REPORT

International review of open communication/standards or protocols for flexibility management

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Final Approval

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Executive Summary

Why do we need communication standards for flexibility services?

As the New Zealand economy transitions to a decarbonised future, the way energy is generated and used is changing with an increase in distributed generation and electrification of energy demand. To support the energy transition, significant changes are necessary for the way the electricity distribution network is developed and managed.

Distributed energy resources (DERs) such as solar photovoltaic (PV), battery storages and electric vehicles (EVs) are being added to the electricity network at a rapid rate. Majority of the DERs are owned by the consumers, hence they are also called consumer energy resources (CERs). CERs' penetration is increasing in NZ incrementally and will require inefficient network upgrades if not managed in a coordinated manner. The main driver behind these resources is to replace fossil fuels with low carbon technologies and achieve a lower cost of energy to the consumers.

It goes without saying that the inherent flexibility in the DER/CER can support networks by enabling them to manage constraints through the utilisation of non-network solutions and allowing enhanced access to electricity markets. However, the large number of distributed resources will require integration, coordination and orchestration to achieve the optimum benefits and avoid unintended consequences. The literature search conducted for this study has revealed that the flexibility market is progressing to some level of maturity across the globe. Electricity distribution businesses (EDBs) in NZ have an opportunity to help support the local flexibility market and remove barriers to achieve a low-cost and low-carbon future for the customers.

Aggregators or flexibility service providers (FSP) must communicate with consumers, networks, markets. They must deal with a variety of devices/proprietary software to gain visibility and dispatch services. It is noted from the study of various markets that open communication standards/protocols are one of the key enablers of flexibility, i.e. to exchange network information, pricing signals, and control signals. International open access standards can help boost market participation, cost efficiency, ease-of-access, and allow for faster and more seamless connection and exchange of data.

Some level of interoperability is necessary to enable cost-effective integration and dispatch of DERs by establishing a common language between all the players/actors, as well as common control commands for devices, e.g., different brands of EV chargers.

In order to make the flexibility services available to all and achieve a level of interoperability in control and switching, greater levels of standardisation (preferably through open access protocols) is essential. This also helps fulfil distribution system operator (DSO)[1] functions efficiently. Absence of open protocols and standards will result in a huge cost to develop private or limited access digital infrastructure by all networks, market operators and aggregators. However, the caveat here is to choose the timings to balance the level of standardisation in order to facilitate innovation, develop an understanding of local requirements, and achieve a competitive supply chain to keep the costs down.

What is FlexTalk?

The Electricity Engineers' Association (EEA) of Aotearoa (New Zealand) in partnership with industry and the Energy Efficiency and Conservation Authority (EECA) is already undertaking the Demand Flexibility Common Communication Protocols Project 'FlexTalk' - https://www.eea.co.nz/Site/asset-management/adr-project/about-adr-project.aspx - an industry initiative that applies the communication protocol to achieve interoperability between EDBs and flexibility suppliers (aggregators).

[1] DSO is an impartial market facilitator ensuring timely and cost-effective dispatch ensuring customer benefits, data privacy and security.

The FlexTalk project is evaluating the processes that need to be in place to apply the OpenADR 2.0 (2.0a and/or 2.0b) communication protocol to achieve active managed charging[2] of EVs, thus enabling flexibility services to be utilised in the electricity sector in New Zealand. This will enable consumers to participate in providing flexibility services and will also put them at the centre of Aotearoa's future electricity system.

Although the FlexTalk project is currently implementing OpenADR 2.0a and 2.0b, it is noted that OpenADR 3.0 has also been launched recently to help manage the DERs, i.e., device and equipment manufacturers should be able to add new functionality more easily into customer products, including smart thermostats, EV charging stations, energy storage and control systems. OpenADR 3.0 is intended to complement rather than replace OpenADR 2.0. In addition to the functionality of OpenADR 2.0, OpenADR 3.0 simplifies messaging, including pricing. This offers more dynamic pricing structures, as well as better enables greenhouse gas signalling, grid code adjustments and capacity management communication such as dynamic operating envelopes (DOE).

What is EA Technology doing?

EA Technology was tasked to scan the published literature on the interface standards/protocols being developed/implemented, in addition to the IEC 62746/OpenADR 2.0. The scope of this study included identification of use cases, rationale/drivers behind the adoption of standards or protocols and the suitability for the NZ context, i.e., establishment and implementation of demand flexibility mechanisms to advance the decarbonisation journey and integrate DERs/CERs (such as EVs & home batteries) efficiently.

Four jurisdictions were selected for the literature search based upon similarities in the electricity market construct and regulations, namely UK, Europe, Australia, and USA.

The literature search conducted in this study indicated that one of the key barriers for a flexible market are the communication standards to exchange information and the control signals for the entire ecosystem, including:

- Registration
- Competition
- Availability
- Dispatch
- Reporting
- Performance
- Settlement
- Grid model

There are several aspects to consider in evaluating and deciding on a suitable standard:

- Open standards
- Interoperability
- Scalability
- Security
- Maintainability
- Platform independence
- Backwards compatibility
- Forwards compatibility
- Governance

This report is primarily focussing on the review of the standards and protocols for flexible dispatch offering open access and interoperability.

What did the study find?

Based upon the information gathered from the four jurisdictions (as detailed in the following report and appendices), it is observed that the adoption of open access communication protocols has been limited so far.

[2] Managed charging referrers to the ability to control EV charging by a third party. This is a form of demand response to manage network minimum/peak demand by incentivising the EV owner to participate.

However, the use of APIs is seen as an interim arrangement to allow data access and also support communication between SCADA/ADMS and DER management systems (DERMS).

OpenADR and IEEE2030.5. are the two most widely used communication protocols for flexibility at this stage. Currently, OpenADR is more mature in Demand Management (DM) market functions while IEEE2030.5 is stronger in smart control functionality. However, both these standards are evolving to fill the known gaps and accommodate new requirements. Open ADR 3.0 is offering more dynamic price structures, as well as capacity management (DOE), and IEEE2030.5 is using site EMS/aggregator to translate DM requirements into specific device commands.

From the international scan it is observed that currently no jurisdiction is following a single pathway on communication protocols and instead are moving down different protocol pathways due to their specific requirements, e.g., the ENA UK is currently investigating the development of a separate communication standard.

High-level summary from selected jurisdictions

UK & Europe summary

It is worth leveraging the work of UK's Energy Network Associations (ENA)[3] moving forward as NZ navigates net-zero. It is expected that this programme will play a key role to enabling the delivery of net-zero in the UK by the following:

- Opening local flexibility markets to demand response, renewable energy, and new low-carbon technology
- Removing barriers to participation
- Providing opportunities for these flexible resources to connect to our networks faster
- Opening data to allow these flexible resources to identify the best locations to invest
- Delivering efficiencies between the network companies to plan and operate secure efficient networks

As part of this work, ENA explored various different potential technologies for dispatch flexibility, including OpenADR, CIM, UMEI. UMEI was an EU funded research project bringing together various DSOs, marketplace providers, and dispatch platforms to demonstrate a proof of concept. This project worked well and demonstrated feasibility, however, the system is not fully fleshed out. It also lacks the surrounding enduring ecosystem and enabling architecture and design. It would provide a strong foundation to build upon, however, differences between the EU and UK energy markets may result in it being easier to build from scratch using the learnings from this project mixed with the UK specific requirements.

The Flexibility Market Standards Study report[4], identified five potential viable candidate standards:

- IEC Common Information Model (CIM)
- ebIX
- OpenADR
- IEC 61850-7-420
- IEEE 2030.5

This study was commissioned by Ofgem (UK's regulator) to provide an initial high-level appraisal of the candidate data standards potentially suitable for facilitating data exchange for market participants.

In another report by EDNA[5], the general use cases of three main open protocols (OpenADR, IEEE2030.5 and EEBUS) are listed for energy management. It states that OpenADR has development and support experience available and can be used for aggregated demand response/management across networked energy devices. On the other hand, IEEE 2030.5 was designed to manage devices directly (PV curtailment). This may change in later versions to include functionality similar to the OpenADR approach of using a site EMS or aggregator to translate demand management requirements into specific device commands. A full implementation of the

[3] Flexibility Services Interoperation Comparative Analysis of Options Open Networks October 2023
[4] Report by Open Grid Systems Ltd 2023- https://www.ofgem.gov.uk/sites/default/files/2023-05/OGS%20Report%20-%20Markets%20Standards%20Study.pdf)
[5] Guide to energy management protocols, November 2022 https://www.iea-4e.org/wp-content/uploads/2022/11/Energy-Protocol-Report-Release.pdf

IEEE2030.5 client and a server capable of managing many clients is a complicated piece of software. It is worth noting that most European jurisdictions seem to prefer OpenADR. EEBUS is seen more as an interface with a commercial building BMS.

Below are the current practices by UK DNOs (refer to Table 1):

Table 1 Summary of UK DNO approaches for procurement and dispatch

DNO	Using Piclo Flex Platform?	Using Flexible Power Platform?	Dispatching Via
Electricity North West	Yes	Yes	API, email
National Grid Electricity Distribution	Yes	Yes	API (Flexible Power)
Northern Powergrid	Yes	Yes	API (Flexible Power), telephone (early stages of a contract),
Scottish Power Energy Networks	Yes	Yes	API (Flexible Power),
Scottish and Southern Electricity Distribution	Yes	Yes	API (Flexible Power), email, phone
UK Power Networks	Yes	No	API or email

USA summary

Pacific Gas and Electric's EPIC 2.02 – Distributed Energy Resource Management System (DERMS) demo project report[6] considered OpenADR 2.0b and IEEE 2030.5 for establishing a utility-to-aggregator interface.

Given below is a high-level summary of the pros and cons of each protocol, with neither protocol fully able to implement all of the functional requirements to meet the goals of the DERMS Demo out of the box (refer to Table 2).

Table 2 Pros and cons of each protocol[6]

	IEEE 2030.5	OpenADR 2.0b
Pros	Supported by SIWG Base protocol already supported by DERMS vendor and one aggregator – Less cost and shorter schedule to implement	Well established for Demand Response use cases Well suited for market environments
Cons	Market functions more difficult to implement Custom extensions required	Did not support reactive power Did not leverage smart inverter functionality – meaning a separate translation layer was needed to harmonize with vendor inverter systems Not supported (at the time) by either aggregator – Additional cost and schedule length to implement Custom extensions required

[6] https://www.pge.com/content/dam/pge/docs/about/corporate-responsibility-and-sustainability/PGE-EPIC-Project-2.02.pdf

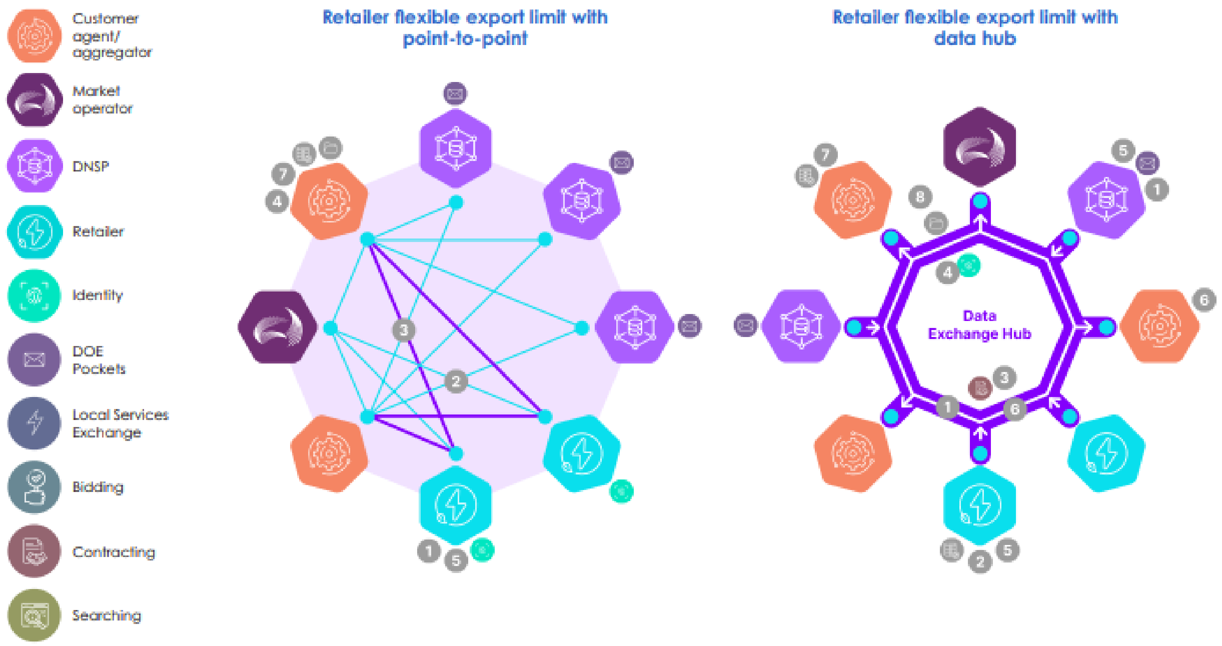
IEEE 2030.5 was managed by the Smart Energy Profile 2.0 (SEP2) Working Group, and California's Electric Rule 21 Smart Inverter Working Group (SIWG) recommended it be used as the default communication protocol for utility-aggregator interfaces for smart inverter-enabled DERs. OpenADR primarily addresses generalized or aggregated resources. However, the device-specific actions performed using OpenADR when responding to the event are usually not explicitly stated in the OpenADR message (though they may be for common devices like thermostats).

Near real-time communication is envisioned through supervisory control and data acquisition (SCADA) and internet protocols but can also be performed through custom-made application programming interfaces (APIs). Using custom-made APIs is a current practice, as in many cases in the USA, a utility DERMS of the specific vendor on one side, and a DER aggregator on the other side, do not support the same protocols. Hopefully, this practice will soon change, as the standardization of the communication protocols is currently taking place, and for example, the IEEE 2030.5 protocol is a very promising solution that could be useful on both ends.

Australia summary

Australia has adopted IEEE2030.5 and CSIP-AUS as the communication protocols to communicate network capacity information (dynamic operating envelope) and control solar PV inverters respectively for all major innovation trials. However, it has not mandated these standards and have not ruled out other standards.

The Project EDGE report[7] explored two options for data exchanges as below (refer to Figure 1):



Note: In the point-to-point architecture, all lines represent point-to-point integrations. Purple-coloured lines highlight an example of 1x agent/aggregator integration for the use case shown; however, this integration would need to be replicated for each agent/aggregator: DNSP pair.

Figure 1 Retailer sending dynamic export limit process with point-to-point architecture (left) and data hub approach (right)[7]

An industry DER data hub would need a more streamlined, user-friendly experience that is ideally consistent with other ways that the industry participants exchange data with each other via a common technical standard. For example:

- Enterprise cloud services that offer cloud-native applications in a simple user interface and automated back-end deployment processes
- A standalone platform (web or desktop application)
  Application Programming Interfaces (APIs)

[7] https://arena.gov.au/assets/2023/10/AEMO-Project-EDGE-Final-Report.pdf

Global summary & NZ context

Table 3 provides a summary of key findings from all four jurisdictions and its significance for the NZ context.

Table 3 Summary of all jurisdictions and its significance for NZ context

Country / Area	Use cases/problem trying to solve	Comms protocol	Comment/comparison to FlexTalk/NZ context
Australia	Flexibility & interoperability[8] DOE (dynamic operating envelope) Solar PV Inverter Control	IEEE2030.5 CSIP-Aus[9] APIs	NZ does not currently have very high level of solar penetration. Foresee EV growth as biggest challenge. However, it will be interesting space to watch for high levels of DERs.
UK	DER dispatch system interoperability	OpenADR* Development of API standards for dispatch system interoperability across ESO, DSO. Rollout use of the standardised API by Dec 2023 for the summer 2024 flexibility tender.	Rationale for NZ and UK are similar, although at a very different scale**.
Europe	DER integration	Single flexibility platform	NZ to watch this space and see the global convergences.
USA	Situational awareness and Distribution Services using DERMS	Open ADR- Aggregated demand response/management across networked energy devices. IEEE2030.5- Curtailing PV inverters. Broader deployment to manage DERs at town level has been trialled. EEBUS- Aggregated control of heat pumps at multiple sites, dynamic building power limitation setpoints, HVAC and electric vehicle management.	The key focus of the DERMS projects is to monitor, control and coordinate DERs and not on the development of the competitive flexibility services market. This may not suit NZ use cases currently.

* ENA UK do not believe that OpenADR (as is) currently meets the requirements for the UK energy market. However, OpenADR is the only evaluated API standard that could be modified to meet the requirements of a flexibility dispatch standard for the UK energy market. As such, there is likely a decision to be taken as to whether or not to develop a standard from OpenADR as a baseline, or to develop from scratch (informed by existing standards and APIs).

** UK DNOs have millions of customers and bigger budget for developing, implementing, and governing new solutions.

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[8] DNSPs in Australia have collaborated to align to IEEE 2030.5 and CSIP-AUS. The ESB's Interoperability Directions paper also explored the need for a national approach to public key infrastructure, both the IEEE 2030.5 and for future EV related standards.

[9] The Common Smart Inverter Profile – Australia, Version 1.1 (CSIP-Aus) specifies a minimum communication protocol to support the visibility of consumer energy resources, and active management though provision of dynamic limits on real power import and export.

Key Project Conclusions

The following summarises the key project conclusions from this analysis which are detailed further within the report:

1) Inherent flexibility in the DER/CER can support networks by enabling them to manage constraints through the utilisation of non-network solutions and allowing enhanced access to electricity markets.
2) Open communication standards / protocols are one of the key enablers of flexibility i.e., to exchange network information, pricing signals, and control signals.
3) Establishing interoperability is an important enabler for establishing:
   a) Common language between networks, DSO, and aggregators/flexibility service providers/market facilitators; and
   b) Controllability of devices from different OEMs e.g., PV inverters, EV chargers etc.
4) International open access standards can help boost market participation, cost efficiency, and easy access, as defined common protocols and standards allow for faster and more seamless connection and exchange of data.
5) The two most mature communication protocols for flexibility currently being considered for adoption internationally are OpenADR and IEEE2030.5.
   a) Currently, OpenADR is more mature in Demand Management (DM) market functions while IEEE2030.5 is stronger in smart control functionality.
6) Whilst each have strengths, both require further progression to meet all the requirements of demand flexibility, with some components still in development to provide end to end functionality. Current enhancements being developed include:
   a) Open ADR 3.0 offering more dynamic price structures, as well as capacity management (DOE); and
   b) IEEE2030.5 using site EMS/aggregator to translate DM requirements into specific device commands.
7) From the international scan it was observed that currently no jurisdiction is following a single pathway on communication protocols and instead are moving down different protocol pathways due to their specific requirements.

   For example, the ENA UK is currently investigating the development of a separate communication standard (leveraging current knowledge) as they consider it may be more suited to their market structure and may provide the adaptability they require as the system continues to transform.
8) Use of APIs can support basic functionalities such as enabling communication between flexibility providers and networks (SCADA/ADMS/DERMS).

Key Project Recommendations

A summary of the key recommendations or next steps for EEA and NZ EDBs are provided below:

1) Continue to monitor closely international developments, with particular emphasis on
    a) Australia due to their market proximity and speed of advancement in managing high penetration levels of DER within their distribution systems; and
    b) The UK due to similarity in structure and drivers in terms of DER/CER penetration, and regulations.
2) Build on existing body of knowledge on communication protocols and map the capabilities against New Zealand's requirements as it moves through the energy transition, before finalising any specific standard/protocol.
3) Consider the following least regrets actions:
    a) Establishment of a DER/CER integration working group to monitor the New Zealand market, scan global developments, and help design and undertake future trials.
    b) Connect and collaborate with similar DER integration and flexibility working groups in other jurisdictions such as the UK, USA, Europe and Australia.
    c) Establish a taskforce/study immediately to
        i) Design and obtain consensus on future energy scenarios for New Zealand; and
        ii) Combine knowledge from local trials.
    d) Design and implement an "regulatory sandbox" to enable trials (innovation with flexible rules) and work with government, industry and regulatory bodies to identify gaps and develop solutions in technology, regulation, functionality and consumer education to ensure industry preparedness.

Acronyms/Glossary

Acronym	Definition
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AMI	Advanced Metering Infrastructure
ANM	Active Network Management
ARENA	Australian Renewable Energy Agency
API	Application Programming Interface
AS	Australian Standard
BEV	Battery Electric Vehicle
CEC	Clean Energy Council
CER	Consumer Energy Resources
CSIP	Common Smart Inverter Profile
CSIP-Aus	Common Smart Inverter Profile – Australia
DEIP	Distributed Energy Integration Program
DER	Distributed Energy Resources
DERMS	DER Management System
DFES	Distribution Future Energy Scenarios
DFS	Demand Flexibility Service
DG	Distributed Generation
DLC	Direct Load Control
DNO	Distribution Network Operator (UK)
DNSP	Distribution Network Service Provider (Australia)
DOE	Dynamic Operating Envelopes
DRSP	Demand Response Service Providers
DSO	Distribution System Operator
DSR	Demand Side Response
ECA	Energy Consumers Australia
EDB	Electricity Distribution Business
ENA	Energy Networks Association
ENW	Electricity North West
ESB	Energy Security Board
ESO	Electricity System Operator
FEL	Flexible Export Limit

Acronym	Definition
FRMP	Financially Responsible Market Participant
FES	Future Energy Scenarios
FSP	Flexibility Service Provider
HEMS	Home Energy Management System
IEEE	The Institute of Electrical and Electronics Engineers
IEEE2030.5	IEEE Standard for Smart Energy Profile Application Protocol
IP	Internet Protocol
IOU	Investor-Owned Utility
ISC DEIP	Interoperability Steering Committee
ISP	Integrated System Plan
LAN	Local Area Network
LCT	Low Carbon Technologies
LV	Low Voltage (less than 1 kV)
MU	Meterable Unit
NEL	National Electricity Law
NEM	National Electricity Market
NEO	National Electricity Objective
NER	NER National Electricity Rules
NGED	National Grid Electricity Distribution
NPg	Northern Powergrid
OEM	Original Equipment Manufacturer
PV	Photovoltaic
SEP2	Smart Energy Profile 2 (IEEE 2030.5)
SPEN	Scottish Power Energy Networks
SSEN	Scottish and Southern Electricity Networks
TNSP	Transmission Network Service Provider
UKPN	UK Power Networks
VPP	Virtual Power Plant

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Appendices

1. Introduction and Background

To support the energy transition, significant changes are necessary in the way networks are designed, operated, and managed. A Distributed Energy Resource (DER or CER) rich scenario is almost certain as the modern society transitions towards net zero future.

The underlying flexibility in DERs/CERs is valuable to electricity networks enabling the maximising of asset utilisation as well as actively mitigating power quality issues. However, orchestration of DERs will have many players/actors in the ecosystem including electricity networks, electricity market, system operators, (DSO or market facilitator), aggregators or flexibility providers, and most importantly the customers (consumers and prosumers).

Communication standards and protocols provide a set of rules and guidelines to facilitate the communication and data exchange between two or more entities to ensure successful integration of DERs/CERs and provide electricity network support and wholesale electricity market services, thus stacking value streams for the benefit of the end users. Communication standards and protocols for DER/CER telemetry (near real time visibility) and dispatchability (contracting and control) are not fully developed or mature yet. Demonstrations and trials exist but are not at a scale where a single standard or protocol or API can meet all the requirements, e.g., the two widely used standards for flexibility IEEE2030.5 and OpenADR 2.0/3.0 still cannot provide a holistic solution for demand flexibility dispatch.

While standards are being developed and evaluated, we must continue to push on with implementations and inform what more is needed over and above the existing standards. Innovation trials are producing the knowledge of possible use cases and implementation challenges which must precede before a standard approach can be finalised to avoid premature standardisation.

Application programming interfaces (APIs) can evolve very quickly and that is the reason many jurisdictions including UK and USA are using APIs to implement in the short term until standards emerge fully. Some APIs are vendor specific, and some follow open internet protocols and provide documentation to be used by all.

Communication protocols can be proprietary, or they can be open (developed by public standard development organisations, or open alliances). Open standards are emerging for flexibility dispatch which can be implemented or referenced to build onto, without charge or constraint. However, there are implementation and governance costs depending upon the local context as every jurisdiction is unique in terms of the DER/CER penetration and challenges.

Specific innovation needs and time required to get an agreement to update open standards may be a limitation. The local context is also emerging and not settled to define all the use cases and it may be prudent to manage with APIs until a clear trend is emerged.

