Power Potential
(Transmission & Distribution Interface 2.0)

DER Aggregator Interface to DERMS - Feasibility Study

April 2020

Contents

Definitions, Acronyms and Abbreviations

Term	Definition
ADR	Automated Demand Response
API	Application Programming Interface
CIM	Common Information Model: This is an IEC standard which allows application software to exchange information about an electrical network.
DER	Distributed Energy Resource
DERMS	Distributed Energy Resources Management System: This is the centralised software-based control system within UK Power Networks that dispatches energy resources to provide active and reactive power services to National Grid Electricity System Operator as part of the Power Potential project.
GSP	Grid Supply Point
HTTP	Hyper Transfer Text Protocol
ICCP	Inter Control Centre Protocol
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
IS	Information System
LAN	Local Area Network
MPAN	Meter Point Administration Number
NGESO	National Grid Electricity System Operator
PowerOn	The end-to-end system that UK Power Networks is using at control centre level to manage its distribution network.
REST	Representational State Transfer
RTU	Remote Terminal Unit
TFA	Two-Factor Authentication
TLS	Transport Layer Security
TOGAF	The Open Group Architecture Framework
SCADA	Supervisory Control And Data Acquisition

UI	User Interface
USEF	Universal Smart Energy Framework
VPN	Virtual Private Network
WAN	Wide Area Network

List of referenced documents

NO.	Document Title	Document Reference
1	DER Technical Characteristics Submission Spreadsheet and Associated Guidance Document	https://www.nationalgrideso.com/document/106416/download
2	DER Technical Requirements	https://www.nationalgrideso.com/document/114901/download
3	IEEE Adoption of Smart Energy Profile 2.0 Application Protocol Standard	https://ieeexplore.ieee.org/document/6552205
4	Common Smart Inverter Profile: IEEE 2030.5 Implementation Guide for Smart Inverters	https://sunspec.org/wp-content/uploads/2018/03/CSIPImplementationGuidev2.003-02-2018-1.pdf
5	Recommendations for Utility Communications with Distributed Energy Resources (DER) Systems with Smart Inverters- Smart Inverter Working Group Phase 2 Recommendations by CPUC	https://ww2.energy.ca.gov/electricity_analysis/rule21/documents/SIWG_Phase_2_Communications_Recommendations_for_CPUC.pdf
6	ZIV Automation UK Limited - DERMS Aggregator Integration - Discussion	Project Internal Document
7	OpenADR 2.0 Profile Specification B Profile	https://cimug.ucaiug.org/Projects/CIM-OpenADR/Shared%20Documents/Source%20Documents/OpenADR%20Alliance/OpenADR_2_0b_Profile_Specification_v1.0.pdf
8	OpenADR 2.0 Demand Response Program Implementation Guide	https://www.openadr.org/assets/openadr_drprogramguide_v1.0.pdf
9	USEF Position Paper-The Independent Aggregator	https://www.usef.energy/app/uploads/2016/12/USEF_IndependentAggregator.pdf
10	USEF: Work Stream on Aggregator Implementation Models	https://www.usef.energy/app/uploads/2017/09/Recommended-practices-for-DR-market-design-2.pdf
11	USEF: The Framework Specifications 2015	https://www.usef.energy/app/uploads/2016/12/USEF_TheFrameworkSpecifications_4nov15.pdf
12	IEEE Adoption of Smart Energy Profile 2.0 Application Protocol Standard	https://ieeexplore.ieee.org/document/6552205
13	Common Smart Inverter Profile: IEEE 2030.5 Implementation Guide for Smart Inverters	https://www.pge.com/includes/docs/pdfs/shared/customerservice/nonpgeutility/electrictransmission/handbook/rule21-implementation-guide.pdf
14	Recommendations for Utility Communications with Distributed Energy Resources (DER) Systems with Smart Inverters- Smart Inverter Working Group Phase 2 Recommendations by CPUC	https://ww2.energy.ca.gov/electricity_analysis/rule21/documents/SIWG_Phase_2_Communications_Recommendations_for_CPUC.pdf

1. Introduction

1.1 Purpose and Scope

This document presents the outcome of the feasibility study conducted by UK Power Networks to develop a Distributed Energy Resources (DER) aggregator interface for managing the dispatch of active (MW) and reactive power (Mvar) services to National Grid (NGESO) as part of the Power Potential project.

For the Power Potential 2020 trial, the implementation of the aggregator interface is not in the scope. In the trial, all participating DER communicate in real time via a direct physical connection with an upgraded UK Power Networks Remote Terminal Unit (RTU) at site. However there is clear stakeholder interest in developing an aggregator interface, and furthermore, scoping interaction with aggregators is a learning objective from the original project bid.

This document informs the project team and the industry on the design considerations and implementation options in the future for UK Power Networks as Distribution Network Operator to interface with DER aggregators to deliver the Power Potential services. This is not a design document or position paper but is a research and learning report from the project, to inform potential future implementation of an aggregator interface after the project.

This document covers requirements associated with the interface for exchanging real time data between the DER aggregators and UK Power Networks, as well as non-real time data exchange such as commercial availability, technical DER capability, etc. There is a separate web portal developed as part of the project to enable DERs and future aggregators to exchange their bids and provide their availabilities. The details on this web portal interface is covered in the relevant project documents and as such, they are not covered in this report.

Through this interface one or more DER aggregators would be capable of interfacing with UK Power Networks and dispatch services to alleviate transmission network constraints. .

