WHEN TRUST MATTERS

Introduction to the integration of EV in the electricity system

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October 2024

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years	employees	customers	countries	of revenue in R&D

Ship and offshore classification and advisory

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Transport in Transition report (DNV, 4 May 2023)

Highlights

Fossil Fuels

- Oil use in road transport reduces from 85 EJ to 42 EJ by 2050
- Aviation oil use is virtually flat to 2050
- Oil benefits from established infrastructure

Electricity

- Share in transport will grow to 23% by 2050
- One third of energy demand in road, powering 80% of the vehicle fleet
- Powers just 2% in aviation and 4% in maritime

Biofuels

- First-generation biofuel will be displaced by electricity in road transport
- Intense competition for advanced biofuels for maritime and aviation

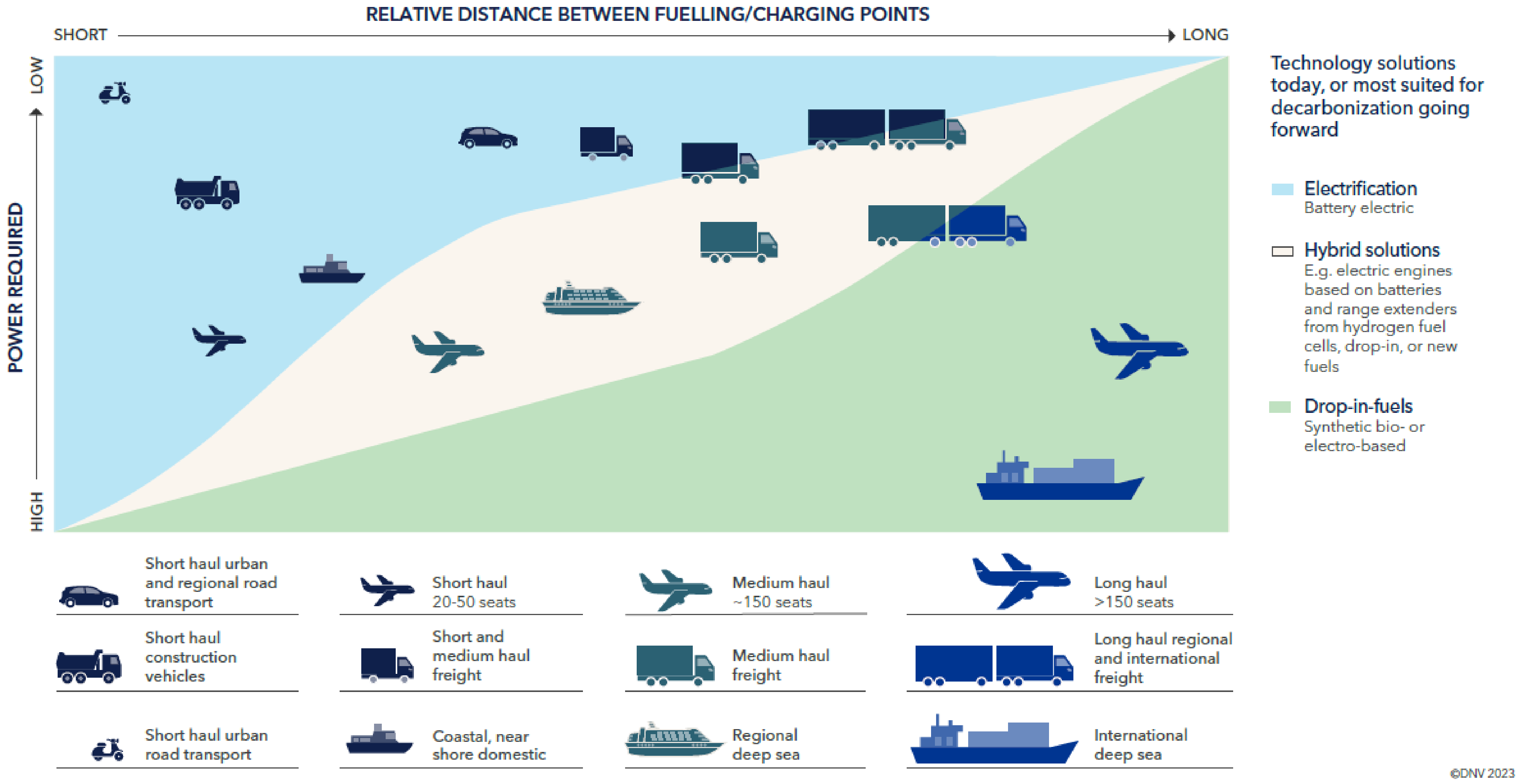
Hydrogen+

- Renewable energy should be prioritized for direct use of electricity
- Hydrogen and its derivatives are important for the heaviest long-distance road segments, shipping and aviation

