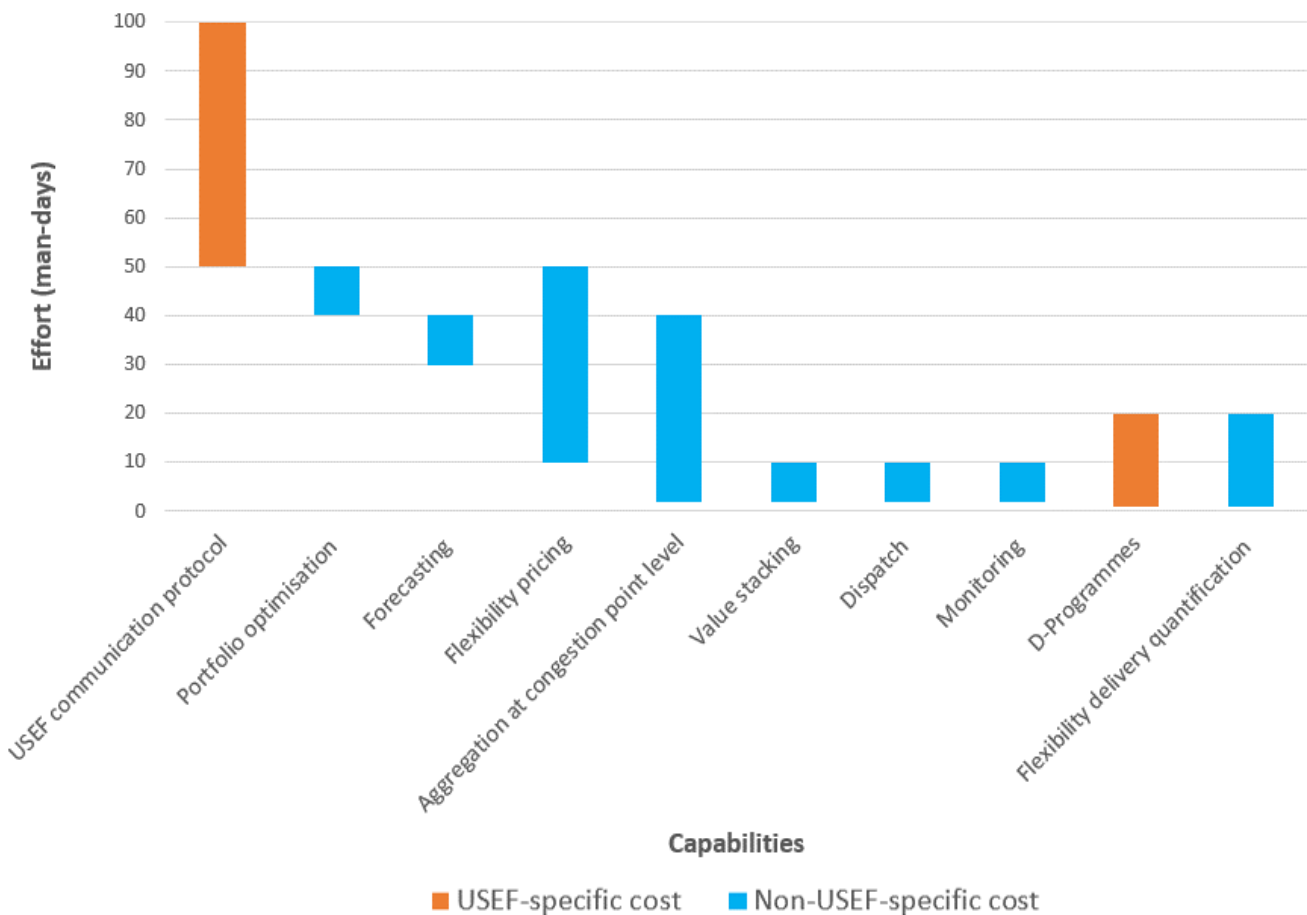


Figure 2 USEF Aggregators' effort range per capability

Figure 3 shows the aggregated costs, for USEF-specific and non-USEF-specific elements, mapped against the different maturity levels of the surveyed aggregators. The figure indicates that lower maturity levels require greater effort to enable the non-USEF-specific capabilities. Whereas the costs associated to USEF implementation, are relatively similar for all aggregators. The maximum effort was estimated at 120 man-days by an aggregator at

maturity level 2-3 and the lowest effort at 70 man-days by an aggregator at maturity level 4.¹² The plot shows the median value of the ranges provided by the survey participants.