1.2 Project Background

The Power Potential project (previously referred to as the Transmission and Distribution Interface 2.0 project) is a joint project between National Grid Electricity System Operator (NGESO) and UK Power Networks to explore an innovative solution to technical constraints experienced at the transmission level.

The project is focused in the South East area of England and there are four existing Grid Supply Points (GSP) in scope for the project: Bolney, Ninfield, Sellindge and Canterbury North. The transmission network, and the areas within the distribution network at this location are at the limit of capacity for transferring generation away from the area. This means for particular faults or conditions on the transmission network, voltage levels at certain points could reach values that can violate statutory voltage limits. This constraint is preventing additional generation from being able to connect to the South East transmission or distribution networks. To enable more generation to connect, large-scale network investment is traditionally required. The Power Potential project aims to help manage transmission constraints by providing power services to the NGESO from DER connected to UK Power Networks' distribution network. This will ultimately facilitate faster and cheaper alternative DER connections and will reduce the operating costs currently being incurred in managing the existing limitations in this area.

- The project aims to create a regional dynamic reactive power market for the first time in the world which will help defer network reinforcement needs in the transmission system. DER can also bid for active power services in the Power Potential project. The project has the following key deliverables:
- A commercial framework using market forces to create new services provided from DER to National Grid ESO via UK Power Networks.

A technical and market solution known as DERMS to support technical and commercial optimisation and dispatch. It includes gathering bids from DER and presenting an optimised view of the services to NGESO split by GSP. The DERMS has been installed and integrated with UK Power Networks' control room.

Figure 1 shows the high-level system architecture and interfaces to DER, both at the station level and via aggregators at the market and enterprise level (based on Smart Grid Architecture Model). The detailed technical requirements for DERs to participate in the Power Potential project - including both functional and non-functional requirements - are specified in the "DER Technical Requirements" document. The DER interface at the station level consists of a hard-wired Local Area Network (LAN) connection between UK Power Networks and DER equipment owned by the customer and installed at the customer's substation. The aggregator interface at the market and enterprise level consists of a secure enterprise connection between the aggregator and the UK Power Networks Wide Area Network (WAN). This path of DER interface is selected by customers who choose to provide active and reactive power services through an aggregated set of DERs.

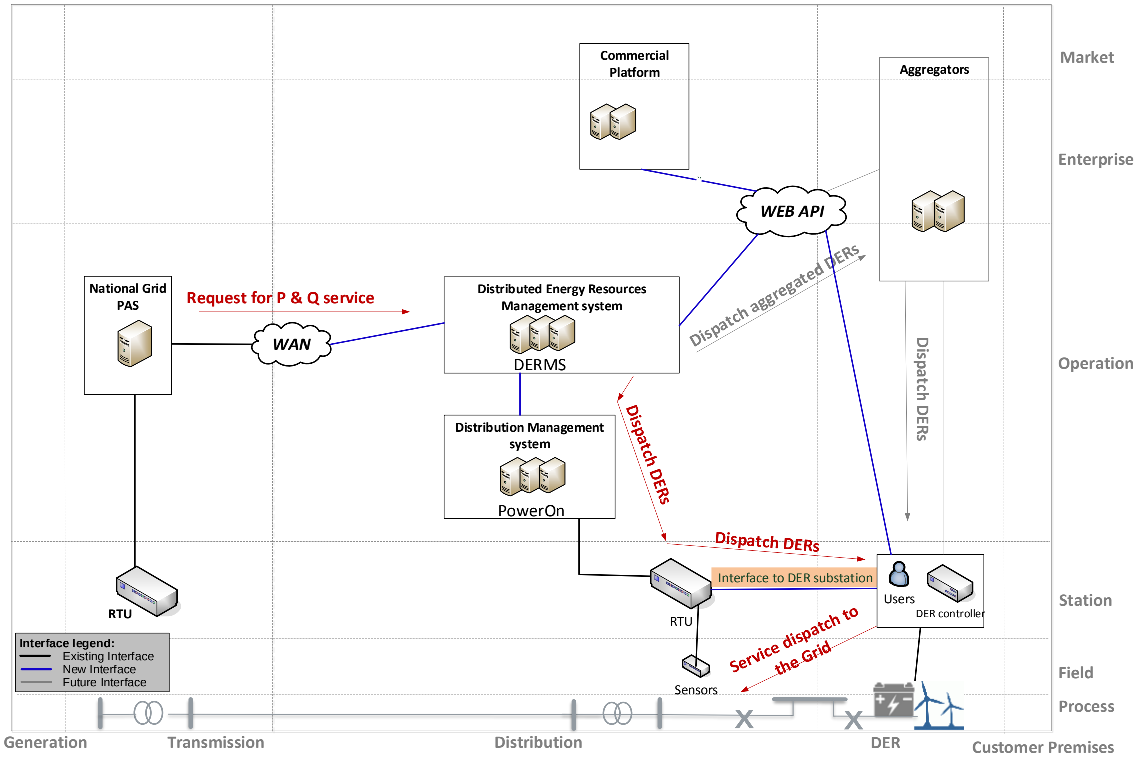


Figure 1: High-level system architecture

2. Summary of Findings

As part of the Power Potential project, UK Power Networks explored the methods of interfacing with the potential DER aggregators who might provide services. To facilitate this, UK Power Networks carried out research on developing a technology interface to support real time data exchanges with DER aggregators. The guiding principle and the key objective is to establish a flexible design, resulting in an aggregator interface gateway that is flexible and scalable to interface to one or more UK Power Networks DERMS and one or more DER aggregators.

