



Interessenverband  
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HOCHSCHULE RUHR WEST  
UNIVERSITY OF APPLIED SCIENCES

# **Measurement and Analysis of Disturbances induced by Electric Vehicles – A Case Study**

November 2<sup>nd</sup>, 2021

Jan-Philipp Kitzig and

Gerd Bumiller

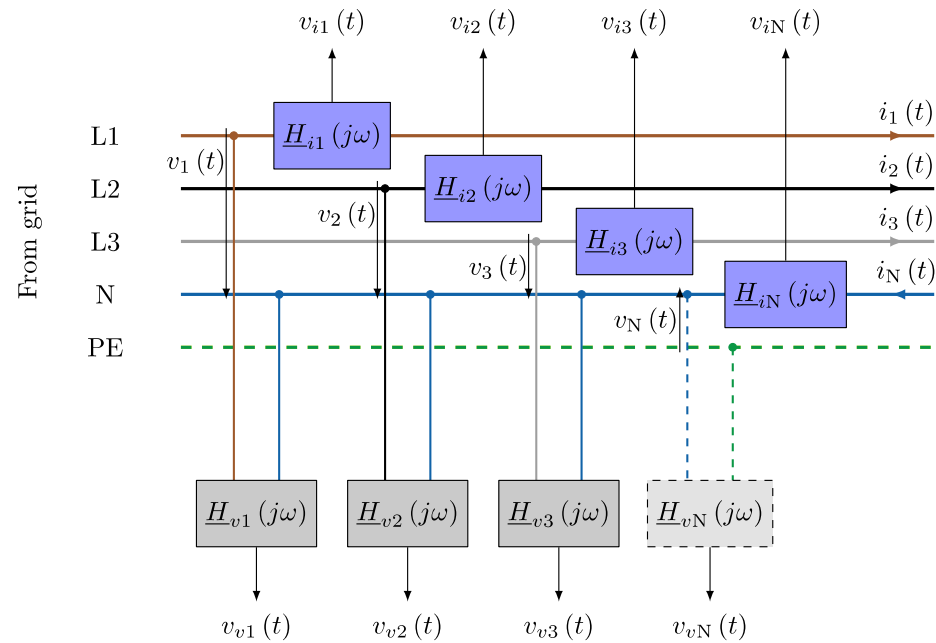
Hochschule Ruhr West, University of Applied Sciences

# Outline

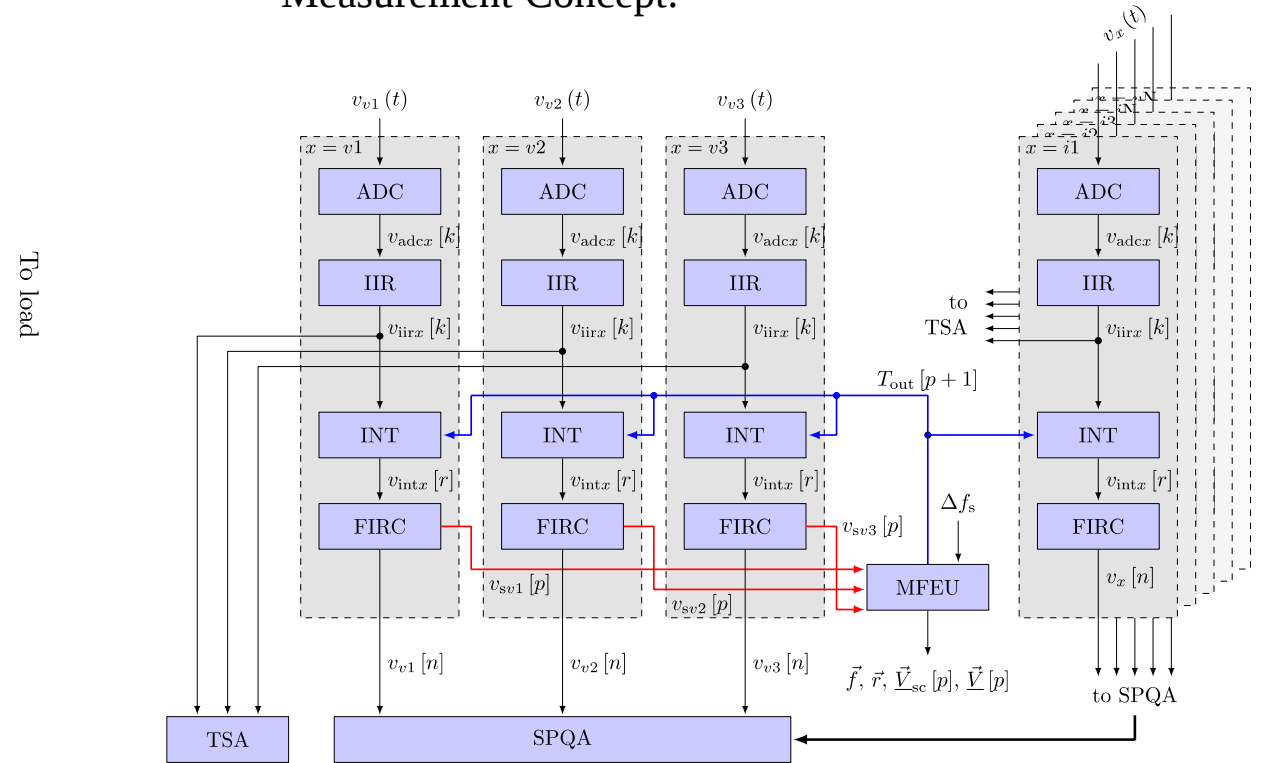
- Revisit: Harmonic Power Flow Measurements with PQMS
- The Case
- Measurement Setup
- Measurements
- Conclusion