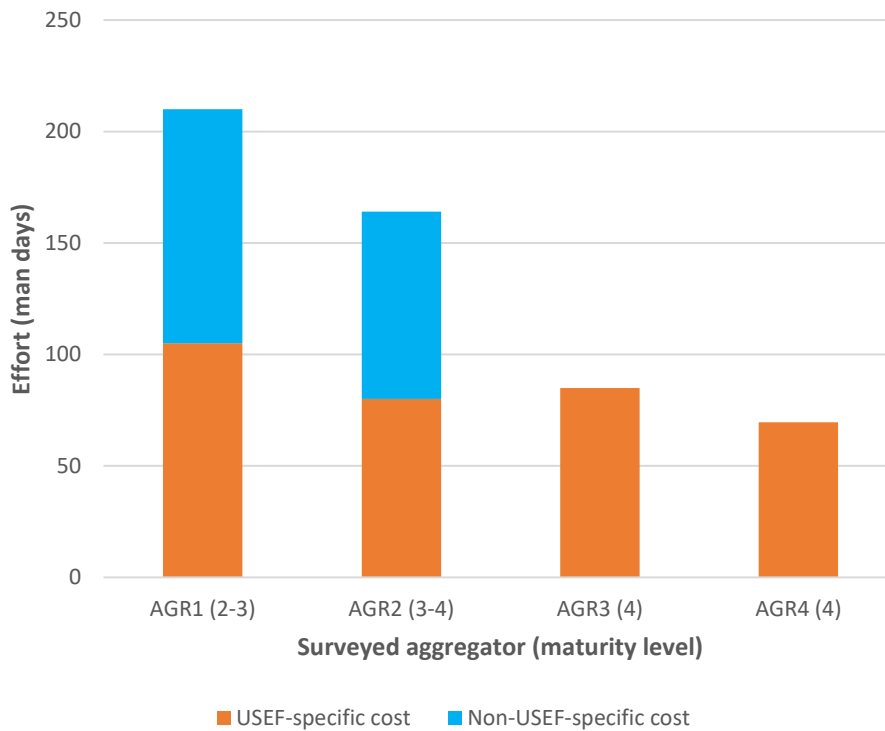


Figure 3 USEF-compliant Aggregators’ median total effort per survey participant AGR1-AGR4 (indicating maturity level in brackets)

Figure 4 has integrated survey figures into Figure 1. Each step has an effort range which is expressed in man-days. Hence, $\Delta USEF$ can be deduced as follows:

$$\Delta USEF = effort([USEF\ communication\ protocol] + [use\ of\ D - Programmes])$$

$$\Delta USEF = [70 - 120] \rightarrow Median\ of\ 95\ man\ days$$

Note that surveyed aggregators at levels 2 and 3 stepped up to level 5 without having implemented or designed a bespoke DSO communication protocol, therefore the cost associated to that element is not represented in the non-USEF-specific effort figures.

¹² Note that the capabilities described under each level only give an indication of the minimum level required to offer flexibility services to DSOs using various mechanisms. An aggregator can decide to further increase the quality level of their capabilities. Those costs are out of scope of this report.