It is a standard practice for UK Power Networks to implement industry standard solutions where possible. This approach is followed during the solution exploration for various industry standards including Institute of Electrical and Electronics Engineers (IEEE) 2030.5, Universal Smart Energy Framework (USEF) and Open Automated Demand Response (ADR) 2.0.

Findings from this research suggested that all the three standards have relevant coverage for aggregator interface but IEEE 2030.5, also referred to as Smart Energy Profile 2.0, is the most suitable standard to be adopted for Power Potential services.

UK Power Networks carried out research across the aggregator market investigating existing and developing standards for aggregator interfaces. The summary approach followed included:

- Feasibility study of multiple industry initiatives and standards
- Design approach
- Implementation considerations

2.1 Summary of Feasibility Study

A feasibility study was carried out by UK Power Networks to research the available industry standards for aggregator interfaces, make comparisons between these and identify the most appropriate method for the Power Potential project. The output of the feasibility study provided UK Power Networks with a good understanding of standards currently available in the industry with information on which vendors currently adopt these and where the standards have been executed within a proof of concept or production capacity.

Table 1 shows the findings of a desktop study with a comparison among some relevant industry standards that were investigated along with measures for comparison. During the feasibility study it was noted that a variety of aggregator interface providers adopted proprietary web based interface in agreement with utilities and DER providers. These are not shown in the table below.

Table 1. Comparison between aggregator interface options

Measures	Open ADR2.0	USEF	IEEE 2030.5
Application	Demand response	End to End flexibility services	End to End flexibility services
Price Communications	Yes (Ahead/Real time)	No	Yes (Ahead/Real time)
Metering	Yes	Yes	Yes
Demand Response / Load Control	Yes	Yes	Yes
DER Aggregation (Generation / Storage)	Yes	Yes	Yes
Open Source	Yes	No	Yes

Measures	Open ADR2.0	USEF	IEEE 2030.5
Ease of Implementation	Yes	Yes	Yes
Scalability	Yes	Yes	Yes
Industry standard	Yes	Yes	Yes

In assessing the suitability among the options listed in Table 1, IEEE 2030.5:2018 (release 2018) was found to give additional benefit with its coverage for the end to end flexibility services.

IEEE 2030.5 is an IEEE standard sponsored by the IEEE Communications Society and is managed by the SEP2.0 – Smart Energy Profile 2.0 Working Group. IEEE 2030.5 can be implemented by UK Power Networks to serve as an aggregator gateway to support both a client and a server architecture. With this approach the DERMS provider contracted by UK Power Networks can implement IEEE 2030.5 as standard for the DERMS application and will act as the client. The aggregator can adopt a server/client role depending on the services required by UK Power Networks. This is subject to detailed design.

A vital strength of IEEE 2030.5 is that the standard utilises elements from existing standards, including IEC 61968 and IEC 61850. It supports a RESTful architecture using Internet Engineering Task Force (IETF) protocols such as Hypertext Transfer Protocol (HTTP). This is an additional benefit for the DERMS adopted by Power Potential as it is already uses REST in its web services.

The feasibility study summary carried out by UK Power Networks included:

- Investigating suitability of relevant industry standards and assessing their pros/cons.
- Identifying three relevant industry standards and making comparisons - Open ADR 2.0, USEF and IEEE 2030.5.
- Identifying IEEE 2030.5, as the most suitable for Power Potential, and potentially for future UK Power Networks use cases.

Based on the above feasibility study, this report primarily focuses on one case study by selecting one industry standard IEEE 2030.5 to investigate the method of designing and implementing the aggregator interface. It is expected that there will be some common steps irrespective of the standards adopted.

2.2 Summary of Design Approach

Figure 2 presents the possible design approach envisaged by UK Power Networks, which supports DERMS to interface indirectly with DERs through multiple DER aggregators' interfaces using the IEEE 2030.5. It is expected that all of the communication data between the web API (Aggregator gateway) and the DER aggregator/DERMS would be based on the Internet Protocol (IP) and use RESTful HTTP standard as per IEEE 2030.5. In terms of security, the aggregators are classified as External and 3rd Party. The IEEE 2030.5 protocol supports Transport Layer Security (TLS 1.2) which is HTTPS. This would be used in conjunction with Virtual Private Network (VPN) and Two-Factor Authentication (TFA) to adhere to the UK Power Networks security model.