It is envisaged that a combination of a selected open access standard suitable of the jurisdiction along with specific APIs will continue in the near future.

Mind the gap-open communication protocols for vehicle grid integration[10] considers open protocols are a building block for a fit for purpose and future proof BEV charging infrastructure (refer to Figure 2).

[10] https://energyinformatics.springeropen.com/articles/10.1186/s42162-020-0103-1

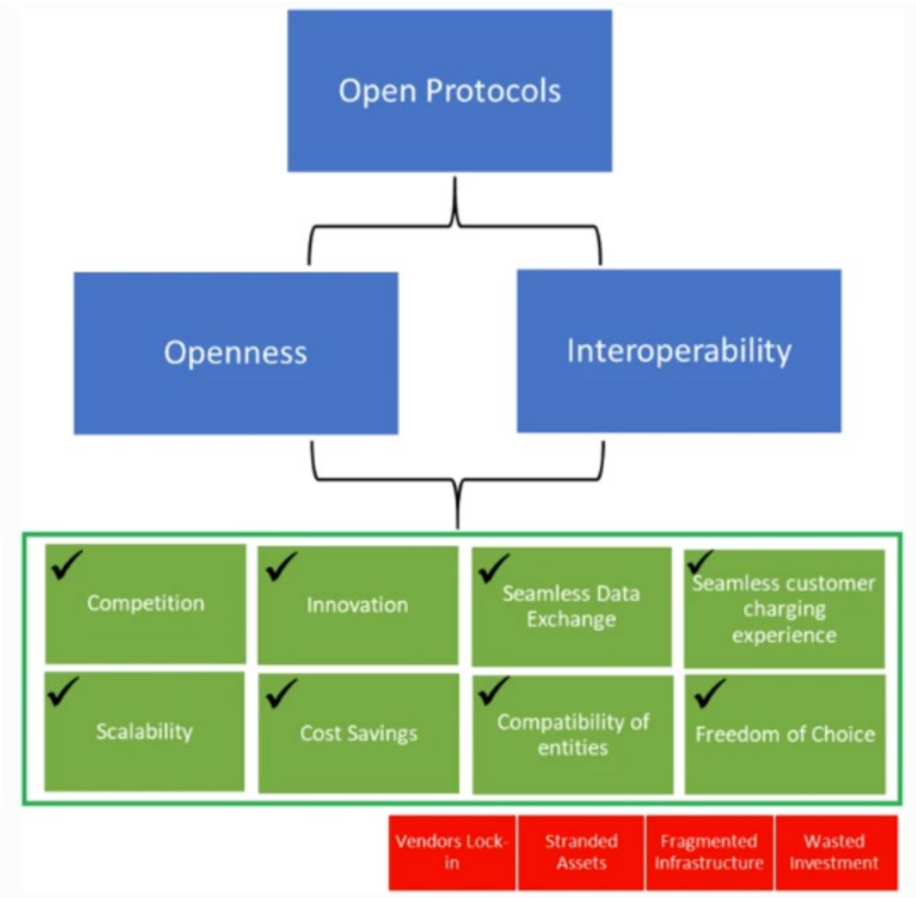

Figure 2 Open Protocols[10]

This paper also acknowledges that developments in other sectors indicate that over time the requirement to coordinate efforts become rather obvious and protocols could converge towards one or few standards voluntarily.

EEA, NZ is undertaking the Demand Flexibility Common Communication Protocols Project (FlexTalk), a joint government and industry initiative that applies the communication protocol to achieve interoperability between EDBs and flexibility suppliers (aggregators). The FlexTalk project is evaluating the processes that need to be in place to apply the OpenADR 2.0 (2.0a and or 2.0b) communication protocol to achieve active managed charging of electric vehicles (EVs), enabling flexibility services to be utilised in the electricity sector in New Zealand. This is summarised in Appendix V and as shown below (refer to Figure 3):

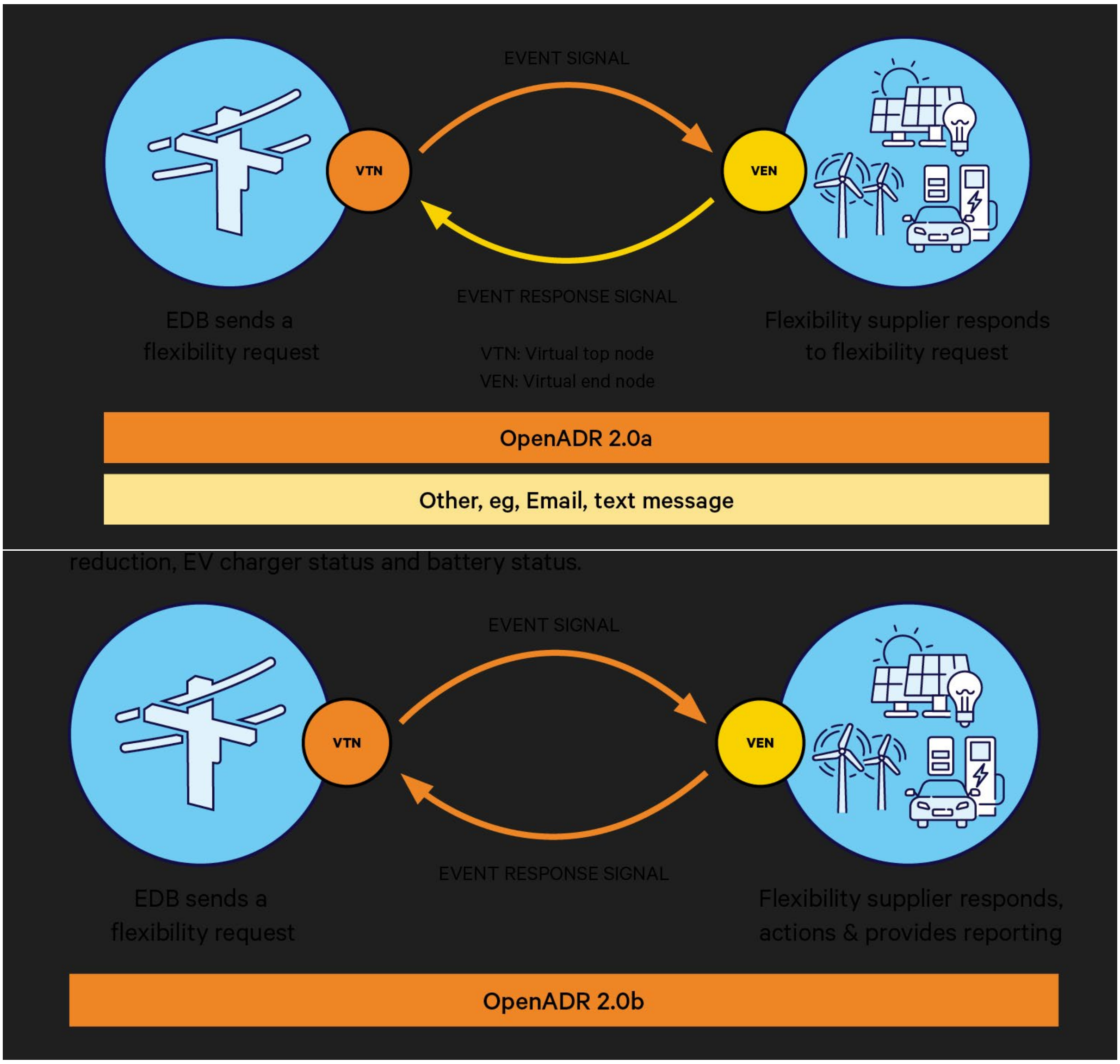

Figure 3 Processes required for OpenADR 2.0a and 2.0b

The FlexTalk is a collaborative partnership between industry, represented by the Electricity Engineers' Association (EEA) and the Energy Efficiency and Conservation Authority (EECA). It is a pilot trial that will develop the procedures needed to enable communication between an EDB and flexibility supplier (aggregator) to achieve active managed charging of EVs as a starting point.

While FlexTalk's initial focus is on OpenADR, it does not preclude the use of other protocols that are found to have benefits throughout the project. The FlexTalk project is not investigating the device control aspect from the Flex Supplier.

EEA has tasked EA Technology with a literature search on the broader communication methods/standards/protocols being developed/implemented in other jurisdictions (such as UK, USA, Europe, and Australia) between EDBs and Aggregators. This review compares various approaches in terms of the drivers, lessons learned, and suitability for the NZ context.

2. Scope of Works

This report details findings from the following scope of works, agreed in the project kick off workshop:

a) Standards/protocols developed/implemented for the exchange of information between EDBs and Flexibility suppliers in UK, Europe, USA and Australia.
b) Use cases for the information exchange, i.e., procurement, dispatch, control or managing solar PV, EVs or providing resilience, point to point control vs. broadcast etc.
c) Rationale or drivers behind adoption of standards/protocols in various jurisdictions including current and future perspectives.
d) Suitability for the NZ context

During the project kick off workshop on 5th October 2023, the EA Technology and EEA team also identified potential additional sources which have been reviewed and are listed in the Appendix I.

2.1 NZ Context and Use Cases

NZ is seeing moderate levels of rooftop solar PV penetration but is expecting higher levels of EVs and residential batteries in the near future. EEA members in NZ have initiated a number of ‘'no-regret actions’' to prepare for the future, e.g., FlexTalk. It is expected that a mature flexibility service market will play a role in integrating and harmonising DER and CER.

Given below are the possible use cases to help develop a better flexibility market:

- Integration of EV (active management of EV charging) and other DER/CER
- Integration of residential batteries and virtual power plants (VPPs)
- DER integration for the benefit of the end customer
    - Better utilisation of existing infrastructure, avoidance of inefficient network upgrades and lower distribution charges to customers.
    - Electrification/net zero
    - Resilience
    - Energy efficiency (EECA)
    - Consumer choices - mobility across service providers
- Reliability and speed of response, e.g., Dispatch of flexibility services
- Interoperability (no silos or proprietary solutions) - open standard APIs
- What other standards can work (compared with OpenADR) in the New Zealand context – challenges and solutions?
- Providing overall envelope and using envelope for dispatch
- Adaptability (future DER/CER penetration and use cases)

3. Review of Standards and Protocols

3.1 Great Britain (UK) and Europe

This section provides a summary of the standards and protocols being adopted in the UK and Europe. Further details and references to further relevant reading are included in Appendix II.

3.1.1 Background and Context

Accessing flexibility from domestic customers and small businesses has become of increasing interest to EDBs/DNOs in the UK since early innovation projects in this area began around 2010. The System Operator (National Grid ESO) launched its Demand Flexibility Service (DFS) in the winter of 2022/23, procuring flexibility services from domestic customers via aggregators (more details below), and will operate the system again during the winter of 2023/24.

DNOs have greatly increased their use of flexibility services as an alternative to traditional reinforcement (or to defer reinforcement). The total volumes of flexibility services tendered and contracted since 2018 are shown below (refer to Figure 4).

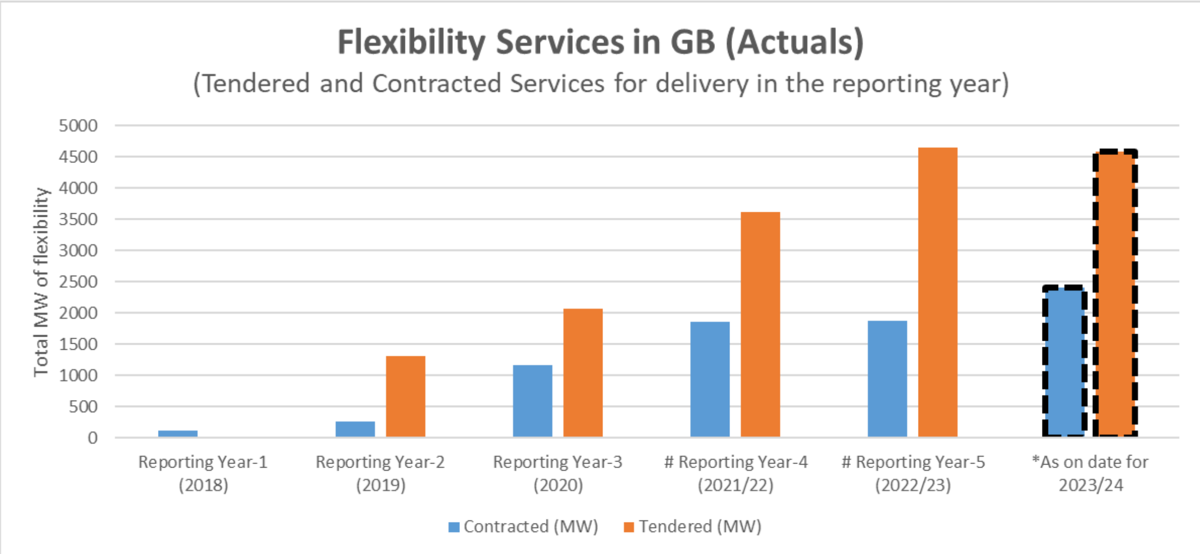

Figure 4 Volume of Flexibility Services procured by DNOs in GB[11]

The technology breakdown for services contracted for delivery in 2022/23 (across all response types) is shown below (refer to Figure 5):

[11] Data from: ENA ON GB Flexibility Figures 2023/2024 – Energy Networks Association (ENA) Accessed November 2023

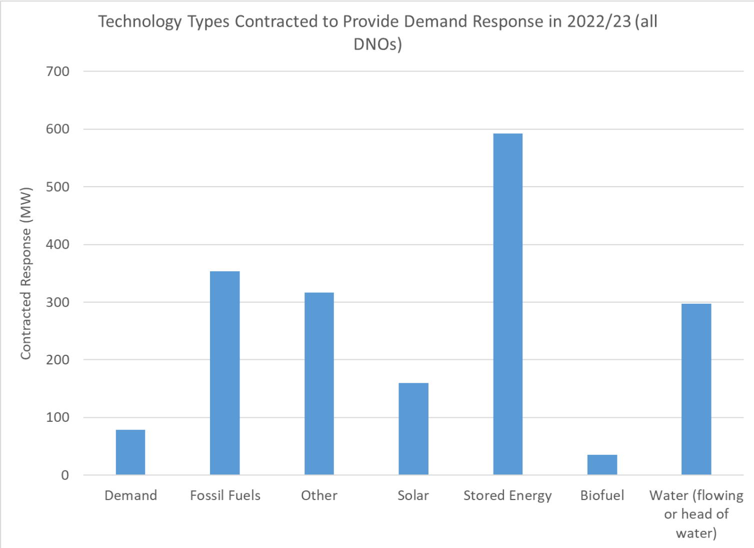

Figure 5 Technology type contracted to provide Demand Response to GB DNOs in 2022/23[11]

The 'demand figure' includes all demand customers – both large industrial customers, and potentially aggregated groups of domestic customers, and the composition of this group is not clear from the data currently available. Data from UKPN indicates that the 'stored energy' category includes the response provided through smart charging of EVs as well as other forms of energy storage.

UK DNOs are working collectively through the ENA Open Networks project to develop and maintain a standardised contract for the procurement of flexibility services, as well as each DNO expanding on this where necessary for their own particular requirements. Several DNOs also use shared online platforms – Piclo Flex[12] and Flexible Power[13] for their procurement and dispatch of flexibility services.

3.1.2 Innovation Trials and Development

The energy regulator for Great Britain, Ofgem, and UK Government have produced various plans, reports and consultations in relation to flexibility and the energy system. This section reviews a number of key documents and further details are included in Appendix II.

Smart Systems and Flexibility Plan (2021)[14]
This plan, a joint publication by the government and Ofgem, sets out a vision, analysis and work programme for delivering a smart and flexible electricity system. The plan sets out work to be completed in the future, "networks must deliver and adopt a standardised approach to procuring flexibility…including common approaches to valuing flexibility baselining methodologies, pre-qualification, **dispatch** and settlement and monitoring requirements." Specific details of how this standardisation of dispatch mechanisms, or how this could be aligned with the ESO are not specified.

Interoperable Demand Side Response Programme[15]
This programme is administered by the Department for Energy Security and Net Zero and the Department for Business, Energy and Industrial Strategy. It "aims to support the development and demonstration of energy smart appliances for the delivery of interoperable demand side response."

It consists of three streams of work, as follows:

12 https://picloflex.com/
13 https://www.flexiblepower.co.uk/
14 Transitioning to a net zero energy system: Smart Systems and Flexibility Plan 2021 (publishing.service.gov.uk) Accessed November 2023
15 Interoperable Demand Side Response programme - GOV.UK (www.gov.uk) Accessed November 2023

1. Supporting the development and demonstration of energy smart appliances to deliver interoperable DSR according to PAS 1878 and 1879[16].
2. As above, but accessing DSR via the GB Smart Metering System, including using a standalone auxiliary proportional controller and Open ADR functionality via the GB smart metering system.
3. Supporting feasibility studies to improve and develop understanding of how energy management systems (EMS) can act together with energy smart appliances to deliver interoperable DSR.

The interfaces covered within the standard focus on those 'downstream' of the aggregator – to the device(s), rather than 'upstream' to the EDB.

The Future of Distributed Flexibility[17]

Ofgem are proposing a "common end vision for distributed flexibility…: a common digital energy infrastructure". However, the paper does not provide a detailed assessment of potential standards to be used but the call for evidence presents three, increasingly interventionist 'archetypes' for the future development of digital infrastructure to support distributed flexibility:

- 'Thin': based on the concept of a directory that would assist market buyers and sellers of distributed flexibility to understand the landscape of markets and assets available. Access to the directory would be open, and common communication standards would be established between all market participants (via open standardised APIs[18]). There would not be a common point of access to join markets, or a co-ordinated approach between markets. To a degree, this appears to be developing organically in the UK with the development of Flexible Power and Piclo Flex used by a majority of DNOs (see below). However, as outlined in the description of this option, there is no co-ordination between DNO and ESO services in this model. Indeed, assets cannot be signed up to provide multiple services during the same time periods.
- 'Medium': an 'exchange' – "a singular and scalable digital location where multiple markets are visible and co-ordinated under a known governance framework, yet continue to retain their own market designs, platforms and systems. An exchange would allow buyers, including independent market operators and system operators, to procure, dispatch, and settle, but they would do so in a transparent and coordinated environment."
- 'Thick': "this archetype is a central platform for the end-to-end delivery of distributed flexibility. The central platform encompasses all activities from exploration to settlement across all markets". The approach would be unlikely to leave any service provision with existing systems.

An additional technical report was published alongside the call for input, produced by Open Grid Systems[19]. This report reviewed five viable candidate standards which enable the interfaces of a common digital energy infrastructure as outlined in the call for evidence.

The results of the review are shown below (refer to Figure 6):

[16] https://www.openadr.org/assets/PAS1878_RS_20230912_OpenADR%20Unlocks%20Flexibility%20Throughout%20Europe.pdf Accessed November 2023
[17] Call for Input: The Future of Distributed Flexibility | Ofgem Accessed November 2023
[18] The APIs to be used are not specified.
[19] Assessment of Candidate System-Wide Flexibility Exchange Interface Models (ofgem.gov.uk) Accessed November 2023

	IEC CIM	ebIX	OpenADR	IEC 61850	IEEE 2030.5
Data Domains	8	4	5	3	3
Data Model	Semantic Model	Message Model	Message Model	Semantic Model	Semantic Model
Development Process	Curated	Curated	Community	Curated	Curated
Message Library	Rich	Developed	Developed	Developed	Developed

Colour Coding (further details are in Section 2.3 of the referenced report):

- Data Domains: Red = 3 or fewer data domains, Yellow = 4 to 7 data domains, Green = all domains
- Data Model: Red = No data model, Yellow = Message model, Green = Semantic model
- Development Process: Red = Proprietary, Yellow = Community, Green = Curated
- Message Level: Red = Limited, Yellow = Developed, Green = Rich

Data Domain is a 1-8 score based on how many of the following data domains are included in the data exchange standard: registration, competition, availability, dispatch, reporting, performance, settlement and grid model.

Figure 6 Standards reviewed and ratings[19]

Open Networks

The Open Networks programme is overseen by the Energy Networks Association (ENA) and began in 2017[20]. It has 10 participating members – the six GB DNOs, Northern Ireland Electricity Networks, ESB Networks (Republic of Ireland DNO), National Grid Electricity System Operator and BUUK (the UK's leading independent provider of last-mile utility networks). The purpose of the programme is "to work together to standardise customer experiences and align processes to make connecting to the networks as easy as possible and bring record amounts of renewable distributed energy resources, like wind and solar panels, to the local electricity grid."

From 2023, workstreams were consolidated into three streams, Planning and Network Development, Network Operation and Market Development. From 2023 onwards, the Open Networks programme will focus on[21]:

- Making it easier for flexibility service providers to participate in the flexibility market by standardising products, processes and contracts
- Improving operational coordination between networks and companies to remove barriers to the delivery of Flexibility services
- Improving the transparency of processes, reporting and decision-making

The Flexibility programme consists of nine product areas – including P3 Dispatch Interoperability and Settlement, which will consist of a "review of interoperability of systems across DNO and ESO and reviewing the approach to settlement across DNO services.[22]". In 2022, the Open Networks programme published a review of existing practices for dispatch and settlement for flexibility services[23]. The key findings from this review were:

- The most significant alignment is amongst DNOs that are using the Flexible Power platform to manage dispatch; however, this alignment is the result of a common choice of platform for managing dispatch rather than as the result of a decision to align practices between DNOs.
- In the longer term, the group have identified that APIs will be used as the primary way for System Operators to communicate dispatch requirements, due to the greater levels of automation and scalability.

[20] Open Networks: Five Years ON – Energy Networks Association (ENA) Accessed November 2023
[21] ENA_RoadmapFlexibilityReport_V3 FEB.pdf (energynetworks.org) Accessed November 2023
[22] ON22-PRJ-2022 Flexibility Consultation Wrapper Document (energynetworks.org) Accessed November 2023
[23] ON22-WS1A-P3 Review of existing practices and gap analysis (05 Apr 2022).pdf (energynetworks.org) Accessed November 2023

- Following the gap analysis, the P3 group agree in principle that the adoption of a common API for dispatching of services should be long term goal of dispatch interoperability, however, such an API would need to be designed in an appropriately flexible manner to provide future proofing.
- The work of the P3 group identified existing dispatch standards such as Universal Smart Energy Framework and IEEE 2030.5. However, these are not currently in use by GB DNOs.

The Open Networks recently released an objective and evaluation of options around APIs and standards for dispatch of flexibility services. Its aim is to propose the framework against which standards should be evaluated (and provide examples of doing this) rather than to make a specific recommendation as to any particular standard. Whilst the report focuses on dispatch of services, flexibility service providers and aggregators highlighted the importance of a system which is integrated across the whole of the lifecycle, from registration to procurement, planning, settlement, etc.

The latest ENA publication[24], a series of 9 evaluation categories is then explored which can be used to evaluate standard or API:

- Open standards
- Interoperability
- Scalability
- Security
- Maintainability
- Platform independence
- Backwards compatibility
- Forwards compatibility
- Governance

It also considers the relative merits of 'build' (developing a bespoke dispatch API for the UK industry) vs. 'buy' (using an existing available product or standard/API). The report highlights that there is a potential that adopting an existing standard limits the UK's influence on the development of that standard (due to time commitment required to participate in standard bodies activities) and the desire for the UK to have the ability to develop its own flexibility dispatch ecosystem over time. Three potential options were identified: the Common Interface Model (CIM), OpenADR and UMEI[25].

It is interesting to note the discussion in the ENA report on cost efficiency and ease of implementation (page 21) specifically in relation to OpenADR as below:

> "...We believe that OpenADR is the only evaluated API standard that could be modified to meet the requirements of a flexibility dispatch standard for the UK energy market… Since there would appear to be a requirement to make a range of modifications to OpenADR however, this is likely to entail the same overheads and cost burdens as running the governance process for a new standard…There would likely be some cost savings if this new standard was able to leverage existing work on OpenADR for a dispatch API …..As such, there is likely a decision to be taken as to whether or not to develop a standard from OpenADR as a baseline, or to develop from scratch, based on requirements.
>
> While there may be some minor advantages in ease of implementation for FSPs by using an existing standard, given we do not believe OpenADR (as-is) currently meets the requirements for the UK energy market, ….and therefore the costs of implementation are likely to be broadly similar to implementing a new standard, as implementers would need to carefully ensure that any variations for the UK version were in their own implementation."

It should be noted that the purpose of the report was to propose a method by which standards could be evaluated (e.g. the criteria to consider) rather than to make a specific recommendation about which the most appropriate standard would be.

