Energy Web Comments Regarding Data Interoperability & Flexibility Resource Register

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Contacts	ioannis.vlachos@energyweb.org patrick.liddy@energyweb.org

Context

In the coming decades CERs (Consumer Energy Resources) and DERs (Distributed Energy Resources) are expected to represent a significant share of total installed system capacity in many countries, providing a range of services benefitting individual consumers and markets as a whole. To fully realise the financial and environmental benefits of investments, energy systems and trading frameworks must adapt to facilitate broad market participation of DER, accommodating their capabilities for dynamic bi-directional trade in, and flows of, electricity.

This DER-driven paradigm shift is acutely felt not only in the Europe[1], but in markets around the world. In the US, regulatory reforms such as FERC 2222[2] are unlocking market access for distributed flexibility. In Australia, CER and DER integration and market participation are driving similar market reforms.[3] And in the UK, market access and coordination issues have resulted in official calls for a "flex-centric system" that can facilitate distributed flexibility that might not otherwise emerge organically.

Though specifics vary by region, the common theme throughout is clear - what is needed is a dramatic expansion of market access for CER and DER via digitalisation that can coordinate the flexibility to balance the needs of wholesale markets, local services, and individual consumers.

Enabling widespread and beneficial CER and DER participation means TSOs, DSOs, aggregators, and customer agents must have the capability to exchange extremely high volumes of data (i.e. business-to-business, or B2B) using consistent data models, controls, and communication

[1] In Europe, the transition from reliance on a small number of centralised fossil fuel generators to a larger number of variable renewable and distributed resources highlights the need for improved coordination between transmission and distribution systems, as outlined by the Council of European Regulators

[2] FERC Order 2222 is a U.S. federal policy designed to remove barriers to DER participation in wholesale capacity, energy, and ancillary services markets; a key tenet of the Order is "coordination among the regional grid operator, the DER aggregator, the distribution utility and the relevant retail regulatory authority":

[3] Roadmap as published in the ESB Post-2025 Market Design Final Advice to Energy Ministers and ESB Interoperability Policy for Consultation

methods throughout the entire DER lifecycle in order to effectively perform their respective functions in the market.

As highlighted in this consultation document, while some individual digital components that address CER and DER coordination needs exist today, market failures preclude them from being consolidated into a cohesive ecosystem. The lack of a coherent, system-wide, digital framework that connects the many different markets for distributed flexibility is a significant barrier to realising the full value of CER and DER. Overcoming this barrier can be accomplished via "a common digital energy infrastructure able to unlock flexibility in multiple markets by facilitating information provision, market access and coordination, and effective trust and governance structures" - a digital spine.

1. What do you think distributed flexibility could contribute to the energy system?

2. Will a focus on CER flexibility also help enable other forms of flexibility, especially distributed flexibility?

3. Is there a 'case for change' and a need for a common vision for distributed flexibility?

Based on Energy Web's experience implementing Digital Spines in other markets for similar CER and DER use cases, there are three key benefits to this approach:

- **Lowering Integration Costs:** A standardised integration mechanism with a central infrastructure enables participants to exchange multiple data types and formats via a single integration, and thus can reduce industry costs and complexity.
- **Unified Identity and Access Management:** Market participants can perform authentication and authorisation processes for multiple markets and use cases with a single portable, self-managed digital identity; this avoids duplicate and redundant processes and streamlines data sharing arrangements. Energy Web has implemented IDAM functionalities using Self-Sovereign Identity (SSI)[4] technologies based on World Wide Web Consortium (W3C) standards, namely Decentralised Identifiers (DIDs)[5] and Verifiable Credentials (VCs)[6]. This approach to IDAM is analogous to the way a person uses a physical passport and visas to travel. Like a passport, a DID is a persistent and universally-recognised identifier that can be presented to authenticate identity in

[4] 'Self-Sovereign Identity' is a growing paradigm that promotes an individual's control over their identity and their data. This is in contrast to the current paradigm where most official identifiers are given to users and maintained by an external authority, where user data can be shared without their knowledge or consent (especially in the event of a cybersecurity breach) and where roles, access, and permissions can be centrally revoked without user knowledge.
[5] A DID is an identifier that can be generated and controlled by individuals or organisations without an external authority. Technical specifications are available at https://www.w3.org/TR/did-core/
[6]A Verifiable Credential is a secure and machine-verifiable digital credential which respects a standard data model. Technical specifications are available at https://www.w3.org/TR/vc-data-model/

different settings. VCs function similarly to visas, in that they are separately-issued credentials that grant the DID holder specific permissions in specific contexts, and can be revoked under certain conditions.