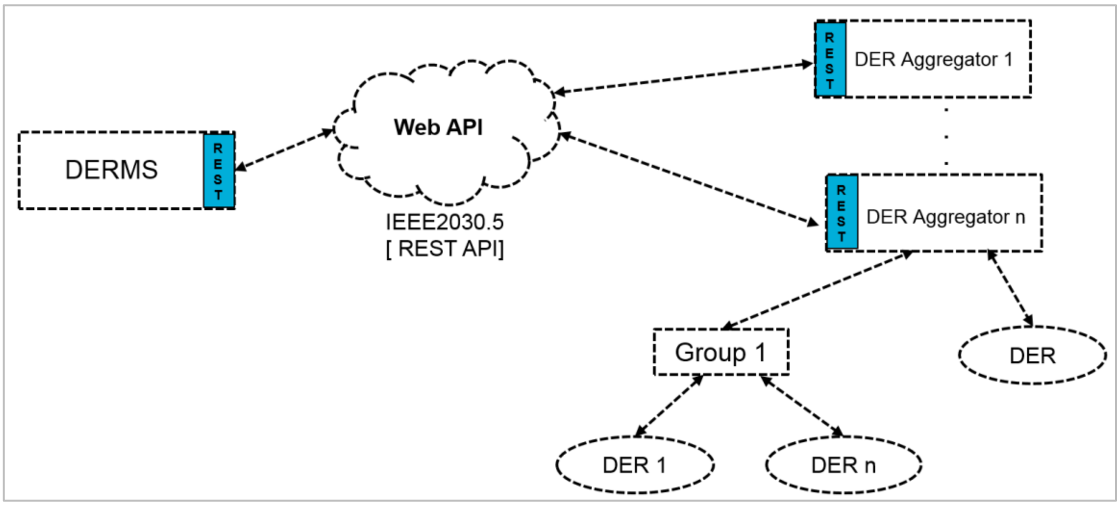


Figure 2: Possible DER aggregator Interface through web API

In order to facilitate a secure connection to the production UK Power Networks aggregator gateway, all interfaces are required to be configured through the cloud environment where UK Power Networks Information Security (IS) security polices and standards shall be adopted.

The design considerations included:

- Consultation with NGESO, the DERMS provider (ZIV Automation) and potential DER aggregators.
- ZIV Automation's agreement on the suitability and deliverability of the interface using the IEEE 2030.5 standard (as an additional benefit, DERMS already uses REST).
- ZIV Automation provided initial aggregator interface design and implementation approach.

2.3 Summary of Implementation Considerations

At the last stage of the process, the feasibility of implementing the DER aggregator interface for Power Potential services was assessed.

In summary this included:

- Investigating the scope, effort, timescale and costs associated with implementation of an aggregator gateway interface in UK Power Networks.
- Assessing the risks involved in terms of uncertainty in overall cost and timescale.
- Assessing the risks involved in terms of the impact on the core design implementation timescale (dependency on the same project resources).
- Ease of implementation and support, efforts, timescale and costs for DER aggregators.

3. Design Consideration

The document herein summarises the feasibility study of implementing the DER aggregator interface as a guidance to design the aggregator interface rather than the detailed requirements.

This section provides the key consideration required in implementing the aggregator interface on both UK Power Networks and aggregator sides. The detailed requirements related to either real-time aspect (i.e., real-time data, detailed dispatch instruction, communication delays and. response time) or non-real time aspect (i.e. settlement and locational/modelling the aggregated DERs), need to be investigated and defined in collaboration with aggregators at the design stage. However, it is expected that the technical as well as commercial requirements to be in line and harmonised with those requirements already defined for individual DERs connected through UK Power Networks' RTU route thereby providing a level-playing field for both aggregators and individual DERs.

3.1 Utility Aggregator Interface considerations

The following points have been identified as the key considerations required in developing the Power Potential aggregator interface.

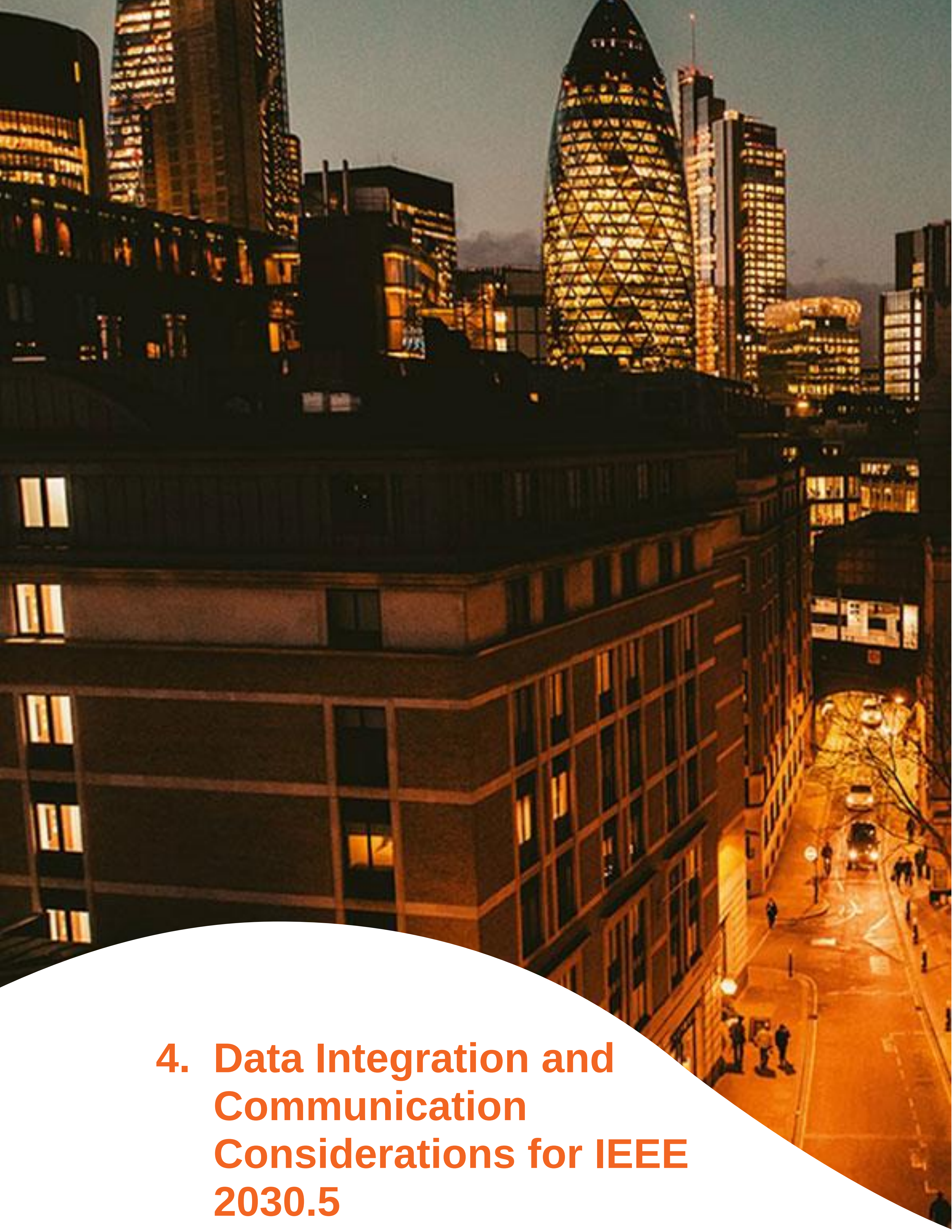
- Integration of DER aggregators into the DERMS architecture must be done in a way that does not disrupt the automatic updating of the network models. Data integration must be done at the database level.
- Issues such as scalability and maintainability must be addressed considering that the interface may need to support high number of market participants or DERs.
- Where possible the aggregators should be able to maintain their own commercial processes privately with aggregated DER resources and manage the recruitment with minimal interaction/overhead on DERMS through some form of self-service capability. To achieve this, participants should be able to support discovery and where possible self-describe.
- Aggregators may control resources of very different capacities, so it is necessary to assume that they need to be modelled as part of the load flow analysis.
- The integration of aggregators into the architecture should be done in a way that preserves the data-driven self-deploying behaviour of the overall system and not introduce manual steps into the process.
- DERMS should indicate possible service range at each of the aggregated DER which cannot be breached. Therefore, the associated operational limits can be imposed to each aggregated DER via an aggregator. This is a similar approach to individual DERs that are connected directly to DERMS but in an indirect way via the aggregator.
- A generic profile requirement can be created through a web interface portal for aggregators so that they can submit their bids and aggregated DERs' information. The access to the web interface could be similar to the current DERMS web interface with individual DER or could be separate. This can be a collaborative approach with aggregators, based on clear functionality definition to identify which parts of protocol to be used.

