Rust Meets the Grid: Building openleadr-rs for Real-World Demand Response

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About us

- Ton Smets (NL)
- Software engineering and innovation at ElaadNL
- Involved with OpenLEADR since 2021

- Hugo van de Pol (NL)
- Director at Tweede Golf and secretary at Trifecta Tech
- Involved with OpenLEADR since 2024

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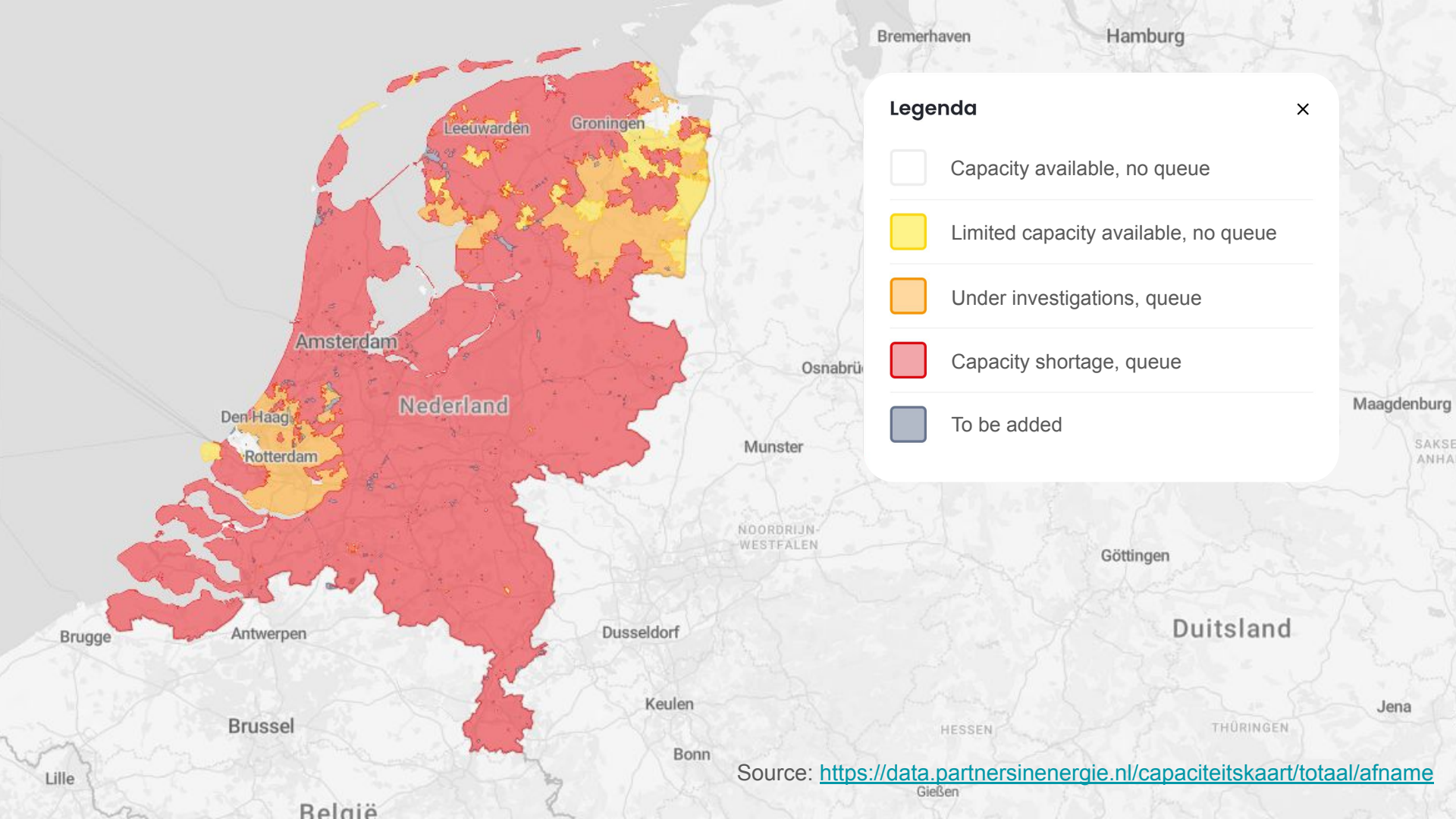
The grid

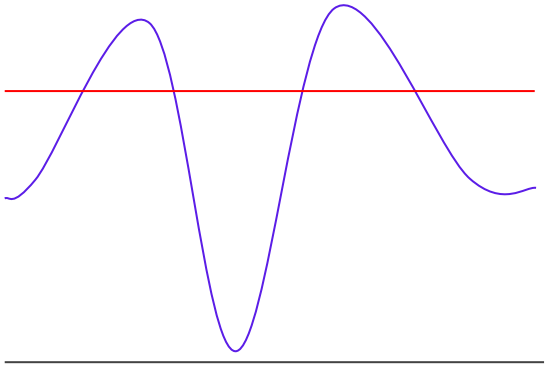
- Big challenges in the electrical grid
- Electrification
- Peak demands
- Congestion across the whole country