# Revisit: Harmonic Power Flow Measurements with PQMS

Hardware Coupling:

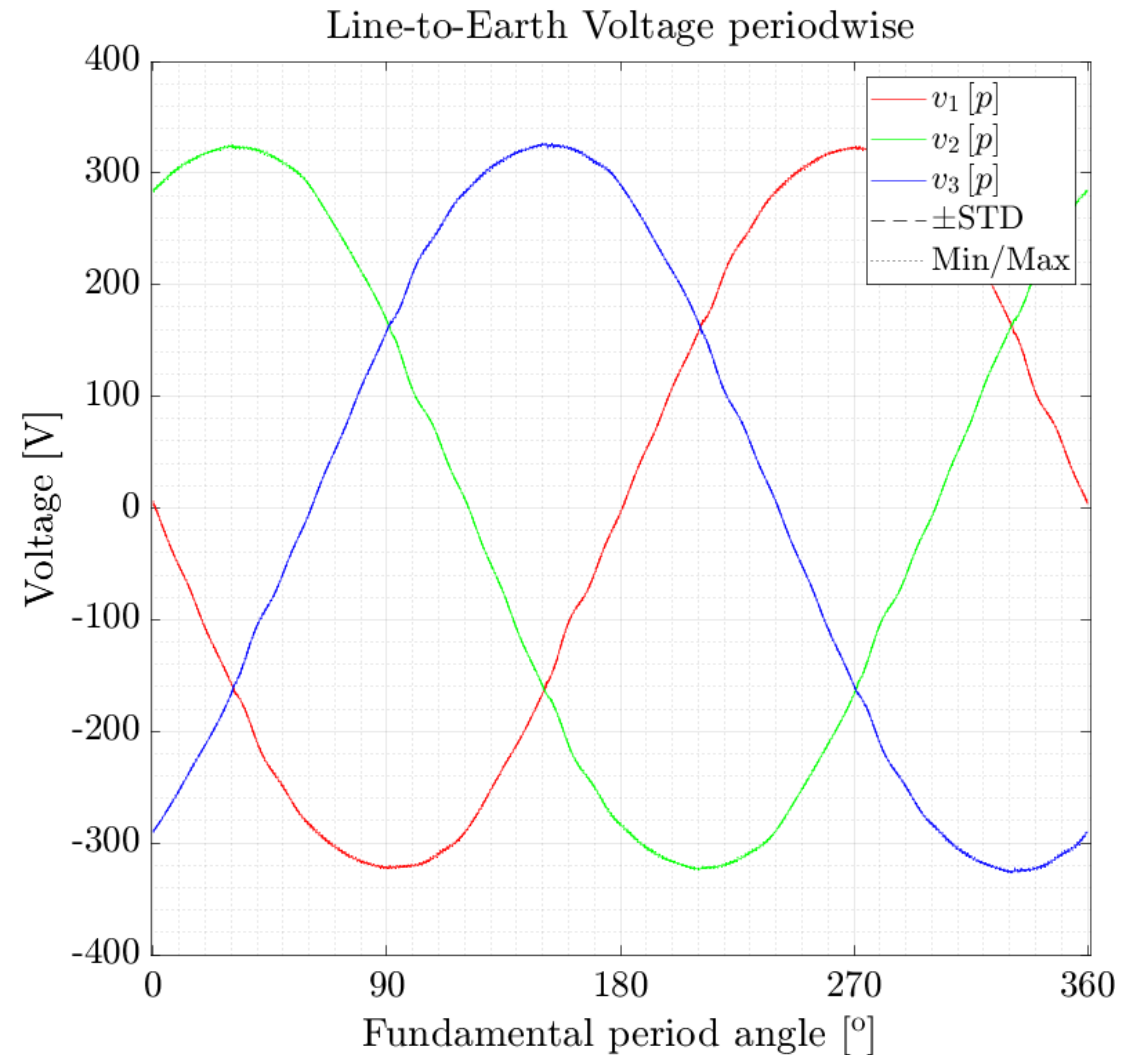