3.2 DER Aggregator Interface Considerations

The following assumptions have been made with regard to the role of an aggregator during the consideration of their integration into the UK Power Networks architecture.

- Aggregators manage a portfolio of aggregated DERs of mixed technologies (Generation / Storage) and be capable of providing a variety of services to DERMS. It is expected that the DERMS shall group these DERs such that the appropriate services can be requested. In doing so, the DERMS use inherited industry standard to monitor the service provision from each aggregated DER or an aggregator.
- Aggregators are managed in the same way other non-aggregated market participants are in terms of market rules.

- Aggregators manage all commercial transactions with their aggregated DERs and commercial arrangements are not exposed to DERMS.
- Aggregators perform all dispatching operations with their aggregated DERs directly. This may introduce an impact to the overall service response hence the detailed consideration to overall time response requirements on the aggregator interface should be defined in the design stage.
- Aggregators perform their own settlement process with their aggregated DERs.
- Each aggregated DER is assigned to one GSP and bids should be separate for each specific GSP. This information also needs to be passed to DERMS. Therefore, DER aggregators should have a visibility of the GSP market associated to each of their aggregated DERs.



4. Data Integration and Communication Considerations for IEEE 2030.5

Due to the locational nature of the reactive power service, aggregators would be expected to indicate the electrical location of their asset portfolio e.g. by Meter Point Administration Number (MPAN). Self-description of the aggregator portfolio would need to be as simple as possible. All DERs are expected to be modelled in the Common Information Model (CIM) model of the UK Power Networks electrical network.

A number of options are available depending on the capabilities of the aggregators themselves and their ability to provide data integration services.

All aggregated DERs should be modelled individually as 'normal' DERs within the load flow engine, therefore, they must be defined within the CIM model. This can be achieved in two ways which are explained in the following:

- ***IEEE 2030.5 Self-Description***

The IEEE 2030.5 Protocol supports discovery and self-description. The Self Device Discovery Service permits an aggregated DER to describe itself to DERMS and be automatically added to the CIM database and includes MPAN information. This could be carried out in two ways; either direct self-description using the Self Device service or via a register maintained by the aggregator using the End Device Service.

This depends on the specific communications architecture of the aggregators themselves. Using self-discovery / self-description the CIM database is updated with all aggregated DERs detected.

This can then be used to auto-deploy web User Interfaces (UI) and the configuration for additional data communicating with UK Power Networks' management system.

- ***Web User Interfaces***

Where aggregated DERs cannot fully self-describe, then a web-based mechanism such as that has been developed for DERs to participate in the Power Potential trials, must be used. These web UIs should ideally auto-deploy based on the updated CIM database.

4.1 Data Modelling

The voltage level of all aggregated DERs determines the extent to which DERMS can calculate safe operating ranges. If aggregated DERs are installed at 11kV, they may be lumped together and modelled at a higher voltage level as a single controllable DER.

This allows groups of aggregated DERs to be restricted by specific network constraints at higher voltages. Therefore, the available generation from an aggregator can be optimised for the provision of services by effectively applying operating range constraints on individual or groups of aggregated DERs.