DNV

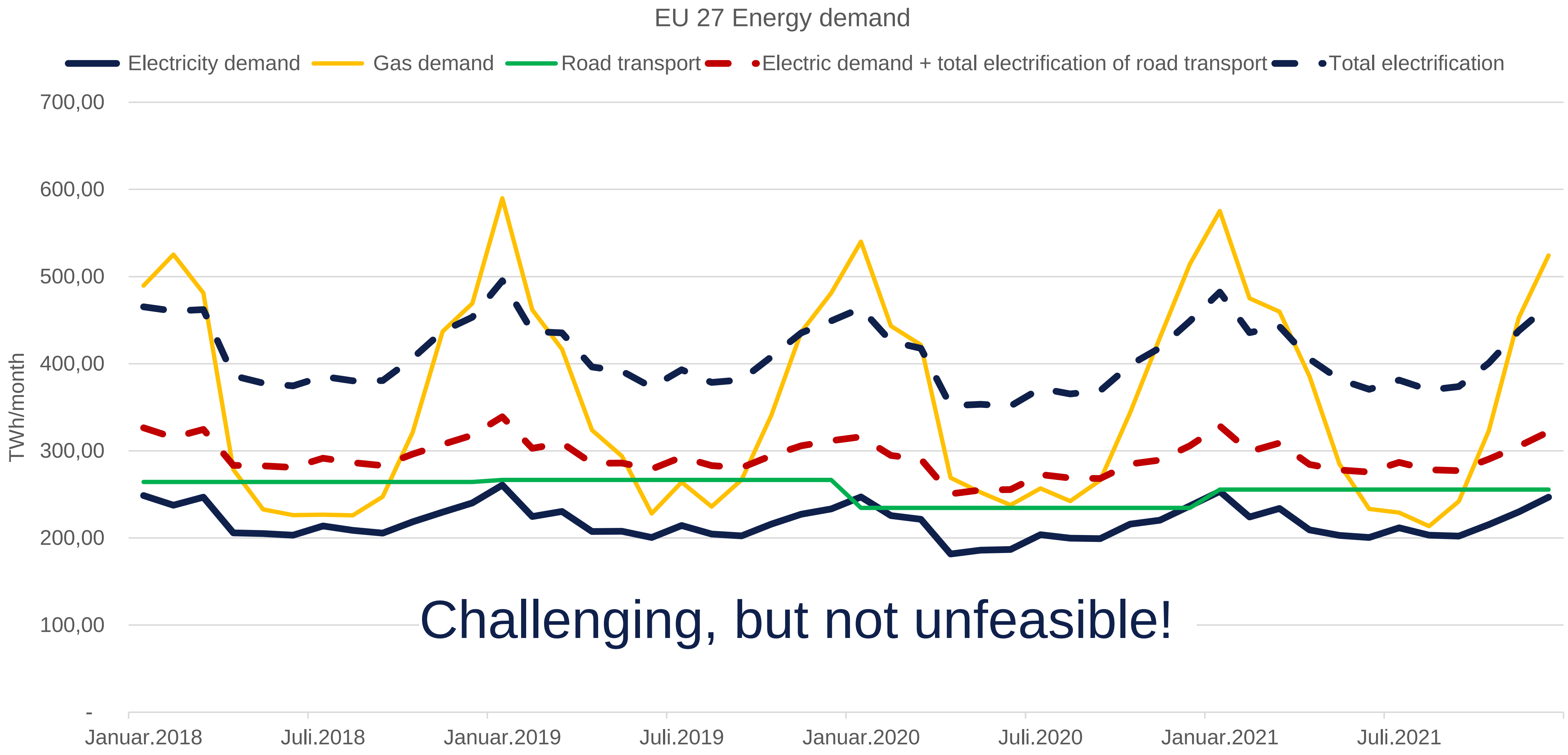
Everything that can be electrified will be cheaper

Other modes of transport: Technology and fuel alternatives for transport decarbonization

