Combining OpenADR and EEBUS for Energy Control

How integrations of OpenADR and EEBUS work together to enhance energy management and the smart grid

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ABSTRACT

- The OpenADR Alliance and the EEBUS Initiative cooperated to integrate the Distribution System Operator (DSO) and device level communication into one system, to realize fully secured end-to-end communication.
- OpenADR's grid and EEBUS's device use cases are defining solutions for capacity and tariff management.
- Capacity management enables power monitoring and limitation on a building or device level (e.g., EV, HVAC or PV) to identify overload hotspots and manage load or production peaks.
- Tariff management enables the management of over and underload scenarios through price of energy as well as cost optimized operation of devices.
- OpenADR and EEBUS technologies are already available in production implementations and are increasing market share day by day.

MOTIVATION

- Increasing the share of renewable energy supply (RES) the energy supply itself is becoming more and more decentralized and volatile.
- At the same time the mobility and heating transition is adding significant load to the grid.
- The extremely fast-growing EV market share requires a short-term technological solution for mass-market applications.
- Management of over or underload scenarios requires seamless bi-directional communication from grid to device level to enable local power monitoring and control.
- The combination of established and standardized solutions helps to accelerate the solution of rapidly growing energy supply problems
- Intelligent solutions based on OpenADR and EEBUS technologies will avoid static prohibitions.

Strength of OpenADR...

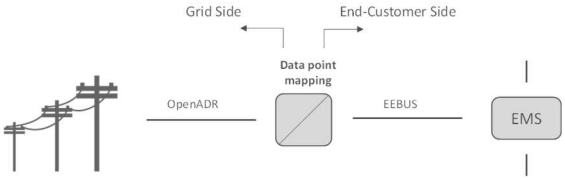
- OpenADR provides open, secure, and a proven way to communicate informational and motivational messages from the Grid Operator to building, controllers, and other resources.
- The technology provides a clear demarcation point between utility controls and customer owned equipment.
- OpenADR has over 250 certified solutions available and is used by over 40 utilities worldwide.
- Conceived during the California Energy Crisis in the early 2000s, OpenADR has expanded into key roles for Demand Response and Distributed Energy Resource management.
- The OpenADR standard is required in several state regulations.
- The standard is available as international standard IEC 62746-10-1
- Web services with TLS security and open implementation architecture allows for local and cloud implementations.

...AND EEBUS

- On behalf of the industry, EEBUS provides the standard for networking energy relevant devices on the building level and offers a standard based interface at the grid connection.
- It provides the standard for energy networking behind the grid connection.
- There is cross sector industry commitment from smart meter to device industry.
- It is a standardized communication solution, continuously evolved by market leaders.
- Broad solution landscape of use cases from capacity and tariff management, self-consumption optimization or monitoring and comfort.
- Plug & play technology through machine-readable device discovery.
- Known as a high security TLS communication standard up to BSI conform elliptic curves.
- The EEBUS specifications are available free of charge, no license fee for device manufacturers.

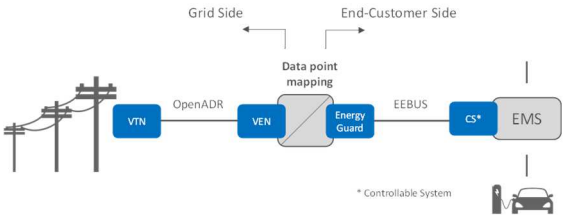
COMBINING OpenADR AND EEBUS

An OpenADR / EEBUS system will seamlessly connect the grid and end-customer domains to realize full end-to-end communication.



Both, OpenADR and EEBUS use cases are fully specified and already widely in use in the industry. The system delivers high value in end-to end security, capacity, and tariff management.

Energy supply systems have high security requirements to make sure there will be no external intervention. Thus, the secure communication from the grid to the device level is one of the key elements that the integration of OpenADR and EEBUS technology provide, including consistent TLS based security starting from OpenADR's VTN server on the grid side through the building's control box at the grid connection point, to the EMS or devices at the end-customer side. Both technologies provide TLS1.2 and secure ciphers (e.g. "TLS_ECDHE_ECDSA_WITH_AES _128_CBC_SHA256" standard and "Secp256r1" elliptic curves.

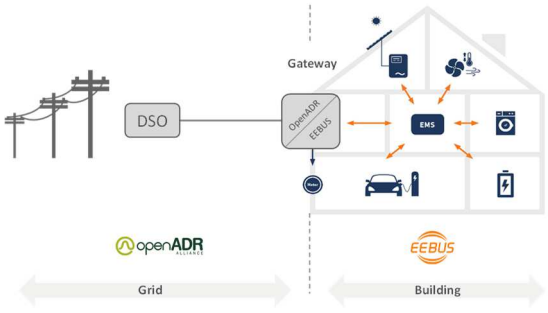


If the communication behind the grid connection fails, the heartbeat mechanism of the EEBUS ensures that the devices operate in a fail-safe mode and return to a normal operation as soon as the communication is re-established. The configurable polling mechanism within OpenADR allows a periodic message exchange between the VEN and VTN to indicate proper communication with the building.