ENA has made 5 high-level recommendations in this report:

[24] ENA Report, Flexibility Services Dispatch Interoperability Interoperation - Comparative Analysis of Options- Open Networks October 2023 Version 1.0
[25] EUniversal UMEI - active management system to flexibility markets Accessed November 2023

1. Build a shared and common understanding around the limitations of selecting an API and standard, and the significant work required beyond this to deliver an implementation.
2. Consider whether it has sufficient information at this stage to make a fully informed selection of an API or standard.
3. Determine exactly what is in scope of the dispatch API work.
4. Conduct a technical analysis across the whole flexibility landscape to determine whether the advantages gained from selecting an API and standard that already exists outweigh the potential opportunities of starting from a clean slate standard or API.
5. Split the scoped future work into a series of logical (but linked and dependency-managed) focus areas.

The ENA report also provides the technical distinction between a standard and an API (page 27). The term API is often used to refer both to the technical specification of communications, as well as a specific implementation of that technical specification. It is important to note that for an API to be interoperable (i.e. allowing others to implement it), there must be a technical specification and documentation around it. A standard could, for example, include the technical definition and specification of an API, but the standard would not cover the implementation itself - the standard would define how implementations should act and behave.

The report also mentions the gap around separation of responsibilities, and how this would be implemented in an API based dispatch and procurement system (page 37). Some of the minimum technical requirements of a flexibility service dispatch interface has also been discussed in the report.

Alongside this, the Networks Operations Works Stream has set up a Dispatch System Interoperability working group[26] (refer to Table 4).

Table 4 Dispatch System Interoperability Working Group[26]

Dispatch Systems Interoperability	Development API standards for dispatch system interoperability across ESO, DSO.	Technical specification for API standards for dispatch system interoperability (Nov 2023), Rollout use of the standardised API by Dec 2023 for the summer 2024 flexibility tender

This working group will deliver the plan set out in 2022 by developing a detailed technical standard for a common API that allows for dispatch system interoperability across ESO, DSO and non-network company systems. A draft scope document will be developed by the working group to support the development of technical specifications for a standardised API and support the rollout by individual networks companies' dispatch systems, for the summer 2024 flexibility tender.

INTERRFACE Project

The purpose of the INTERRFACE project[27] was to design, develop and exploit an Interoperable pan-European Grid Services Architecture to act as the interface between the power system (TSO and DSO) and the customers and allow the seamless and coordinated operation of all stakeholders to use and procure common services.

The first area is considered to be the most relevant in the context of this project, and in particular the 'Single flexibility platform'. This was the 'IEGSA' (Integrated pan-European Grid Services Architecture) platform, which was designed to "connect multiple actors such as Market Operators, System Operators (i.e. TSOs and DSOs), Flexibility Service Providers (i.e. Balance Service Providers or Aggregators), Settlement Responsible Parties, along various electricity markets focusing on providing support on the procurement of services (such as balancing, congestion management and ancillary services) from assets connected to the network both at

[26] ENA Report, January 2023
[27] Home | INTERRFACE Accessed November 2023

transmission and at distribution level, in a coordinated way, implementing multiple coordination schemes between TSOs and DSOs.[28]".

The report states, "All data exchanges are primary served utilising CIM data profiles based on European Standard Market Profiles; in certain cases, custom profiles or customisations of standard profiles were adopted in order to address the demo needs. Therefore, the wider utilisation of IEGSA would involve an update of its APIs to be fully compliant with IEC CIM data profiles for all business profiles". The use of CIM is consistent with the recommendations of the Open Grid Systems report.

Flexible power Alliance Network[29]

The Flexible power Alliance Network (FAN) was established in 2013 and aims to "provide open standards for unlocking flexible energy in energy systems". It is based in the Netherlands. FAN has developed the "Energy Flexibility Interface" (EFI) – a communications protocol for controlling equipment by means of energy management software. They state, "Whenever manufacturers develop devices that support EFI, these devices can communicate with all Smart Grid technologies (Powermatcher, OpenADR, Triana). Conversely, by supporting EFI, developers of Smart Grid technologies can rely on their solution being able to communicate with all smart devices that support EFI." The focus of this standard appears to be between aggregators and individual DER (e.g. heat pumps, electric vehicles etc.) rather than between EDBs/DNOs and aggregators (the focus of this study).

Equigy[30]

Equigy is a European crowd balancing platform owned by leading European transmission system operators. Their mission is to "support energy transition by enabling smaller distributed flexibility assets to participate in the energy system through aggregation." The platform is currently in live use in the Netherlands, Germany, Austria, Switzerland and Italy.

The Interoperability Network for the Energy Transistion (Int:net)[31]

This project has been funded by the EU's Horizon Europe research and innovation programme. It brings together bodies from across Europe (with strong representation from Germany in particular), including the European Network of Transmission System Operators for Electricity, the European Distribution System Operators for Smart Grids and EPRI Europe DAC. The group is jointly working on "developing, testing and deploying interoperable energy services". They also state, "The int:net-interoperability network will be formally established to exist beyond our project lifetime. With a comprehensive, FAIR knowledge platform and a series of attractive events, the int:net-community guides those who deal with the heterogeneous interoperability landscape of energy services." A high-level review of deliverable titles published to date suggests this project is concerned with multiple aspects of interoperability across the energy system and is therefore much wider in scope than the focus of this report.

3.1.3 Commercial Platforms in the UK

Most DNOs use one of the following two commercial platforms as summarised below (please refer Appendix II for more details).

Piclo Flex Platform

Piclo Flex[32] is an independent marketplace for energy flexibility services. In GB it is used by UK Power Networks (UKPN), SP Energy Networks (SPEN), Electricity North West (ENW) and Northern Powergrid (NPg) for their procurement of flexibility services in addition to the System Operator. Piclo Flex is also used in Ireland, Italy, Portugal, Lithuania and the US (New York State).

The platform provides a single point where flexibility providers can find information on DNO flexibility tenders, determine whether or not they meet qualification criteria and submit their bids.

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[28] Interrface_Roadmap Accessed November 2023
[29] About FAN - Flexible Energy (flexible-energy.eu) Accessed November 2023
[30] Home - Equigy Accessed November 2023
[31] Home - Int:net (intnet.eu) Accessed February 2024
[32] Piclo Flex Accessed November 2023

The communication protocols used for the 'operations' part of the platform are not stated publicly – it is not clear if this follows any international standards or is consistent between DNOs. Piclo Flex is engineered for integration with ADMS, DERMS and other back-office systems of Flexibility Service Providers and System Operators[33].

Flexible Power

Flexible Power[34] is a joint initiative from five of the six UK DNOs (ENW, National Grid Electricity Distribution (NGED), NPg, SSEN and SPEN). It is used to provide a central reference point for calls for flexibility/procurement from multiple DNOs. Once a provider is under contract, they can use the Flexible Power portal to "declare assets availability, receive dispatch signals and view performance and settlement reports". Users are able to search a map using postcodes to determine if their assets align with areas of the networks in which DNOs are procuring flexibility services.

Flexible Power publish an API Guide[35] to assist flexibility providers in setting up a connection to the Flexible Power portal. The portal is used by providers to declare availability and submit associated meter readings. DNOs use the portal to accept availability declarations and instruct utilisation events. The portal provides the API between the DNO and flexibility providers – they may have further control systems/communication protocols to communicate within their hardware, or to multiple CER in the case of distributed flexibility resources such as EV chargers.

The Flexible Power portal represents progress towards standardisation and automatization in the dispatch of flexibility services by GB DNOs. However, it does not appear to be based on specific international standards (e.g. those covered by the Open Grid Systems report). The extent to which it can be readily used by aggregators operating a large, distributed portfolio of CERs is also not clear.

3.1.4 IIndividual DNO Approach and Plans

GB DNO's approach towards flexibility is summarised below (please refer to Appendix II for more details). The table below summarises information for each DNO (refer to Table 5).

Table 5 Summary of DNO approaches for Procurement and Dispatch

DNO	Using Piclo Flex Platform?	Using Flexible Power Platform?	Dispatching Via
Electricity North West	Yes	Yes	API, email
National Grid Electricity Distribution	Yes	Yes	API (Flexible Power)
Northern Powergrid	Yes	Yes	API (Flexible Power), telephone (early stages of a contract),
Scottish Power Energy Networks	Yes	Yes	API (Flexible Power),
Scottish and Southern Electricity Distribution	Yes	Yes	API (Flexible Power), email, phone
UK Power Networks	Yes	No	API or email

Electricity North West

Electricity North West (ENW) operate a single electricity distribution licence area in the North West of England, serving 2.4 million customers.

[33] Flexibility Markets: Market Standards Study. Open Grid Systems. 2023
[34] Home (flexiblepower.co.uk) Accessed November 2023
[35] Guide to API Set UP UAT Testing V2.2.pdf Accessed November 2023

ENW use both Piclo Flex (for procurement) and Flexible Power. They are currently tendering for 413 MW of flexible capacity to be provided over the period from 2024 to 2028. The technical requirements for providers of flexibility are available online[36]. These state that "utilisation instructions for services as standard will be issued via an API or Email". Details of the communications protocols used are not given.

National Grid Electricity Distribution

National Grid Electricity Distribution (NGED) operate the electricity distribution networks for four UK licence areas, East Midlands, West Midlands, South West and Wales. They serve over 8 million customers and cover an area of 55,500 km^2. NGED will adopt a 'flexibility first' approach to resolve network constraints, procuring and using flexibility services as an alternative to conventional network reinforcement which allows customers to connect quicker and at lower cost.

NGED operate 'Flexible Power' solutions where customers with controllable demand and generation can aid in network capacity management. This is achieved using four types of flexibility services (Secure, Dynamic, Sustain, Restore). They utilise the 'Flexible Power Operations Portal' as the platform through which they conduct flexibility services. The flexible service provider is required to implement their own API to send data to the various APIs within the Flexible Power Portal.

Northern Powergrid

Northern Powergrid (NPg) operate two licence areas in North East UK serving more than 8 million people across 3.9 million homes and businesses.

NPg operate the Flexible Power portal with four flexibility services (Sustain, Secure, Dynamic, Restore). Flexibility is dispatched through the Flexible Power toolkit via an API between NPg and providers. The system includes a calendar for preplanned flexibility services. The dispatch mechanism between NPg and service providers using the Flexible Power API has three key features:

1) Flexibility Start Switch On – 15-minute notice to activate service.
2) Flexibility Stop Switch Off – 15-minute notice to deactivate service.
3) Emergency Stop – communicated by phone call.

In the early stages of a new contract, NPg use a telephone service to confirm agreements.

Procurement activities are announced through the Flexible Power website and tenders submitted through the online procurement portal (Piclo Flex).

Scottish Power Energy Networks

Scottish Power Energy Networks (SPEN) operate two licence areas in two regions of the UK (NW England and Southern Scotland). They have approximately 7 million customers and operate in three of the UK's largest cities as well as three significant rural areas of the UK.

SPEN currently use the Flexible Power API to conduct their flexibility services. They offer five types of flexibility services (Secure, Dynamic, Sustain, Restore, Reactive Power). They also utilise Piclo Flex as their engagement channel for tendering when open. Once contracted, providers are given access to the joint Flexible Power Portal where they can declare their assets availability, receive dispatch signals and view performance and settlement reports.

Using the Flexible Power Portal customers can submit meter readings, create declarations, and receive start stop signals.

Scottish and Southern Electricity Distribution

Scottish and Southern Electricity Distribution have two licence areas – in the central south of England and the northern part of Scotland, serving 3.8 million homes and businesses.

SSEN's is adopting a flexibility first approach, which they estimate will defer investment of £46 million over the price control period. The Flexibility tenders are "device agnostic" allowing providers of storage, generation, demand side response (DSR) or energy efficiency services to respond to any tenders. At the low voltage level,

[36] https://www.enwl.co.uk/globalassets/future-energy/flexibility-hub/latest-requirement/autumn-23/tt111205---flexibility-services-autumn-2023---appendix-2---technical-specification.pdf Accessed November 2023

SSEN foresee that flexibility services will be predominantly recruited via intermediaries such as aggregators, energy suppliers, and other aggregating parties including suitably equipped community groups. They are designing and delivering an API interface for their Automated Network Management systems which will allow SSEN to interact - dispatch and monitor - aggregator service providers. Details of this API, such as the standards used are not provided.

The standard agreements used between SSEN, and flexibility providers are available online for both those operating manually[37], and those on the 'Flexible Power' platform[38].

UK Power Networks

UK Power Networks (UKPN) operate three distribution licence areas in the South and East of England, including London. They serve 8.4 million homes and businesses – approximately 19 million people. UKPN is operating a "Flexibility First" strategy through which all future network needs will be tested for non-network asset solutions.

UKPN's plans include:

- Establish a Distribution Market Platform. UKPN envisage data flows between the Distribution Market Platform and DSO functions will be facilitated via Open API interfaces. However, the details of these interfaces are not specified.
- An intention for the DSO to publish API standards for market platform data flows annually.

Since April 2023 UKPN have published data on the dispatch of flexibility under the 'Secure[39]' and 'Dynamic[40]' flexibility products[41]. This data has been analysed to show the providers of flexibility in terms of the type of response they offer, and the dispatch methods used[42].

This shows that while a large number of requests have been made from the two suppliers offering flexibility from CER, the volume of response provided is relatively low. In addition, only two of the suppliers are currently operating via API, indicating the relative immaturity of use of flexibility services. The dispatch method is not yet at a stage where an industry standard message is being used via an automated system. UKPN have stated that they intend to develop a flexibility services dispatch platform with work starting in April 2023. Initial deployment of the platform is planned for April 2024[43].

UKPN are currently procuring around 850 MW of flexibility across 452 constraint zones with contracts extending to winter 2026/27. Information on the tender is available online[44], although with minimal details of the dispatch mechanism, beyond the option to use either email or API, as per extending flexibility dispatch shown above. UKPN require a minimum of 10kW of response in each flexibility unit, to allow easy participation from a wider range of suppliers. UKPN use Piclo Flex to manage the procurement process.

National Grid Electricity System Operator

The Electricity System Operator (ESO) in the UK operates a number of flexibility/balancing services. Traditionally these have been provided by generation, or larger industrial or commercial customers. The most relevant service to the NZ context (the provision of DSR by CER) is the 'Demand Flexibility Service[45]' first operated during the winter of 2022/23. Participants are required to have half-hourly metering and be able to sustain demand reduction for a minimum of 30 minutes.

The Demand Flexibility Service will operate again for the winter of 2023/24.

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[37] ssen-standard-flexibility-service-agreement-manual-v2.1.pdf Accessed November 2023
[38] ssen-standard-flexibility-service-agreement-flexible-power-v2.1.pdf Accessed November 2023
[39] A firm, dispatchable service (location specific). Suppliers are paid an availability (£/MW/hours available) and utilisation fee and are notified the day ahead of need via email or API. This service operates in specific seasons and time windows as set out in the tender.
[40] A non-firm dispatchable service (location specific). Suppliers are paid for utilisation only and the service has no predefined service windows, with provision of the service being optional. Suppliers are notified on a day ahead basis via email or API.
[41] Further information on service types is available from: PowerPoint Presentation (d1lf1oz5vvdb9r.cloudfront.net) Accessed November 2023.
[42] Data from: Flexibility Dispatches — UK Power Networks (opendatasoft.com) Accessed November 2023
[43] Flexibility Services Dispatch Platform - UKPN DSAP (ukpowernetworks.co.uk) Accessed November 2024
[44] Autumn-2023-Tender-Participation-Guidance-v1.0.pdf (d1lf1oz5vvdb9r.cloudfront.net) Accessed November 2024
[45] Demand Flexibility Service (DFS) | ESO (nationalgrideso.com) Accessed November 2023

3.1.5 Summary and Suitability for the NZ Context

Parties across the electricity sector in the UK have increased their focus on using flexibility services, including those from domestic and small business customers. All DNOs have stated an intention to use a 'Flexibility First' approach when considering network reinforcement needs.

The Government and regulator have also identified the benefits which flexibility can offer the energy system and have sought the industry's views on how a common digital energy infrastructure platform could be developed, including reviewing a number of existing standards.

However, these developments are at a relatively early stage. Use of flexibility services began in innovation trials from the start of the distribution price control in 2010. Whilst this activity is now seen as 'business as usual' the DNOs are not using international standards for communication protocols between themselves and flexibility providers/aggregators. The majority of DNOs are now using a combination of the Piclo Flex and Flexible Power portals for the procurement and dispatch of flexibility services, which should result in a degree of standardisation. However, the use of email or telephone dispatch still remains an option in some cases. Clearly this has limited potential for scalability on the part of the DNOs as the number of flexibility providers grows. Standardisation would offer significant benefits for providers of flexibility, as they would only need to develop a single (or limited) number of interfaces in order to provide services to multiple parties within the electricity system. Progress has clearly been made towards a more 'automated' and standardised system, from the use of phone calls and emails in early trials, to a move towards the majority of DNOs using the same platform (Flexible Power) and its API. The latest ENA report on the subject clearly show that UK DNOs are considering moving towards formal standardisation, based on learnings made so far. They are contemplating whether to create from scratch or use existing standard e.g., OpenADR.

The UK is made up of a relatively small number of individual DNOs, each covering large geographic areas. DNOs have coalesced around the use of Piclo Flex and Flexible Power. With a larger number of smaller DNOs this process may take longer but may also offer advantages as it limits the activities and new processes which each individual DNO has to set up.

The industry regulator has identified a need for changes in the flexibility markets, including co-ordinating the activities across the system (e.g. DNO flexibility and the system operator). The use of standardised communication protocols is one of the elements of developments for this flexibility market. Ofgem have recently done a study to assess those potential protocols to provide general guidance to the industry. However, Ofgem tend to take a technologically agnostic approach, so are unlikely to specify the protocols to be used in the future. The Open Networks project has also identified this as an area for future work with a plan to provide "an optimal end-to end experience of DSO flexibility market platforms through developing API standards, saving flexibility providers from needing to develop multiple interfaces". Stakeholder engagement undertaken as part of the Open Networks project has shown that "the supply side of the flexibility market seeks an integrated and coherent flexibility ecosystem that reduces costs and streamlines market access, with as few barriers to participation and entry as possible". The route to ensuring this ecosystem develops is still unclear. However, this finding from the stakeholder engagement is likely to translate to other geographies, highlighting the importance of developing integrated systems as the distribution flexibility market develops.

3.2 Australia

3.2.1 Background and Context

Australia is experiencing an ever-increasing uptake of DER – leading the world in rates of household solar and an emerging uptake of newer resources like energy storage and electric vehicles.

Australia stands out as a global leader, with a remarkable adoption of Distributed Energy Resources. Australia's focus has been the communication of Dynamic Operating Envelopes and Dynamic Export Limits to resolve network issues arising from the high DER penetration specifically the rooftop solar PV.

To better support the growth in solar generation and its impact on network system security, distribution networks are transitioning away from fixed site export limits towards dynamic export limits and dynamic operating envelopes (DOEs). DOEs could support greater flexibility in the market in alignment with the post-2025 market design and transition towards a two-sided market, including the participation of aggregation VPP fleets.

A key element of a successful DOE framework is having consistent standards of communications so that retailers/aggregators can automate the application of DOEs, regardless of the solar manufacturer and distribution zone.

CSIP-AUS/ IEEE2030.5 provides a suitable framework for network-client communication - CSIP-AUS/ IEEE2030.5 is being adopted by various DOE trials underway and provides a suitable framework for network-client communication.

The energy industry has focused on developing a fit-for-purpose interoperability technical standards framework to support the communication of DOEs. Through the DER API Technical Working Group, industry developed the CSIP-AUS Australian Implementation Guide for IEEE 2030.5 (an international standard that has typically been used by vertically integrated utilities in the US).

Several use cases have been included by industry through collaboration within DEIP's Application Programming Interface (API) Technical Working Group which developed CSIP-AUS to suit the Australian context for IEEE2030.5. This foresight within the drafting of CSIP-AUS permits communication to sites either at the NMI-level or to flexible device(s), with the same protocol. This would enable the consumers' agent to manage individual sites within their export limit and in-turn aggregate their sites together to remain within the overarching 'network-wide' DOE.

Unlike overseas jurisdictions where IEEE2030.5 has been applied (in which retail and distribution services are vertically integrated), distribution and retail services are disaggregated in the Australian market and technical standards therefore need to support contestability and customer choice. The use cases initially implemented in CSIP-AUS focus on network outcomes without sufficient attention given to aggregator use cases that could support more cost-effective outcomes based on the structure of Australia's energy market system.

3.2.2 Innovation Trials and Development

As per the DEIP outcome report[46], communications systems and protocols (including cyber security) require ongoing development. DNSPs and the DER industry are aligning on IEEE2030.5 as the national standard for DOE communications. The cross-sector national DEIP Interoperability Steering Committee has recently released the Common Smart Inverter Profile – Australia (CSIPAUS), now in the process of standardisation through Standards Australia, which describes how IEEE2030.5 is to be used to implement DOEs in the Australian market. The adoption of the CSIPAUS is a successful example of DNSPs and industry coming together to address a common gap. The Working Group considers further work on developing consistent standards through the DEIP Interoperability Steering Committee and other forum as essential.

Please refer Appendix III for some of the DOE projects and protocols used.

In a Distributed Energy Integration Program (DEIP) report[47], the Table given below (refer to Table 6) presents an overview of the various approaches the trials and pilots are exploring, with bold features denoting a novel approach to DER integration. Areas of commonality between trials and pilots tend to be where there has been a large amount of industry collaboration and common understanding, such as the use of dynamic operating envelopes (DOEs) for communicating local network hosting capacity, and the Common Smart Inverter Profile Australia (CSIP-AUS) as a protocol to communicate that capacity. Areas of diverging approaches occur in less explored areas, such as how network services are procured or whole-of-system data architectures.

[46] Dynamic Operating Envelopes Working Group OUTCOMES REPORT March 2022 (DEIP)
[47] DER Markets Integration Trials, September 2022

Table 6 Technical settings of the market integration trials. Bold denotes a novel approach[47]

	AEMO PROJECT EDGE	WESTERN POWER PROJECT SYMPHONY	AUSGRID PROJECT EDITH	EVOENERGY PROJECT CONVERGE
METERING POINT	Connection Point or **Sub-metering**	Connection Point	Connection Point	Connection Point
ENERGY MARKET BIDDING	**Model consistent with scheduled BDU from IESS**	Bids into balancing and **contingency reserve** raise markets	Current bidding process for FCAS	**Bids first sent to DSO**
DOE ALLOCATION	Various	Various	**Subscription model**	**Bid-optimised**
LOCAL CONSTRAINTS	DOE	DOE	DOE	DOE
NETWORK SUPPORT	**Local services exchange**	**Contracted network services**	**Dynamic network price**	**Real-time RIT-D**
DATA TRANSFER	**Data-hub**	**Platform integrations**	**Point-to-point**	Point-to-point
LOCAL CONSTRAINTS COMMUNICATION PROTOCOL	CSIP-AUS (only using schema)	CSIP-AUS	**CSIP-AUS extended with pricing)**	CSIP-AUS

As per this report, the Energy Security Board is currently developing advice on an interoperability policy for Consumer Energy Resources. This work is currently considering mechanisms to implement CSIP-AUS as a standard. CSIP-AUS is a communications protocol used to support interoperability and data sharing between parties, for example transmitting DOEs between the DSO and trader or site. Standardising the use of CSIP-AUS and/or communications protocol would allow traders and devices to easily send and receive information from the DSO regardless of which network area or state they're in. This is the first step in standardising how information can be sent between different DER actors.

However, SA Power Networks included the following comments on the DER Interoperability report prepared by FTI[51]:

The CSIP-AUS is about standardising the DNSP interface for system limits, not the DER interfaces used by aggregators to control customer DER for market services (although in some cases these may use the same underlying communications protocol, IEEE2030.5). Mandating the CSIP-AUS will not standardise the aggregator-DER interface to enable portability between service providers, nor will it ensure any interoperability of devices behind the meter (e.g. with a home energy management system).

The DEIP Market Integration report also mentions the SA Power Networks and AusNet Flexible Exports trial[48] which is an in-field trial where consumers in constrained parts of the network are offered 'flexible exports. In this trial the networks are using CSIP-AUS as the protocol to communicate flexible export limits. Technology providers Fronius, SMA, and SolarEdge (inverters) and SwitchDin (gateway) are integrating against this CSIP-AUS signal to receive export limits and operate onsite generating equipment to remain below that limit.

Figure 7 summarises at a high level the interlinkages between DER communications standards and protocols applicable to Australia.

