The energy data-X data ecosystem: Cross-sector and BESS data exchange enabled by the European Business Wallet and market role credentials

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The energy system is becoming more decentralised and digital, and increasingly composed of small-scale units, as the number of actors, assets and data flows increases. Data ecosystems offer a way to manage this new situation. They enable the trusted cross-sector data exchange that is needed, with reliable verification of identities, market roles and usage rights. The energy data-X project provides insight into how the European Business Wallet and market role credentials can be used to establish a robust, market-ready operating model for data exchange in the energy sector. The underlying trust architecture applied to BESS systems, extends beyond the energy sector, and can also be applied in other industries.

The energy sector faces a structural integration challenge. The deployment of distributed generation, flexibility resources, storage systems, charging infrastructure and smart metering systems is advancing rapidly. This is causing a sharp increase in data flows between grid operators, suppliers, metering point operators, direct marketers, platform operators and new energy service providers. Sector coupling is needed to achieve a cost-effective transformation of the energy sector. Future requirements of the EU internal market add further demands that existing IT systems were not designed to meet.

Data exchange between energy industry stakeholders requires increasingly complex security mechanisms *Picture: Adobe Stock*

Why does the energy sector need a data ecosystem?

Data ecosystems based on Gaia-X and the principles of the International Data Spaces Association (IDSA) offer an approach to this challenge because they combine standardisation, trust and data sovereignty. Data remains decentralised, but common rules, trusted identities and machine-readable usage policies allow it to be used interoperably and under controlled conditions.

The energy data-X project brings this approach to the energy sector and draws on the results of the German Energy Agency's (dena) Reference System for Data Exchange in the Energy Sector (Re-4DE) [1]. It is not developing a central data pool. Instead, it is creating a data ecosystem that meets European standards and incorporates trust from the outset. In energy data-X, data is held in decentralised systems, made available through connectors and controlled through identity, trust and policy mechanisms. Connectors act as gateways to the data ecosystem. They link a participant's existing back-end systems to the services of the data ecosystem and provide functions for catalogue access, contract and policy checks, and secure data transfer.

In a data ecosystem with many actors, however, the task is not only to transfer data. It is also necessary to verify reliably who the participant is (which company or legal entity), which market role it holds, and which tasks it may delegate to employees, machines, services and AI agents. In data-ecosystem processes, authenticating a company merely as an organisation is not enough. The decisive question is whether, for the relevant process, the company holds a verifiable market role credential issued by a trusted issuer (an authorised issuer).

This is where the European Business Wallet (EBW) comes in. It is a digital company ID standardised by the EU and usable across Europe [2]. A company stores verifiable evidence of its identity, attributes, market roles and delegations in the wallet. Connectors use this evidence when deciding whether to permit data access through a policy check.

This approach is an essential foundation for sector coupling because energy-sector data must be interoperable with data from adjacent sectors and domains such as mobility, industry, buildings, battery

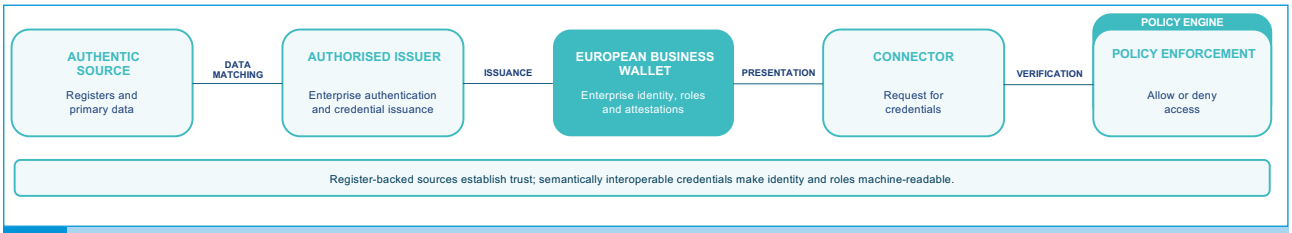

Fig. 1 **EBW trust chain in the data ecosystem - from the authentic source via authorised issuers and the EBW to verification in the connector and policy enforcement**

Source: Carsten Stöcker, Spherity GmbH

storage and digital product passports. European interoperability is not created by common data models or connectors alone. It also requires a common level of trust: consistent rules for authentication (who is who), authorisation (who may do what) and data provenance.

The approach also strengthens cybersecurity. Every access decision is based on verifiable credentials and machine-readable usage policies. Rights granted through delegation can be limited and revoked. The EBW therefore acts as a cross-sector trust bridge between regulated energy-market participants and participants in other data ecosystems such as Catena-X or Manufacturing-X.

