Critical software

Certified B Corporation

ConnectaX: Connecting Supply and Demand

Bringing enhanced autonomy to distributors, suppliers, consumers and prosumers.

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What will your home look like 10 years from now?

Think forwards 10 years from now. What will our homes look like? Will we be able to communicate with the many appliances within? For instance, could our online calendars be used to determine if the heated seats in our cars need to be activated before a long journey on a cold winter's day? How about our alarm clocks, which could use our schedules to automatically set themselves and give us a head start into our working day?

Smart devices already infiltrate our lives. In fact, as of February 2021, 57% of homes in the UK owned some sort of smart device. And that number is only going in one direction...

All this will require energy – and lots of it. That energy could be managed by smart grids, the benefits of which are clear. By creating both strategic and operational improvements through increasing information generated and enabling energy flow to more endpoints through more channels, there are disruptive and positive gains in resource management that could hasten our journey to Net Zero.

As of February 2021, 57% of homes in the UK owned some sort of smart device. [1]

Smart grids, through integrating Information and Communication Technology (ICT), offer real-time management of electricity loads. A second level of more advanced optimisations and improvements could be achieved by these with Home Energy Management Systems (HEMS), connecting electric vehicle (EV) charging points, heat pumps and storage for micro-generation and smart appliances. This could bring even more intelligent control into our lives and offer the capability to schedule electric loads that, in turn, brings significant advantages to all energy stakeholders.

[1] - https://www.theecoexperts.co.uk/smart-home/statistics

Matching demand

The successful operation of smart grids relies on the intelligent distribution of electricity. But how can that be done?

Demand Side Flexibility (DSF) is the ability of consumers to adapt their electricity usage in response to market signals. The end-consumer may adjust power demand by delaying tasks requiring large amounts of power or may decide to pay a higher price for their electricity.

An opportunity arises amid all this complexity: if operated smartly, this can help grid operators relieve overload or under-supply and defer infrastructure investments. One way of incentivising such resources is to create local markets for flexibility where consumers can work together to scale and optimise their energy generation portfolio by leveraging the gap between generation and demand, minimising costs and generating revenues from surplus energy.

How can each stakeholder in the provision of energy play their part in managing demand?

TSOs & DNOs

A clear distinction exists between the roles performed by Distribution System Operators (DSOs) and Transmission System Operators (TSOs):

DSOs connect new loads and ensure that the distribution network is always operational, delivering power to consumers all year round.

TSOs connect the generators needed to supply those consumers with power and manage the real-time flows on the network.

A DSO is responsible for the low and medium voltage electricity networks and has an interest in providing sufficient flexibility to keep power demand within the network's limits. This flexibility is obtained by working with the end consumer and encouraging them to optimise their energy usage by avoiding usage that could occur at another time, thus minimising the peak load on a network, resulting in lower generation demand.

Energy flexibility is also relevant to TSOs and their high-voltage grids; it offers the possibility to assist with grid balancing, keeping the frequency at 50Hz or 60 Hz depending on the network. This is an increasing challenge with the growth of intermittent energy production from, for example, wind power.

SUPPLIERS

Device flexibility offers energy suppliers various technical options to better control electricity use. These include better ways to coordinate consumption with the production/purchase of electricity. In addition to being explicitly asked by external parties for flexibility, it is also conceivable that new capacity rates to level off peak loads will be used in future.

CONSUMERS AND PROSUMERS

The main advantage for this category of stakeholder is to lower the cost of energy without sacrificing comfort.

The idea is that the flexibility of various devices can be used in such a way that complete power demand remains below the network's contracted capacity limit, without the consumer having to sacrifice comfort.

Different devices in a building offer the potential to provide flexibility by shifting or reducing energy demand; this is known as demand-side management. This is possible, for example, by not charging electric cars at full charge-rates when everyone comes home in the evening, but at lower charge-rates during the night.

AGGREGATORS

Prosumers (users who both produce and consume energy) can aggregate to create value. This offers the opportunity for smaller residential and commercial customers to exploit their flexibility potential. Aggregation is a commercial function of pooling decentralised generation and/or consumption to provide energy and services to users within the system.

A separate aggregation option exists for retailers or third parties acting as intermediaries between customers to provide such flexibility.

The flexibility challenge

The three Ds of energy transformation – Decarbonisation, Decentralisation and Digitalisation – bring challenges and opportunities for distribution grids, suppliers and end users.

Small-scale generation, batteries, electric heating and e-mobility will put progressive strain on grids. Demand Side Flexibility (DSF) is needed to enable efficient and effective grid management. Yet gaps remain that must be overcome by stakeholders.