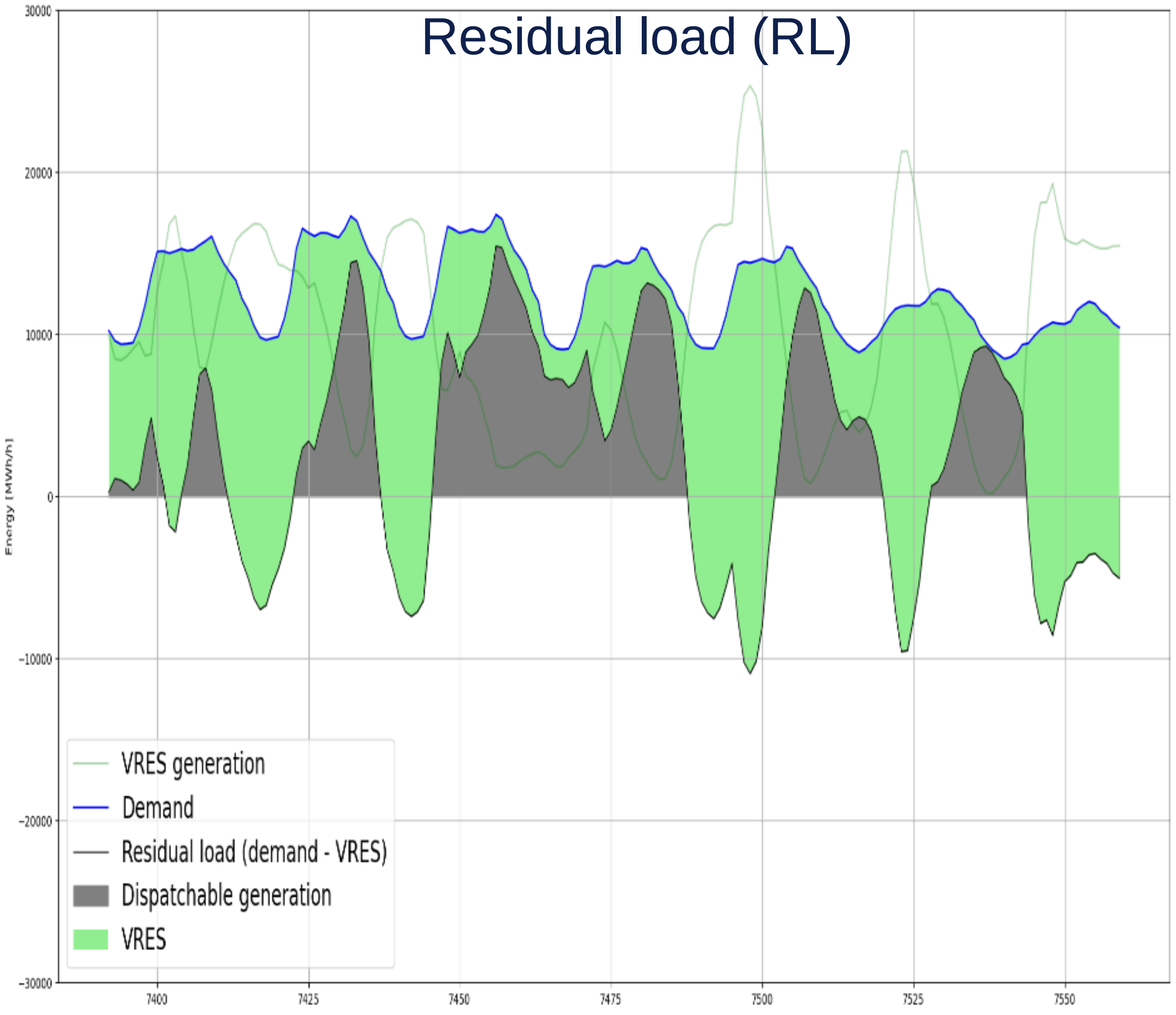


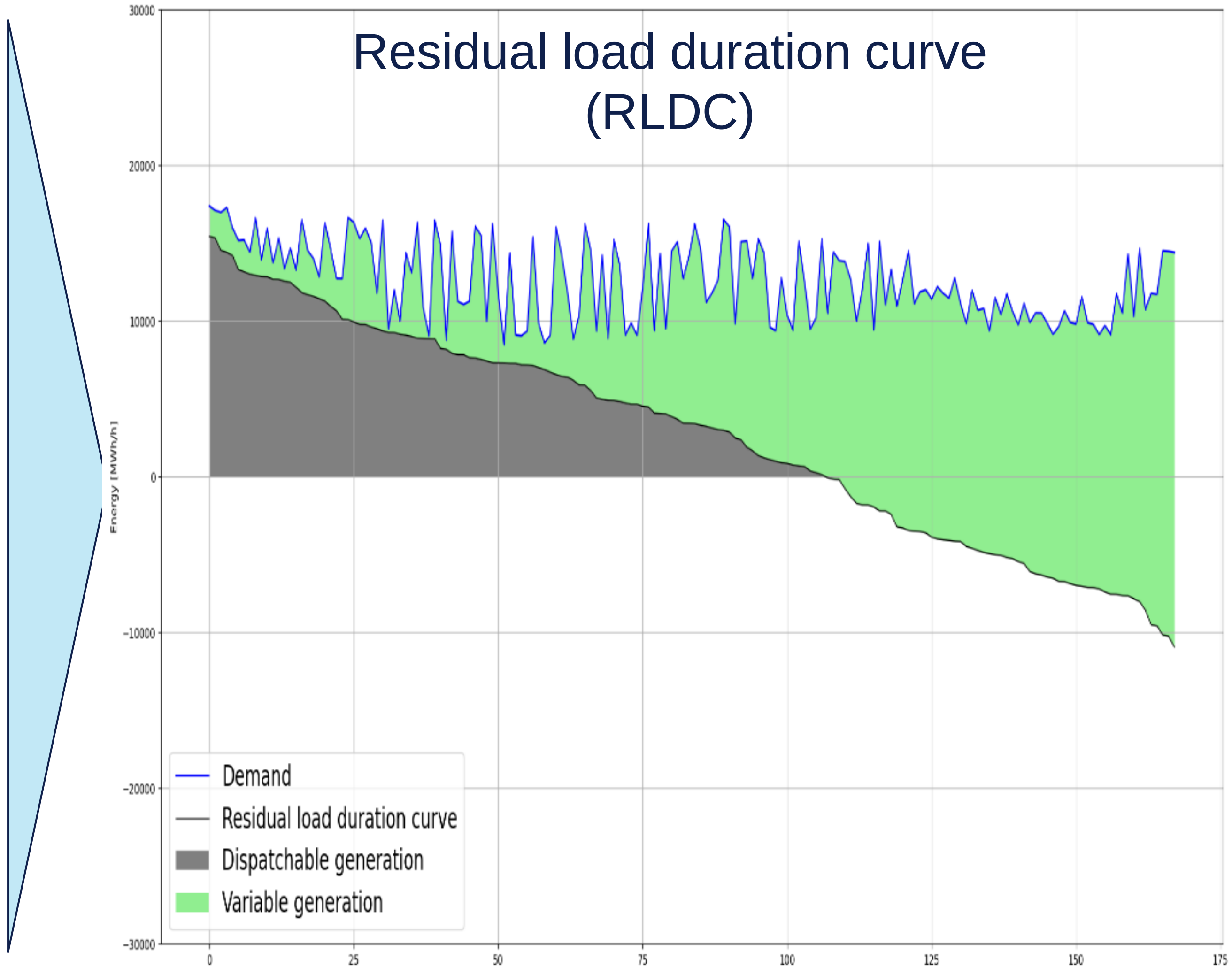
Transport
Electricity system
Infrastructure

Is it feasible?
Sector coupling is both a challenge and an opportunity.