Making trust machine-readable

The European Business Wallet (EBW) serves as a digital ID for companies in the data ecosystem. It combines identity, attributes, roles and authorisations in a verifiable trust model. The EBW approach shifts trust away from individual platform operators and towards officially recognised registers that serve as authentic sources. These registers and other bodies recognised by public authorities or by the relevant sector can issue the required evidence themselves or authorise others to do so. Evidence of identity, roles and authorisations is held in the EBW as verifiable credentials and can be verified, updated and revoked. Access can therefore be controlled by role and attribute in line with the zero-trust principle, under which every access request is checked and nothing is trusted by default.

energy data-X applies this approach to energy-sector data ecosystems. As an authorised issuer, Bundesanzeiger Verlag issues register-backed company information as verifiable credentials. Companies can manage these credentials in their EBW and present them in the data ecosystem. The European Unique Identifier (EUID), EU Company Certificate (EUCC), Market Partner ID and market role credentials can be integrated in the same way. These credentials are issued by the competent primary registers, which serve as authentic sources. This creates an end-to-end chain of trust extending to the data-ecosystem connector and the policy engine, the component that automatically allows or denies each access request (see Figure 1).

Market roles are not simply master data. They define responsibilities in a regulated market and therefore different rights, obligations and permitted actions. A supplier, grid operator, metering point operator or direct marketer may use similar interfaces but may not perform the same actions. The Market Partner ID provides an established reference point. A market role credential enables the policy engine to check whether the issuer, role, ID and usage policy associated with the data offering are consistent (see Figure 2).

The policy engine is the technical component in the connector where the actual access decision is made. It checks whether the credentials presented are valid, have not been revoked, come from a trusted issuer and contain the required attributes. It then compares them with the

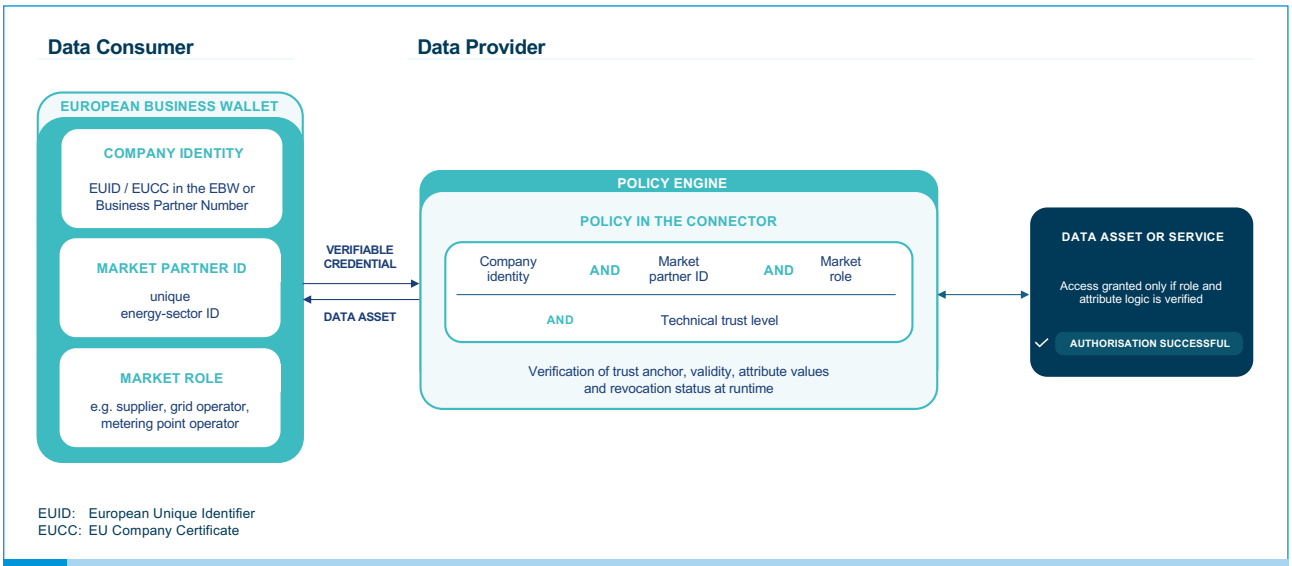

Fig. 2 **Trust architecture – joint evaluation of company identity, Market Partner ID and market role in the policy engine**

Source: Carsten Stöcker, Spherity GmbH

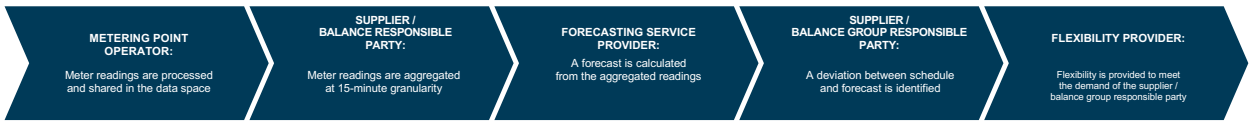

Fig. 3 **Process chain for the 'Imbalance settlement quality' use case, executed through the energy data-X data ecosyst**

Source: Jan-Niklas Gößling, Amprion GmbH

usage policies of the relevant data asset or service. This check can take place during catalogue access, contract negotiations and data transfer. Only at the time of access is it determined whether the role and attributes meet the requirements.