DSOs have no standardised way to notify end users when to adjust their energy consumption profiles. Privacy concerns also make it difficult for DSOs to investigate consumers' energy profiles and derive useful insights for planning purposes.

Additionally, suppliers and prosumers do not have the means to receive or action notifications about their usage, such as suppliers informing users of changing prices or DSOs informing users that they must immediately reduce consumption to safeguard the network.

Whilst it is very much needed, large scale implementation of DSF has not yet occurred at scale. We see several countries already implementing flexible tariffs along some form of Demand Response, but this is in its very early stages. Plus, there are significant barriers for implementation, many of which are regulatory, e.g. regulated tariffs, and market rules for operating flexibility or technical, e.g. interoperation and security.

DSF implementation not only requires energy market players, such as DSOs and suppliers, to co-operate, but also that their technical demand management infrastructures are closely coupled. Interoperability is vital, especially where the DSO infrastructure provides information such as smart meter data that is needed by demand-side flexibility applications.

Our solution: ConnectaX

ConnectaX is a Home Energy Management System (HEMS) that enables collaboration between energy providers and energy consumers. DSOs and suppliers benefit from gaining an enhanced view of home energy usage patterns, and end users obtain a better integrated HEMS.

ConnectaX brings with it the vision of coordinated energy flexibility and consists of three sub-systems: Home Energy Management System, Resource Manager and Network Flexibility Protocol.

HOME ENERGY MANAGEMENT SYSTEM (HEMS)

This is the in-home subsystem enabling advanced resource management through providing highly granular patterns of energy use.
The system records the type of device and specific consumption of individual devices. It would encapsulate and coordinate both the sub-systems related to network flexibility (representing network-side stakeholders) and demand side flexibility (servicing the home user). In turn, this will enable the system to target advanced management of power limits applied to the distribution grid. Additionally, HEMS may provide users – the householders – to schedule tasks, thus participating in smart management of electricity resources while increasing their level of comfort and financial benefit by selling excess energy back to the grid or aggregators. Since there are diverse types and brands of flexible devices which can be used, it is highly likely that those devices use different communication protocols and/or different data/function models. To exploit the energy flexibility of all smart devices in the home, it is essential that the HEMS can communicate with them. Therefore, it is important to define a common data/function model, message structures and message sequencing rules, enabling a HEMS to use a single language and communication protocol to define device functions, e.g. registration, reservation, metering, etc. and use them through a single communication protocol with the Resource Manager.

THE RESOURCE MANAGER (RM)

This sub-system provides support for multiple home devices, using diverse protocols.

Home devices have various levels of instrumentability, ranging from zero to advanced methods of control. The RM is the 'connection point' of the device from and to the HEMS and determines, for example, the integrity of the device and the associated impact on user comfort. These devices (figure 1) could be:

- **Inflexible energy devices** that do not provide any option to control their flexibility; they can be either on or off.
- **Shiftable smart energy devices** that perform a task which has a corresponding power profile known or predicted beforehand, e.g. a washing machine. Flexibility comes from the ability to change the start time of that power profile usage.
- **Adjustable smart energy devices** for which power consumption or generation may be controlled without significant effect on the energy flexibility in the future, e.g. HVAC, variable intensity lights.
- **Storage smart energy devices** that can store or buffer energy, noting that there must be a way to measure how full the storage or buffer is, e.g. PV batteries.
- **Hybrid Energy Type devices** that can use diverse types of energy, such as hybrid heat pumps, that can use electricity and/or gas as an energy source.

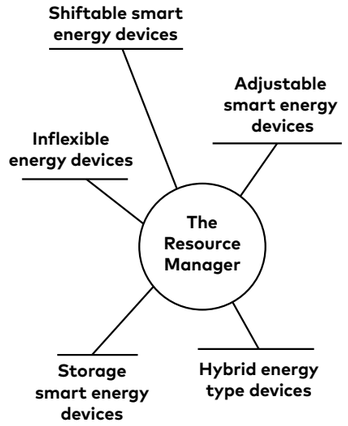

Figure 1 Resource Manager devices

To control these devices, the protocols that ConnectaX will be able to work with initially are:

- **EEBus** – supports a high number of use cases for the energy flexibility goals.
- **KNX** – a worldwide open standard for home and building control.
- **Open Connectivity Foundation (OCF)** – focuses on the smart home where devices can communicate with each other, without direct customer interaction, to increase efficiency and deliver better user experiences.
- **Open Charge Point Protocol (OCPP)** – used for operating and managing EV charging stations.
- **Zigbee Smart Energy Profile (SEP)** – standard for interoperable wireless products that monitor, control and automate the delivery and use of energy.
- **Great Britain Companion Specification (GBCS)** – defines the requirements for communications between Smart Metering Devices in consumers' premises, and the Data and Communications Company (DCC).