This needs to be an automated process to allow different aggregated DER portfolios to change without significant re-engineering. Imposing restrictions on aggregators would limit their ability to recruit additional participants.

4.2 Aggregator CIM Modelling Issues

The CIM Model needs to be extended to support identifying DERs as individual DERs or as part of an aggregator's portfolio.

The schema also needs to be extended to include an assignment of an aggregated DER to a specific aggregator. This requires that the schema include a definition of the aggregators themselves to support:

- Settlement
- Real-time Communications
- Security

- Services Provided
- MPAN

4.3 Real-Time Data Integration with the Aggregator

Figure 3 presents a high-level real-time data communication of the UK Power Networks architecture which includes the aggregator interface. The diagram shows UK Power Network interfaces between the DERMS and the UK Power Networks Supervisory Control And Data Acquisition (SCADA) system, PowerOn using IEC 60870-6/TASE.2 - Inter-Control Centre Communications Protocol (ICCP). All interfaces between UK Power Networks and the DER currently integrated with substations uses the DNP3.0 protocol: IEEE Std 1815. For the aggregator interface, UK Power Networks will potentially need to develop an aggregator's gateway which then interfaces DERMS with the DER aggregators. The internal UKPN architecture is out of scope for this document as such, they are represented at high level.

In order to preserve the data driven architecture of the DERMS, DERMS should assign all DERs to the ICCP Interface and build the data maps automatically, and assign the aggregated DERs to the IEEE 2030.5 Interface. This will happen based on the updated CIM database configuration.

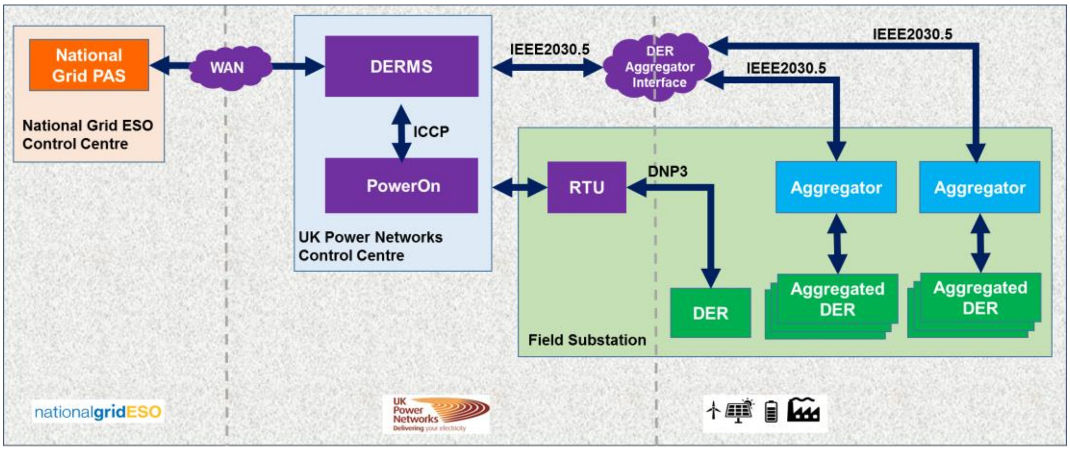


Figure 3: Real-Time data communication interfaces between aggregators and UK Power Networks

4.4 Communications Architecture

IEEE 2030.5 allows two possible options for the communication with the aggregators' interface depending on the capabilities of the aggregator - which are either direct or indirect communications. This depends on aggregators' internal communications architecture and can be driven by existing legacy protocols. These options are depicted in Figure 4 and summarised below.

4.4.1 Indirect Communications

In this model, the aggregated DERs communicate with the aggregator and are dispatched by the aggregator. The aggregated DERs may communicate with the aggregator with any protocol including IEEE 2030.5. The aggregator consolidates the data and presents the data to DERMS in the 2030.5 format. It is expected that the aggregator models each of its aggregated DERs as logical 2030.5 servers. DERMS transmits acceptable operating ranges for all aggregated DERs to the aggregator, and the aggregator declares availability based on this, for different services. From a functional point of view, the aggregator performs all dispatching against its own commercial rules which are not known to DERMS.

4.4.2 Direct Communications

In this model the aggregated DERs communicate with both the aggregator and DERMS. This presumes that the aggregated DERs are capable of supporting multiple clients. The aggregator performs direct dispatch and manages commercial processes, where the FEP transmits operating ranges and functions such as self-discovery, etc.