- **Ensuring Information Integrity:** Establishing a unified role-based access control mechanism to dedicated communication channels that feature standardised data schemas provides a foundation for ensuring consistency and security in the exchange of information between stakeholders. Two additional features further augment this capability. First, the use of SSI enables all messages broadcast within channels to be cryptographically signed by the public key of the sender, which enables recipients to authenticate the origin. This is a well-established approach for communicating information securely between two parties for processes where both sender and recipient are known to each other and agree to disclose underlying data within the message. However, some emerging CER and DER use cases require the transmission of information among three or more parties in a way that does not necessarily reveal all data to all parties. For these use cases Energy Web has developed with a novel approach called Decentralised Logic Execution (DLE). DLE is where a distributed network of independent worker nodes[7] - a cluster of computing resources operated by separate hosting providers - ingest data from external sources, execute custom workflows based on predefined business logic, and vote on results in order to establish consensus without revealing or modifying the underlying data. DLE borrows concepts from public distributed ledger solutions, namely distributed consensus protocols which use cryptographic techniques to establish provably correct and timely results.

4. What is your vision for how to accelerate the delivery of accessible, coordinated and trusted markets for distributed flexibility?

5. Will certainty of an end vision help accelerate enabling work and make it cohesive

6. When should a common digital energy infrastructure be in place? And therefore, when should development begin?

7. What should a common digital energy infrastructure look like, and why? Please consider the archetypes or develop your own proposition.

8. What is your view on the desirability and feasibility of the archetypes or your own alternative proposition?

[7] Learn more at https://medium.com/energy-web-insights/proof-of-good-work-energy-web-releases-worker-node-toolkit-to-the-public-e67a9d8a2973

EnergyWeb has worked with over 100 Energy stakeholders in multiple geogrpahies and we believe that the critical elements to delivering a successful digital spine project are as listed below. These include the requirements of the Medium and Heavy elements as listed in the Call for Information

Functional Requirements & Capabilities for a Flexibility Resource Register

Each use case and business process related to CER and DER participation in electricity markets involves different stakeholders communicating specific datasets with particular formats at varying frequencies and volumes. Accordingly, while it is important to identify detailed functional requirements for each use case there are three core capabilities that a Flexibility Resource Register must provide as a foundation to enabling scalable CER and DER integration and data exchange:

- **Managing Identities and Permissions:** inter-organisational data exchange is predicated on the ability for multiple parties to mutually authenticate each other's identity and authorise selective disclosure or communication of information between them based on their respective roles and responsibilities. Achieving secure and scalable data exchange to enable emerging CER and DER use cases requires common, consistent authentication and authorisation frameworks (collectively referred to as Identity and Access Management or "IDAM") that span the entire industry. A unified digital IDAM approach can improve interoperability and streamline the establishment of trusted relationships between devices, systems, and organisations - the UK needs a digital "passport" and "visa" solution for CER and DER to be fully engaged in market transactions and services.

- **Managing Integrations:** from an operational perspective, CER and DER data exchange currently relies on technical integrations between siloed, disparate systems owned and maintained by CER and DER agents, such as aggregators, retailers, OEMs, and DERMs providers, and DSOs, as well as TSOs. Today such integrations are piecemeal and bilateral, with the diversity of technologies and integration methods between stakeholders meaning consumers and industry face higher costs, unnecessary complexity, and technical challenges that directly diminish the value of CER and DER participation in flexibility markets. Continuing on this trajectory is undesirable, as the number of discrete integrations will need to grow exponentially as the number of CER and DER and related stakeholders increases. A more efficient approach is to enable many participants spanning multiple markets to exchange a variety of data types and formats via a single integration with a common digital infrastructure.[8]

- **Maintaining Information Integrity:** given the growing volume and diversity of CER and DER data, it's imperative that all market organisations work with an accurate and consistent set of facts. Markets will need mechanisms to ensure that data quality and integrity is maintained in the process of being exchanged among systems and stakeholders to enable the transition to a market with significantly larger volumes of distributed flexibility.