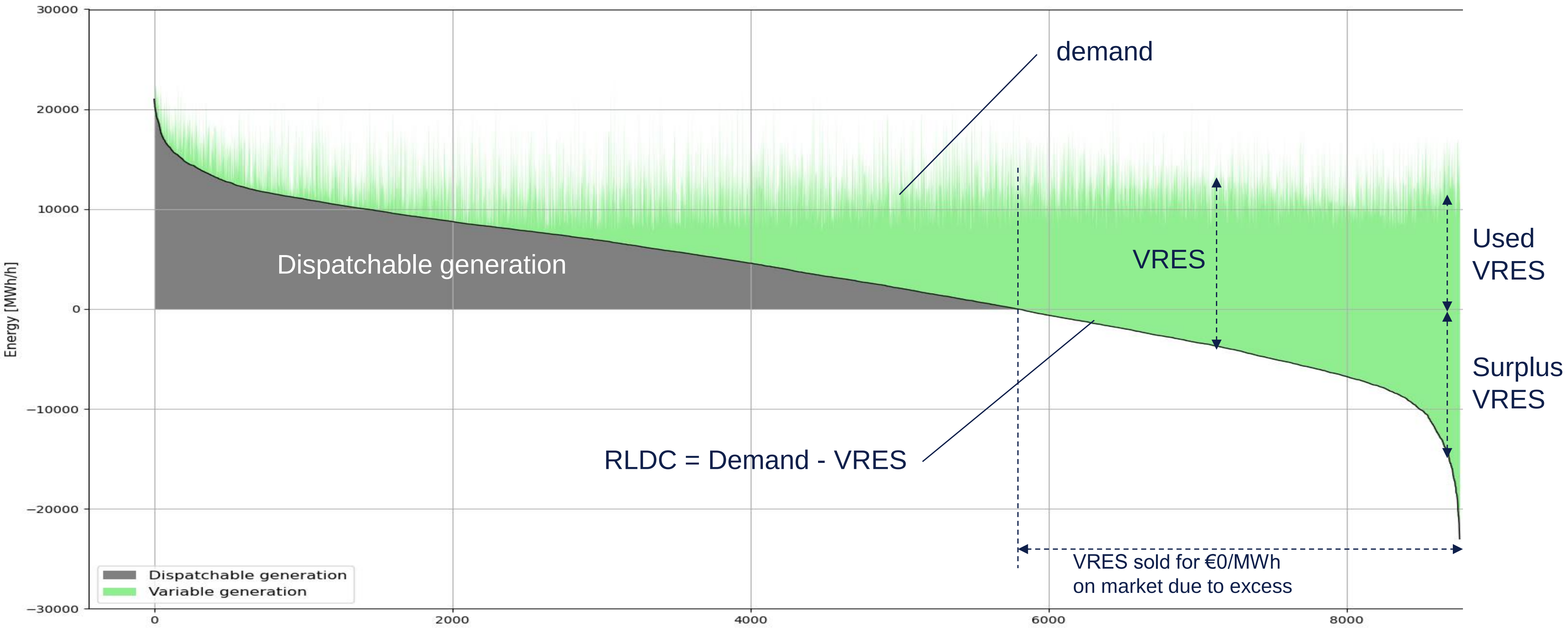


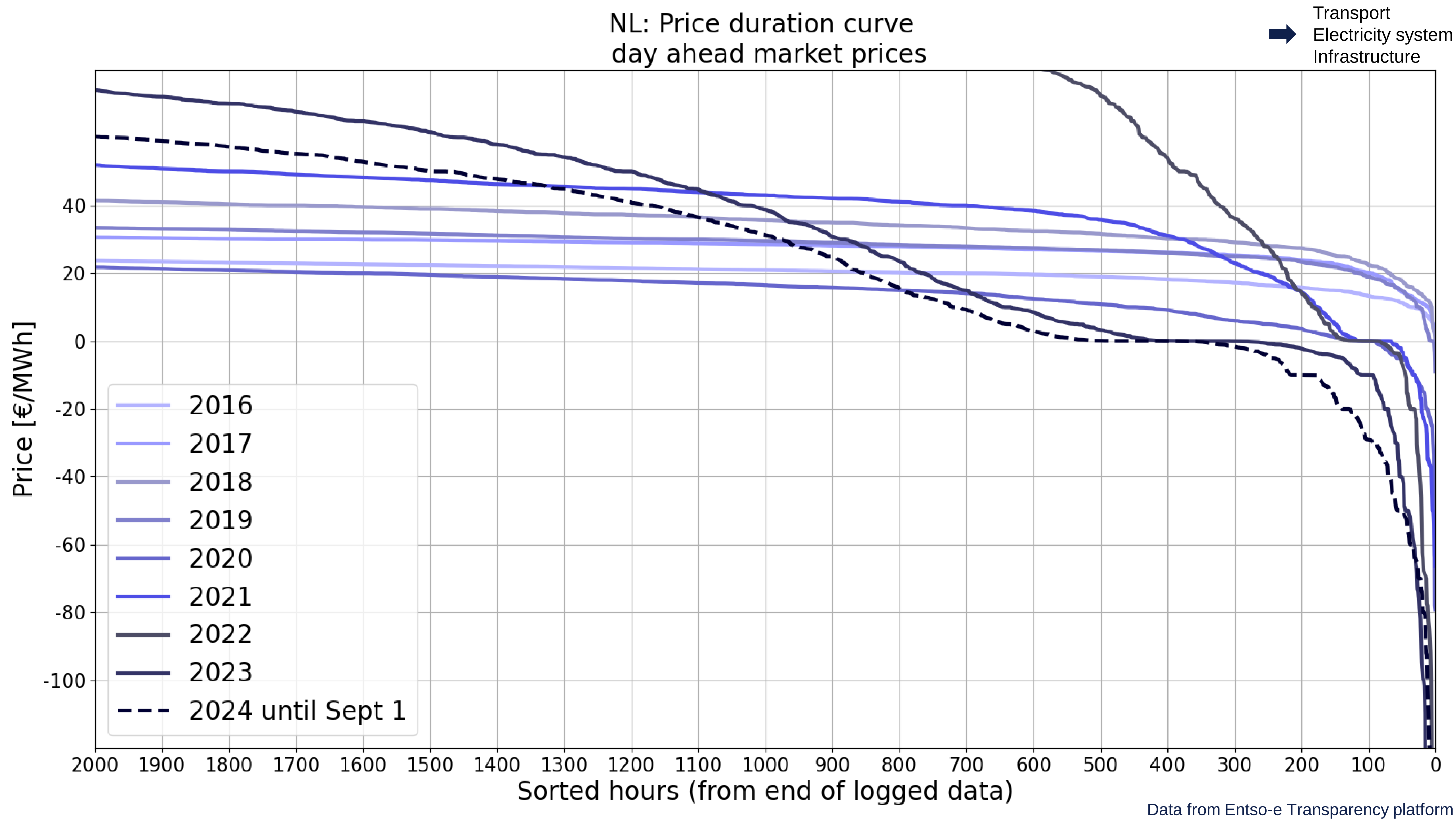
VRES Variability: Over and undersupply can be visualized by the Residual load Duration Curve (RLDC)