[48] https://www.sapowernetworks.com.au/future-energy/projects-and-trials/flexible-exports-for-solar-pv-trial/

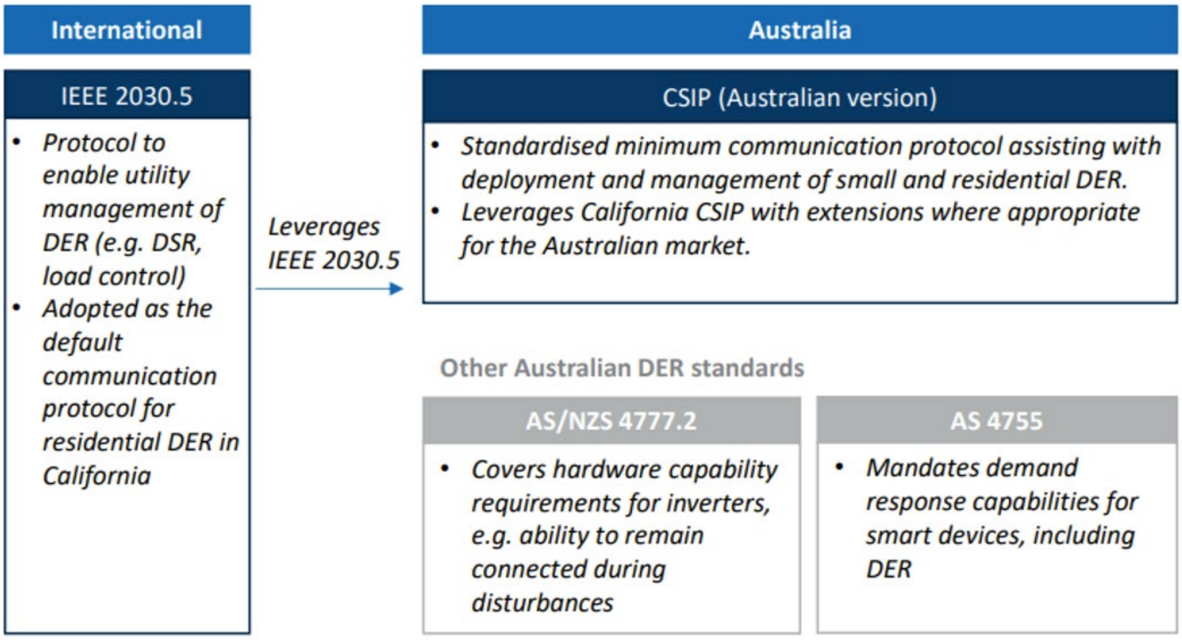


Figure 7 Selected Australian DER communication standards/protocols

	1 Grid support DER functions	2 Mechanisms for control	3 Data	4 Registration	5 Cyber security
Description	• Features (autonomous or controllable) which can support the security and reliability of the power system	• The levels of communication which must comply with IEEE 2030.5 under CSIP • The interfaces through which entities and assets must communicate	• Measuring, collecting and reporting data relating to the performance of DER and the local network	• Registration of DER assets and their respective technical characteristics	• Protecting data shared between the aggregators, site hosts, and DERs and other entities.
Example features	• Grid import and export limits • Charge and discharge rate limits	• Protocols between the aggregator and DER • Range of DER which standards will apply to	• Monitoring data (power, voltage and frequency) • Operational status reports • Alarms	• Maximum rate of energy transfer • Maximum reactive power • Max apparent power • Min power factor displacement	• Data flows • Data storage • Device authentication • Request authorization

Figure 8 Key categories of technical features within CSIP AUS

The above figure provides the key features of the CSIP AUS (refer to Figure 8). Out of this, the mechanism for control is more relevant for the NZ context.

Further AEMO's report[49] on VGI integration summarises standards with regard to EVs context (refer to Figure 9):

[49] DEIP VGI Standards Report https://aemo.com.au/-/media/files/stakeholder_consultation/working_groups/der-program/deip-ev/2021/deip-vgi-standards-report.pdf?la=en

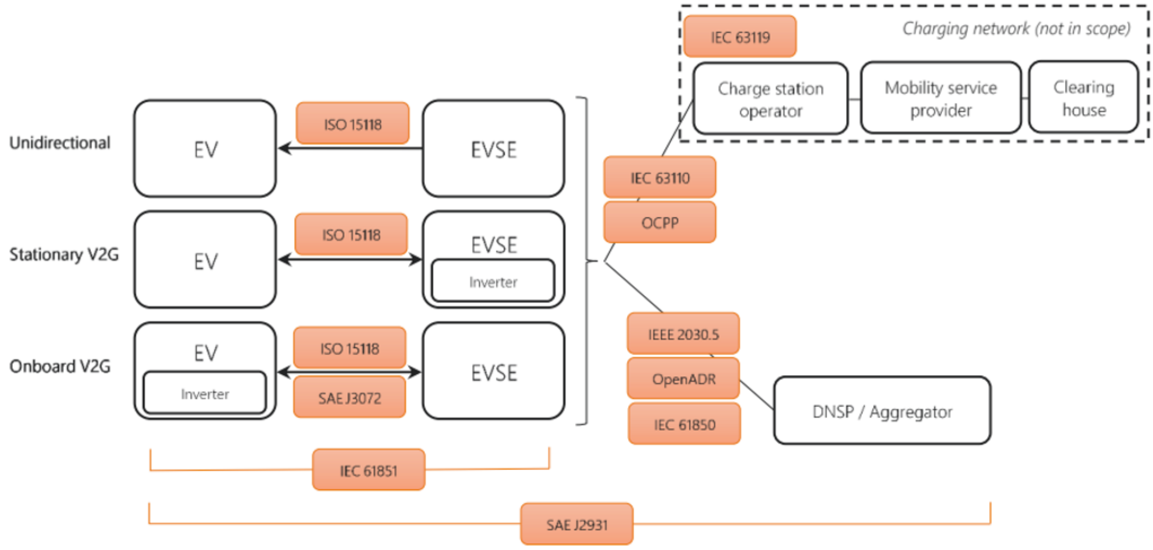


Figure 9 Coverage of major international communication and interoperability standards investigated by the Taskforce[49]

This makes OpenADR and IEEE2030.5 as the two main candidates for DNSP/Aggregator interface as below (refer to Table 7):

Table 7 Summary of IEEE 2030.5 and OpenADR[49]

Standard	Coverage	Status	Key features
IEEE 2030.5	Communication between DER devices (including EVSE) and aggregators/NSPs/market operators, as well as between devices on a Home Area Network (HAN)	Active	• Also referred to as Smart Energy Profile 2.0 (SEP 2.0) • Recent versions of the standard allow for interoperation with ISO 15118
OpenADR (IEC 62746-10-1)	Communication between demand response assets (including EVSE) and aggregators/NSPs/market operators	Active, administered by OpenADR Alliance (IEC 62746-10-1 administered by IEC)	• IEC 62746-10-1 provides a formalised standards pathway for the OpenADR 2.0b protocol • Defines a communications framework to interact with demand response assets

It is noted in the report that communications standards like IEEE 2030.5, OpenADR, and ISO 15118 could work with AS 4755.2 to provide a complete interoperable demand response framework for EVs, including communications, information exchange, response specification, cybersecurity requirements, and test procedures.

Project EDGE final report[50] states that open communication standards and the ability to send control signals locally will enable DER interoperability and offer greater customer choice of service providers. It is also noted that standardisation creates a ‘chicken versus egg’ situation: standardisation to minimise the costs of coordinating DER could improve the commercial viability of VPPs but future obligations on performance standards will have to balance the need to manage power system risks with the commercial feasibility for aggregators to comply with the standards.

[50] Project EDGE final report October 2023-https://aemo.com.au/-/media/files/initiatives/der/2023/project-edge-final-report.pdf?la=en

IEEE 2030.5 standard is used to communicate between Utility server and Aggregator cloud as illustrated below (refer to Figure 10):

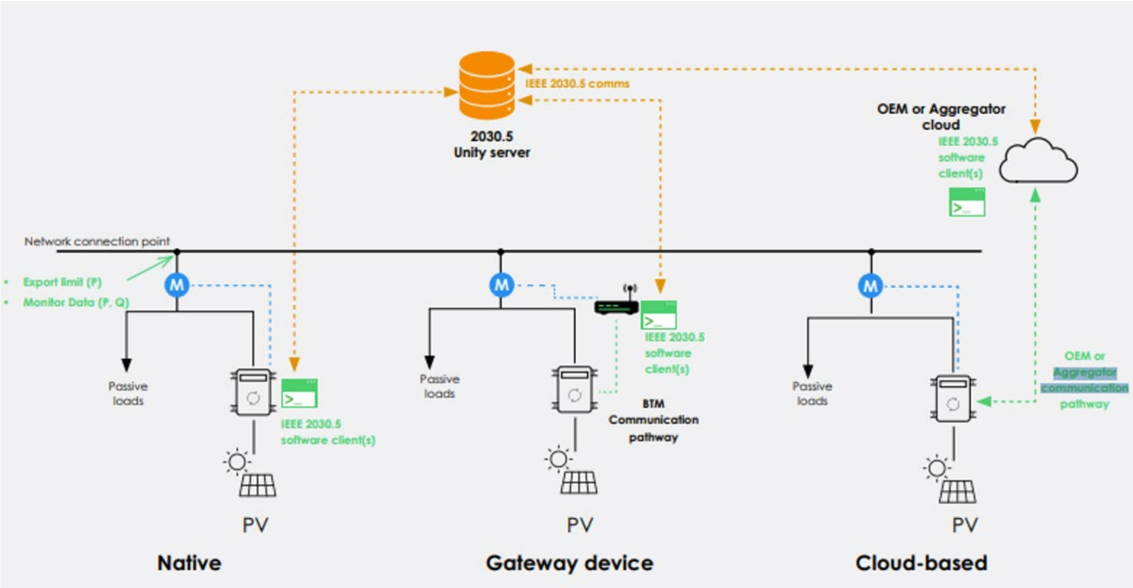


Figure 10 Initial Proposal of DOE interface landscape[50]

Communications systems and protocols (including cyber security) require ongoing development. DNSPs and the DER industry are aligning on IEEE2030.5 as the national standard for DOE communications and the cross-sector national DEIP Interoperability Steering Committee has recently released the Common Smart Inverter Profile – Australia (CSIPAUS), now in the process of standardisation through Standards Australia, which describes how IEEE2030.5 is to be used to implement DOEs in the Australian market.

3.2.3 Summary and Suitability for the NZ Context

CSIP-AUS is a communications protocol used support interoperability and data sharing between parties, for example transmitting DOEs between the DSO and trader or site. Standardising the use of CSIP-AUS and/or communications protocol would allow traders and devices to easily send and receive information from the DSO regardless of which network area or state they're in. This is the first step in standardising how information can be sent between different DER actors.

CSIP AUS draws on the international standard IEEE 2030.5, and also on the CSIP California, to develop a standardised communication protocol for residential DER, with a view to allow different DER assets to communicate with each other and with third party interfaces, in order to make Australia DER more interoperable.

While DEIP considers that the 2030.5 interoperability standard is the right direction, it also acknowledged the need to develop consistent standards through the Interoperability Steering Committee and other forums as essential.

There is currently a lack of compatible technology that is flexible exports capable. This can increase the costs of participation (due to having to install a gateway or a more expensive compatible inverter) or cause a consumer to be ineligible for the program (AusNet identified that 90% of their existing consumers with solar in constrained network areas would be ineligible for the program due to their inverter).

The DER interoperability assessment framework[51] states that the CSIPAUS, currently serving only as market guidance, focuses on the active management of DER by setting recommended operational and communications protocols. The CSIP focuses specifically on the technical specifications of visibility of DER and the provision of dynamic import and export limits.

NZ does not currently have high residential solar PV penetration issue and foresee EV and residential batteries as the biggest challenges in the near future.

[51] DER interoperability assessment framework, December 2021 by FTI Consulting

3.3 USA

3.3.1 Individual IOUs Approach and Plans

While a literature search on a wider approach to standards and protocols is listed in the Appendix IV, given below are a few case studies from the US industry.

Case Study #1- Pacific Gas and Electric Company

Standards/protocols developed/implemented
Pacific Gas & Electric Company's EPIC 2.02 DERMS project[52] provided an opportunity for PG&E to define and deploy a proof-of-concept DERMS software and supporting operational technology to uncover barriers and specify requirements to prepare for the increasing challenges and opportunities of integrating and deriving value from DERs at scale.

The two protocols considered for this project were OpenADR 2.0b and IEEE 2030.5. OpenADR was widely known for its demand response capabilities. IEEE 2030.5 was managed by the Smart Energy Profile 2.0 (SEP2) Working Group, and California's Electric Rule 21 Smart Inverter Working Group (SIWG) recommended it be used as the default communication protocol for utility-aggregator interfaces for smart inverter-enabled DERs.

Through collaboration among the DERMS vendor and the aggregators, IEEE 2030.5 was chosen as the most efficient protocol to implement for this project given current capabilities of the parties and perceived long-term adoption. However, it was recommended that PG&E and industry leaders should continue to be engaged in the various standards, policy, and regulatory bodies that are shaping utility to aggregator interactions.

Use cases
IEEE 2030.5 could not implement all the functionality required to perform all use cases (DERMS and SCADA integration). Custom extensions were needed for implementing the day-ahead market, the hourly ad hoc market, time series controls, and flexibility reporting (refer to Table 8).

Table 8 Pros and cons of each protocol

	IEEE 2030.5	OpenADR 2.0b
Pros	Supported by SIWG Base protocol already supported by DERMS vendor and one aggregator – Less cost and shorter schedule to implement	Well established for Demand Response use cases Well suited for market environments
Cons	Market functions more difficult to implement Custom extensions required	Did not support reactive power Did not leverage smart inverter functionality – meaning a separate translation layer was needed to harmonize with vendor inverter systems Not supported (at the time) by either aggregator – Additional cost and schedule length to implement Custom extensions required

Rationale
The project was designed to identify requirements and prove technical feasibility of a DERMS and supporting infrastructure by demonstrating 3 progressive core functionalities that underpin a DERMS:

1. Enhanced Situational Awareness

[52] EPIC 2.02 – Distributed Energy Resource Management System (Electric Program Investment Charge -EPIC final report)

2. Distribution Services

3. Economic Optimization

The following list outlines other technology considerations that supported the longer-term use of IEEE 2030.5 in context of DER interoperability with the DERMS:

- IEEE 2030.5 is based upon the Internet protocol:
  - No application layer knowledge required at the gateways – can implement standard Internet routers
  - Allows for end-to-end security using TLS 1.2
  - Allows for multiple link layer technologies (e.g. Wi-Fi, ethernet, cellular)
- IEEE 2030.5 implements a RESTful HTTP interface:
  - Mature interface that is well understood and stable
  - Little risk of stranding assets or not being able to reuse interface code, if desired.
  - Easy to implement by a wide body of developers
- IEEE 2030.5 mandates the use of TLS 1.2 Security (HTTPS):
  - Same foundational security layer as used in standard Internet banking
  - Meets US National Institute of Standards and Technology (NIST) ECDHE Suite B requirements
  - All devices have certificates
- IEEE 2030.5 is based upon IEC 61968 Common Information Model:
  - IEC 61968 has widespread usage around the world in context of "Smart Grid" and leverages international developments and extensions
  - Where gaps existed in IEC 61968, IEC 61850 was included (IEC 61850-90-7 is the foundational model that has been used for all smart inverter functionality.

Suitability for the NZ context

The scope of this project included the following:

- Test the abilities of DERMS operation at PG&E through a minimum viable product field demonstration to address key DER management use cases.
- Demonstrate the ability to monitor and control a diverse set of aggregated 3rd party and utility owned DERs in a limited geography.
- Create, test, and iterate on future DERMS requirements to inform near-term and long-term DER strategy and future vendor selection.

As evident, the key focus of the DERMS demo project was to monitor, control and coordinate DERs and not on the development of the competitive flexibility services market.

Case Study #2 - Southern California Edison

SCE commissioned a study through EPRI on Communication Protocols and Standards for Residential Demand Response[53]. This report provides an objective status update of Demand Response (DR) automation and control protocols for the residential sector. This study provides detailed information on the following protocols:

This paper has discussed three classes of networking technology related to residential DR: application protocols, messaging systems ("middleware"), and telecommunications infrastructure.

All three application protocol standards discussed below (OpenADR, IEEE 2030.5, and CTA-2045) have advanced sufficiently to be included in DR and DER grid codes, manufacturer standards, and regulations. They are recognized by national and international standards bodies (IEC, IEEE, and ANSI) and are being specified and adopted across the country and the world (refer to Table 9).

[53] Communication Protocols and Standards for Residential Demand Response (dret-ca.com)

Table 9 Summary of OpenADR, IEEE 2030.5 and CTA-2045[53]

OpenADR	IEEE2030.5	CTA-2045
OpenADR is the leading protocol for standards-based DR, accommodating both utility-supplied or utility-specified devices as well as "Bring Your Own Device" programs. Its focus has been on managing DR in the form of generalized resources (via grid condition codes, prices, etc.).	IEEE 2030.5 was built around information models that describe specific device types and is consequently typically used to modify the detailed behaviours or responses of such equipment (such as power factors and Volt-VAR curves in smart inverters). Although in principle IEEE 2030.5 could be used to manage "pure" DR via load control and pricing feature sets that have been defined for it, this has not received much attention. Its main appeal has therefore been to utility protection and control engineers concerned about the predictability of autonomous responses performed by the power electronics associated with distributed generation (supply) resources.	CTA-2045 is not a wide-area protocol at all. Rather, it provides a physical, electrical, and logical standard for attaching universal communication modules to smart-grid DR devices.

OpenADR

OpenADR primarily addresses generalized or aggregated resources (rather than devices), it does not contain information models with detailed device specific characteristics (settings, load information, power levels, etc.). However, OpenADR is now being explored to control both loads and inverters. The device-specific actions performed when responding to the event are usually not explicitly stated in the OpenADR message (though they may be for common devices like thermostats).

OpenADR is a profile (subset) of the OASIS Energy Interoperation standard and has been approved as an IEC standard (IEC 62746-10-1) in 2019. It has seen broad adoption in California (where it was created) and in Japan. It is also used when a generic, open standard is desired for integrating a heterogeneous mix of devices, such as in many "bring your own thermostat" programs. Furthermore, OpenADR is being required as part of other standards, such as AHRI's forthcoming 1380P standard for variable-speed HVAC equipment, "Methods for Coordinated Energy Management in Residential Applications," and in California's Title 24 building code related to non-residential HVAC Controls, Lighting Controls, and Electronic Messaging Centre Controls. Recently, the British Standards Institution (the national standards body of the UK) mandated the use of OpenADR in its latest Publicly Available Specification for Energy Smart Appliances (BSI PAS 1878:2021)

IEEE2030.5

It was developed as a secure communication protocol to integrate consumer's smart devices into the smart grid, including smart loads, electric vehicles, and distributed energy resources (DERs). The protocol reduces communications architectural challenges by using the familiar Internet Protocol (IP) and supporting a variety of protocols at the physical layer (including Ethernet, Wi-Fi, powerline communications, and low-power radio technologies). IEEE 2030.5 includes "function sets" for price communication and for DR/DLC.

IEEE 2030.5 has attracted much attention due to being one of the DER device-level communication protocols listed in the most recent draft of IEEE 1547. However, it has yet to see significant use for DR. It is premature to discuss adoption of this protocol because 2030.5's application (even for DER) is relatively new. Several California utilities have conducted laboratory testing using IEEE 2030.5 to evaluate its smart inverter functions. One of the IOUs is conducting a pilot project to demonstrate its application to DER. No demonstrations of its use for DR or DLC have been identified thus far.

ANSI/CTA-2045

Officially called the “Modular Communications Interface for Energy Management,” the CTA2045 standard was first released in February 2013 by the Consumer Electronics Association (which has since become the “Consumer Technology Association”). It was created by a consortium of stakeholders to provide a single, standardized interface for smart grid-enabled devices.

Starting in 2019, adoption of the CTA-2045 standard has seen exponential growth across the industry. The following table includes links to state laws, standards, and specifications that depend on this standard (refer to Table 10):

Table 10 CTA-2045 state laws, standards, and specifications[52]

Entity/Source	Title
Northwest Energy Efficiency Alliance	Advanced Water Heater Specification
Consortium of Energy Efficiency	CEE Residential Water Heating Specification
Air-Conditioning, Heating, & Refrigeration Institute	AHRI 1380 (I-P) Demand Response through Variable Capacity HVAC Systems in Residential and Small Commercial Applications
Environmental Protection Agency’s ENERGY STAR® Program	ENERGY STAR® Program Requirements Product Specification for Residential Water Heaters Eligibility Criteria Version 3.3 Draft 2
Washington State	House Bill 1444 APPLIANCE EFFICIENCY STANDARDS
California Energy Commission	Appendix JA13 – Qualification Requirements for Heat Pump Water Heater Demand Management Systems

With the growing adoption of CTA-2045, there has come new interest in increasing the visibility of the standard and developing a testing certification program. The OpenADR Alliance has recently announced that it will be taking the lead for these activities for CTA-2045. The 3-13 Consumer Technology Association will continue to the standards organization that owns the standard. As part of this new initiative, there will be an introduction of a new name for CTA2045-enabled devices: in the future, the connector will be known as EcoPort.

Suitability for the NZ context

Above summary is very clear and reinforces that OpenADR is the closest match for flexibility market at the moment and is evolving. IEEE2030.5 on the other hand started from the device control but is evolving too. IEEE2030.5 is likely to be the preferred protocol between SCADA and DERMS. NZ EDBs will need to watch both standards in the near future.

4. Conclusions and Recommendations

Key conclusions and recommendations from this study are given below:

4.1 Key Project Conclusions

The following summarises the key project conclusions from this analysis which are detailed further within the report:

1) Inherent flexibility in the DER/CER can support networks by enabling them to manage constraints through the utilisation of non-network solutions and allowing enhanced access to electricity markets.
2) Open communication standards / protocols are one of the key enablers of flexibility i.e., to exchange network information, pricing signals, and control signals.
3) Establishing interoperability is an important enabler for establishing:
   a) Common language between networks, DSO, and aggregators/flexibility service providers/market facilitators; and
   b) Controllability of devices from different OEMs e.g., PV inverters, EV chargers etc.
4) International open access standards can help boost market participation, cost efficiency, and easy access, as defined common protocols and standards allow for faster and more seamless connection and exchange of data.
5) The two most mature communication protocols for flexibility currently being considered for adoption internationally are OpenADR and IEEE2030.5.
   a) Currently, OpenADR is more mature in Demand Management (DM) market functions while IEEE2030.5 is stronger in smart control functionality.
6) Whilst each have strengths, both require further progression to meet all the requirements of demand flexibility, with some components still in development to provide end to end functionality. Current enhancements being developed include:
   a) Open ADR 3.0 offering more dynamic price structures, as well as capacity management (DOE); and
   b) IEEE2030.5 using site EMS/aggregator to translate DM requirements into specific device commands.
7) From the international scan it was observed that currently no jurisdiction is following a single pathway on communication protocols and instead are moving down different protocol pathways due to their specific requirements.

   For example, the ENA UK is currently investigating the development of a separate communication standard (leveraging current knowledge) as they consider it may be more suited to their market structure and may provide the adaptability they require as the system continues to transform.
8) Use of APIs can support basic functionalities such as enabling communication between flexibility providers and networks (SCADA/ADMS/DERMS).

4.2 Key Project Recommendations

A summary of the key recommendations or next steps are provided below:

1) Continue to monitor closely international developments, with particular emphasis on
    a) Australia due to their market proximity and speed of advancement in managing high penetration levels of DER within their distribution systems; and
    b) The UK due to similarity in structure and drivers in terms of DER/CER penetration, and regulations.
2) Build on existing body of knowledge on communication protocols and map the capabilities against New Zealand's requirements as it moves through the energy transition, before finalising any specific standard/protocol.
3) Consider the following least regrets actions:
    a) Establishment of a DER/CER integration working group to monitor the New Zealand market, scan global developments, and help design and undertake future trials.
    b) Connect and collaborate with similar DER integration and flexibility working groups in other jurisdictions such as the UK, USA, Europe and Australia.
    c) Establish a taskforce/study immediately to
        i) Design and obtain consensus on future energy scenarios for New Zealand; and
        ii) Combine knowledge from local trials.
    d) Design and implement an "regulatory sandbox" to enable trials (innovation with flexible rules) and work with government, industry and regulatory bodies to identify gaps and develop solutions in technology, regulation, functionality and consumer education to ensure industry preparedness.