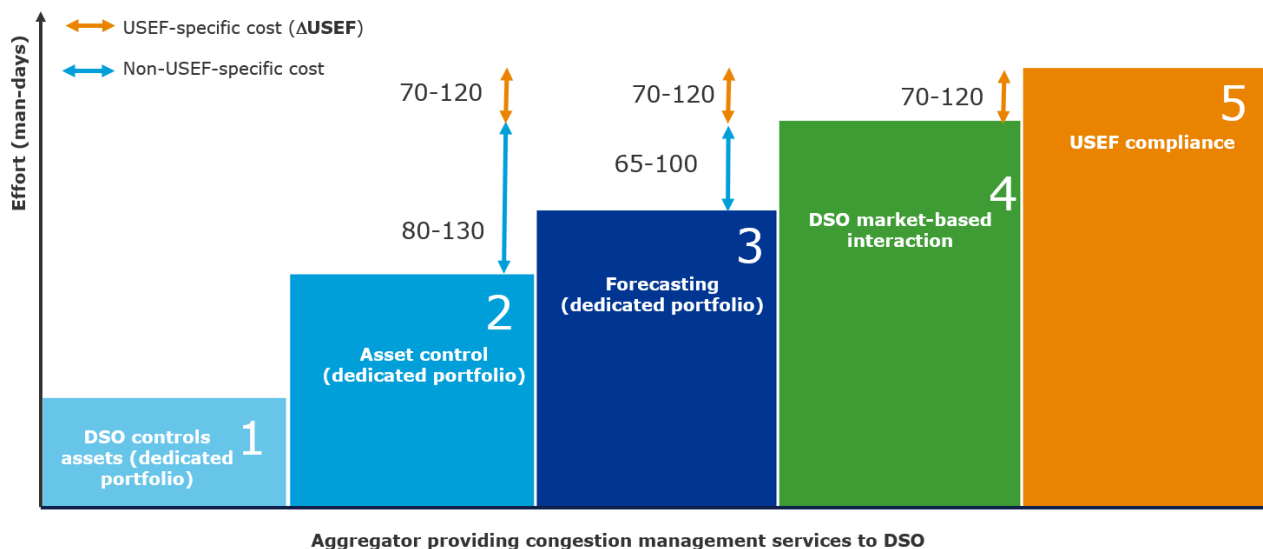


Figure 4 Aggregated effort range associated with increasing maturity level and becoming USEF-compliant

5.2 Tools to reduce cost of USEF participation

As per Figure 2, USEF-compliant aggregators acknowledged the implementation, testing and simulation of the USEF communication protocol as one of the highest costs for becoming USEF compliant. Dutch DSOs, in collaboration with Project FUSION and the USEF Foundation, are developing two tools to reduce USEF implementation costs and ease the implementation process. These tools are listed below:

1. UFTP message library: This tool will consist of the combination of two parts: 1) an open-source Java software library that can be integrated in the aggregator's own software; and 2) A wrapper around this library that offers an Application Program Interface (API) that enables the aggregator (or any other USEF role) to communicate to other USEF roles according to the UFTP messaging scheme. This tool will be open-source and accessible to all aggregators.
2. USEF simulator: This tool intends to simulate the end-to-end DSO-Aggregator message exchange for the different USEF Market Coordination Mechanism phases. There might be a license cost associated to this tool. For the FUSION trial, Project FUSION might partly or fully absorb this cost to support the trial participants.

DNV GL has estimated that the use of these tools during the USEF implementation can reduce the effort of implementing the USEF communication protocol by approximately 30 to 50 man-days. This range is based on the estimate of the tool development effort by Dutch DSOs.

Applying this figure to the estimation deduced in Section 5.1, the resulting USEF implementation cost using the USEF tools, $\Delta USEF_{tools}$, is as follows:

$$\Delta USEF_{tools} = \Delta USEF - effort([tool\ saving]) = [70,120] - [30,50]^{13}$$

$$\Delta USEF_{tools} = [20 - 90] \rightarrow Median\ of\ 55\ man\ days$$

¹³ The intervals are subtracted as follows, 70-50=20; 120-30=90

5.3 USEF benefits

Surveyed USEF-compliant aggregators have also reported the benefits from implementing USEF and participating in DSO products based on the USEF framework. To the question “What are the benefits that you have experienced by implementing USEF?” aggregators answered that USEF:

1. “Saves time by having a protocol that is ready for implementation (for both DSO and Aggregator) and being able to do it simultaneously;”
2. “Saves time by avoiding discussions and negotiations with the DSO on which party should develop communication protocol;”
3. “Is a standard protocol and allows for fast implementation after the first experience;”¹⁴
4. “Gives an extra market position;”
5. “Provides structure;”
6. “Messaging works well and it is useful;”
7. “Helps to think on a more local and aggregated level;”
8. “Helps to build expertise as an independent aggregator;” and
9. “The protocol can be built in a flexible way and components can be reused for other flexibility trading activities.”

The most valuable USEF benefit and the purpose of its development is USEF’s potential to become a European flexibility standard. DNV GL’s analysis highlights that the lack of a standardised communication protocol between flexibility providers and DSOs creates additional market entry costs for aggregators who wish to participate in DSO flexibility trading. Particularly, the cost of implementing a bespoke DSO communication protocol, according to one of the surveyed aggregators, is approximately 60-70 man-days.

