

Current state of affairs of open source development of protocols **EEBus, Matter, OCPP, S2** and **OpenADR**

Ton Smets - ElaadNL

The logo for Elaadnl, featuring the text "Elaadnl" in a blue sans-serif font with a stylized lightning bolt graphic underneath, all contained within a white circular background.The logo for Residential Flexibility, featuring a stylized house icon with a lightning bolt inside, above the text "Residential FLEXIBILITY" in a blue sans-serif font.

About me



Ton Smets

- Software engineering background
- 8+ years in the energy domain
- Interoperability



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Agenda



- Why the Residential Flexibility project exists
- What problem we are solving
- What we asked the market to build
- Where we are today
- What this means going forward



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Why this project exists

The logo for Residential Flexibility, featuring a stylized house icon with a lightning bolt inside, positioned above the text "Residential FLEXIBILITY" in a blue sans-serif font.

Residential
FLEXIBILITY

The urgency

- Net congestion increasing (LS-net issues)
- “Saldering” ends in 2027
- Growth in EVs, heat pumps, batteries, PV inverters
- Dynamic tariffs increasing

*“Residential flexibility is no longer optional,
it is structurally required”*

What is residential flexibility?

Flexibility = the ability to

- Limit peak demand
- Shift energy use in time
- Store surplus PV energy
- Modulate power
- Respond to grid signals

Main flexible assets in homes:

- Heat pump
- EV charger (EVSE)
- PV inverter
- Home battery

“THE BIG 4”





The hard truth: No interoperability

Market research findings:

- 26 protocols and communication methods identified
- Modbus most used inside homes
- Custom APIs mostly in homes (cloud-based)
- No interoperability



We have connectivity, but no shared language

The market research



“Residentiële Flexibiliteit” conducted by **Powerfolio** on behalf of **ElaadNL** and **Flexiblepower Alliance Network (FAN)** – *February 2025*

- Powerfolio identified 26 different communication protocols and methods currently used in the Dutch residential flexibility landscape
- The most widely used protocol inside homes is Modbus (RTU/TCP), but implementations differ per vendor and project, meaning there is connectivity without a shared semantic language.
- Market parties agree that interoperability is essential to scale residential flexibility, but they are hesitant to commit to a single standard without coordinated action and architectural clarity.

NL: <https://nl.flexible-energy.eu/nieuws-events/rapport-residentiele-flexibiliteit-nu-beschikbaar/>

EN: <https://flexible-energy.eu/wpcms/wp-content/uploads/2025/04/Residential-Flexibility-march-2025-v1.0.pdf>



Architectures

Two interoperability challenges:

- HEMS → Devices inside home
- Grid / Aggregator → HEMS

Hybrid future:

- Local HEMS
- Cloud HEMS
- OEM cloud integrations



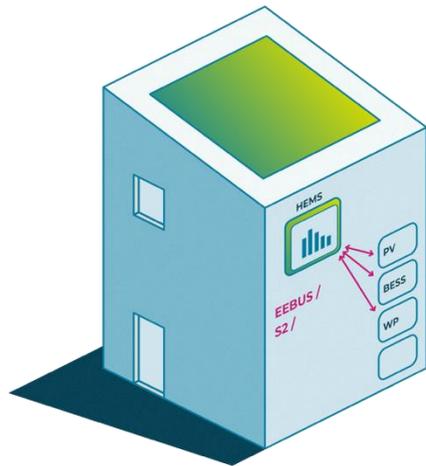
Different routes

- Countries around us prescribe how signals should be communicated to HEMS or directly to assets
 - Example: Germany §14a legislation where a DSO is able to control/limit assets via a physical “Steuerbox” connected to the smart meter
- Many different options possible
 - Direct control (example: DSO → heatpump)
 - HEMS control (example: DSO → HEMS)
 - Aggregated control (example: DSO → Aggregator → HEMS)
- Possibilities for future markets