The OpenADR/EEBUS end-to-end security enables the following use cases to be securely implemented:

Capacity management - the DSO will be able to manage critical grid situations without static power limitations on end-user device (e.g., no charging of EVs between 4 p.m. and 6 p.m.). Such regulations have been introduced in some countries, but this is not in line with the overall transition in mobility and heating. Both, the EV and HVAC system do have high flexibility in their energy behavior which makes them as ideal flexible loads for grid support: in times where energy is short, flexible loads can be operated with reduced power and in times of over production they will take as much energy as possible. A static 24/7 limitation in power is not required anymore. This managed approach will significantly reduce over and underload scenarios in the low voltage grid.

Data point mapping of OpenADR and EEBUS can be made e.g., in the grid gateway, which is in charge of the DSO. An energy management system (EMS) with controllable devices or a controllable device is directly connected to the grid connection box to interpret the received commands and to act accordingly.



By measuring the power consumption, the DSO may identify hotspots and take in-time corrective action by limiting power consumption via setpoints. In addition to controlling the power demand, the feed-in

power of a PV system may also be controlled according to the needs of the grid.

Tariff management - furthermore, energy service providers (ESP) will be enabled to manage high or low energy amounts through influencing the local power consumption or production by incentives. The ESP will submit the price of energy to an EMS or the device directly which will interpret the tariff information and optimize the consumption plan to lower the costs of energy.

The marketing of energy according to its availability through price incentives enables RES integration at large scale.

MAPPING OpenADR AND EEBUS

Illustrating mapping of the OpenADR and EEBUS data points can be done using the power limitation and power consumption monitoring use cases.

OpenADR commands are exchanged between a Virtual Top Node (VTN) and a Virtual End Node (VEN). EEBUS the commands are exchanged between a client, that reads or changes data, and a server, that is the owner of the data that is read or changed by the client.

Several objects are defined for the different commands with OpenADR. For the power limitation function, the use of the “oadrDistributeEvent” payload is to set a power limit on a VEN and the “oadrRegisterReport” payload to make a report available to the VTN with the VEN’s current power consumption.

In EEBUS, classes are defined that are re-useable for different commands. For setting a power limit, the “LoadControl” class is used with the two functions “loadControlLimitDescriptionListData” (for the static information about the limit) and “loadControlLimitListData” (for the actual limit values).

A bridging device that maps OpenADR and EEBUS messages must be capable of receiving OpenADR commands and map them to EEBUS commands that are sent to the corresponding EEBUS receiver and vice versa. The basic mapping is shown below.

The OpenADR commands “Load Dispatch and Telematry Usage” are mapped to the EEBUS use cases "Limitation of Power Consumption" (LPC) and "Monitoring of Power Consumption (MPC). The complete message definitions can be found in the corresponding specifications.

The OpenADR command “Load Dispatch” can be identified by the signalName "LOAD_DISPATCH" whereas the corresponding EEBUS message is identified by the limitType "signDependentAbsValueLimit", the unit "W" and the scopeType "activePowerLimit".

The actual power limit value within OpenADR can be found in the "currentValue. payloadFloat. value" element whereas the power limit within EEBUS is modelled in the "loadControlLimitListData" and the element "value".

	OpenADR	EEBUS
Setting Power Limitation	LOAD_DISPATCH: oadrDistributeEvent. oadrEvent. eiEvent. eiEventSignals. eiEventSignal. signalName: LOAD_DISPATCH itemBase. powerItem. itemUnits: W currentValue. payloadFloat. value: *float value*	LPC/LPP: loadControlLimitDescriptionListData limitType: "signDependentAbsValueLimit" limitDirection: "consume" | "produce" unit: "W" scopeType: "activePowerLimit" loadControlLimitListData value
Monitoring Current Power	TELEMETRY_USAGE: oadrRegisterReport: reportName: TELEMETRY_USAGE reportType: usage itemBase. powerItem. itemUnits: W Request via oadrCreateReport Report values via oadrUpateReport Link via eireportSpecifierID and eireportRequest	MPC: measurementDescriptionListData measurementType: power commodityType: "electricity" unit: "W" scopeType: "acPowerTotal" measurementListData valueType: "value" value

CONCLUSION

Secure capacity and tariff management provided by OpenADR and EEBUS will create a solution which significantly mitigates or even solves the upcoming under and overload scenarios due to the transition in energy supply, mobility, and heating - at no loss of comfort for the end-customer. By combining the established standards OpenADR and EEBUS there is a solution available today to handle the rapidly growing power demands while increasing the share of RES without major expenditures for grid expansion. Short-term grid capacity expansions to secure the energy supply are largely unnecessary and grid capacity expansions may be planned more mid or long-term according to needs. Static power consumption constraints are not required to enable the transition in power supply, mobility and heating.