Home charging of electric vehicles in Belgium

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Living labs in Flanders

Flemish government

5 living labs

1. Installation & monitoring of public charging network
2. Electric freight and public transport
3. Networked mobility (car sharing, e-bikes...)
4. Integration of electric vehicles in company fleets & local micro grids
5. Search for solutions that could expedite the breakthrough of EV’s
• Out of scope of Flemish living labs
  – Home charging
  – Electrician

First point of contact for general public
THEO-project

- Education of electricians on home charging
- Strategy determined by stakeholders
  - Government
  - Distribution network operators
  - Manufacturers
  - Electric control bodies
  - Electricians
  - Other
• Workshops
  – Existing plug types & charging modes
  – Mode 3 charging protocol
  – Overview of available home charging stations
  – Self-assembly of home charging station
  – Average domestic electrical installation in Flanders
  – Charging problems on Belgian grid
  – Type B RCD ↔ Belgian law
Mode 3 charging protocol
Mode 3 charging protocol
Mode 3 charging protocol

- L1, L2, L3, N
- H1, H2, H3, S4
- S1, S2, S3
- PE, PP, R1, R2, R3
- D1
- Ground fault
- EV connected
- Cable break
- EV ready to charge

Specifications:
- 4700 Ohm
- 2200 Ohm
- 4700 Ohm
- 1500 Ohm (13 A)
- 680 Ohm (20 A)
- 220 Ohm (32 A)
- 100 Ohm (63 A)
- 2740 Ohm
- 270 Ohm (ventilation required)
- 1300 Ohm (no ventilation)
Mode 3 charging protocol

- **L1**, **L2**, **L3**: Phase lines
- **N**: Neutral line
- **PE**: Protective earth
- **PP**: Phase point
- **S1**: EV connected
- **S3**: Cable break
- **S4**: Ground fault
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- **R1**: 1500 Ohm (13 A)
- **R2**: 680 Ohm (20 A)
- **R3**: 270 Ohm (ventilation required) / 1300 Ohm (no ventilation)

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Charging problem on part of Belgian grid

- 3x230V – grid
- Voltage between PE & L
- Some types of EV
Charging problem

- Line to line voltage: 400V
- Line to neutral voltage: 230V
- Load between N and (L1, L2 or L3)
- Voltage between neutral and earth: 0V
Charging problem

- Line to line voltage: 230V
- No neutral conductor
- Load between 2 lines
• 3x230V grid: 30% of Belgian households
• Also in Norway & Italy
Charging problem due to voltage between earth and neutral conductor.

$3 \times 400V + N$

$3 \times 230V$

Electrical diagram showing the voltage distribution in a electrical system. The diagram illustrates the charging problem caused by the voltage difference between the earth and the neutral conductor.
• Average domestic installation in Belgium
• Adaptions needed to charge EV?
• On-line
• 815 respondents (Flanders & Brussels)
Do you own a garage?

- 77% Yes
- 23% No

Charging without garage?
- Public charging?
- Charging at work?
Do you have a RCD in your electrical installation?

- Yes: 79%
- No: 21%

No proper earthing? Investments are needed for safely charging of EVs!
**Survey**

**Grid connection**

- **3x400V+N**: Some EVs can charge up to three times faster!
- **3x230V**: Only single phase charging. Can cause problems with some EVs.
- **Single phase**: Sometimes connected to a 3x230V-grid

**Pie Chart**:
- Single phase: 42%
- 3x230V: 34%
- 3x400V+N: 23%
Do you rent the building?

- Yes: 13%
- No: 87%

Rented building
Higher threshold to invest!
Would you buy an EV when they would cost about the same as a car with ICE and with a minimal range of 300 km?

- Yes: 31%
- No: 69%
Type B RCD $\iff$ Belgian law

- Belgian law
  - Type A RCD required (domestic)

- Three phase charging
  - Fault current $< 6$ mA possible
    - Type A RCD not sufficient

In Belgium: impossible to install 3-phase charging points both safely & legally compliant
Thanks for your attention!
Questions?