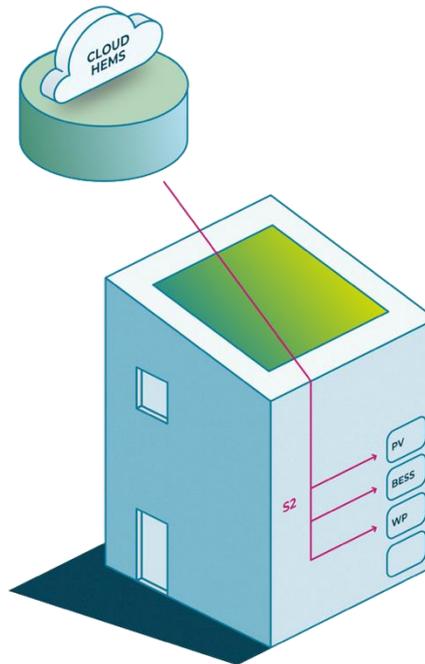
Different routes



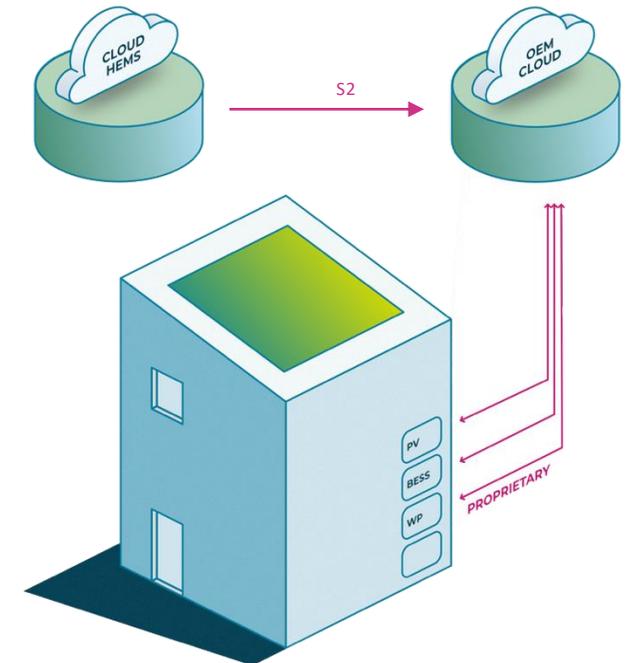
Local HEMS



Cloud HEMS



Cloud HEMS
+ Device OEM Cloud



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From research to action

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What the market told us



Market feedback:

- Need interoperability
- Avoid vendor lock-in
- Prefer limited number of standards
- Align internationally
- Avoid overly complex frameworks

But:

- No clear market leader
- No party wants to move first

Someone needs to take a first step





Already available solutions

- A small amount open source software implementations for some protocols were available already
- Our research showed a variety flaws in most of them
 - Feature incompleteness
 - No maintainer for the open source repository
 - Non-permissive licensing
 - Limited tests and test results
 - Less popular programming languages used

So we launched an RFP



Objective

Develop open-source standardized connectors for:

- S2
- Matter
- EEBUS
- Modbus bridge
- OCPP

Requirements

- Open Source
- Permissive licensing (Apache 2.0)
- Easily accessible (Public GitHub)
- Quality
- Cybersecure
- Written in popular programming languages
- Interoperability testing (like today, tomorrow and later this year)



Open source experience



OpenLEADR (Python)

OpenADR 2.0 implementation

openleadr-rs (Rust)

OpenADR 3.0 implementation

Already deployed in Dutch Grid Aware Charging (live)

Used for:

- Grid capacity limiting
- Real EVs responding to real DSO signals



Difference in protocols

Home-Level Protocols

- S2
- EEBUS
- Matter
- OCPP

Grid-Level Protocol

- OpenADR (OpenLEADR)

Clear separation

- Grid signal transport
- Home device coordination



RFP ideology



- A HEMS should offer multiple options for protocols to connect with, ideally all 4 from the RFP list
- A device OEM implements at least 1 protocol from the RFP list
- A user should be able to buy for example a home battery and a HEMS that have the same protocol printed on the box. Installation should be plug-and-play

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What we asked the market to build

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The 5 work packages



WP	Protocol	Purpose
WP1	S2	Energy flexibility
WP2	Matter	Energy flexibility
WP3	EEBUS	Energy flexibility
WP4	Modbus	Support for installed base
WP5	OCPP	EV charging control integration



The 3 core usecases

1. Peak Grid Demand Limiting

- DSO capacity profiles
- OpenADR at grid level
- S2 / EEBUS / Matter inside home

1

2. Dynamic Tariff Optimization

2

3. Self-Consumption Optimization

3

Current state with 3 selected parties

Where we are now

S2 / Matter / EEBUS

- Active development
- GitHub repositories running (in private for now)

Modbus

- Bridge architecture under implementation with focus on interchangeable configuration files

OCPP

- Alignment phase with OCA ongoing

OpenADR

- Python for OpenADR 2.0 stable
- Rust for OpenADR 3.0 still evolving (active development)
- Live Grid Aware Charging



Summary



Residential
FLEXIBILITY

The icon depicts a pink outline of a house with a lightning bolt symbol inside the roofline, representing residential energy flexibility.

Why this is important

Without this effort:

- Continued API fragmentation
- Vendor lock-in
- Conflicting control models
- Slower growth & scaling of flex ecosystems

With this effort:

- Open reference implementations
- Reduced integration cost & time
- Foundation for (inter)national interoperability



Next phase

- Integration testing at ElaadNL Test Lab
- Interoperability demonstrations
- OCPP architectural decision in collaboration with OCA
- Preparation for broader market adoption
- Community building
- Expansion of Grid Aware Charging to support new OpenADR 3.x versions



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Elaadnl

A central graphic featuring three pink house outlines with solar panels on their roofs. A pink lightning bolt is positioned between the middle and right houses. Below the houses, the text 'Residential FLEXIBILITY' is displayed in a large, bold, sans-serif font. The word 'Residential' is in a light green color, while 'FLEXIBILITY' is in a light blue color. The background is a complex digital illustration with a green-to-blue gradient, showing a globe, a wind turbine, a power line tower, a car, and various circuit-like patterns and icons.

Residential FLEXIBILITY