Measurement Concept:



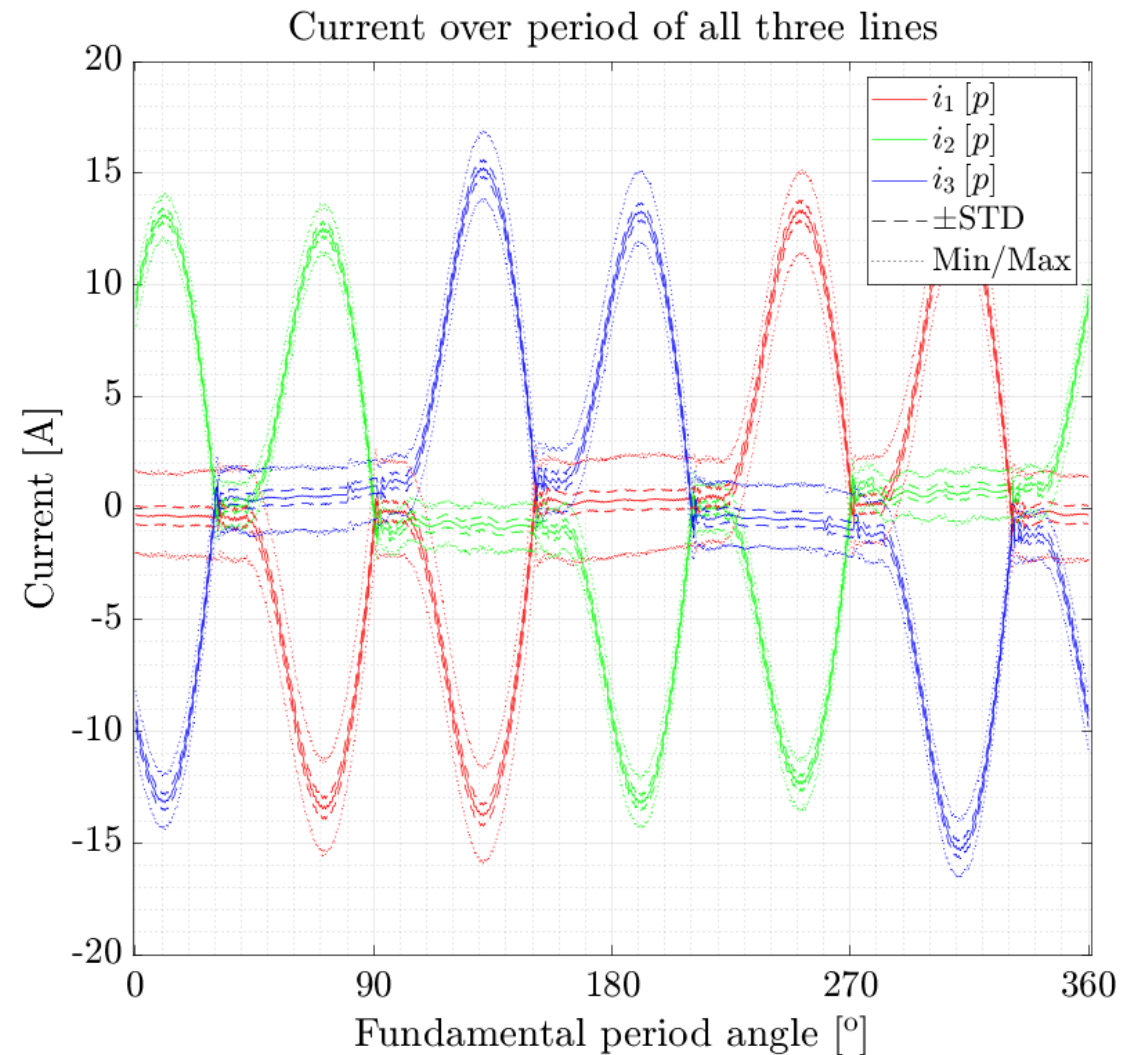
## Revisit: Advantages of Synchronous Measurements