The capabilities mentioned above will need to be enhanced to facilitate many discrete CER and DER use cases involving significantly more stakeholders and exponentially larger volumes of data compared to today's energy market landscape.

Design Principles & Example Architecture for a Flexibility Resource Register

Development of a Flexibility Resource Register should be informed by the following design principles:

- Reduce complexity and cost for industry by reducing the number of integrations required by participants to exchange data associated with multiple use cases;
- Standardise rule-based logic for data exchange;
- Simplify reporting, reconciliation, and incident management;
- Make it easier to coordinate and perform maintenance / system updates over time;
- Be protocol agnostic – the data exchange solution architecture should not be predicated on a specific communication protocol and vice versa; any communication protocol or standard can be utilised without rigid hardware requirements;
- Improve system resiliency by eliminating single points of failure and implementing highly-available infrastructure with built-in failover and recovery mechanisms;

[8] Ofgem Call for Input: The Future of Distributed Flexibility, March 2023, Section 1.4

- Enable participants to configure their own bespoke communication channels to support data exchange with many others (broadcasts), or directly with a single participant (unicast);
- Empower all participants to self-manage their own identity and credentials, and to have direct control over their data (instead of relying on a separate administrator);
- Reduce error and disputes by enforcing rules, roles, and responsibilities defined via collaborative, shared industry governance in code; and
- Foster innovation and build market value by enabling participants to build custom applications on top of shared infrastructure, with new use cases being established and supported.

Energy Web has developed an open-source software solution based on these principles. As shown in the figure below, Energy Web's solution implements a secure, open-access messaging infrastructure that:

- Allows market participants to send, receive, and authenticate messages based on the roles that have been issued to and associated with their self-managed identity;
- Allows market participants, DSOs, and TSOs to exchange diverse datasets, ranging from real-time telemetry to bulk file uploads, in support of multiple DER use cases;
- Requires only a single integration mechanism with a central infrastructure in order to communicate via one:one (unicast), one:many (broadcast), and many:many (multicast) channels.