NETWORK FLEXIBILITY PROTOCOL

This is a channel that enables homes to receive network signals related with energy flexibility and to optionally share information that increases the future effectiveness of such signals. The protocol aims to automate demand response communication, to allow the DSO to signal the home system to change power consumption or production of demand-side resources. The DSOs could, for instance, send emergency signals to trigger adjustments to avoid blackouts. Suppliers could disseminate new tariffs in real time enabling energy usage optimisation which in turn would influence market prices. The candidate protocol for enabling the flexibility with the network is Open Automated Demand Response, known as OpenADR. The protocol is aimed at automating demand response communication and can be used by grid companies to send Demand Side Response (DSR) signals based on grid needs - for example, via tariff or emergency signals.

When applying this architecture, the consumer can still control and influence the operation of 'in-home' flexible devices and determine flexibility levels. The consumer has their own set of preferences for the behaviour of their flexible device that must be accounted for by the HEMS. These preferences should normally take precedence over those of energy stakeholders unless otherwise specified.

A relevant and salient use-case for the near future will be in-home smart charging for EVs. A system that can consider other consumers' power requirements within the household and is able to adjust accordingly will be a fundamental part of the solution, primarily to protect the network. For this to happen, the home or building would need to be equipped with a compatible HEMS to which the charging system is able to communicate using the appropriate protocols.

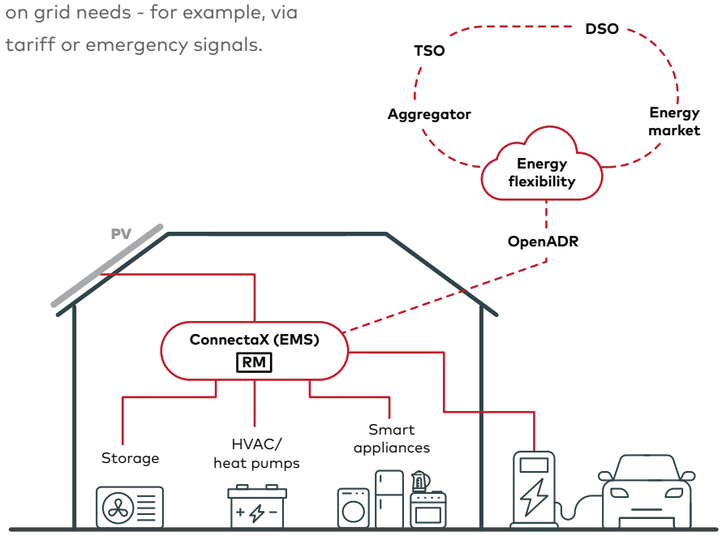

Figure 2 ConnectaX as it relates to other smart devices in the home.

The role of big data

A system like this depends on real-time data, but it also relies on whether this data can be stored and managed if it is to deliver additional advantages.

A data analytics-based smart energy strategy can support the sustainability goals of Net Zero and provide many different ways to optimise services. From customer behaviour analysis to demand forecasting and energy generation optimisation - an embedded information layer built into the energy network will produce huge volumes of data, including measurements and control instructions in the grid for collection, transmission, storage and analysis in a fast and comprehensive way.

A smart grid is an intelligent system of both energy and information. ConnectaX can significantly contribute an abundant source of data, focused on energy distribution and consumption. Collection and analysis of this data would provide essential information that would support the scheduling of power plant operations, subsystem optimisation, optimal maintenance regimes for vital power equipment, as well as specific direction that businesses might wish to choose for their strategy.

ConnectaX can contribute and enrich the Big Data model for all stakeholders. Here's how:

- A DSO would be able to improve the granularity and resolution of data depicting energy usage patterns, leading to optimisations and savings.
- An energy supplier would be able to compare and forecast their energy requests and pricing policies, leading to more efficient balancing, settlement and increased profitability.
- Consumers and small-scale producers would be able to benefit from the upstream Big Data processes, while still always being able to control how much privacy they want to trade for such benefits.

Time to ConnectaX

ConnectaX can provide the connection between in-home devices, DSOs, TSOs, aggregators and other key players in the electricity marketplace to encourage flexible services. In an age of increasing connectivity between smart devices, a single platform facilitating a variety of functions is more essential than ever.

Want to find out how ConnectaX could open the door to your interoperable future? Get in touch with our expert, Charles Vertigen.

We are CMMI Maturity Level 5 rated.

For a list of our certifications & standards
visit our website.

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