- Period-wise spectral analysis with magnitude and phase of voltage and current signals



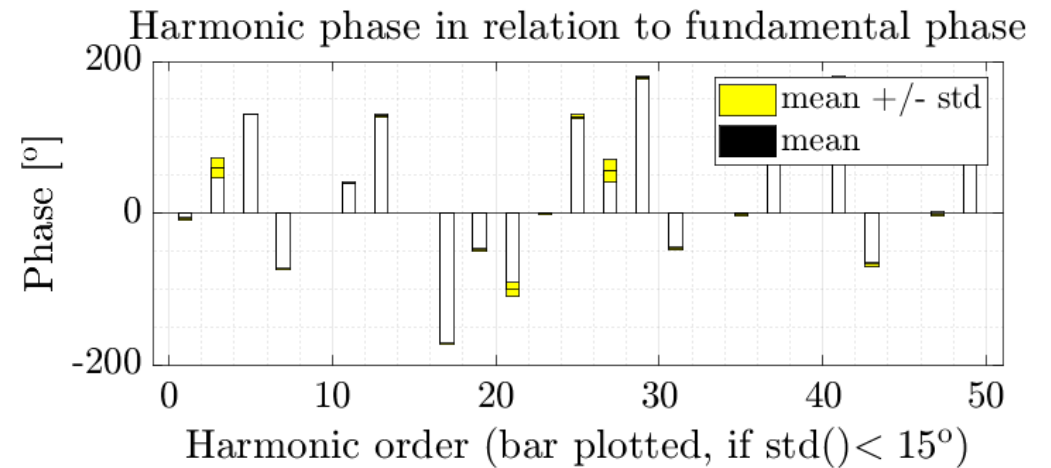
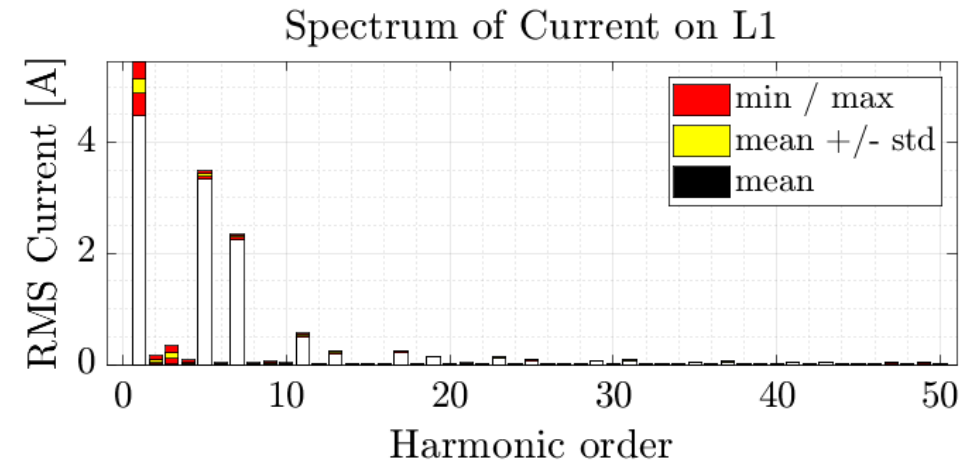
## Revisit: Advantages of Synchronous Measurements