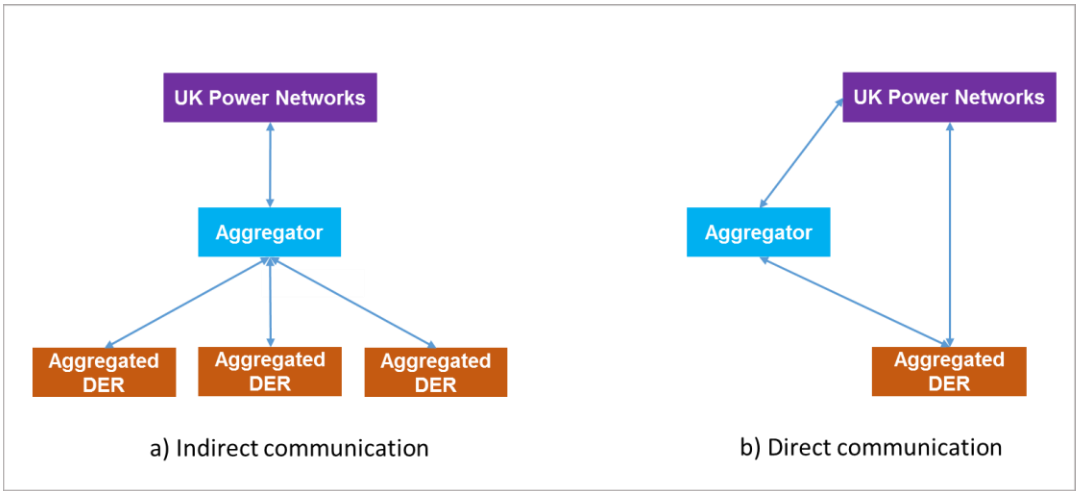


Figure 4: Options for communications with the aggregated DERs; a) Indirect, b) Direct

4.5 DER Resource Modelling Approach

Representing and modelling of the resources within the DERMS application is also an important consideration. Certain rules need to be defined to ensure consistent and standard representation and correct utilisation of the aggregated assets.

Figure 5 shows an example of modelling the aggregation nodes the aggregated DERs where the scoped zone of the distribution network consists of two GSP nodes, Node 1 for the **GSP1** segment, and Node 2 for the **GSP 2** segment.

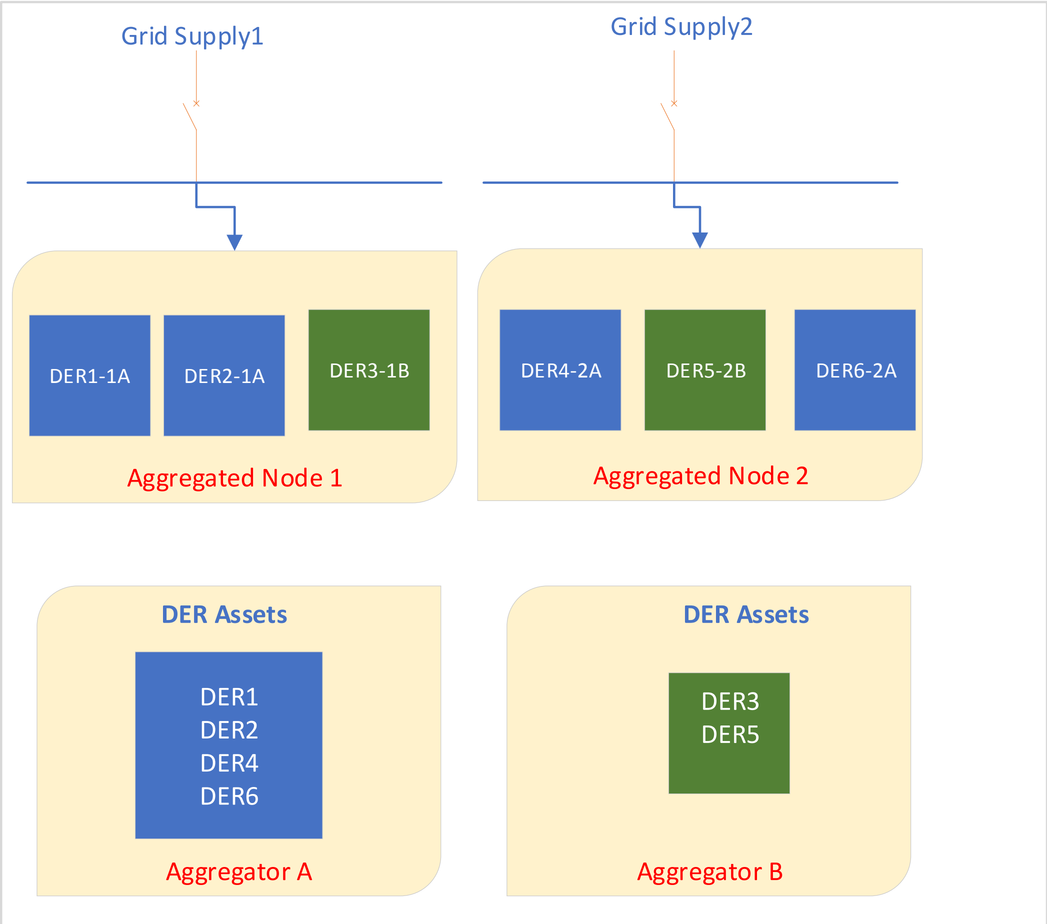


Figure 5. Aggregation nodes and aggregated DERs

Note that no node intersects partially with another node. But if needed, Node 3 can be formed that encompasses Node 1 and Node 2. There are four DERs; DER1, DER2, DER4 and DER6 that are operated by Aggregator A and DER3 and DER5 that are operated by Aggregator B. Following additional rules may be applied:

- Each aggregated DER is operated by one and only one aggregator.
- Each aggregated DER contains the same type of physical DERs e.g. wind and PV at one site would be considered as two aggregated DER, not one aggregated DER.
- Each physical DER belongs to one and only one aggregated DER, and
- An aggregated DER can be contained in one or more nodes but no aggregated DER is partially contained in any node.
- Each aggregated DER is modelled as a generation unit in the DERMS and assigned to an IEEE 2030.5 EndDevice object for the UK Power Networks aggregator interface's purposes.