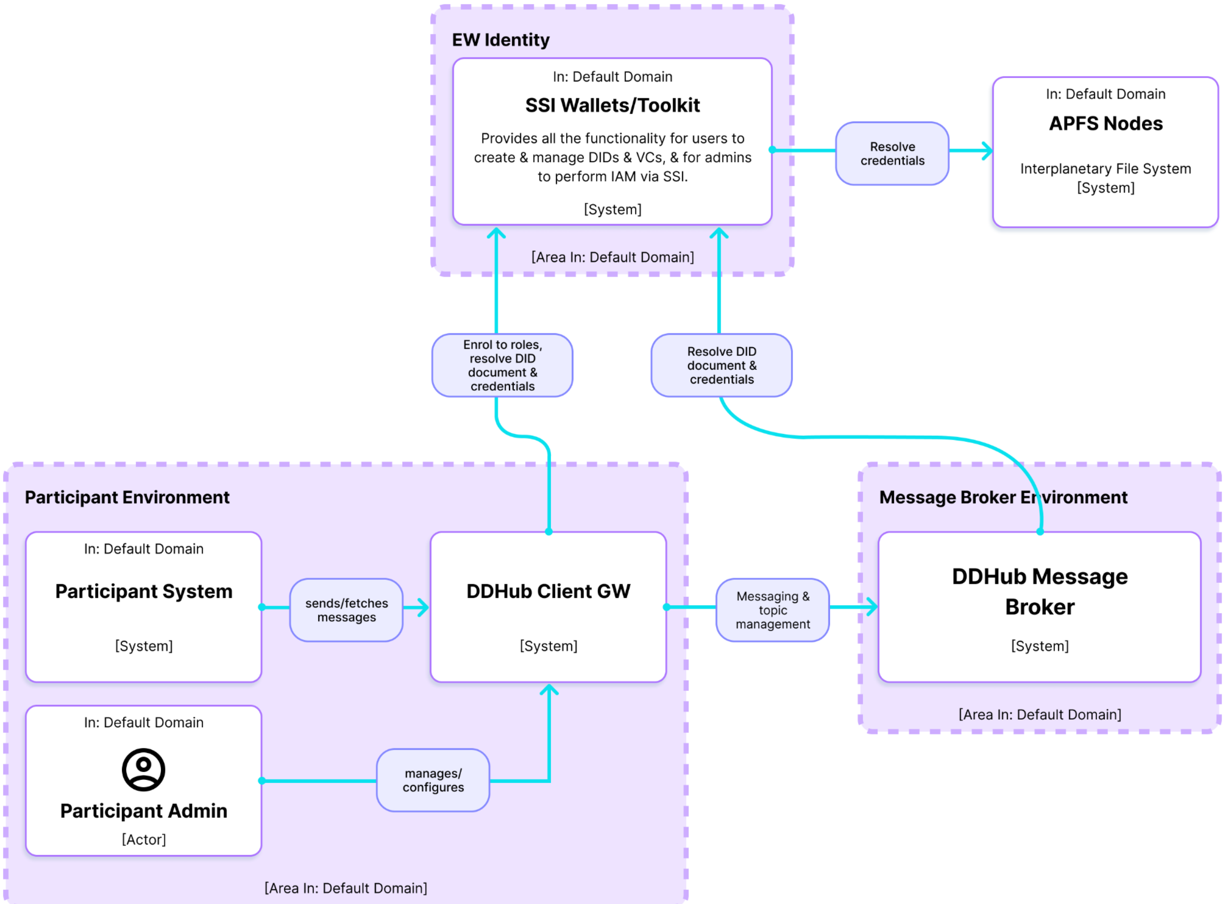

Figure 1: Energy Web Messaging and Integration Solution architecture

<u>*Legend:*</u>

- **Participant Environment:** Hosting environment (e.g. public cloud instance, or on-premise server) where market participants deploy and operate the DDHub Client Gateway Application.
- **Participant System:** Participant applications (e.g. CER and DER management system, market operation systems) that send and receive messages on relevant channels (within the shared message broker) via the Client Gateway.
- **Decentralised Data Hub ("DDHub") Client Gateway:** The interface presenting UI, and API for interacting with the Message Broker to send and receive messages
- **DDHub Message Broker:** The component that routes messages between Client gateways (using API to control NATS messaging).
- **SSI Toolkit:** Libraries and components that implement identity and access management functionalities.
- **IPFS:** Distributed file storage system used to store and manage identity and role definitions.

Conceptually, this approach mimics the functionality of a shared personal computer in which multiple independent users have the ability to run multiple applications on top of a common operating system and hardware.

In this architecture, the shared message broker is analogous to a computer - it is foundational infrastructure upon which TSOs, DSOs, and market participants gain the ability to establish their own “profiles”, exchange messages, and run their own applications. The DDHub Message broker is the component that routes and translates messages between participants; it can be implemented in a decentralised architecture, in which multiple organisations host independent nodes that perform messaging and data validation functions. This design can improve resiliency and scalability compared to conventional hub-and-spoke models hosted centrally by a single entity. Messages are structured and organised in distinct channels corresponding to specific CER and DER use cases, and formatted in topics which define data formats and schemas.

TSOs, DSOs, and market participants gain the ability to exchange data and write to a common data registry with each other by integrating with the Message Broker via the DDHub Client Gateway, an independent application that participants run in an environment of their choosing. In order to access certain channels and gain permissions to send and/or receive specific message types, participants acquired roles that reflected their role within the market, using credentials attached to their self-determined identity. Credentials can be defined and granted by different issues (e.g. regulatory bodies, TSOs, or DSOs) and govern the ability to send messages to other participants using channels (what messages are sent and received) and topics (data schemas that define the payload of a message). Recipients can use identities and credentials to restrict who they receive messages from, could send to, as well as authenticate messages to ensure they are valid.
This solution architecture has already been deployed in support of a CER and DER marketplace (involving the local TSO, a DSO, and multiple aggregators) in Australia under Project EDGE[9]. It provides an indicative example of how this architecture could be used to implement a Flexibility Resource Register in the UK: different entities involved in the DER lifecycle (such as OEMs, installers, DSOs, aggregators, retailers TSOs, and customers themselves) could use the shared message broker to create, read, and/or update CER and DER records (or specific fields within records) stored in a common database, based on their role within the market and the relationship to the CER and DER (or associated customer). Any given entity could publish certain data to the shared registry once, and authorised subscribers can access the data based on their role.