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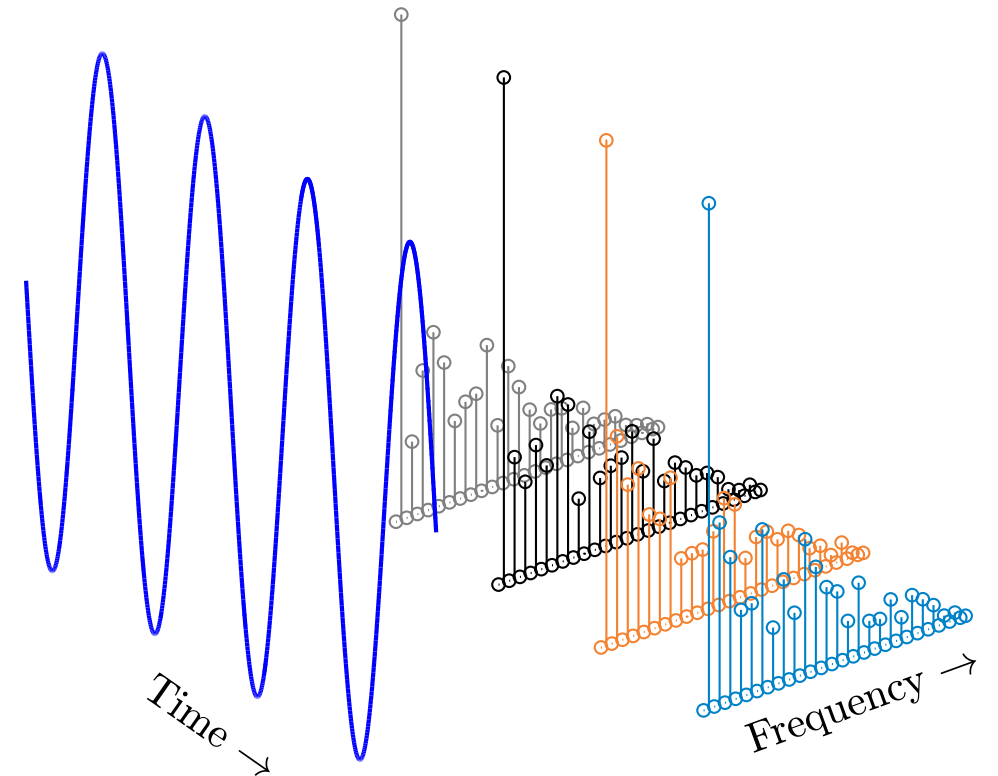
## Revisit: Advantages of Synchronous Measurements

- Period-wise spectral analysis with magnitude and phase of voltage and current signals
- No leakage error with mains frequency deviations