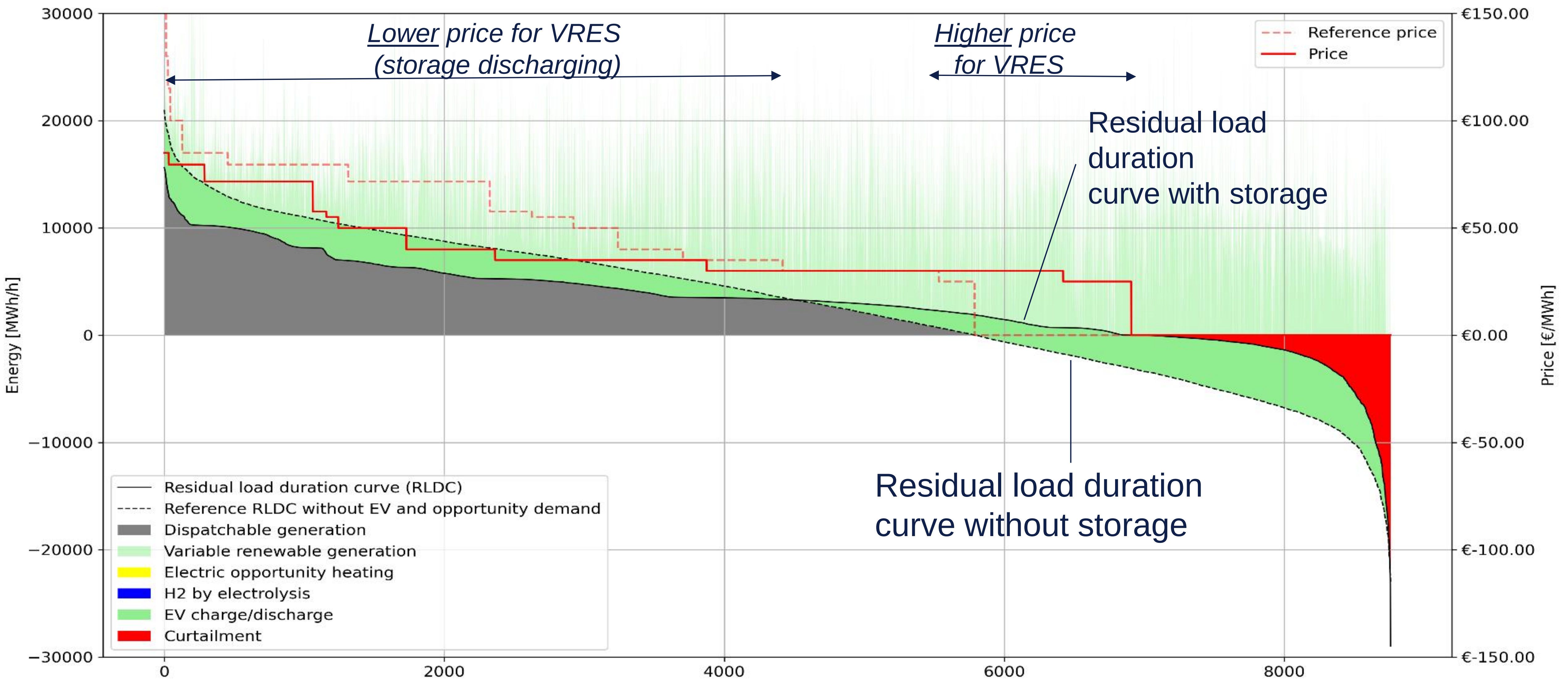
Residual load duration curve (RLDC) demonstrated the effect of surplus renewables on the electricity system (200% system)



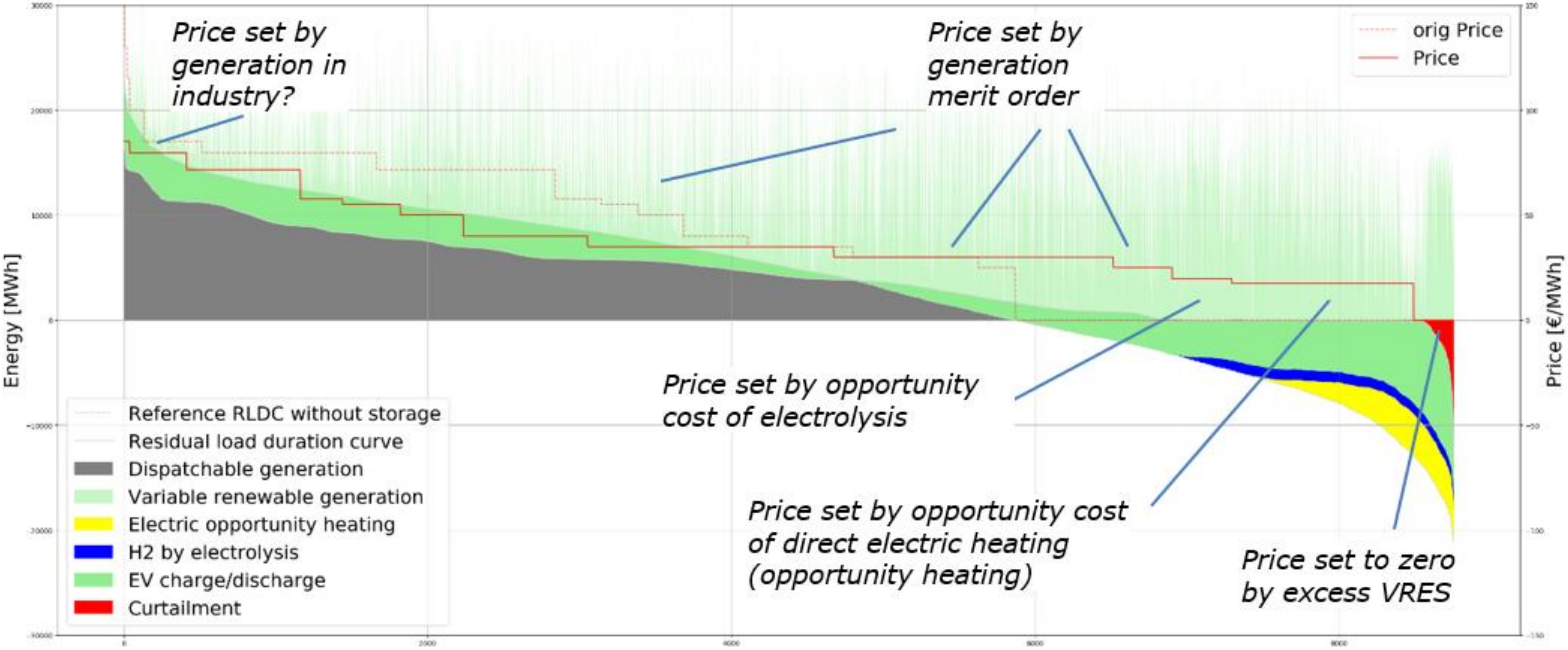

NL: Price duration curve
day ahead market prices
Transport
Electricity system
Infrastructure
Price [€/MWh]
40
20
0
-20
-40
-60
-80
-100
2016
2017
2018
2019
2020
2021
2022
2023
2024 until Sept 1
2000 1900 1800 1700 1600 1500 1400 1300 1200 1100 1000 900 800 700 600 500 400 300 200 100 0
Sorted hours (from end of logged data)
Data from Entso-e Transparency platform