Source: https://data.partnersinenergie.nl/capaciteitskaart/totaal/afname

Demand Response (DR)

- DR Program:
  - Price signals and
  - Temporary usage limits
- Peak shaving: optimizing the use of the grid
- Load shedding: avoiding blackouts

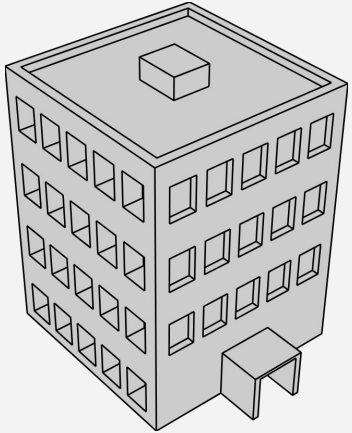


Glossary

- **DSO**: Distribution System Operator
- **CPO**: Charge Point Operator
- **VTN**: Virtual Top Node
- **VEN:** Virtual End Node

Distribution System Operator (DSO)

Business Logic (BL)
Virtual Top Node (VTN)



Events

Reports

Consumers

Virtual End Nodes
(VENs)

The challenge: scaling DR

- Scaling DR programs is the challenge
- We should build on open standards: OpenADR
- We should use open source software: openleadr-rs

OpenADR 3.0

- Originated from Lawrence Berkeley National Laboratory in 2009
- OpenADR Alliance
- Versions: 2.0b (2015), 3.0 (2024), 3.1 (August 2025)
- Generic messaging protocol supporting many use case
- Use case specific OpenADR profile

openleadr-rs

- Joint effort by ElaadNL and Tweede golf
- Part of the existing LF Energy OpenLEADR project since the fall of 2024
- First annual review in July 2025
- Currently in the incubation stage

Features

- Supports uses cases such a grid-aware EV Charging and sending dynamic price signals
- Offers a VTN, VEN and a (WIP) CLI for easy testing and prototyping
- Supports CRUD operations on programs, events, reports, etc
- Fine-grained access control
- Does not implement the subscriptions feature yet
- Relatively small well documented and well tested project

Why Rust?

- **Reliability:** digital infrastructure should be implemented in a language that yields reliable, memory-safe, and efficient code.
- **Ease of deployment:** just a single binary
- **Growing Rust adoption**: across infrastructure and embedded systems communities
- **Interop is easy:** communication via HTTP requests

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Test results

- 166 of 168 applicable test cases pass
    - 2 applicable tests not passing are due to more fine-grained AC
- 38 tests not passing are related to the subscription feature we currently don't implement

40 Failed, 166 Passed, 0 Skipped, 0 Expected failures, 0 Unexpected passes,

Result	Test
Passed	VTN_test/event_test/test_events.py::test_create_event_bad_body_b
Passed	VTN_test/event_test/test_events.py::test_create_event_bad_token
Passed	VTN_test/event_test/test_events.py::test_create_event_bl
Passed	VTN_test/event_test/test_events.py::test_create_event_bl_no_progr
Passed	VTN_test/event_test/test_events.py::test_create_event_bl_wrong_p
Passed	VTN_test/event_test/test_events.py::test_create_event_by_id
Passed	VTN_test/event_test/test_events.py::test_create_event_ven
Passed	VTN_test/event_test/test_events.py::test_delete_event_bad_id_bl
Passed	VTN_test/event_test/test_events.py::test_delete_event_bad_token
Passed	VTN_test/event_test/test_events.py::test_delete_event_bl
Passed	VTN_test/event_test/test_events.py::test_delete_event_ven

Who’s on board?

- Dutch OpenADR profile for Grid Aware Charging (GAC)
- Based on the Dutch National Charging Infrastructure Agenda
- DSOs: Alliander, Enexis, Stedin
- 8 CPOs on board
- CPO polls for data and receives a 48h rolling window of event data
- Custom GAC compliance tooling for Dutch DSOs and CPOs

Looking ahead: new pilots and use cases

- Why stop at public charging stations?
- Broaden the scope to also target homes via Home Energy Management Systems for example
- Grid congestion on multiple levels
    - High voltage, medium voltage, low voltage
- V2G demo currently being made that will be presented on the OpenADR conference october 2nd & 3rd @ ElaadNL in Arnhem

What's on the roadmap?

- An OpenADR 3.1 branch
- Implementing the subscription feature
- Finishing the CLI
- Securing funding for maintenance in 2026
- Publishing an official field-test-ready release

Looking ahead: contributing

- ElaadNL and Tweede golf are committed to the project, but we need your help!
- Talk to us! (Or engage via Slack)
- Join one of the monthly Technical Steering Committee meetings
- Create a PR for one of the good first issues
- Donate via Trifecta Tech Foundation

Thank you!

Questions? Yes, please! Or contact us:

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