In GB, there is no standardised aggregator-DSO communication protocol in place. In this case, an aggregator willing to offer flexibility to all 6 DSOs would need to implement 6 different DSO bespoke protocols. This implementation will add up to an effort that ranges from 360-420 man-days. This cost can be fully or partly avoided by having the same standardised protocol adopted by all aggregators and DSOs across GB.

Although not widely adopted yet, USEF has been implemented in multiple pilots in European countries as well as for business as usual flexibility services by several DSOs. This report has identified USEF as the only open standard in Europe that provides a DSO-aggregator communication protocol as well as market interaction processes for congestion management services. As such, if widely adopted USEF could provide this standardisation for all aggregators and DSOs in GB and aggregators could avoid costs related to bespoke protocols (e.g. 360-420 man-days).¹⁵ Therefore, one of the Project FUSION objectives is to validate that the USEF standard is fit for purpose in the GB market.

¹⁴ In the Netherlands several DSOs have implemented the USEF protocol for their congestion products.

¹⁵ This cost does not include extra security and testing requirements by individual DSOs.

6 SUMMARY AND RECOMMENDATIONS

This report informs GB flexibility providers about the costs for an aggregator to become USEF-compliant, i.e. to comply with those USEF requirements specified as necessary to participate in the FUSION trial.

The first step of the quantification of the market participant costs is to summarise the functional requirements of USEF compliance. Secondly DNV GL categorized aggregator maturity levels as a function of the extent to which the aggregator was able to deliver these functional requirements and others, allowing for the functional elements that are exclusive to USEF to be distinguished from those which are not USEF-specific. At the end of the process, DNV GL developed a survey and asked USEF-compliant aggregators to provide an indication of the effort/cost that they had to invest in order to transition becoming USEF-compliant. The conclusions of the quantification of market participant costs are summarised below:

- **Cost of USEF participation:** the effort invested by the surveyed USEF-compliant aggregators ranged between 70 and 120 man-days for the implementation of 'USEF-specific' elements, i.e. of implementing, testing and simulating the USEF communication and learning how to use D-programmes. Less mature aggregators incurred costs to develop/improve other functionalities, which were not exclusive to USEF, such as forecasting, flexibility pricing, flexibility quantification, etc. The estimated effort to enable these 'non-USEF' functionalities is between 65 and 130 man-days depending on the original maturity level of the aggregator.
- **USEF cost saving tools:** to reduce the effort of USEF implementation, Dutch DSOs in collaboration with Project FUSION are developing two USEF software tools: one will contain a USEF messaging component to aid communication between DSO and aggregator platforms and the other will be a DSO simulation tool through which USEF aggregators can test that their communication processes comply with UFTP. This report anticipates that these tools might reduce the effort of implementation by 30 to 50 man-days; this range is based on the Dutch DSOs estimate of the tool development effort. Without taking into account any potential additional costs associated to the tools, the effort of USEF participation in that case would then be reduced to a range of between 20 and 90 man-days.
- **USEF benefits:** aggregators identified a number of direct benefits that they experienced from implementing USEF. Among others, aggregators highlighted the potential value of standardisation. DNV GL quantified the value of standardisation as the avoided cost of implementing a bespoke DSO communication protocol for congestion management services (60-70 man-days as estimated by one of the surveyed aggregators) compared to the one-off cost of implementing a standard protocol. In GB, there is no standardised aggregator-DSO communication protocol in place. In this case, an aggregator willing to offer flexibility to all 6 DSOs would need to implement 6 different DSO bespoke protocols which will add up to an effort that ranges from 360-420 man-days. This cost can be fully or partly avoided by having the same standardised protocol for aggregators and DSOs across GB. If widely adopted, USEF could provide this standardisation for all aggregators and DSOs in GB and aggregators avoid costs related to bespoke protocols (e.g. 360-420 man-days). Although not widely adopted, DNV GL identifies USEF as the only standard in Europe that provides a DSO-Aggregator communication protocol and market interaction processes for congestion management services. As such, one of the main objectives of Project FUSION is to validate the suitability of the USEF standard for the GB market.