Storage and DR has a dual effect on the BC for VRES

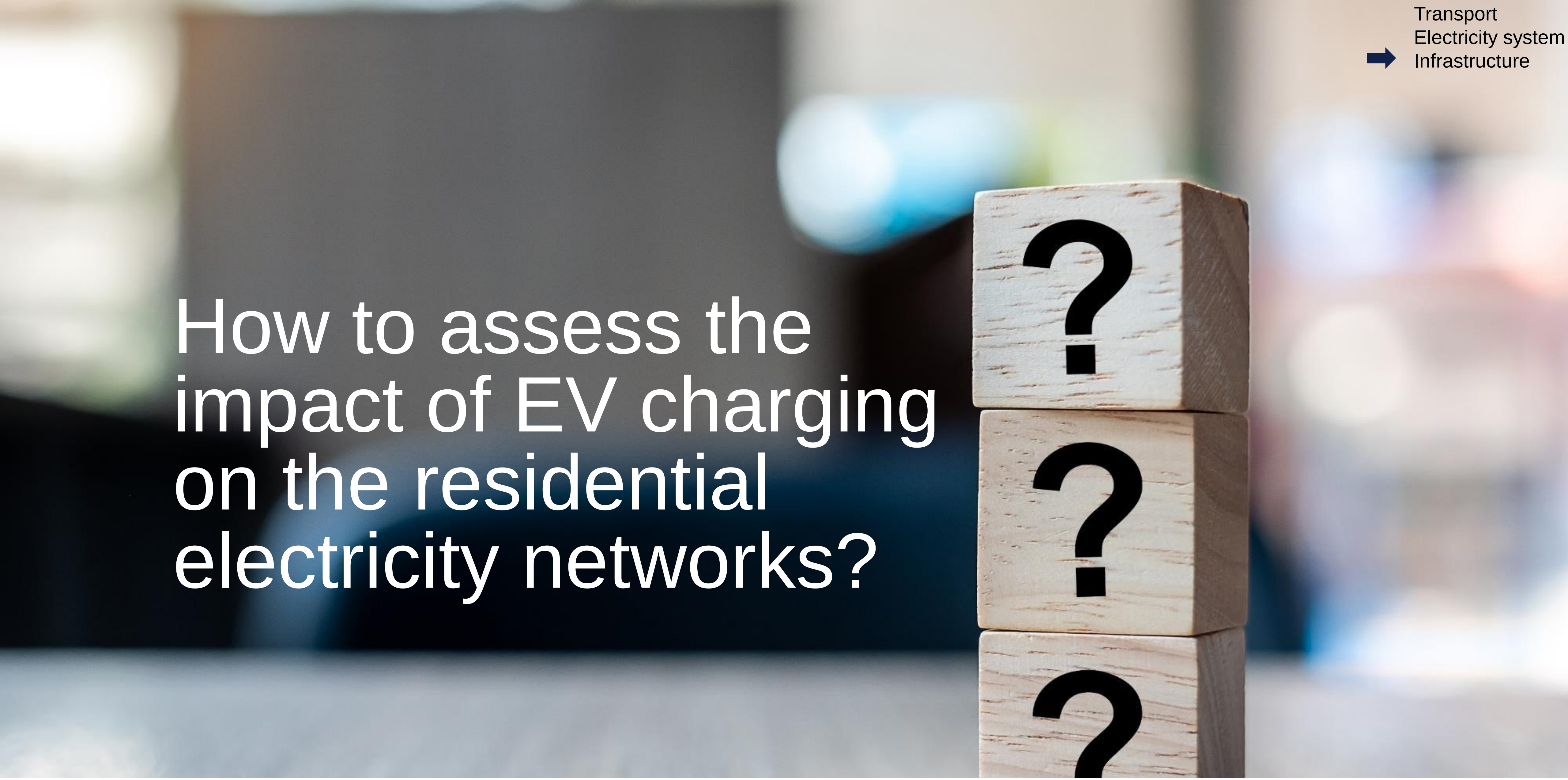
(30 GW/180 GWh provided predominately 3 mln EVs ≈ 30% of total car leet in 2030)



Two new price plateaus: opportunity heating and opportunity electrolysis (2030)



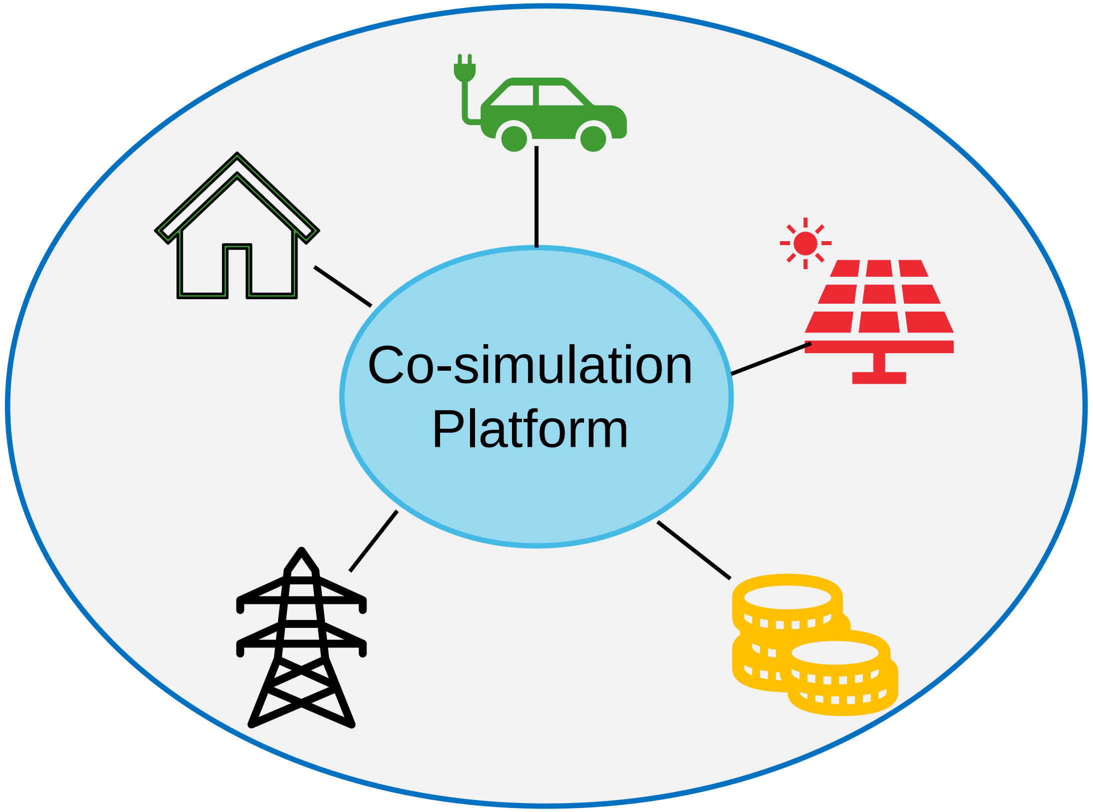
Industry electrification in a renewable power system, DNV, 2023