Appendix I Information Sources-Workshop Summary

UK & Europe

- ENA Open Networks project: focusing specifically on specifications developed for flexibility.
- National Grid ESO Demand Flexibility Service: this service procures flexibility from consumer energy resources both for 'test' and 'live' events from energy suppliers and aggregators. Review to focus on API/protocols used.
- Flexible Power: portal used by four GB DNOs to share information on their flexibility requirements (flexibility is contracted by the DNO, not Flexible Power)
- EDB/DNO flexibility procurement details: reviewing published information from individual DNOs, particularly those not included on Flexible Power on their procurement of flexibility.
- Piclo Flex Great Britain: an independent marketplace for flexibility services – used by a number of GB DNOs. Piclo Flex are also active in Italy, Portugal, Lithuania and the US
- Flex Project for NIE Networks: this developed an initial technical and commercial framework for the procurement and utilisation of flexibility services in Northern Ireland. This will be reviewed to determine how the interface between the DNO, and aggregator was specified.
- Further review to follow to identify sources for mainland Europe via ENTSOE innovation hub, including the INTERRFACE project.

Open Networks 2023 Detailed Work Plan January 2023

https://www.energynetworks.org/assets/images/Resource%20library/2023/Jan/Open%20Networks%202023%20Detailed%20Work%20Plan%20(Jan%202023).pdf

Interoperable Demand Side Response programme

https://www.gov.uk/government/collections/interoperable-demand-side-response-programme#:~:text=The%20Interoperable%20Demand%20Side%20Response,of%20interoperable%20demand%20side%20response

The Future of Distributed Flexibility

https://www.ofgem.gov.uk/publications/call-input-future-distributed-flexibility

Open Networks-ENA UK

https://www.energynetworks.org/industry-hub/resource-library-old/open-networks-2023-launch-document-(jan-2023).pdf

Catapult Energy System

https://es.catapult.org.uk/

Energia

https://www.energia.ie/home

USA

Open communication protocols for vehicle grid integration

https://energyinformatics.springeropen.com/articles/10.1186/s42162-020-0103-1

ENERGY Industry Review

https://energyindustryreview.com/energy-efficiency/siemens-ranks-no-1-vendor-for-managing-distributed-energy-resources/

National Grid

https://www.nationalgrid.com/

Hawaiian Electric

https://www.hawaiianelectric.com/

Texas

https://www.ercot.com/gridmktinfo/dashboards

Rocky Mountain Institute

https://rmi.org/

Southern California Edison

AUTOMATED DEMAND RESPONSE CONTROL INCENTIVES

https://www.sce.com/sites/default/files/2022-05/Auto-DR%20Program%20Handbook%204.27.22.pdf

PG&E

https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/PGE-EPIC-Project-2.26.pdf

https://www.iea-4e.org/wp-content/uploads/2022/11/Energy-Protocol-Report-Release.pdf

https://www.epri.com/research/products/000000003002024179

DERMS (what protocols available?)

https://www.hitachienergy.com/us/en/products-and-solutions/scada/network-management/network-manager-adms/distributed-energy-resource-management-system-

https://guidehouseinsights.com/reports/guidehouse-insights-leaderboard-derms-vendors

https://www.smartergridsolutions.com/products/strata-grid

https://www.opusonesolutions.com/opus-one-derms-platform/

https://www.ge.com/digital/sites/default/files/download_assets/opus-one-derms-from-ge-digital.pdf

Quality Logic (for testing)

https://www.qualitylogic.com/

NZ

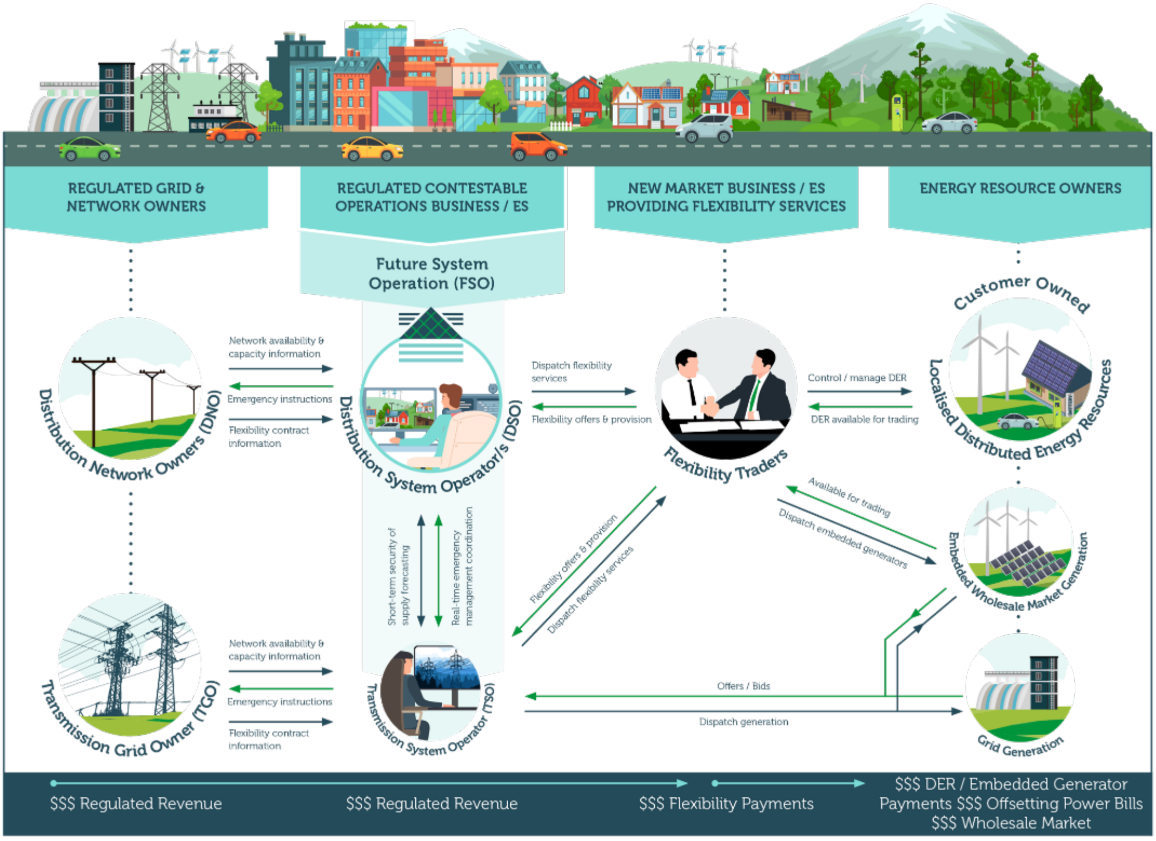
Flex Forum / A Flexibility Plan 1.0

https://assets.nationbuilder.com/seanz/pages/1484/attachments/original/1684101343/FlexForum-Flexibility-Plan-1.0_%281%29.pdf?1684101343

Demand Flexibility Common Communication Protocol Project Overview January 2023

https://www.eea.co.nz/Site/asset-management/adr-project/about-adr-project.aspx

Flextalk



Solar Zero VPP

https://www.solarzero.co.nz/virtual-power-plant

Australia

DER Interoperability Assessment Framework

https://www.energy.gov.au/sites/default/files/2021-12/FTI%20-%20Assessment%20Framework%20for%20DER%20interoperability%20policy%20-%20December%202021.pdf

DEIP-DER Market Integration Trials

https://arena.gov.au/assets/2022/09/der-market-integration-trials-summary-report.pdf

SAPN-Flexibility Export Project

https://www.linkedin.com/posts/brendonhampton_we-were-incredibly-honoured-to-be-awarded-activity-7130157709332549633-rfTb/

https://www.sapowernetworks.com.au/data/317030/world-leading-energy-initiative-and-safety-win-premier-s-award/

Appendix II UK & Europe

Innovation Trials and Development

The energy regulator for Great Britain, Ofgem, and UK Government have produced various plans, reports and consultations in relation to flexibility and the energy system in recent years. This sub-section reviews a number of key documents, including those highlighted in the project workshop and subsequently.

Smart Systems and Flexibility Plan (2021)[54]

This Plan, a joint publication by the government and Ofgem, sets out a vision, analysis and work programme for delivering a smart and flexible electricity system (defined as "one which uses smart technologies to provide flexibility to the system, to balance supply and demand and manage constraints on the network"). The plan covers flexibility from consumers, removing barriers to flexibility on the grid (including electricity storage and interconnection), reforming markets to reward flexibility and digitalisation of the energy system. It estimated that with 40GW of wind generation on the system in 2030, around 30GW of low carbon flexible assets (storage, DSR and interconnection) will be required – a threefold increase compared to the time of writing, including around 4GW of flexible demand.

The plan envisages widespread uptake of flexibility by domestic customers facilitated by smart meter roll-out, smart tariffs (and half hourly settlement), interoperable and secure smart appliances and smart charging of EVs.

The Plan also sets out proposed and planned changes to the energy market necessary to develop a smart and flexible energy system. Of particular relevance to this project, these include:

- The development of a single integrated platform for all ESO balancing service markets.
- Highlighting work already undertaken by DNOs in the Open Networks projects, such as taking, "initial steps towards standardisation, including the development of standard products, a common contract for distribution flexibility tenders and a common valuation methodology for flexibility".
- The plan sets out work to be completed in the future; "networks must deliver and adopt a standardised approach to procuring flexibility…including common approaches to valuing flexibility baselining methodologies, pre-qualification, **dispatch** and settlement and monitoring requirements." Details of how this standardisation of dispatch mechanisms, or how this could be aligned with the ESO are not specified.
- It also highlights a need for co-ordinated activity between the DNOs and system operator, in order to optimise the electricity system as a whole.

Interoperable Demand Side Response Programme[55]

This programme is administered by the Department for Energy Security and Net Zero and the Department for Business, Energy and Industrial Strategy. It "aims to support the development and demonstration of energy smart appliances for the delivery of interoperable demand side response." The programme is focused on LV connected loads under four categories – EV charge points, battery storage, electric heating ventilation and air conditioning (HVAC) and white goods. It was allocated £9.15 millions of funding (forming part of a wider £65m Flexibility Innovation Programme) and was open for applications in 2022.

It consists of three streams of work, as follows:

1. Supporting the development and demonstration of energy smart appliances to deliver interoperable DSR according to PAS 1878 and 1879[56] (see below).

[54] Transitioning to a net zero energy system: Smart Systems and Flexibility Plan 2021 (publishing.service.gov.uk) Accessed November 2023
[55] Interoperable Demand Side Response programme - GOV.UK (www.gov.uk) Accessed November 2023
[56] https://www.openadr.org/assets/PAS1878_RS_20230912_OpenADR%20Unlocks%20Flexibility%20Throughout%20Europe.pdf Accessed November 2023

2. As above, but accessing DSR via the GB Smart Metering System, including using a standalone auxiliary proportional controller and Open ADR functionality via the GB smart metering system.

3. Supporting feasibility studies to improve and develop understanding of how energy management systems (EMS) can act together with energy smart appliances to deliver interoperable DSR.

The list of projects supported by the initial funding allocation were announced in January 2023[57]. On the whole the participant companies in these projects, and their focus is on developing controllable loads, and linking these with an aggregator. The development of standardised communication protocols from the EDB/DNO to the aggregator is not within scope.

The government commissioned two codes of practice from the British Standards Institute (BSI):

- PAS 1878: Energy smart appliances – smart functionality and architecture (specification): this standard specifies requirements and criteria that an electrical appliance needs to meet in order to perform and be classified as a smart appliance. It is intended to be used by manufacturers of smart appliances and consumer energy managers.
- PAS 1879: Energy smart appliances – demand side response operation (code of practice): provides minimum recommendations for functionality, information flow, communications capability and cyber security for the implementation of a DSR service.

The diagram below shows the entities/elements considered within PAS 1878 and 1879:

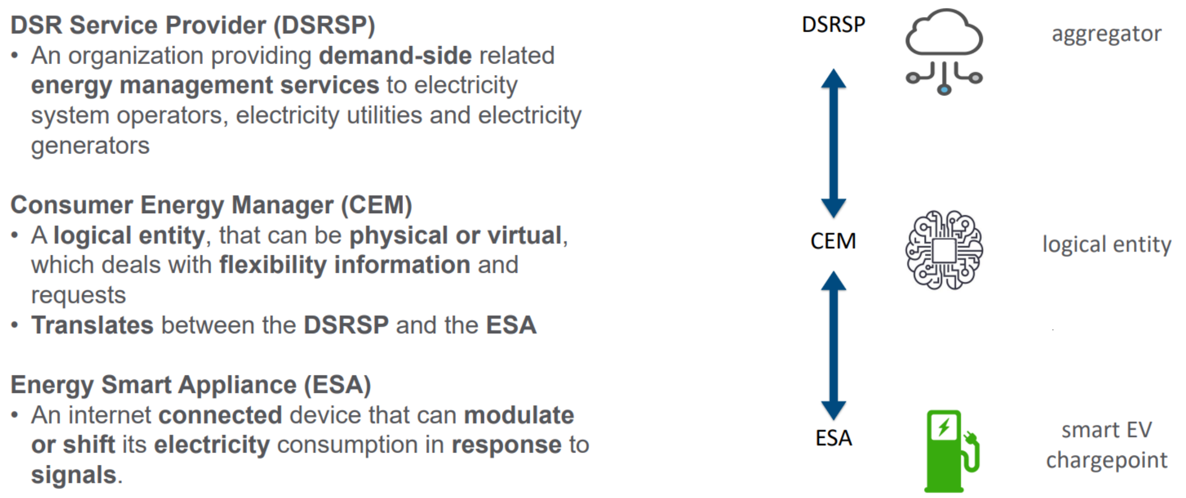


Figure AII.1 Entities defined in PAS 1878 and 1879[58]

The interfaces covered within the standard focus on those 'downstream' of the aggregator – to the device(s), rather than 'upstream' to the EDB.

The Future of Distributed Flexibility[59]

This is a call for input issued by Ofgem in 2023. Ofgem are proposing a "common end vision for distributed flexibility…: a common digital energy infrastructure". They suggest that "the common digital energy infrastructure would address three of the market failures by delivering information provision, market coordination of operations and actions, and trust and governance". The call for evidence explores three potential archetypes for a common digital energy infrastructure, with varying levels of information provision from 'thin', to 'medium' and finally 'thick'.

A key accelerator to flexibility is identified as the ability for "consumers/the companies that aggregate their assets together to know "where and when it is a "good" or "bad" location or time to use electricity". Energy

[57] Interoperable Demand Side Response Programme: successful projects - GOV.UK (www.gov.uk) Accessed November 2023
[58] https://www.openadr.org/assets/PAS1878_RS_20230912_OpenADR%20Unlocks%20Flexibility%20Throughout%20Europe.pdf (Slide 6) Accessed November 2023
[59] Call for Input: The Future of Distributed Flexibility | Ofgem Accessed November 2023

markets are identified as the best indicator of this. However, it is also acknowledged that these markets were designed for a legacy market, which did not include CER, and there is a requirement to remove barriers to entry (to the market) to ensure that all distributed assets can access the market and are aware of the value-streams available.

The document makes the distinction between Consumer Energy Resources (CER) and Distributed Energy Resources (DER, business owned assets which are larger in scale and can be connected at any voltage level on the distribution network). Ofgem propose that resolving issues to facilitate CER participation in the market will also resolve issues for DER, whilst the converse is not true. The focus of the paper is therefore on solutions which will allow participation of CERs in flexibility markets – in line with the focus of this project.

One of the pain points highlighted in the document around market co-ordination is a lack of operational co-ordination. The potential for standardisation in the communications protocols used by DNOs to communicate with aggregators would result in an element of consistency.

The paper proposes a "common digital energy infrastructure". The need for an approach including core software, hardware and networking approaches which are designed such that they can be deployed globally is acknowledged, including the role for international data standards and communication protocols. However, the paper does not provide a detailed assessment of potential standards to be used, although a number are compared in the Open Grid Systems report summarised below.

The call for evidence presents three, increasingly interventionist 'archetypes' for the future development of digital infrastructure to support distributed flexibility:

- **'Thin':** based on the concept of a directory that would assist market buyers and sellers of distributed flexibility to understand the landscape of markets and assets available. Access to the directory would be open, and common communication standards would be established between all market participants (via open standardised APIs[60]). There would not be a common point of access to join markets, or a co-ordinated approach between markets. To a degree, this appears to be developing organically in the UK with the development of Flexible Power and Piclo Flex used by a majority of DNOs (see below). However, as outlined in the description of this option, there is no co-ordination between DNO and ESO services in this model. Indeed, assets cannot be signed up to provide multiple services during the same time periods.
- **'Medium':** an 'exchange' – "a singular and scalable digital location where multiple markets are visible and co-ordinated under a known governance framework, yet continue to retain their own market designs, platforms and systems. An exchange would allow buyers, including independent market operators and system operators, to procure, dispatch, and settle, but they would do so in a transparent and coordinated environment."
- **'Thick':** "this archetype is a central platform for the end-to-end delivery of distributed flexibility. The central platform encompasses all activities from exploration to settlement across all markets". The approach would be unlikely to leave any service provision with existing systems.

Discussion on whether a common digital energy infrastructure should take a new build approach or be an extension of/build on existing technologies such as the ESO's platforms being extended to co-ordinate across multiple markets.

All three of the proposed archetypes described above call for some degree of common communications protocols, even in the 'thin' option. Ofgem have not proposed any specific standard to be used in the call for evidence. However, it reflects the current position of the UK market, where these protocols are not yet standardised.

An additional Technical Report was published alongside the call for input, produced by Open Grid Systems[61]. This report reviewed five viable candidate standards which enable the interfaces of a common digital energy infrastructure as outlined in the call for evidence. It notes that "existing flexibility solutions have typically leveraged only those standards supporting device level communications, rarely implementing standards-based data exchange among market parties." This can be seen in the context of EV chargers providing flexibility to

[60] The APIs to be used are not specified.
[61] Assessment of Candidate System-Wide Flexibility Exchange Interface Models (ofgem.gov.uk) Accessed November 2023

network operators. A well-developed standard (the Open Charge Point Protocol[62]) is available for communications between a back-office provider and the ChargePoint itself, with the majority of charge points on the UK market having this functionality. A similar open standard is not yet in place for parties in the energy market to communicate with the back-office provider or an aggregator, who could offer flexibility services.

The report reviewed five candidate standards against the following criteria:

- Data domains covered by the standard across eight areas – registration, competition, availability, dispatch, reporting, performance, settlement and grid model. Standards which covered a larger number of domains scored more highly.
- Type of information model used (message model, defining the structure of individual messages vs. semantic model, defining an underlying information model used to structure the content of all messages). A semantic model scored more highly.
- The development process, with standards developed by a Standards Development Organisation (such as the IEC) rated more highly than those supported by a community process.
- The richness of the message library.

The results of the review are shown below:

	IEC CIM	ebIX	OpenADR	IEC 61850	IEEE 2030.5
Data Domains	8	4	5	3	3
Data Model	Semantic Model	Message Model	Message Model	Semantic Model	Semantic Model
Development Process	Curated	Curated	Community	Curated	Curated
Message Library	Rich	Developed	Developed	Developed	Developed

Figure AII.2 Standards Reviewed and Ratings[63]

The IEC CIM standard is recommended as the preferred standard, supporting all eight data domains and having been developed by a Standards Development Organisation. Further details of each of the standards considered are given in the report. It should be noted that the recently released Open Networks document setting out evaluation criteria for dispatch signals states the following, "CIM is a popular standard for an information model to communicate structured information through, but it is not in itself a transport protocol, API or architecture for a wider cross-organisation IT interface for dispatch commands to be sent over the public internet".

[62] OCPP 2.0.1, Protocols, Home - Open Charge Alliance Accessed November 2023
[63] From Page 7 of Assessment of Candidate System-Wide Flexibility Exchange Interface Models (ofgem.gov.uk) Accessed November 2023

Table AII.2 Five Candidate Standards – The Future of Distributed Flexibility

Standard	Data Domains	Data Models
IEC Common Information Model (CIM) The Common Information Model (CIM) is a comprehensive, cohesive information model which structures a wide range of data representing the "things" of importance in electric utility operation. Includes IEC 62325-451; IEC 62325-452; IEC 62746-4; and IEC 61970.	Registration, Competition, Availability, Dispatch, Reporting, Performance, Settlement, Grid Model	Semantic Mode
Energy Business Information eXchange (ebIX) ebIX is the name applied to the collection of data exchange standardisation artefacts curated by the European Forum for Energy Business Information Exchange (ebIX Forum).	Registration, Reporting, Performance, Settlement, Grid Model	Message Model
OpenADR The OpenADR Alliance publishes and promotes the OpenADR specification32, which is based on work originally developed by Lawrence Berkeley National Laboratory. The OpenADR Alliance was created to enable utilities and aggregators to cost-effectively manage growing energy demand and decentralised energy production, and customers to control their energy future. Includes OpenADR 2.0 as a IEC Publicly Available Specification numbered IEC/PAS 62746-10-1	Registration, Availability, Dispatch, Reporting, Performance	Message Mode
IEC 61850 IEC 61850 is a well-established international standard defining communication protocols for Intelligent Electronic Devices (IEDs) at electrical substations.	Registration (partial), Availability (partial), Dispatch, Reporting	Semantic (but structured around device modelling)
IEEE 2030.5 Institute of Electrical and Electronics Engineers (IEEE) 2030.5 is an application protocol for smart metering and automation of demand/response and load control in local or home area networks.	Registration (Partial), Availability (Partial), Dispatch, Reporting	Semantic Model

Open Networks

The Open Networks programme is overseen by the Energy Networks Association (ENA) and began in 2017[64]. It has 10 participating members – the six GB DNOs, Northern Ireland Electricity Networks, ESB Networks (Republic of Ireland DNO), National Grid Electricity System Operator and BUUK ("the UK's leading independent provider of last-mile utility networks"). The purpose of the programme is "to work together to standardise customer experiences and align processes to make connecting to the networks as easy as possible and bring record

[64] Open Networks: Five Years ON – Energy Networks Association (ENA) Accessed November 2023

amounts of renewable distributed energy resources, like wind and solar panels, to the local electricity grid." There were originally six workstreams:

- WS1A: Flexibility Services
- WS1B: Whole Electricity System Planning
- WS2: Customer Connections
- WS3: DSO Transition
- WS4: Whole Energy Systems
- WS5: Communications and Stakeholder Engagement

From 2023 these were consolidated into three, Planning and Network Development, Network Operation and Market Development. From 2023 onwards the Open Networks programme will focus on[65]:

- "Making it easier for flexibility service providers to participate in the flexibility market by standardising products, processes and contracts.
- Improving operational coordination between networks and companies to remove barriers to the delivery of Flexibility services.
- Improving the transparency of processes, reporting and decision-making."

The Flexibility programme consists of nine product areas – including P3 Dispatch Interoperability and Settlement, which will consist of a "review of interoperability of systems across DNO and ESO and reviewing the approach to settlement across DNO services.[66]". In 2022 the Open Networks programme published a review of existing practices for dispatch and settlement for flexibility services[67]. The key findings from this review were:

- "The most significant alignment is amongst DNOs that are using the Flexible Power platform to manage dispatch; however, this alignment is the result of a common choice of platform for managing dispatch rather than as the result of a decision to align practices between DNOs".
- In the longer term, the group have identified that APIs will be used as the primary way for System Operators to communicate dispatch requirements, due to the greater levels of automation and scalability.
- "Following the gap analysis the P3 group agree in principle that the adoption of a common API for dispatching of services should be long term goal of dispatch interoperability, however, such an API would need to be designed in an appropriately flexible manner to provide future proofing…With this in mind the P3 group will now explore existing dispatch standards at a high level to see if these could be appropriate for adoption"
- The work of the P3 group identified existing dispatch standards such as Universal Smart Energy Framework and IEEE 2030.5. However, these are not currently in use by GB DNOs. IEEE 2030.5 is described in the PG&E example described in the USA section, below.

Future work for the Open Networks programme (under the 'Network operation') stream includes "providing an optimal end-to end experience of DSO flexibility market platforms through developing API standards, saving flexibility providers from needing to develop multiple interfaces". This reflects the findings of the review below – that DNOs in the UK have not currently standardised the methods they use to dispatch flexibility and are not using communication protocols based on international standards. This is supported in the further document described below. The stakeholder engagement undertaken as part of preparing that report included feedback from participants that while there may be existing viable solutions (i.e. standards for the dispatch of flexibility services), "no flexibility service provider/aggregator stakeholder had experience with such solutions however, indicating that the maturity of existing standards/APIs was not necessarily at system-ready level".