5. Use Cases for Aggregator Interfaces

Aggregators may be required to implement their interfaces to support many use cases but for the purpose of this report, the following five use cases are discussed.

It should be noted that aggregators can exchange their bids and provide their availabilities through the DERMS web interface in a similar approach to the individual DERs.

5.1 Aggregation / Grouping of DER Assets

UK Power Networks may require location based aggregation/grouping of DERs in the electrical network, providing dispatch/service to areas where conditions/constraints are affected. This is particularly useful if the available DER assets of the aggregator are of smaller capacity (less than 50 kW) than what is potentially required by DERMS at any given time. Such small assets are out of the scope of the current Power Potential trial, but this feasibility study looks forward to expanding the scope of participating DER. In order to aggregate and group DER assets, there are several pre-conditions and recommendations that need to be considered.

5.2 Aggregator Day-Ahead Service Availability Reporting

UK Power Networks may require from the aggregator, the capability to report aggregated DER service availability, on a day-ahead basis. The pre-condition is that the aggregation nodes have been pre-defined by DERMS and uploaded to the aggregator. At a minimum this functionality is used to display the day-ahead MW and Mvar availabilities as provided by the aggregator. This functionality also forms the minimum situational awareness of aggregator's available services to UK Power Networks. Any hourly (or other periodic) updates to available service would modify the base display created by this data. This data is used in post-processing to correlate projected (but aggregator self-reported) service against actual (aggregator-reported) service. This functionality may be provided through a web user interface as per the Power Potential project which enables aggregators to provide their availability through the DERMS web interface.

5.3 Aggregator End Device Asset Data Reporting

This use case describes the functionality of the aggregator's system providing asset-level performance data on a periodic basis. This aggregator use case is successful when the aggregator sends asset-level data, at least once daily, to DERMS. This information may also be used for internal audit compliance reporting within UK Power Networks. A pre-condition for this use case is that the aggregated DERs that have been pre-defined are configured in both DERMS and the aggregators' systems.

5.4 DER Controls and Ad-hoc Dispatches for Service Provision

This aggregator use case allows DERMS to set all the controllable DERs underlying a pre-defined aggregated DER to a pre-defined control mode or call an ad-hoc event to dispatch the required services of an aggregated DER. Pre-conditions to this use case are:

- Aggregated DERs have been pre-defined by DERMS and uploaded to the aggregator and the aggregator has capability to place the DERs in Voltage, power factor or other modes as required by UK Power Networks.
- Additionally, the aggregator may configure smart inverter assets in modes INV1, INV2, and INV3 as defined in the IEC 61850-90-7 standard or follow an ad-hoc service dispatch schedule.

This aggregator use case is successful when UK Power Networks is able to place an aggregated DER in a desired mode.

5.5 Intra-Day Cancellation of Dispatch Events

Real-time and ad-hoc reliability events (e.g. due to weather condition or DER local controller fault) can cause forward-projected service at a specific aggregated DER to change due to use of assets prior to their scheduled time. Consequently, a pending dispatch instruction must able to be cancelled so that it does not occur. The pre-conditions are that the aggregated DERs have been pre-defined by DERMS and uploaded to the aggregator and dispatch instructions have been made to the affected aggregator. This aggregator use case is successful when DERMS successfully sends a cancellation of a pending dispatch instruction and the aggregator successfully cancels a pending event at the affected aggregated DER. This means that the aggregator will not send any service request to its associated DERs and the aggregated DERs remain at their current mode of operation.

5 Implementation Approach to Deliver a DER Aggregator Interface

6.1 Requirements

In the requirements phase, the detailed requirements will be captured. These requirements feed in to the design phase where UK Power Networks and aggregators in a collaborative approach can agree a detailed design document which includes the functional and non-functional design entities and artefacts.

6.2 Design and Development

This phase will produce the detailed design documents on the development and implementation of the use case where UK Power Networks and aggregators can agree and develop the appropriate web services and Application Programming Interfaces (APIs) to deliver the design. As part of the requirements gathering, UK Power Networks will evaluate infrastructure needs to support the interfaces between DERMS and aggregators. This might include setting up secure web interfaces, file exchange services or maybe developing an Enterprise Service Bus / API Gateway as deemed necessary. UK Power Networks together in close collaboration with aggregators will establish the most suitable solution options in line with the UK Power Networks' Enterprise strategy, standards and policies.

6.3 Infrastructure readiness

UK Power Networks standards are in line with The Open Group Architecture Framework (TOGAF) frameworks for deploying IS infrastructure. As part of the requirements and design outcomes, UK Power Networks can plan on installing and deploying the needed infrastructure for the solution. Environments for testing and production need to be made ready in this phase. The system integrator will work with UK Power Networks to establish this infrastructure. Any additional infrastructure that is required for communication between aggregators and UK Power Networks will be provided through the UK Power Networks' usual system design and delivery process.

6.4 Proof of Concept and Test Planning

In this phase, UK Power Networks will present the details of various scenarios for testing and what success looks like. Different test cases for both functional and IT interfaces need to be detailed in this phase. The scenarios need to be carefully planned and the aggregators and UK Power Networks should be consulted so that the various business functions that need to be tested can be supported.

UK Power Networks, Energy House, Carrier Business Park
Hazelwick Ave,Three Bridges, Crawley, West Sussex, RH10 1EX

www.ukpowernetworks.co.uk

National Grid ESO, Faraday House, Warwick Technology Park,
Gallows Hill, Warwick, CV34 6DA

nationalgrideso.com