Based on Energy Web’s experience implementing this architecture in other markets for similar CER and DER use cases, there are three key benefits to this approach:

[9] See AEMO's Project EDGE website for background and objectives. An interim report highlighting the implementation of Energy Web’s technology as described in these comment is available at https://aemo.com.au/-/media/files/initiatives/der/2021/edge-ew-solution-intro-and-info.pdf .

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- **Ensuring Information Integrity:** Establishing a unified role-based access control mechanism to dedicated communication channels that feature standardised data schemas provides a foundation for ensuring consistency and security in the exchange of information between stakeholders. Two additional features further augment this capability. First, the use of SSI enables all messages broadcast within channels to be cryptographically signed by the public key of the sender, which enables recipients to authenticate the origin. This is a well-established approach for communicating information securely between two parties for processes where both sender and recipient are known to each other and agree to disclose underlying data within the message. However, some emerging DER use cases require the transmission of information among three or more parties in a way that does not necessarily reveal all data to all parties. For these use cases Energy Web has developed with a novel approach called Decentralised Logic Execution (DLE). DLE is where a distributed network of independent worker nodes[13] - a cluster of computing resources operated by separate hosting providers - ingest data from external sources, execute custom workflows based on predefined business logic, and vote on results in order to establish consensus without revealing or modifying the underlying data. DLE borrows concepts from public distributed ledger

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[13] Learn more at
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solutions, namely distributed consensus protocols which use cryptographic techniques to establish provably correct and timely results.

Regarding setting a clear vision and, a clear yet flexible target vision helps all stakeholders to invest with certainty in their own systems. It is also important to know that as achieving this vision will take time, the system will need to facilitate both current and future connection methodologies on an ongoing basis to ensure that work done by participants at the early stage is outdated as technologies progress.

9. Should a common digital energy infrastructure be new-build, or should it build-out from existing infrastructure?

While a new and flexible system is required, it should be able to interface with the existing system so as to allow all participants to be treated equally from the point of view of accessibility and payment as well as allowing the System Operators to access different technologies seamlessly.

10. What are the important areas for consideration when designing institutional delivery models for a common digital energy infrastructure?

We believe a central authority is required from the point of view of system maintenance, but where possible distributed systems should be used to facilitate calculations, data storage and provide transparency.

11. What are the important areas for consideration when designing financial delivery models for a common digital energy infrastructure?

We believe that where possible implementing flexible systems such that common financial treatment is possible between existing energy resources with CERs and DERs. This allows for complete market transparency and a level-playing field for all.

Conclusion

In the enterprise IT world, complex integration problems are often solved with hub-and-spoke architectures[14], in which many different point-to-point connections between systems are replaced with standardised integrations with a central component that implements common security and communication patterns. The hypothesis that a CER and DER data hub model provides a scalable and long-term approach for implementing a Flexibility Resource Register compared with heterogeneous point-to-point interactions between industry actors is based on strong evidence.

[14] For example, see: https://learn.microsoft.com/en-us/azure/cloud-adoption-framework/ready/azure-best-practices/hub-spoke-network-topology

However the nature of CER and DER - the fact that CER and DER operation impacts both wholesale / transmission systems under the purview of TSOs, as well as distribution network systems under the purview of DSOs - together with recent advances in enterprise software architectures, present an opportunity to challenge conventional assumptions and reimagine how a Flexibility Resource Register could be implemented. A hub architecture based on decentralised digital infrastructure, with self-sovereign digital identities and appropriate governance arrangements, can enable opportunities for broader benefits to efficient operation of, and participation in electricity markets, and addressing cybersecurity risks and consumer data privacy.