APPENDIX A: GLOSSARY

Aggregator (AGR)	A service provider that contracts, monitors, aggregates, dispatches and remunerates flexible assets at the customer side. (USEF terminology)
Common Reference (or congestion point repository)	USEF defines the Common Reference as a repository which contains information about connections and congestions points in the network.
Common Reference Operator (CRO)	In USEF, the CRO is responsible for operating the Common Reference. The CRO's role is to ensure the publication of both the DSO flexibility requirements and the associated flexibility assets in each congested point as well as the standardisation of this publication for all distribution areas.
Congestion Management	The avoidance of the thermal overload of system components by reducing peak loads. The conventional solution to thermal overload is grid reinforcement (e.g. cables, transformers). Congestion management may defer or even avoid the necessity of grid investments.
Constraint Management Service Provider (CMSP)	A provider of constraint management services to a DSO or the TSO. This is a USEF role and is not currently used in GB. This role takes on specific responsibilities in communicating and coordinating flexibility transactions with the ESO and DSOs, to ensure effective deployment of flexibility as well as effective management of network constraints. Responsibilities also involve ensuring efficient dispatch of flexibility to maintain the safety and reliability of the networks.
D-prognosis	Aggregator forecast of the amount of energy to be consumed or produced at a given congestion point.
D-programmes	Aggregator forecasts of planned activations of flexibility (day-ahead and intraday) to be shared with DSOs in congested distribution network areas.
Distribution System Operator (DSO)	As defined in DIRECTIVE 2009/72/EC: A natural or legal entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.
Flexibility	Ability of an asset or a site to purposely deviate from a planned or normal generation or consumption pattern.
Market Coordination Mechanism (MCM)	The Market Coordination Mechanism in USEF includes all the steps of the flexibility trading process, from contractual arrangements to the settlement of flexibility. USEF splits the flexibility trading process in five phases and describes the interactions between market participants and information exchange requirements in each phase of the MCM.
Prosumer	This role refers to end-users who only consume energy, end-users who both consume and produce energy, as well as end-users that only generate (including on-site storage). (USEF terminology)
Post-fault products	Flexibility products under which the DSO procures, ahead of time, the ability of a Service Provider to deliver an agreed change in output following a network fault.
Settlement Period	The time unit for which imbalance of the balance responsible parties is calculated. In GB is 30 minutes.
Supplier	The role of the Supplier is to source and supply energy to end-users, to manage (hedge) delivery and imbalance risks, and to invoice its customers for energy.
USEF Flexibility Trading Protocol (UFTP)	A protocol that describes the interactions for the exchange of flexibility between Aggregators (or other flexibility service providers) and DSOs.

APPENDIX B: SURVEY QUESTIONS TO USEF AGGREGATORS

Questions			
1. Existing capabilities previous to USEF implementation			
Capability	Complexity		
	Low	Medium	High
<input type="checkbox"/> Flexibility pricing capabilities (L: long term – M: day-ahead – H: intra-day)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Value stacking capabilities (L: long term – M: day-ahead – H: intra-day)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Forecasting capabilities (L: on/off – M: other assets – H: thermal asset)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Flexibility delivery quantification (baseline) capabilities (L: on/off – M: historical – H: rolling baseline)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Portfolio optimisation (L: small homogeneous – M: small heterogeneous – H: large heterogeneous)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Dispatch capabilities (L: manual – M: automated scheduled – H: automated real time)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Monitoring capabilities (L: post-event manual – M: post-event automatic – H: real time)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> DSO communication protocol (bespoke) (L: email/phone call – M: manual – H:(semi)automatic)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Aggregation at congestion point level (L: none – M: static – H: reconfigurable)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Local submetering (optional) (L: none – M: post-event – H: real time)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. What of the following elements did you need to develop/enable to implement USEF? What cost was associated to those?			

Capability	Effort (man days)				
	<10	10 - 50	50-100	100-200	>200
<input type="checkbox"/> USEF communication protocol (UFTP) implementation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Flexibility pricing capabilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Use of D-programmes	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Value stacking capabilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Forecasting capabilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Flexibility delivery quantification (baseline) capabilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Portfolio optimisation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Dispatch capabilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Monitoring capabilities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Aggregation at congestion point level	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Local submetering (optional)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3. What are the benefits that you have experienced by implementing USEF?

Click here to enter text.

4. How can the cost of USEF implementation be brought down?

Click here to enter text.