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65 ENA_RoadmapFlexibilityReport_V3 FEB.pdf (energynetworks.org) Accessed November 2023
66 ON22-PRJ-2022 Flexibility Consultation Wrapper Document (energynetworks.org) Accessed November 2023
67 ON22-WS1A-P3 Review of existing practices and gap analysis (05 Apr 2022).pdf (energynetworks.org) Accessed November 2023

A further document[68] was released by the Open Networks project during the preparation of this report which aims to enable "objective assessment and evaluation of options around APIs and standards for dispatch of flexibility services." Its aim is to propose the framework against which standards should be evaluated (and provide examples of doing this) rather than to make a specific recommendation as to any particular standard. Whilst the report focuses on dispatch of services, flexibility service providers and aggregators highlighted the importance of a system which is integrated across the whole of the lifecycle, from registration to procurement, planning, settlement etc.

The report identifies the following considerations in selecting an API standard:

- Performance: not likely to be a limiting factor for a modern API interface, given the current speed at which the market operates (i.e. week ahead or at the latest, day ahead signals). Performance may be become of greater importance in the future if a real-time system was in operation – either for DNOs sending dispatch signals, or service providers communicating status in real time. There may also be performance requirements for the speed of information exchange if a communications protocol is used with defined 'handshake' routines requiring a response in a set period of time to prevent a time out.
- Open standard: an open standard is preferred by flexibility providers as well as offering better value for bill-payers through efficiency of implementation. Openness should include governance and ability to participate (e.g. via a Standards Development Organisation) so that the standard can evolve to meet the UK's future energy system requirements.
- Interoperability: this is a key concern as flexibility providers may be providing their services to multiple different operators. A testing system or type approval should be in place which allows providers to confirm their system complies with the standard and will therefore integrate correctly with the DNO's systems.
- Scalability: a standard or API should not pre-judge how the market will evolve and should therefore be sufficiently scalable to allow for a large number of market participants and avoid the technology or standard from becoming a constraint to market access. Scaling to include additional markets, such as interaction with the ESO should also be considered.
- Security: this should be considered and addressed from the earliest design phase of a project and consist of "defence in depth".
- Maintainability: consideration should be given to the feasibility of market participants running and operating the necessary infrastructure to participate in the market and ensure that this is not too onerous (which would reduce choice in the market). Ideally the system should also be modular to allow integration with other business systems. The ability for the API standard to evolve as the market evolves is also a consideration under this category.
- Platform independence: the API should be platform independent to allow service providers flexibility to either create their own implementation or purchase it from a range of third-party vendors – a single source supplier should be avoided.
- Backwards and forwards compatibility: this allows for flexibility – for vendors who wish to continue to operate older versions (where still secure), as well as allowing new components to be introduced without causing issues.

It also considers the relative merits of 'build' (developing a bespoke dispatch API for the UK industry) vs. 'buy' (using an existing available product or standard/API). The report highlights that there is a potential that adopting an existing standard limits the UK's influence on the development of that standard (due to time commitment required to participate in standard bodies activities) and the desire for the UK to have the ability to develop its own flexibility dispatch ecosystem over time.

Three potential options were identified: the Common Interface Model (CIM), OpenADR and UMEI[69]. It should be noted that the purpose of the report was to propose a method by which standards could be evaluated (e.g. the

[68] Flexibility Services Interoperation. Comparative Analysis of Options. Open Networks. October 2023. Version 1.0. To date this document has been circulated via email and is not currently available online.
[69] EUniversal UMEI - active management system to flexibility markets Accessed November 2023

criteria to consider) rather than to make a specific recommendation about which the most appropriate standard would be. The standards which were not shortlisted, and the rationale for this, is given in the tables below.

Table AII.3 Standards Not Shortlisted – Open Networks

Standards Not Shortlisted	
Standard or Proposal	**Rationale to not shortlist**
OASIS Energy Interoperation Common Transactive Services (CTS)	• Standard reached a draft v1.0 in April 2022, with a feedback deadline of June 2022, and has not been ratified since, with draft containing many TODO's. • While standard implements a wide marketplace specification, the semantics used to represent "transactions" (i.e. their concept of an invoked tender/contract) do not align with the messages required to carry out dispatch. • The transaction support does not allow for cancellation or modification of transactions (i.e. to implement cease or variation instructions as required by ENA). Nor is there any concept of declaration of availability. Transaction support only includes price and quantity fields; therefore is not communicating what is being dispatched, and would not meet needs of a dispatch protocol.
Energy Flexibility Interface (EFI)	• Is a protocol for direct control of end-user smart devices, seeking manufacturers to implement EFI on those devices, to enable the in-home devices to work with other protocols such as OpenADR and similar. • May be useful for aggregators and FSPs for their "to device" communications. • Protocol is heavily designed around end device control, and announcing device capabilities. It is stated (Section 1.2) as a solution for interoperability in communications between a consumer device and demand-side management system.
IEEE 2030.5	• The relevant portion of IEEE 2030.5 (i.e. demand response and load control) is effectively a SCADA control-type protocol for direct asset control, rather than dispatch. Messages are therefore end-device oriented, focusing on parameters like temperature offsets for thermostats. • The protocol contains no concepts for reference to procured services, and instead focuses on the actual control events for end devices.
USEF	• The USEF Foundation is no longer active as of June 2021, although the materials it produced are available online. • USEF defines a wider flexibility ecosystem in their standards, which may deliver on other areas of interest such as issuing flexibility requests (i.e. market engagement). • The operate phase of the standard is the one which pertains to flexibility dispatch, but the written standard does not provide sufficient details to allow the standard to be implemented or validated (i.e. the schemas for operate phase messages such as "FlexOrder" were not defined or available in the XML schema).
Inter-Control Center Communications Protocol (ICCP) [IEC 60870-6]	• ICCP is a widely used tele-control protocol for communications between control centres. It offers basic control requests (switching, trips, raise/lower, etc.) and code execution. • ICCP offers no security, and assumes it is provided by network layers – this would present challenges in a flexibility market with a wide range of participants.

The report provides two additional, prior deliverables as appendices:

- D1 Interoperability gaps: identifying the requirements of stakeholders for a common interface for all flexibility service providers. The feedback gained is broken down by that gained from flexibility service providers and DNO/DSOs. This work identified areas which would need to be addressed in future work.
- D2 Minimum requirements: outlines the minimum technical requirements a flexibility service dispatch interface would require in order to provide a minimum viable product.

INTERRFACE Project

The purpose of the INTERRFACE project[70] was to "design, develop and exploit an Interoperable pan-European Grid Services Architecture to act as the interface between the power system (TSO and DSO) and the customers and allow the seamless and coordinated operation of all stakeholders to use and procure common services". The project ran from 2019 to 2023 and was funded by the European Union's Horizon 2020 programme[71]. It included the following areas:

- Congestion Management and Balancing Issues (Finland, Estonia, Latvia, Bulgaria, Italy):
  - DSO and consumer alliance – centralised energy management system for microgrids
  - Intelligent distribution nodes – grid services management system for flexible LV/MV networks
  - Single flexibility platform – exchange platform for distributed flexibilities in end-to-end electricity networks
- Peer to peer trading (Hungary):
  - Asset enabled local markets – microgrid local electricity markets using the assets capabilities.
  - Blockchain-based TSO-DSO flexibility – market platform with smart contract and smart billing
- Pan-EU clearing market (Romania and Greece):
  - DERS into wholesale – a retail to wholesale market approach for DERs' integration
  - Spatial aggregation of local flexibility – a EUPHEMIA-based market platform to engage local flexibility resources.

The first area is considered to be the most relevant in the context of this project, and in particular the 'Single flexibility platform'. This was the 'IEGSA' (Integrated pan-European Grid Services Architecture) platform, which was designed to "connect multiple actors such as Market Operators, System Operators (i.e. TSOs and DSOs), Flexibility Service Providers (i.e. Balance Service Providers or Aggregators), Settlement Responsible Parties, along various electricity markets focusing on providing support on the procurement of services (such as balancing, congestion management and ancillary services) from assets connected to the network both at transmission and at distribution level, in a coordinated way, implementing multiple coordination schemes between TSOs and DSOs.[72]". The screenshot below shows the IEGSA architecture.

[70] Home | INTERRFACE Accessed November 2023
[71] Final project report available from: Interrface_Roadmap Accessed November 2023
[72] Interrface_Roadmap Accessed November 2023

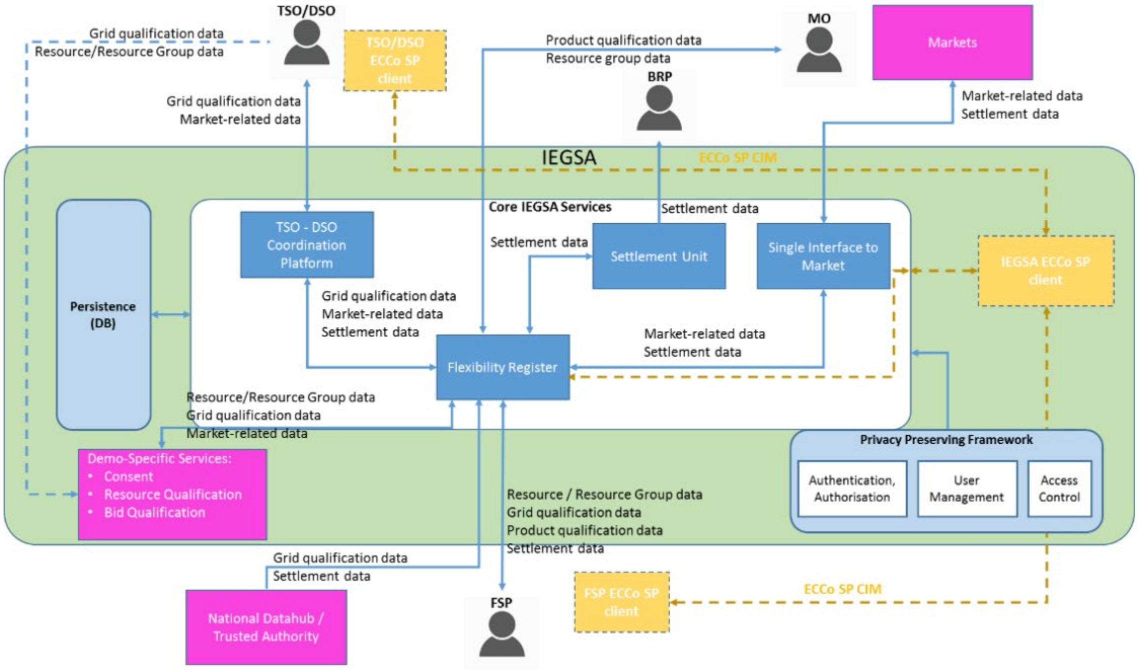

Figure AII.3 IEGSA platform architecture (Figure 3 from Interface Roadmap, Deliverable D9.13 of the INTERRFACE project)[72]

The report states, "All data exchanges are primary served utilising CIM data profiles based on European Standard Market Profiles; in certain cases, custom profiles or customisations of standard profiles were adopted in order to address the demo needs. Therefore, the wider utilisation of IEGSA would involve an update of its APIs to be fully compliant with IEC CIM data profiles for all business profiles". The use of CIM is consistent with the recommendations of the Open Grid Systems report.

Flexible Power Alliance Network[73]

The Flexible power Alliance Network (FAN) was established in 2013 and aims to "provide open standards for unlocking flexible energy in energy systems". It is based in the Netherlands. FAN has developed the "Energy Flexibility Interface" (EFI) – a communications protocol for controlling equipment by means of energy management software. They state, "Whenever manufacturers develop devices that support EFI, these devices can communicate with all Smart Grid technologies (Powermatcher, OpenADR, Triana). Conversely, by supporting EFI, developers of Smart Grid technologies can rely on their solution being able to communicate with all smart devices that support EFI." The focus of this standard appears to be between aggregators and individual DER (e.g. heat pumps, electric vehicles etc.) rather than between EDBs/DNOs and aggregators (the focus of this study).

Equigy[74]

Equigy is a European crowd balancing platform owned by leading European transmission system operators. Their mission is to "support the energy transition by enabling smaller distributed flexibility assets to participate in the energy system through aggregation." The platform is currently in live use in the Netherlands, Germany, Austria, Switzerland and Italy. Elements of the Equigy offering are shown in the screenshots below[75].

[73] About FAN - Flexible Energy (flexible-energy.eu) Accessed November 2023
[74] Home - Equigy Accessed November 2023
[75] Details taken from 'Equigy – Standardization of Data Exchange for Enabling Flexibility from Distributed Resources' presented at Flexcon 2023. Available from: Presentations Wednesday 20 September 2023 - FLEXCON, 20 & 21 September 2023 Brussels Accessed November 2023

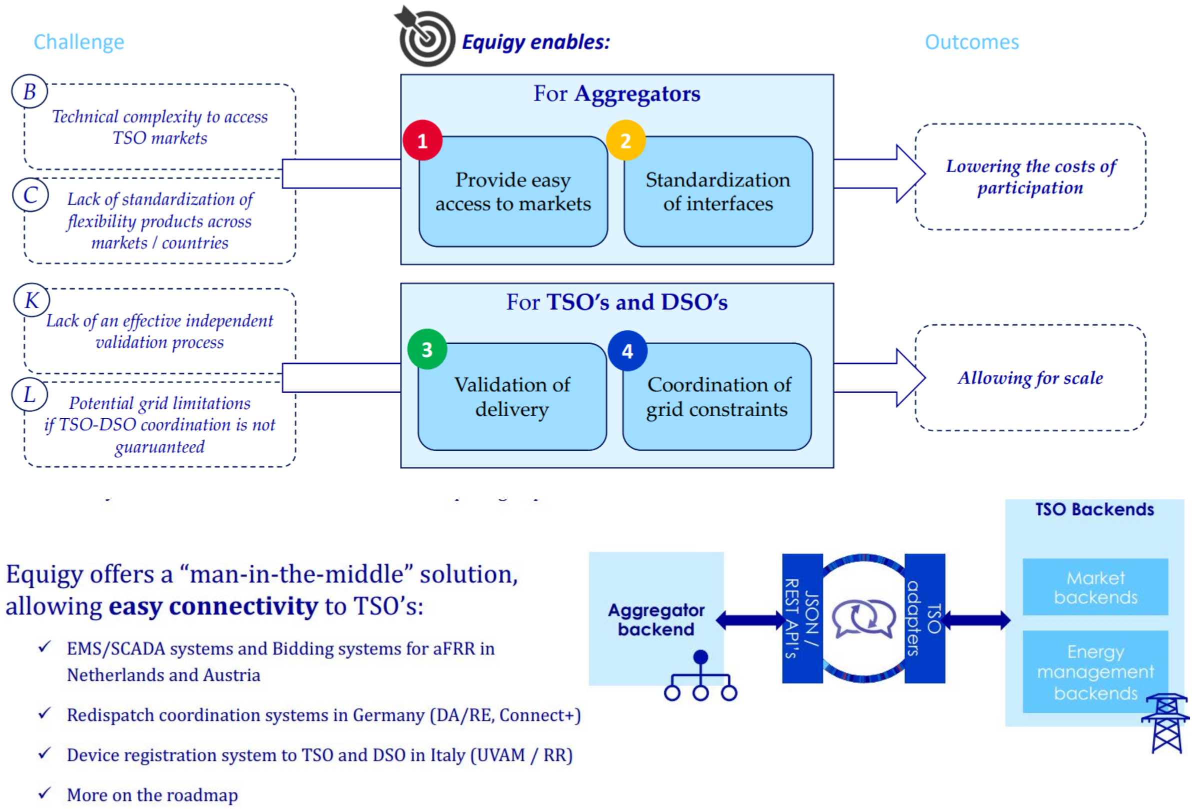

Figure AII.4 Elements of the Equigy offering[75]

Note: The communication protocols used in this system are not reported in the material reviewed.

Commercial Platforms in the UK

Piclo Flex Platform

Piclo Flex[76] is an independent marketplace for energy flexibility services. In GB it is used by UK Power Networks (UKPN), SP Energy Networks (SPEN), Electricity North West (ENW) and Northern Powergrid (NPg) for their procurement of flexibility services in addition to the System Operator. Piclo Flex is also used in Ireland, Italy, Portugal, Lithuania and the US (New York State).

The platform provides a single point where flexibility providers can find information on DNO flexibility tenders, determine whether or not they meet qualification criteria and submit their bids. The functionality of the platform is shown in the diagram below:

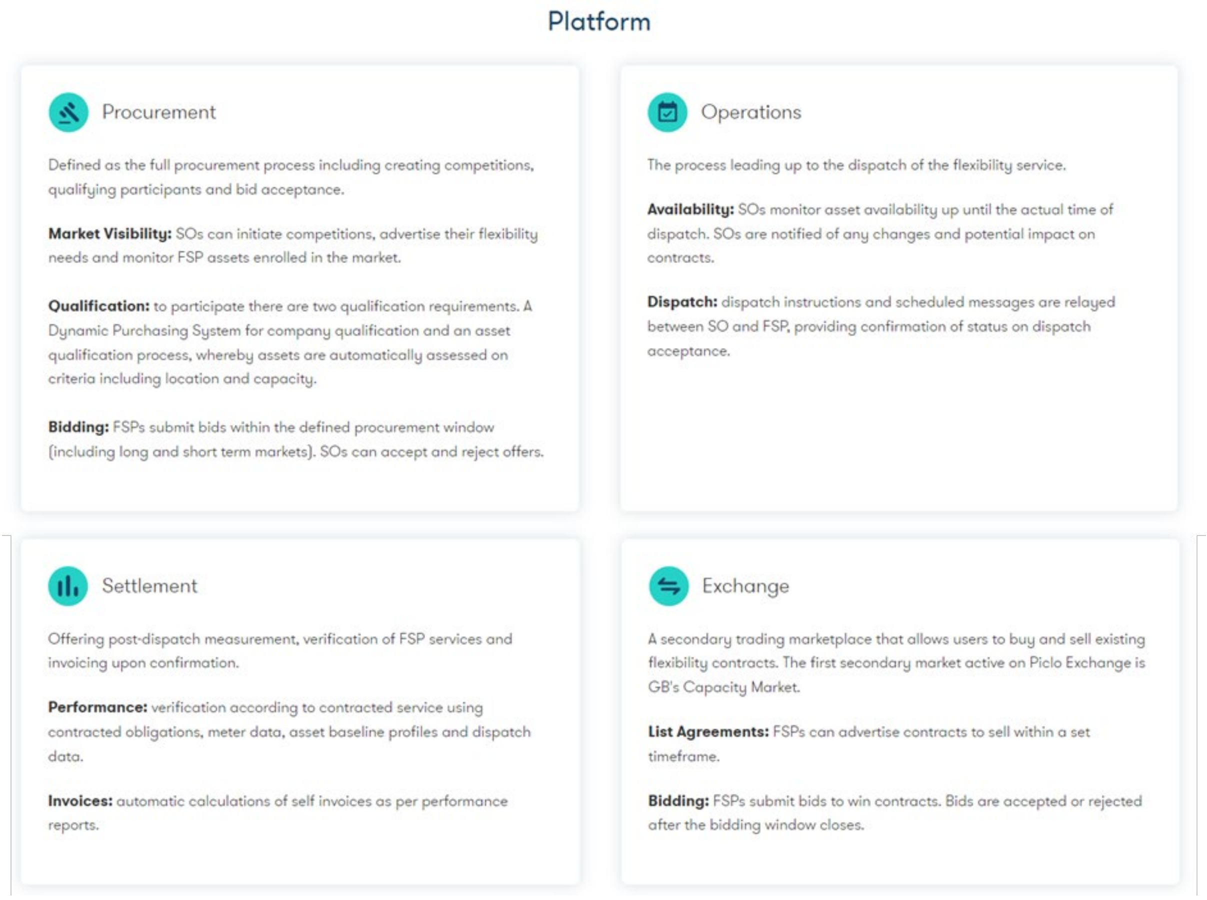

Figure AII.5 Piclo Flex Platform[77]

The communication protocols used for the 'operations' part of the platform are not stated publicly – it is not clear if this follows any international standards or is consistent between DNOs. Piclo Flex is engineered for integration with ADMS, DERMS and other back-office systems of Flexibility Service Providers and System Operators[78].

Flexible Power

Flexible Power[79] is a joint initiative from five of the six UK DNOs (ENW, National Grid Electricity Distribution (NGED), NPg, SSEN and SPEN). It is used to provide a central reference point for calls for flexibility/procurement from multiple DNOs. Once a provider is under contract, they can use the Flexible Power portal to "declare assets

[76] Piclo Flex Accessed November 2023
[77] Image from: Piclo — The leading independent marketplace for flexibility services Accessed November 2023.
[78] Flexibility Markets: Market Standards Study. Open Grid Systems. 2023
[79] Home (flexiblepower.co.uk) Accessed November 2023

availability, receive dispatch signals and view performance and settlement reports". Users are able to search a map using postcodes to determine if their assets align with areas of the networks in which DNOs are procuring flexibility services.

UK DNOs have defined four types of flexibility services, as part of the ENA's Open Networks project[80]. These are defined below.

Table AII.4 Flexibility Services for UK DNOs[81]

	Sustain	Secure	Dynamic	Restore
Use Case	Scheduled	Pre-fault	Post-fault	Post-fault network restoration
Availability Payment	Yes, for scheduled availability pre-agreed within contract	Yes, payment for availability at week-ahead	Yes, payment for availability at week-ahead	No
Utilisation Payment	Yes	Yes	Yes	Yes
Availability Declarations	Week-ahead. By midnight every Wednesday for the following week (Mon-Sun)	Week-ahead. By midnight every Wednesday for the following week (Mon-Sun)	Week-ahead. By midnight every Wednesday for the following week (Mon-Sun)	Week-ahead. By midnight every Wednesday for the following week (Mon-Sun)
Availability Acceptance	Week ahead. By midday every Thurs for the following week (Mon-Sun)	Week ahead. By midday every Thurs for the following week (Mon-Sun)	Week ahead. By midday every Thurs for the following week (Mon-Sun)	Week ahead. By midday every Thurs for the following week (Mon-Sun)
Dispatch Notice	Fixed within contract and notice sent 15 minutes ahead of requirements	Fixed within contract and notice sent 15 minutes ahead of requirements	Fixed within contract and notice sent 15 minutes ahead of requirements	Fixed within contract and notice sent 15 minutes ahead of requirements

Flexible Power publish an API Guide[82] to assist flexibility providers in setting up a connection to the Flexible Power portal. The portal is used by providers to declare availability and submit associated meter readings. DNOs use the portal to accept availability declarations and instruct utilisation events. The portal provides the API between the DNO and flexibility providers – they may have further control systems/communication protocols to communicate within their hardware, or to multiple CER in the case of distributed flexibility resources such as EV chargers. The data sent/received via the API (at a high level) is as follows:

- Sent from flexibility provider to DNO:
  - Readings: current power usage in kW, with a timestamp, for each meterable unit and per constraint managed zone. This data is provided throughout the operational season to allow baselining of power consumption against which events will be compared.

80 Open Networks: developing the smart grid - Energy Networks Association Accessed November 2023
81 Table contents from: About Flexibility Services (flexiblepower.co.uk) Accessed November 2023
82 Guide to API Set UP UAT Testing V2.2.pdf Accessed November 2023

  - Emergency stop signal per meterable unit, per programme and per constraint managed zone. This is a facility to allow users to rapidly opt an asset out of providing flexibility (e.g. in the event of unexpected events during an accepted availability window).

- Sent from the DNO to the flexibility provider:
  - Dispatch start instruction per programme, per constraint managed zone, listing the relevant meterable units.
  - Dispatch stop instruction (as above)

Flexible Power use a structure of 'Dispatch Groups' and 'Meterable Units', defined in the API guide as follows:

- "A dispatch group is the higher-level component and is used for availability declarations, dispatch and settlement.
- A meterable unit is made up of one or more flexibility assets behind a single metering feed. Baselining is applied at the meterable unit level."