How to assess the impact of EV charging on the residential electricity networks?

How to include all the mechanisms?

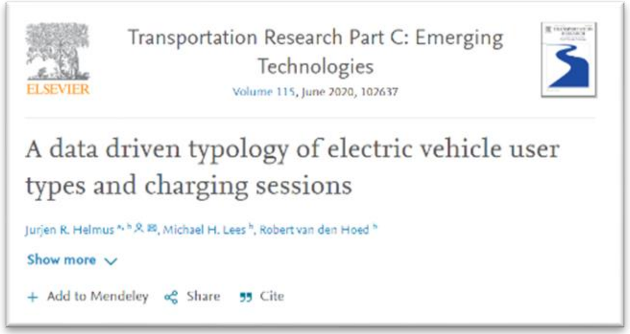
- Electricity Network
- Households
- Rooftop solar
- EVs
- Markets
- Charging behaviour
- Others if present



Co-simulation

EV charging behaviour: Based on empirical data (AUAS)

(4,9 mln charging sessions of 27.000 users)


ELSEVIER
Transportation Research Part C: Emerging Technologies
Volume 115, June 2020, 102637

A data driven typology of electric vehicle user types and charging sessions

Jurjen R. Helmus [a, b], Michael H. Lees [b], Robert van den Hoed [a]

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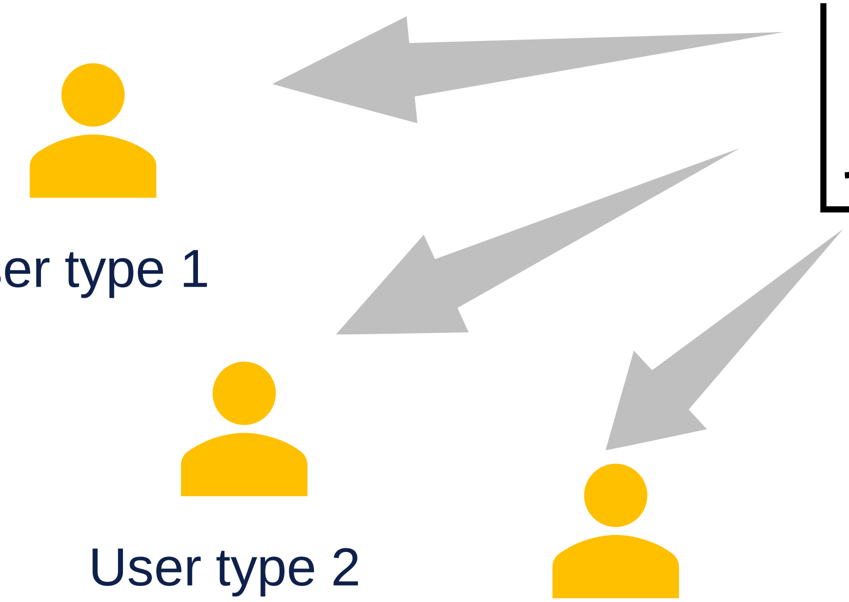
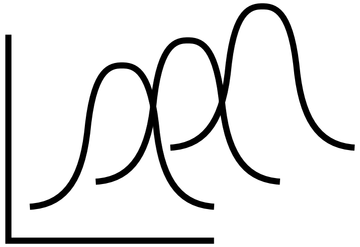
- 13 different charging session types
- 9 different EV user types



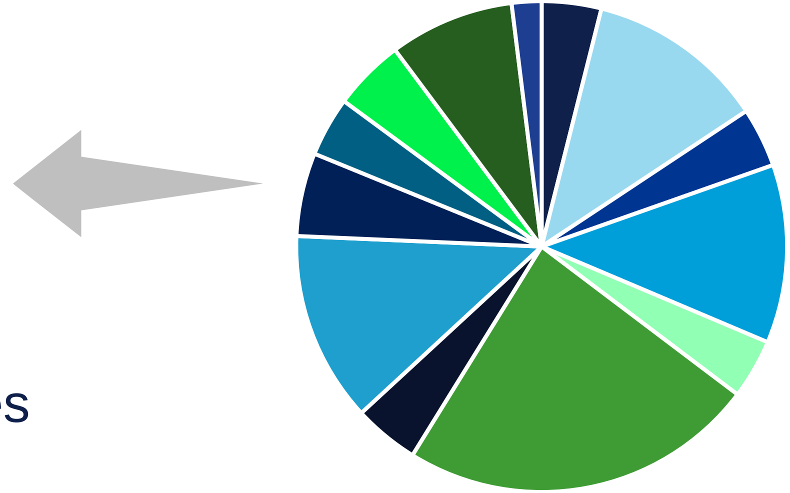
User type 1

User type 2

User type n



Portfolio of session types



Charging session types based on:

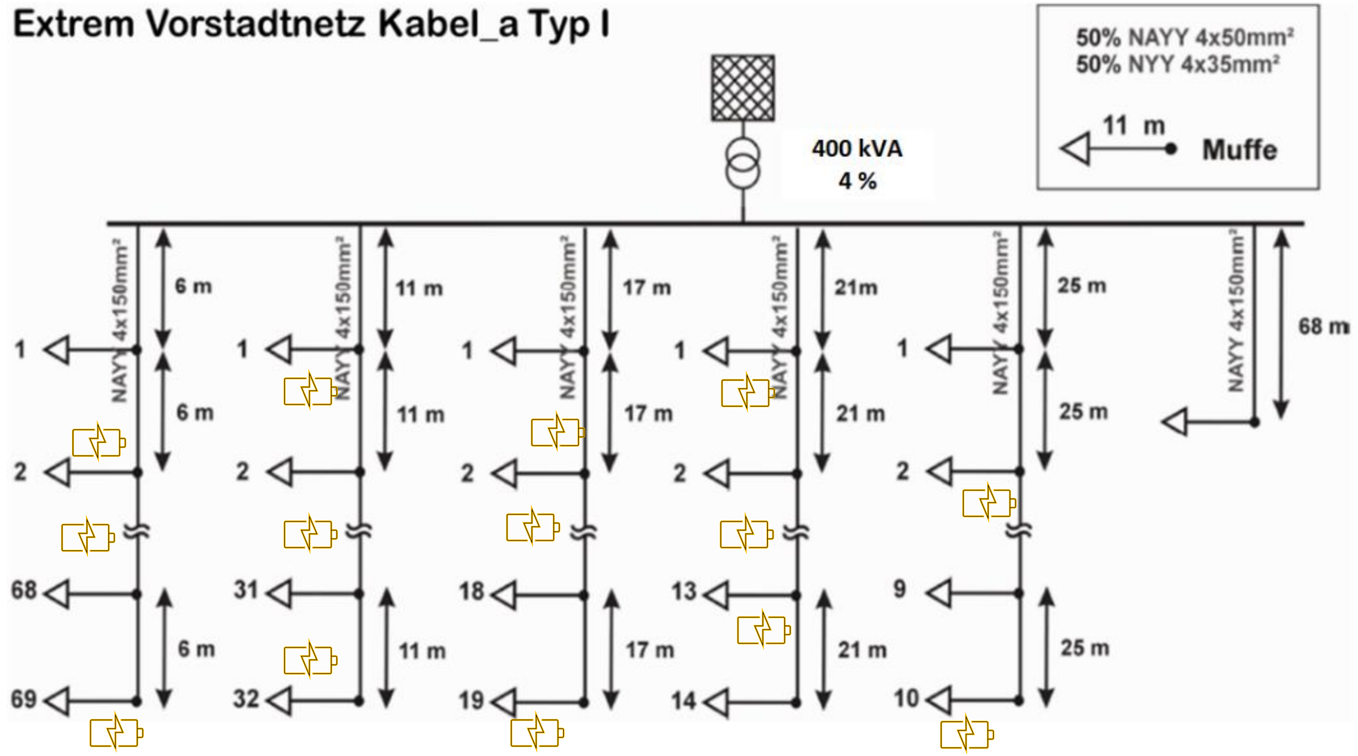
- Arrival time
- Connection duration
- Time between two sessions

EV charging strategy

- Normal (EV-basic)
- Smart (EV-smart)
- Smart Vehicle2grid (EV-v2g)

The grid

- Suburban network with 145 households
- 3 kW rooftop solar at each household
- Chargers distributed in each feeder
- On EV Arrival → Check for available chargers
- Simulation scenarios:
  A. 50% EVs ; 4 EVs per charger
  B. 100% EVs ; 4 EVs per charger
  C. 50% EVs ; 9 EVs per charger

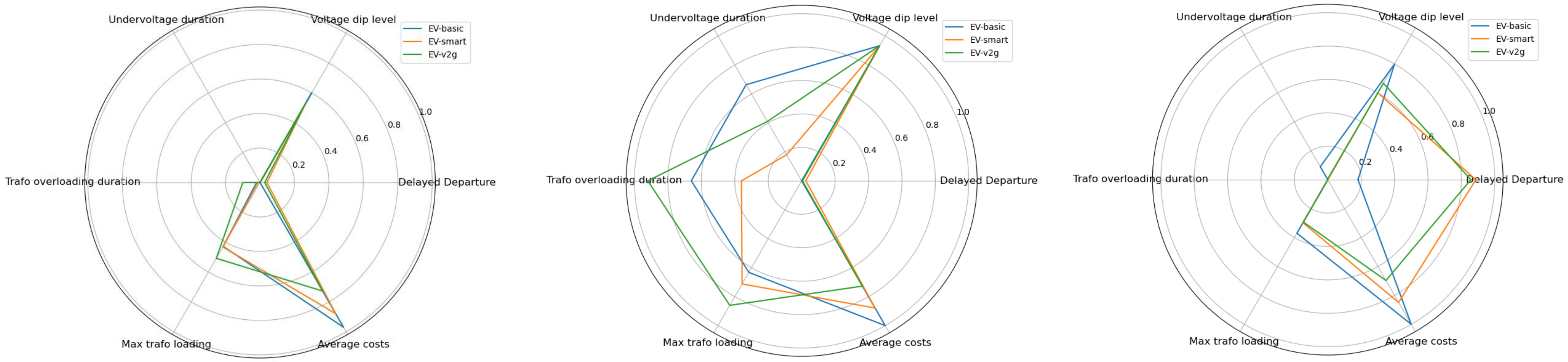


https://pandapower.readthedocs.io/en/v2.6.0/networks/kerber.html#extreme-kerber-vorstadtnetze

Performance Indicators: for grid and EV owners

- Minimum voltage observed (p.u)
- Undervoltage duration (%)
- Maximum loading of transformer (%)
- Duration of transformer overloading (%)
- Delayed departures (%)
- Average Cost (Euro Cents/kWh)

Results: Number of cars and chargers



a b c

a) Scenario 1: 50% EV ownership and 4 EVs per public charger

b) Scenario 2: 100% EV ownership and 4 EVs per public charger

c) Scenario 3: 50% EV ownership and 9 EVs per public charger

Conclusion

- A co-simulation-based environment to assess the impact of EVs in modern residential neighborhood.
- Implemented the EV behavior model based on empirical data
- Interaction reviewed from grid & EV owners' perspective
- 9 EVs per chargers (norm at many EU countries) not sufficient.

Thank You!

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