The requirements of the Smart Metering PKI (SM-PKI) continue to apply to mandated energy-sector processes. Re4DE already integrates the SM-PKI as a technical trust level. In energy data-X, this technical trust level is combined with EBW credentials without compromising European interoperability.

Use case: 'Imbalance settlement quality'

Many systems are currently used in the energy sector to support different processes. Most are operated separately and are not interoperable without bespoke implementation work. In future, data will also need to be available at high temporal resolution and processed quickly. Linking existing system landscapes through a standardised, modern interface can address these challenges.

The energy data-X use case 'Imbalance settlement quality' tested this approach. Representative processes from market communication, forecasting and flexibility provision were linked using test data.

The metering point operator first collects meter readings from smart metering systems, processes them and makes them available through a connector in the data ecosystem to the relevant authorised supplier or Balance Responsible Party (BRP). The supplier/BRP creates aggregated time series from the readings and sends them to a service provider in the data ecosystem. The service provider enriches the meter readings with additional data and calculates a forecast for the supplier/BRP. If the supplier/BRP identifies a deviation between the forecast and the schedule, it can request and activate flexibility from a flexibility provider through the data ecosystem. The supplier/BRP can thereby rebalance the balancing group at short notice. Figure 3 shows the process chain.

The data ecosystem offers several benefits for this process. All participants can see the data available to them in a data catalogue and retrieve it in near real time. All data offerings in the catalogue are described in machine-readable form and can be filtered using attributes such as title, description, version, resolution, type and data model. This also lowers barriers to data access for new participants because relevant data can be found and retrieved with little effort through the catalogue and the data ecosystem technology.

Overall, the use case shows that energy-sector processes can be represented and linked effectively through a data ecosystem. Fine-grained authorisations using the EBW and verifiable credentials have also been implemented in the data ecosystem. These standardised components improve scalability and automation. Once registered in the data ecosystem, new participants can immediately communicate through their connector with participants that are already registered.

Blueprint for the battery passports and BESS systems

The trust architecture in energy data-X can also be applied to product passports, including the battery passport. For the battery passport required from February 2027, the EU Batteries Regulation [3] distinguishes between public data; data for market surveillance authorities, notified bodies and the European Commission; and data for persons with a legitimate interest. Some data, for example on material composition, safety or battery status, may be commercially sensitive but is needed for repair, remanufacturing and recycling. Access decisions must therefore also depend on roles and verifiable responsibilities. As in energy data-X, this requires role registers, authorised issuers, revocation and update processes, and machine-readable policies governing read, write and update rights.

For stationary battery energy storage systems (BESS), battery passports are more than regulatory compliance documents. They concern systems that participate in flexibility processes and contain safety, maintenance and take-back data. Their architecture should be designed from an early stage to be compatible with data ecosystems, subject to European oversight and based on verifiable chains of trust.

At the same time, the battery passport for BESS installations should go beyond the statutory minimum scope of the EU Batteries Regulation. Relevant processes include predictive maintenance, flexibility aggregation, second-life use, responsible take-back and system safety. These processes require product data and verifiable evidence of roles, authorisations and provenance that data ecosystems can evaluate automatically. Partners in energy data-X are currently testing this approach on a large research battery storage system together with Spherity GmbH and the Federal Institute for Materials Research and Testing (BAM) and a major energy utility.

Data ecosystems: A foundation for trustworthy AI

Data ecosystems support industrial AI applications wherever AI depends on distributed, context-dependent and protected data. In the energy sector, examples include forecasting, predictive maintenance, flexibility optimisation, anomaly detection and asset operation.

engThese AI use cases were not tested in energy data-X because they were addressed in related projects. The Catena-X/Tractus-X AI Service KIT is one example of Trusted Industrial AI [4]. It describes AI systems and agents as service assets with standardised metadata and usage policies, making them discoverable and usable through connectors. For energy data-X, this means that AI services can also be published, verified, made subject to contractual terms and used within the data ecosystem. The policy engine then decides on data access and the permitted use of a model or agent in a market process.

Technical accessibility alone is not sufficient for trustworthy AI. Evidence is required of the identity of the legal entity, the applicable market role and delegations, the provenance of the data, the version of the model or service, and who may access it. The Trusted AI approach brings these elements together. Access, provenance, usage rights and processing steps therefore remain verifiable and can meet requirements such as those of the EU AI Act. This allows AI outputs in the energy sector and industry to be used safely, while remaining auditable and traceable for liability purposes.

References

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