Various potential relationships between assets, meterable units and dispatch groups are possible. Shown in the diagram below:

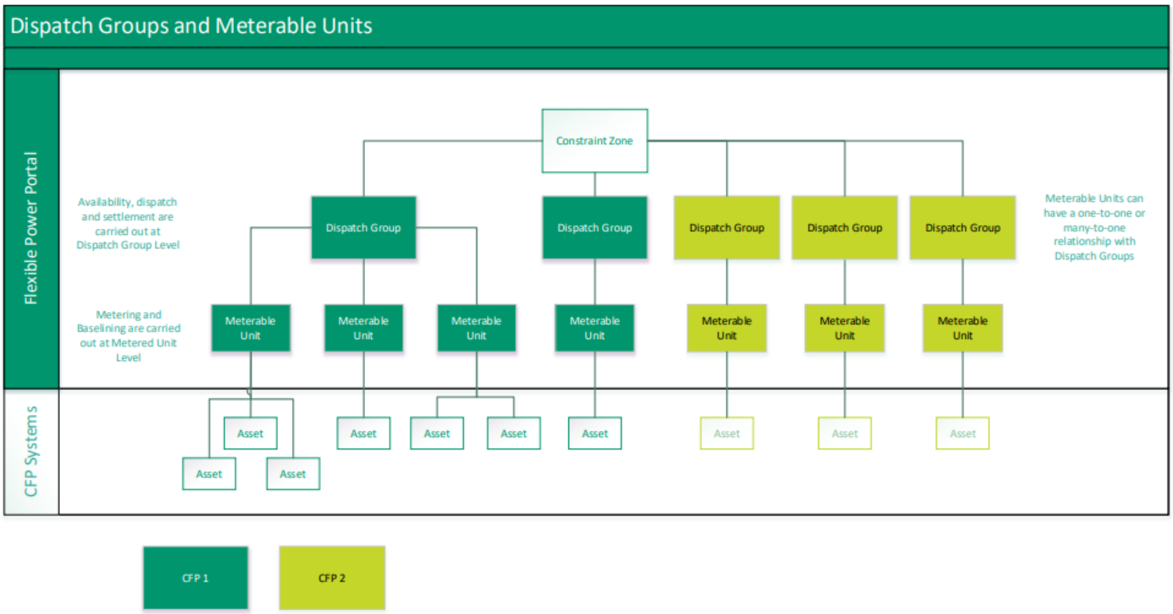

Figure AII.6 Flexible Power relationship between dispatch groups, meterable units and assets (N.B. CFP = Contracted Flexibility Provider)[82]

The Flexible Power portal represents progress towards standardisation and automatization in the dispatch of flexibility services by GB DNOs. However, it does not appear to be based on specific international standards (e.g. those covered by the Open Grid Systems report). The extent to which it can be readily used by aggregators operating a large, distributed portfolio of CERs is also not clear. In this case it would appear that each customer asset would be a 'meterable unit' (assuming one customer provides one asset each, e.g. an EV charger).

The sub-sections below review the activities of each DNO in turn, focusing on their use of flexibility services, how they procure and dispatch services (where this information is available) and commitments/plans in relation to flexibility for the current price control period (RIIO-ED2, running from 2023 to 2028).

Individual DNO(s) Approach and Plans

Electricity North West

Overview

Electricity North West (ENW) operate a single electricity distribution licence area in the North West of England, serving 2.4 million customers.

Business Plan Commitments

- Developing Distribution System Operator (DSO) activities through "learning by doing" through the ED2 (2023-28) period and consolidating this learning into business as usual (rather than legally separating DSO functions at this point).
- Continuing (from the previous price control) to both adopt a flexibility first approach to reinforcement and activity to develop a market for participation in flexibility services.
- Significant expenditure during the price control in developing new systems for active network management and flexibility management.
- Publishing heat maps of network capacity for the full distribution network (132kV to LV) to facilitate the development of flexibility services markets and enable third-party options to be developed for mitigating network needs.

Existing Flexibility Procurement and Dispatch

ENW use both Piclo Flex (for procurement) and Flexible Power (see above). They are currently tendering for 413MW of flexible capacity to be provided over the period from 2024 to 2028. The technical requirements for providers of flexibility are available online[83]. These state that "utilisation instructions for services as standard will be issued via an API or Email". Details of the communications protocols used are not given.

National Grid Electricity Distribution

Overview

National Grid Electricity Distribution (NGED) operate the electricity distribution networks for four UK licence areas, East Midlands, West Midlands, South West and Wales. They serve over 8 million customers and cover an area of 55,500 km^2. At the beginning of 2023 (the start of RIIO-ED2) NGED had 5.5 GW of distributed generation capacity installed within their network.[84]

Business Plan Commitments

In relation to flexibility, NGED's business plan included the following commitments:

- Support the creation of community energy projects to enable distributed generation to connect to the network.
- NGED will adopt a 'flexibility first' approach to resolve network constraints, procuring and using flexibility services as an alternative to conventional network reinforcement which allows customers to connect quicker and at lower cost.
- Utilisation of automated flexibility approaches for domestic customers with the vision of flexibility being offers through supplier tariff signals and aggregation offers. No mention is given however of platforms or interfaces to support this.
- By adopting a flexibility approach to load related decisions NGED have committed to avoiding £94 millions of reinforcement costs by 2028.

[83] https://www.enwl.co.uk/globalassets/future-energy/flexibility-hub/latest-requirement/autumn-23/tt111205---flexibility-services-autumn-2023---appendix-2---technical-specification.pdf Accessed November 2023
[84] NGED RIIO-ED2 Business Plan. Accessed November 2023.

Existing Flexibility Procurement and Dispatch

NGED operate 'Flexible Power' solutions where customers with controllable demand and generation can aid in network capacity management. This is achieved using four types of flexibility services (Secure, Dynamic, Sustain, Restore). They utilise the 'Flexible Power Operations Portal' as the platform through which they conduct flexibility services. The flexible service provider is required to implement their own API to send data to the various APIs within the Flexible Power Portal. The APIs vary depending on the Product and Asset types utilised.

Table AII.5 Data requirements for different flexibility services (NGED)

Types	Readings (used for minute by minutes metering)	Readings/energy (used for HH metering)	Dispatch (both Start and Stop)	Stop (for emergency stop)
Sustain	Not required (unless no HH metering)	Required (unless using minute by minute metering)	Optional	Optional
Secure	Required (for all but domestic which need 'energy' API)	Only permitted for domestic	Required	Optional
Dynamic	Required	Not permitted	Required	Optional
Restore	Required (for all but domestic which need 'energy' API)	Only permitted for domestic	Required	Optional

The Flexible Power API covers 3 key areas:

1. The collection of metering from the Flexibility Service Provider (FSP) to the DSO via the readings API. This is built of 2 sub-APIs to collect either minute by minute or half hourly metering data. This needs to be built out per MU.
2. The sending of Utilisation Instructions from the DSO to the FSP via the Dispatch API. This needs to be built out per Trade Dispatch Group. Within the signal it will detail the component, MU IDs.
3. The sending of an Emergency Stop from the FSP to the DSO via the Stop API. This is implemented at MU level.

Alternatively, to the API process, metering data can also be submitted via uploading data (in the form of csv files) to the Flexible Power portal.

Northern Powergrid

Overview

Northern Powergrid (NPg) operate two licence areas in North East UK serving more than 8 million people across 3.9 million homes and businesses.

Business Plan Commitments

NPg's ED-2 business plan includes the following commitments to flexibility:

- Full establishment of a DSO which will be instrumental in building a flexibility market.
- Employment of a 'Flexibility First' programme through their DSO business unit[85].
- To tender for up to 82 MW of flexibility at 19 locations across the North East.

[85] Northern Powergrid - Distribution System Operator v1. Accessed November 2023.

- Flexibility is discussed within the relevant sections of NPg's DSO strategy with focus upon:
    - Create a customer flexibility system with network operation processes that enables them to automatically dispatch flexibility services by integrating systems (such as Power on Fusion) with their flexibility platform (Flexible Power Platform).
    - NPg predict that net benefits up to £156 million could be delivered during the ED-2 framework through use of flexibility over traditional reinforcement.
    - Flexibility providers are viewed agnostically whether the flexibility is delivered from dispatchable generation, demand turn down or battery discharge.

Existing Flexibility Procurement and Dispatch

NPg operate the Flexible Power portal with four flexibility services (Sustain, Secure, Dynamic, Restore). Flexibility is dispatched through the Flexible Power toolkit via an API between NPg and providers. The system includes a calendar for preplanned flexibility services. The dispatch mechanism between NPg and service providers using the Flexible Power API has three key features:

1. Flexibility Start Switch On – 15-minute notice to activate service.
2. Flexibility Stop Switch Off – 15-minute notice to deactivate service.
3. Emergency Stop – communicated by phone call.

In the early stages of a new contract, NPg use a telephone service to confirm agreements.

Procurement activities are announced through the Flexible Power website and tenders submitted through the online procurement portal (Piclo Flex).

Scottish Power Energy Networks

Overview

Scottish Power Energy Networks (SPEN) operate two licence areas in two regions of the UK (NW England and Southern Scotland). They have approximately 7 million customers and operate in three of the UK largest cities as well as three significant rural areas of the UK.

Business Plan Commitments

SPEN's ED-2 business plan[86] includes the following commitments:

- Using the ED-2 plan commitments they forecast £36 million in savings through the planned use of flexibility services over traditional reinforcement.
- Develop an enhanced flexibility platform to improve capabilities as needed by new flexibility service types and customer requirements.
- To be the first DNO to tender for reactive power services in the flexibility market.
- SPEN will deliver a new DSO functional model[87] that will be responsible for network planning and investment, flexibility procurement, and operational decision. The DSO strategy includes:
    - SPEN's project FUSION is currently underway. This is a live trial of a local DER flexibility market trading through creation of a competitive market.
    - The 1st DNO to publish site-specific pricing for flexibility tenders.
    - Make use of flexibility BaU during planned outages and to manage HV and LV constraints.

[86] SPEN RIIO-ED2 Final Business Plan. Accessed November 2023
[87] SPEN ED2 DSO Strategy Report. Accessed November 2023

Existing Flexibility Procurement and Dispatch

SPEN currently use the Flexible Power API to conduct their flexibility services. And offer five types of flexibility services (Secure, Dynamic, Sustain, Restore, Reactive Power). They also utilise Piclo Flex as their engagement channel for tendering when open. Once contracted, providers are given access to the joint Flexible Power Portal where they can declare their assets availability, receive dispatch signals and view performance and settlement reports.

Using the Flexible Power Portal customers can submit meter readings, create declarations, and receive start stop signals.

Scottish and Southern Electricity Distribution

Overview

Scottish and Southern Electricity Distribution have two licence areas – in the central south of England and the northern part of Scotland, serving 3.8 million homes and businesses.

Business Plan Commitments

SSEN's business plan includes the following commitments:

- Adopting a flexibility first approach, which they estimate will defer investment of £46 million over the price control period.
- The DSO strategy is available here[88], covering all elements of the development of SSEN's DSO functions. The elements in relation to flexibility (Section 6.6) have been reviewed in greater detail, with the following relevant points:
  - SSEN intend to contract for 5GW of flexibility services in RIIO-ED2 (currently 600MW across two licence areas). They estimate that the use of flexibility services will result in savings of between £18.3- £46.3million during the price control (2023-28).
  - Flexibility tenders are "device agnostic" allowing providers of storage, generation, demand side response (DSR) or energy efficiency services to respond to any tenders.
  - At the low voltage level, SSEN foresee that flexibility services will be predominantly recruited via intermediaries such as aggregators, energy suppliers, and other aggregating parties including suitably equipped community groups. They are designing and delivering an API interface for their Automated Network Management systems which will allow SSEN to interact - dispatch and monitor - aggregator service providers. Details of this API, such as the standards used are not provided.

Existing Flexibility Procurement and Dispatch

The standard agreements used between SSEN, and flexibility providers are available online for both those operating manually[89], and those on the 'Flexible Power' platform[90]. The agreements require the following:

- "Each DER shall have minute by minute or 30-minute metering with sufficient accuracy to enable the Company to monitor the provision of Flexibility Services. The data shall be made available to the Company at the end of every service month or upon request via a spreadsheet."
- The agreement stipulates that email and phone calls will be used for communications with Providers on the 'manual' agreement. It also states that "Providers can be given the option of using the Flexible Power portal and API to simplify scheduling, dispatch, performance reporting and invoice generation." The Flexible Power agreement states that the flexible power platform shall be used for communication with Providers.

[88] A_11.1._DSO_Strategy_CLEANFINAL_REDACTED.docx (ssenfuture.co.uk) Accessed November 2023
[89] ssen-standard-flexibility-service-agreement-manual-v2.1.pdf Accessed November 2023
[90] ssen-standard-flexibility-service-agreement-flexible-power-v2.1.pdf Accessed November 2023

- Under the Flexible Power agreement, providers agree to "use the Flexible Power portal and API to simplify scheduling, dispatch, performance reporting, self-billing and invoice generation".
- The agreement gives details of the information set out in various elements of reporting.
- For users of the Flexible Power platform the following instructions are issued via the API:
  - Start Instruction in accordance with specified notice periods (all service types)
  - Stop Instruction at the Event end time (all service types)
  - If, during an event, a change to the Stop Time is required the Company may issue an updated stop instruction via API, accompanied (optionally) by a phone call.
  - The provider agrees to provide power (per minute) and energy (half hour) metering per Meterable Unit
- Further details of the API used by the Flexible Power portal are available online[91].

UK Power Networks

Overview

UK Power Networks (UKPN) operate three distribution licence areas in the South and East of England, including London. They serve 8.4 million homes and businesses – approximately 19 million people. At the time of preparing their current (ED2, 2023- 2028) business plan, 9.8GW of distributed generation was connected to the network and they had a peak demand of 14.2GW[92].

Business Plan Commitments

UKPN's business plan includes the following relevant commitments, in the context of DER flexibility[93]:

- Establishing the UK's first legally separate Distribution System Operator (DSO) function
- Where additional capacity is required UKPN will utilise "market-based flexibility solution to create capacity at lowest cost". They estimate this will deliver a £410 million reduction in load related expenditure during the price control period. This saving will include that drawn from LV flexibility, including from domestic customers. An expansion into "high volume LV flexibility" is envisaged in Phase 3 of the DSO service roadmap, in the latter part (2026-2028) of the price control.
- Operating a "Flexibility First" strategy through which all future network needs will be tested for non-network asset solutions.
- Establish a Distribution Market Platform. UKPN envisage data flows between the Distribution Market Platform and DSO functions will be facilitated via Open API interfaces. However, the details of these interfaces are not specified.
- An intention for the DSO to publish API standards for market platform data flows annually.

[91] Flexible Power - API Documentation (flexiblepowerportal.co.uk) Accessed November 2023
[92] UKPN-RIIO-ED2-Final-Business-Plan-Summary.pdf Accessed November 2023
[93] Appendix-18-Our-DSO-Strategy.pdf Accessed November 2023

Existing Flexibility Procurement and Dispatch

Since April 2023 UKPN have published data on the dispatch of flexibility under the 'Secure[94]' and 'Dynamic[95]' flexibility products[96]. This data has been analysed to show the providers of flexibility in terms of the type of response they offer, and the dispatch methods used[97].

The demand types for each supplier are given in the table below. Those believed to be relevant to the NZ use case of contracting flexibility from CER are highlighted in bold.

Table AII.6 Table 1: UKPN Flexibility Suppliers

Supplier	Dispatch Type	Technology	Average MWh requested per event	Dispatch Method Used
Ev.energy	**Demand turn down**	**Stored energy**	**0.02**	**API**
AMP Energy Services limited	Generation turn up	Fossil – gas	6.41	API
Octopus Energy Ltd	**Demand turn down**	**Stored energy**	**0.42**	**Email**
Quintas Energy	Generation turn down	Solar	10.66	Email
Bankenergi limited	Demand turn down	Demand	0.08	Email
CUB (UK) Ltd	Demand turn down	Demand	0.74	Email
SMS Energy Services Limited	Generation turn up	Stored energy	4.43	Email
Gunfleet Sands	Generation turn down	Offshore wind	26.25	Email

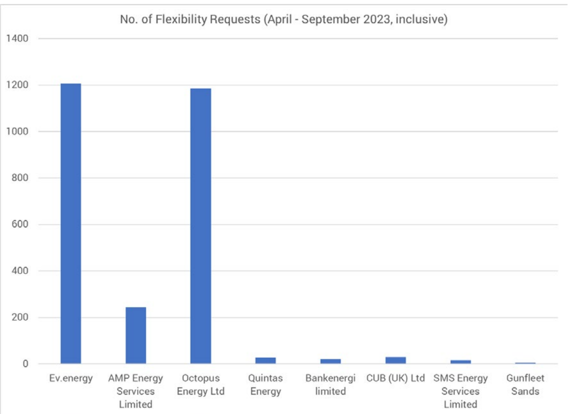

Figure AII.7 Number of Flexibility Requests (UKPN) by Supplier

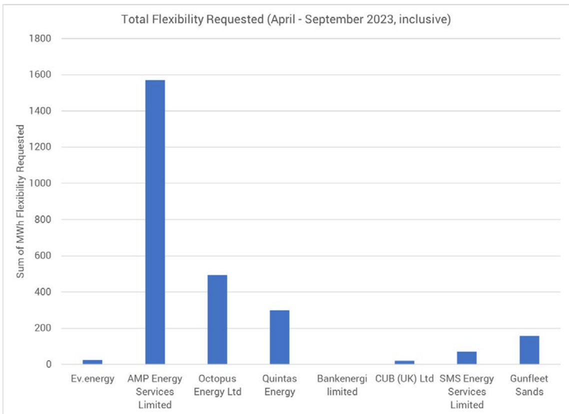

Figure AII.8 Total Flexibility Requested (MWh) (UKPN) by Supplier

This shows that while a large number of requests have been made from the two suppliers offering flexibility from CER, the volume of response provided is relatively low. In addition, only two of the suppliers are currently

[94] A firm, dispatchable service (location specific). Suppliers are paid an availability (£/MW/hours available) and utilisation fee and are notified the day ahead of need via email or API. This service operates in specific seasons and time windows as set out in the tender.
[95] A non-firm dispatchable service (location specific). Suppliers are paid for utilisation only and the service has no predefined service windows, with provision of the service being optional. Suppliers are notified on a day ahead basis via email or API.
[96] Further information on service types is available from: PowerPoint Presentation (d1lf1oz5vvdb9r.cloudfront.net) Accessed November 2023.
[97] Data from: Flexibility Dispatches — UK Power Networks (opendatasoft.com) Accessed November 2023

operating via API, indicating the relative immaturity of use of flexibility services. The dispatch method is not yet at a stage where an industry standard message is being used via an automated system. UKPN have stated that they intend to develop a flexibility services dispatch platform with work starting in April 2023. Initial deployment of the platform is planned for April 2024[98].

UKPN are currently procuring around 850MW of flexibility across 452 constraint zones with contracts extending to winter 2026/27. Information on the tender is available online[99], although with minimal details of the dispatch mechanism, beyond the option to use either email or API, as per extending flexibility dispatch shown above. UKPN require a minimum of 10kW of response in each flexibility unit, to allow easy participation from a wider range of suppliers. UKPN use Piclo Flex to manage the procurement process.

National Grid Electricity System Operator

The Electricity System Operator (ESO) in the UK operates a number of flexibility/balancing services. Traditionally these have been provided by generation, or larger industrial or commercial customers. The most relevant service to the NZ context (the provision of DSR by CER) is the 'Demand Flexibility Service[100]' first operated during the winter of 2022/23. Participants are required to have half-hourly metering and be able to sustain demand reduction for a minimum of 30 minutes. The process followed is shown in the diagram below:

Figure AII.9 Figure 1: Overview of the DFS Process[101]

A number of findings have bene released in relation to the first winter of operation:

- Over 1.6 million households took part and provided approximately 350MW of flexibility.
- There were 20 test and 2 'live' events (i.e. periods where flexibility services were required for operational reasons).
- 31 providers took part (14 domestic only, 10 non-domestic, 7 both). These included both energy suppliers and aggregators – allowing participants to provide response via an aggregator (e.g. where their energy supplier was not taking part).
- 3,300MWh of electricity reduction delivered.
- A number of surveys, interviews and focus groups were completed as part of the analysis of the performance of the scheme, with the findings available online[102].

98 Flexibility Services Dispatch Platform - UKPN DSAP (ukpowernetworks.co.uk) Accessed November 2024
99 Autumn-2023-Tender-Participation-Guidance-v1.0.pdf (d1lf1oz5vvdb9r.cloudfront.net) Accessed November 2024
100 Demand Flexibility Service (DFS) | ESO (nationalgrideso.com) Accessed November 2023
101 Image from Figure 1 download (nationalgrideso.com) Accessed November 2023
102 download (nationalgrideso.com) Household engagement with the Demand Flexibility Service 2022/23. Accessed November 2023

The Demand Flexibility Service will operate again for the winter of 2023/24. The table below shows data transfers which take place for the operation of the service[103].

File number	File name	From	To	How	Frequency	When	Period
1	Weekly Indicative Forecast	Provider	ESO	DFS Assessment Platform	Weekly (also at the onboarding stage)	Friday at or around 10:00 Can be updated daily	7 days (Sat - Fri)
2	Unit Meter Point Schedule	Provider	ESO	DFS Assessment Platform or API	At most daily. Only needed if there are changes to portfolio	Daily, before 11 am	7 days (Sat - Fri)
3	Anticipated DFS Requirement Notice	ESO	Provider	BMRS, ESO Data Portal & DFS Assessment Platform	Day ahead or within day	Endeavour between 08:00 and 10:00, depending on whether it is for a day-ahead or within-day procurement event	NA
4	Service Requirement	ESO	Provider	BMRS, ESO Data Portal & DFS Assessment Platform	Day ahead or within day	At or around 14:30 for Day Ahead and 09:00 or 12:00 for Within Day	NA
5	DFS Bids	Provider	ESO	DFS Assessment Platform or API	Day ahead or within-day	Within 60 minutes of a Service Requirement	NA
6	DFS Utilisation Report (DFS Acceptance)	ESO	Provider & Industry	DFS Assessment Platform and ESO Data Portal	Post assessment	At or around 16:30 for Day Ahead and 11:00 or 14:00 for Within Day	NA
7	DFS Utilisation Report Summary	ESO	Industry	ESO Data Portal	Post assessment	As soon as possible following DFS Acceptances	
8	Weekly Settlement Submission	Provider	ESO	DFS Assessment Platform	Weekly	Monday after the end of the DFS service week	7 days (Mon- Sun)

Figure AII.10 Demand Flexibility Service Data Transfer Requirements[103]

[103] Page 16 of download (nationalgrideso.com) Accessed November 2023

Appendix III Australia

Innovation Trials and Developments

Given below are some of the DOE projects and protocols used:

Table AIII.1 Overview of current DOE projects and initiatives[46]

2020 – 2023 Project EDGE – AEMO	Operating envelope algorithm based on abstraction from iterative power flow models that take in forecast to determine active customer limits	Open-source data message bus – Energy Web Foundation	Equal capacity and maximum network utilisation	Negotiated contract/ Aggregator owns customer relationship	AEMO hosted market exchange platform for aggregator/DER Offers into market Local services exchange for network services Off market, but testing a real time market	*Currently in phase 1 of 3*
2020 – 2022 **Flexible Exports for Solar PV Trial –** *SA Power Networks*	Abstract hosting capacity model of LV and HV network constraints	IEEE2030.5 CSIP -AUS	Capacity divided equally between all customers in each constraint area	Change to MSO to include flexible connection option	Provides dynamic export limit for solar that would otherwise have a static limit. Utilised for contingency curtailment of generation on AEMO instructions manually	*Field trial commenced in September 2021 with IEEE2030.5 gateway device. Native inverter support from Fronius and SMA due Q1 2022.*
2021 – 2023 **Model free operating envelopes –** *C4NET with Victorian DNSPs*	Machine learning and neural networks applied to smart meter data for NMI level DOEs	N/A	TBD	N/A	N/A	*Early stages of development*
2021 – 2023 **Project Symphony -** *Western Power*	Operating envelope algorithm based on abstraction from iterative power flow models that take in forecast to determine active customer limits	TBC - Various options under consideration, including open-source data message bus, IEEE 2030.5.	Equal capacity and maximum network utilisation. Also exploring alternative allocation methods.	As per recently updated network connection requirements for basic embedded generation (includes provision for operation in a VPP). Aggregator owns	Off-market simulations.	Pilot platforms established. Entering MVP (Bi-directional energy

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Table 3: Overview of current DOE industry projects and initiatives

Year **Project Name –** *Organisation*	Focus area					***Project Status***
	DOE calculation methodology	**Communications standards and interoperability**	**Allocation methodology**	**Customer connection agreements**	**Level of DOE Market Integration**	
2018 – 2020 **Solar Enablement Initiative (SEI) –** *University of Queensland*	State Estimation based on any available data set including a forecast	N/A	Equal	N/A	None	*Technology spun out into GridQube Being utilised at Energy Queensland for limits to solar systems at small scale*
2019 – 2021 **Advanced VPP Grid Integration Trial -** *SA Power Networks*	Abstract hosting capacity model based on LV network taxonomy & templates	IEEE2030.5 lite	Capacity divided equally between all customers in each LV area. Aggregated (nodal) DOEs also available.	Waiver to allow trial customers to export up to 10kW	Aggregator performs market services within the operating limit	*12-month field trial with 1,000 VPP customers. Knowledge utilised for other projects and transferred into CSIP-AUS*
2019 – 2021 **Evolve DER Project** *– Zepben*	*Information not available*	IEEE2030.5 CSIP -AUS	Transformer Level Equal Feeder Level Equal NMI Level Maximised	N/A	Aggregators perform market services within the DSO shared operating envelope	*Project nearing completion and technology being rolled into other trials. Nearing commercial capability*

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				customer relationship.		balancing market scenario).
2021 – 2023 **Neighbourhood Battery Initiative –** *Network led (CitiPower, Powercor and United Energy)*	In development but to increase solar hosting capacity and manage network constraints	Network to battery under development/ Custom API to retailer	Multiple use cases: Retailer for FCAS and arbitrage, virtual battery.	None	Community energy sharing and provide network support	Battery deployment second half of 2022
2021 – 2023 **Neighbourhood Battery Initiative –** *Community led (CitiPower, Powercor and United Energy)*	In development but to increase solar hosting capacity and manage network constraints	*Information not available*	Multiple use cases: Retailer for FCAS and arbitrage, virtual battery.	Community model	Community energy sharing and provide network support/ Optimisation by ANU BSGIP	Battery deployment second half of 2022
2021 – 2023 **LV Pole-Mounted Battery Trial –** *CitiPower, Powercor and United Energy*	Manage peak demand and made available for market services all other times	IEEE2030.5 network to battery Custom API for retailer access	FCAS and arbitrage, network support when required	None	Retailer uses asset in FCAS and wholesale markets when battery not required for network support	*Near end of initial development phase*
2020 – 2023 **EV Grid –** *Jemena*	Spare capacity of transformer allocated to smart charger	IEEE2030.5 lite. Not compliant implementation	None	Equal	*Information not available*	*Information not available*
2021 – 2023 **Project Edith –** *Ausgrid*	Leveraging Evolve DER Project DOE calculation methodology	IEEE2030.5 CSIP-AUS and exploring additional fields for pricing (import/export)	Testing interaction between capacity allocation and dynamic pricing (i.e. maximising capacity allocation and managing congestion with pricing)	N/A for trial participants but will include research piece on how to integrate into dynamic connection agreements	Aggregator takes dynamic network prices into account and performs market services within the operating limit (i.e. distributed co-optimisation)	*Project currently in early stages. Testing pricing and DOE impacts with single aggregator (Reposit) with field trial*

Appendix IV USA

Development and comparison of standards

PACIFIC NORTHWEST NATIONAL LABORATORY has recently issued a report for UNITED STATES DEPARTMENT OF ENERGY titled as 'Transactive Energy Communication Interface Standards Landscape'[104].

A summary of this report is presented in the following paragraphs.

This report reviews the state of communication interface standards that show promise for transactive energy (TE) approaches to the coordination of distributed energy resources (DERs). The report recognizes some gaps in the TE standards landscape and makes specific suggestions how to improve the TES communications standards situation.

The integration of large numbers of devices requires that they be able to connect and interoperate easily and reliably. Given the many technologies and solution providers integrating products, communications interfaces based on clear, unambiguous specifications with supporting tests require standardization and adoption by the community of system integrators.

The following actors or players are defined in the TES report:

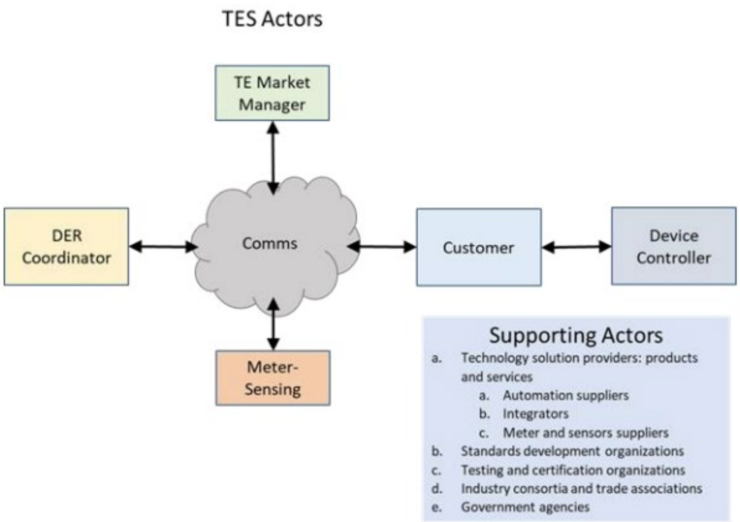


Figure AIV.1 Actors involved in TES application scenarios of interest[104]

Eighty-one standards were identified, and these standards are available via the SEPA Navigation Tool—an online tool that allows users to navigate the 81 annotated standards according to their relevance to the National Institute of Standards and Technology (NIST) framework of smart grid domains.

The Institute of Electrical and Electronic Engineers (IEEE) P2030 Smart Grid Interoperability Reference Model addresses interoperability. The reference model is the foundation for an extensible series of standards in specific application domains like vehicle electrification (numbered P2030.1) and energy storage (numbered P2030.2). Under the IEEE group, it standardized the smart energy profile, which has its origins in the Zigbee Alliance, in P2030.5. The objective of this standard is to provide an internet protocol-based approach to communicating with a variety of DERs.

The International Electrotechnical Commission (IEC) brought a group of international experts together to develop a "framework for IEC standardization, which includes protocols and model standards to achieve interoperability of smart grid devices and systems…" called IEC TR 63097:2017 "Smart Grid Standardization Roadmap" The Information modelling in IEC 61970 (Common Information Model) can be relevant for TE.

[104] PNNL-34505 Report July 2023- Transactive Energy Communication Interface Standards Landscape

Similarly, the IEC 61850 series of standards originated in substation automation, where utilities have ownership and control of the equipment. In 2018, IEC adopted the OpenADR 2.0b specification from the OpenADR Alliance as the IEC 62746-10-1:2018 standard. This is a service-oriented standard that aligns better with the service-oriented paradigm seen in TES.

The European electrical standards organizations European Committee for Standardization (CEN), European Electrotechnical Committee for Standardization (CENELEC), and European Telecommunications Standards Institute (ETSI) created the smart grid coordination group to organize and review the many standards relevant to European smart grid projects. The work is captured in "Final Report on Standards for Smart Grids" (CEN-CENELEC-ETSI, 2011).

The GridWise Interoperability Context-Setting Framework introduced an interoperability model, referred to as the "GWAC Stack," consisting of three main interoperability layers and their sublayers (The GridWise Architecture Council, 2008). A diagram of the GWAC Stack is reproduced below:

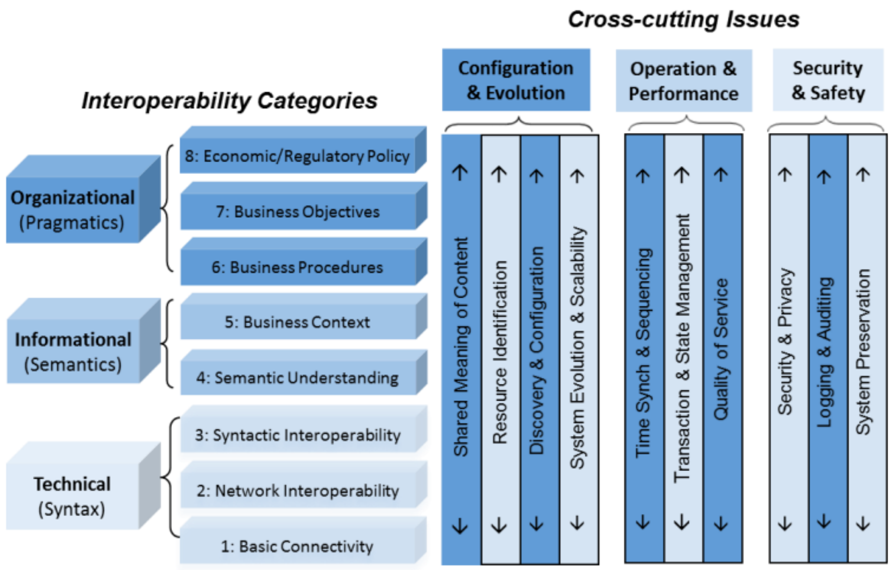


Figure AIV.2 GWAC Stack – interoperability context-setting framework[104]

There is a suite of OASIS TE specifications that is important to the TE standards landscape. The development of these standards is intertwined with a TES implementation, named the Transactive Energy Market Information Exchange (TeMIX) profile.

The Flexible power Alliance Network (FAN) developed the Energy Flexibility Interface Specification (EFI), Version 2.0, with staff from TNO, an independent scientific research organization in the Netherlands. The primary contribution of the EFI specification is its description of four types of device energy flexibility, including the XML/UML models that are needed to represent these devices' energy flexibilities in a TES. Its four categories of energy flexibility are inflexible, shiftable, storage, and adjustable.

The Universal Smart Energy Flexibility (USEF) Foundation developed a framework for integrating flexibility that involves aggregators interacting with end-users to offer flexibility services to distribution system operators (DSOs) or coordinated DSO/TSOs. A subset of this framework is the USEF Flex Trading Protocol (UFTP) which specifies bi-lateral trading market interactions between aggregators and DSOs. The protocol covers the following process steps: contract, plan, validate, operate, and settle.

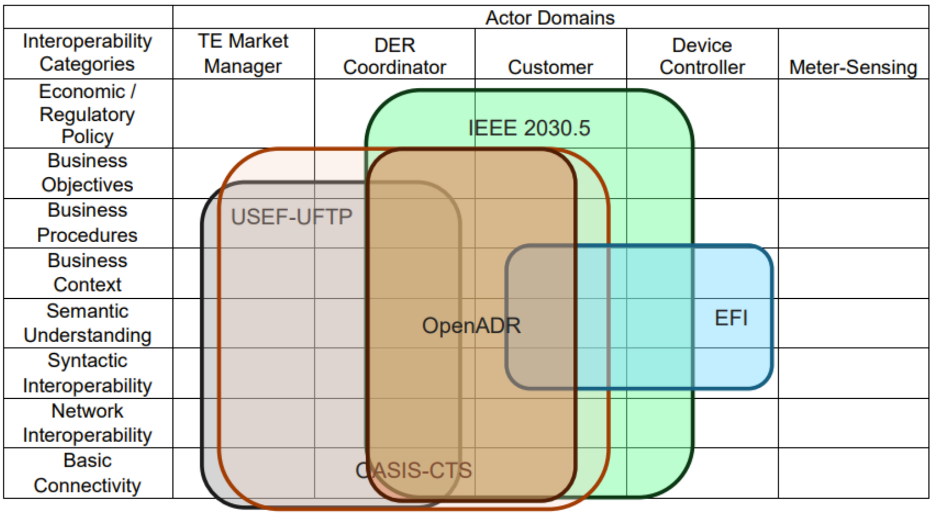
The following view provide insights into their similarities and differences in terms of broad coverage of standards:

Table AIV.2 Landscape of interoperability categories and actor domains[104]

PNNL-34505

A.1 Landscape of interoperability categories and actor domains

The following table diagrams the broad coverage of standards considering the GWAC Stack (Figure 3) interoperability categories and the actor domains in Figure 1.



- OASIS CTS: This standard targets DER coordinators interacting with customers using TE market mechanisms. The boundary of scope does not include protocols for talking to device controllers and it assumes that metering is handled through other means (meter management system or other meter communications protocol standards). It also is layered on networking protocols, deferring to their specifications. It includes an information model with a TE business context and business processes; however, alignment with economic/regulatory policy is lacking from the standardization process. This includes the lack of an ecosystem of organizations working with policy makers to make sure interoperability is achieved.
- EFI: This standard focuses on the information modelling aspects for representing flexibility of various types of equipment in a standard way from device controllers. It is specified in XML, which supports a level of syntactic interoperability, but it does not cover networking protocols or specific business process interactions. In this regard, it can complement a transactive system.
- USEF UFTP: This protocol specification is targeted for TE market interactions between DER aggregators and DSOs. The work assumes aggregators (i.e., DER coordinators) have their own means to control DER. USEF uses the example of The PowerMatcher as a platform for interactions with customers. For this reason, the ability to use UFTP for DER coordination is unclear. While the protocol has been implemented in European projects, the involvement of policy makers appears to be done on a project basis and not in the standard itself.
- OpenADR: This standard originated with demand response applications. While it supports the distribution of dynamic prices and demand response events, there is no explicit support for an TES. There may be discussions to harmonize with OASIS CTS, but OpenADR 3.0 takes a separate path from CTS without explicit support for a TE market. OpenADR assumes interactions with device controllers and metering are handled outside their specifications. Policy makers appear to be involved on a project implementations, particularly in California.
- IEEE 2030.5: IEEE 2030.5 is shown to cover aspects of the economic/regulatory policy category because of the common smart inverter profile experience with California Rule 21, which includes regulatory alignment that has advanced integration with multiple technology solution providers in multiple service provider jurisdictions. Besides this, 2030.5 has coverage similar to OpenADR. However, it does include

specific device control modelling and interactions. From a TE point of view, that distracts from the equipment agnostic nature of the market interface, which 2030.5 does not specifically model.

Distributed Energy Resources (DER) Protocol Reference Guidebook—5th Edition: 2021[105]

This report further discusses the broad coverage of standards considering the interoperability maturity levels. It includes briefs on 11 DER standards, focusing on the nuances in adoption across electric vehicles (EVs), solar, storage, group/aggregation management, and demand management. A brief summary is presented below.

The fifth edition (2021) of EPRI's DER Protocol Reference Guidebook includes the following information and protocol standards:

Table AIV.3 Protocol standards and application focus[105]

Application Focus	Standard Name	Technical Name
Demand Response	Modular Communications Interface for Energy Management	EcoPort (ANSI/ CTA-2045:2018)
	Open Automated Demand Response	OpenADR / IEC 62746-10-1:2018
DER Group Management	Standards for Information Exchanges Between Electrical Distribution Systems	IEC 61968-5:2020
	Standard for Smart Energy Profile Protocol	IEEE 2030.5-2018
Electric Vehicle	Open Charge Point Protocol	OCPP
	Road Vehicles – Vehicle to Grid Communication Interface	ISO/IEC-15118:2019
	Standard for Smart Energy Profile Protocol	IEEE 2030.5-2018
Energy Storage and Smart Inverters	Communication Protocols for Intelligent Electronic Devices at Electrical Substations	IEC 61850 Series and IEC 61850-7-420:2021
	DNP3 Profile for Communications with Distributed Energy Resources	IEEE P1815.2 (DNP3) and DNP AN2018-001
	SunSpec Modbus	SunSpec Modbus
	Standard for Smart Energy Profile Protocol	IEEE 2030.5-2018
	MESA-DER	MESA-DER
	MESA-Device	MESA-Device

It answers questions including:

- What types of industry drivers are causing DER protocols to be adopted?
- What data models are used that could be leveraged in an abstraction layer?
- What certifications are available for different protocols to ensure conformity?
- What are the strengths of and opportunities for each protocol in the DER domain?
- What projects is EPRI working on in relation to each DER protocol?

[105] The Electric Power Research Institute's (EPRI's) DER Protocol Reference Guidebook: 5th Edition 2021

To answer these questions, each brief covers five key areas: maturity models, architecture applicability, key recent developments, key event timelines, and supporting information.

EPRI captures the applicability of each protocol on a generic model of a DER-centric grid architecture as shown below:

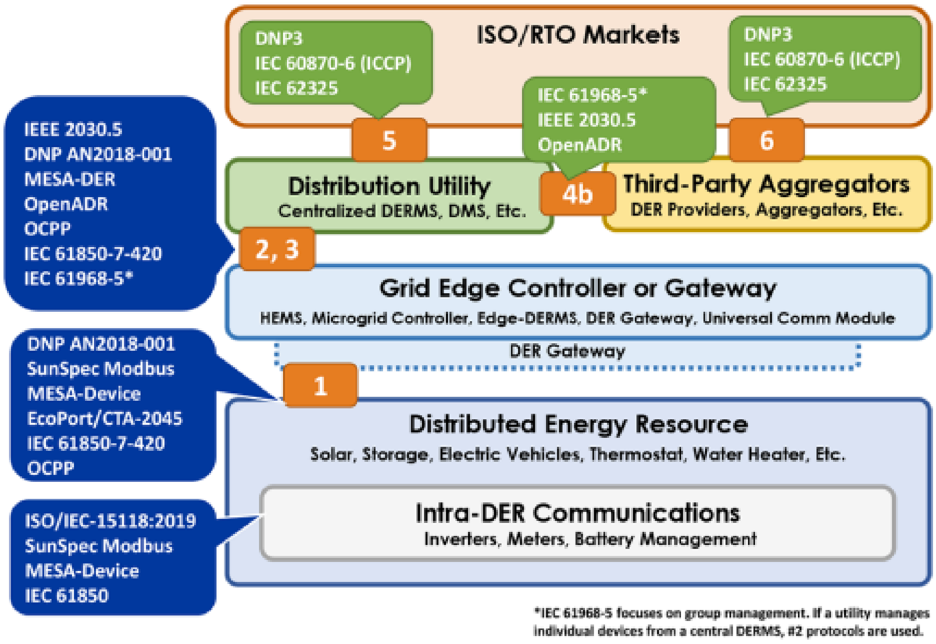


Figure AIV.3 Model of a DER-centric grid architecture[105]

Additional Papers and References

Another DERMS review paper[106] states the following:

"Near real-time communication in this context is envisioned through supervisory control and data acquisition (SCADA) and internet protocols but can also be performed through custom-made application programming interfaces (APIs). Using custom-made APIs is a current practice, as in many cases, a utility DERMS of the specific vendor on one side, and a DER aggregator on the other side, do not support the same protocols. Hopefully, this practice will soon change, as the standardization of the communication proto- cols is currently taking place, and for example, the IEEE 2030.5 protocol is a very promising solution that could be useful on both ends."

Similarly, PREVENT DER CHAOS: A Guide to Selecting the Right Communications Protocols for DER Management by QualityLogic[107] states the following:

[106] Luka Strezoski, Harsha Padullaparti, et al., " Integration of Utility Distributed Energy Resource Management System and Aggregators for Evolving Distribution System Operators" JOURNAL OF MODERN POWER SYSTEMS AND CLEAN ENERGY, VOL. 10, NO. 2, March 2022

[107] https://www.qualitylogic.com/wp-content/uploads/2022/06/Protocol-Selection-Guide.pdf

Use Case/Application	Recommended Protocol(s)	Alternative Protocols
Utility Scale Solar/Storage – SCADA Control	DNP3, IEC 61850	IEEE 2030.5
DR: Utility to EMS/Aggregator	OpenADR	IEEE 2030.5
Solar Smoothing	DNP3, IEC 61850	IEEE 2030.5
Solar Shaping	IEEE 2030.5	DNP3, IEC 61850
Duck Curve Mitigation	IEEE 2030.5	DNP3, IEC 61850
Black Start – Wildfire Prevention	IEEE 2030.5	
Frequency Regulation	DNP3, IEC 61850	IEEE 2030.5, OpenADR
CA Rule 21 Solar and Storage	IEEE 2030.5	DNP3, IEC 61850
V2G Applications: Utility to EVSE/PEV/ Gateway	IEEE 2030.5	DNP3, IEC 61850, OpenADR, OCCP, ISO 15118

Figure AIV.4 Use case applications and recommended protocols[107]

According to the Energy Management Protocol[108] , November 2022 issued by 4E (Energy Efficiency End-use Equipment, International Energy Agency), appropriately defined and standardised application protocols like IEEE2030.5 and Open ADR can support a rich set of demand management use cases across many device types. Other protocols may support a smaller range of use cases on a more limited set of device types. OpenADR, IEEE2030.5 and EEBUS all support EV charging use cases including Open Charge Point Protocol mappings.

The following table present summaries of selected protocols:

Table AIV.4 Protocols designed to support device energy management[108]

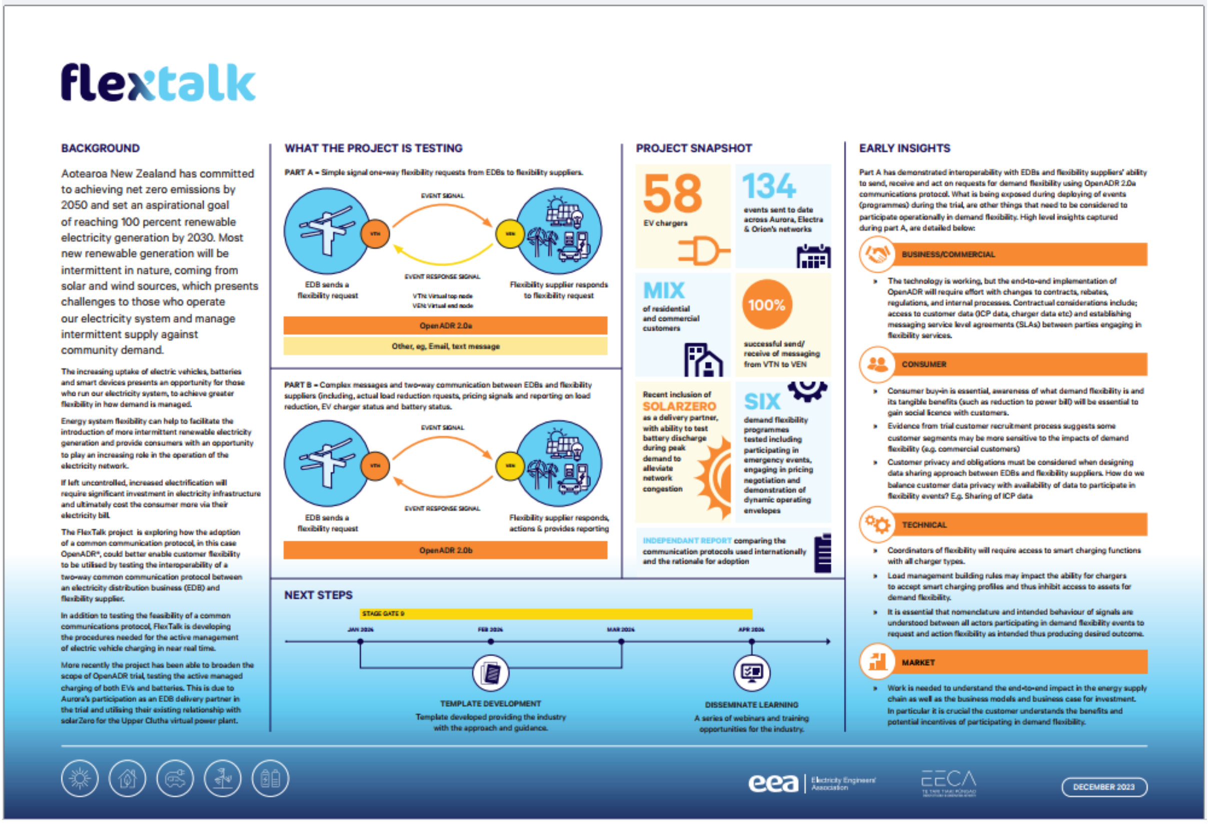
Designed to support device energy management							
Protocol	**Responsible Entity**	**Used for**	**Open source avail.**	**License required**	**Market presence**	**Technical ecosyst.**	**Cybersecurity support**
OpenADR	OpenADR Alliance	Smart grid	Yes	No	Established	Yes	Yes
IEEE 2030.5	IEEE	Smart grid	Yes	No	Growing	Growing	Yes
EEBUS	EEBUS Initiative	Selected smart grid use cases	No	No	Implemented by range of manufacturers	Growing	Yes

As per this report the following are the common uses:

- Open ADR- Aggregated demand response/management across networked energy devices.
- IEEE2030.5- Curtailing PV inverters. Broader deployment to manage DERs at town level has been trialled.
- EEBUS- Aggregated control of heat pumps at multiple sites, dynamic building power limitation setpoints, HVAC and electric vehicle management.

[108] https://www.iea-4e.org/wp-content/uploads/2022/11/Energy-Protocol-Report-Release.pdf

Appendix V FlexTalk Project, NZ



Safer, Stronger, Smarter Networks

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