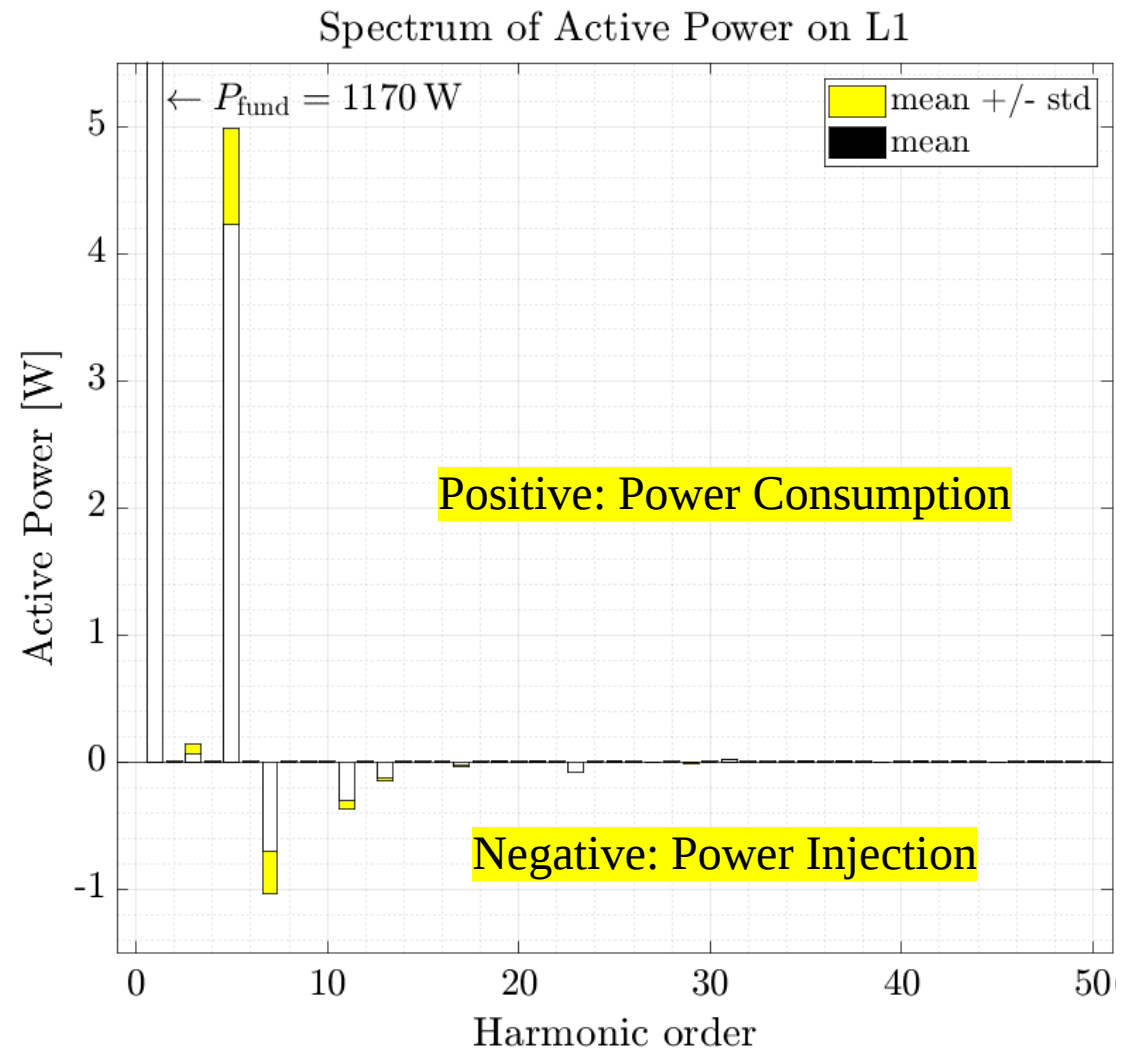
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- High time resolution in spectral data (period-wise)



## Revisit: Advantages of Synchronous Measurements

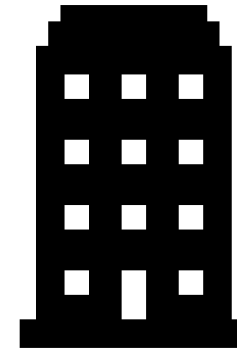
- Period-wise spectral analysis with magnitude and phase of voltage and current signals
- No leakage error with mains frequency deviations
- High time resolution in spectral data (period-wise)
- Harmonic active power and impedance measurements





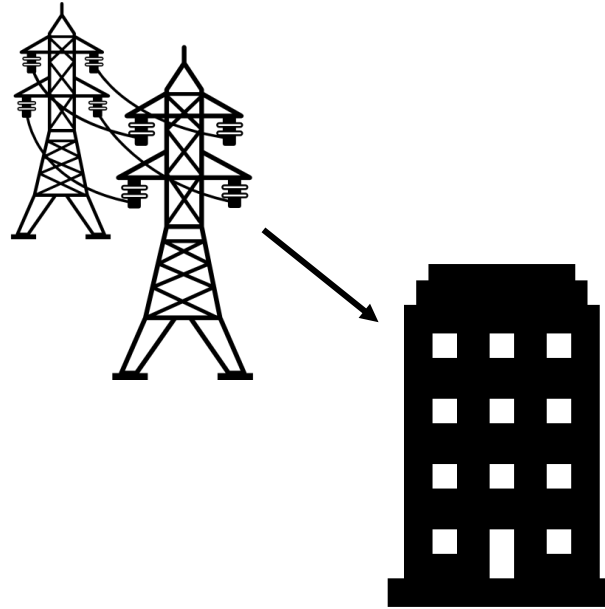
## The Case

- Medium-sized IT company in own office building



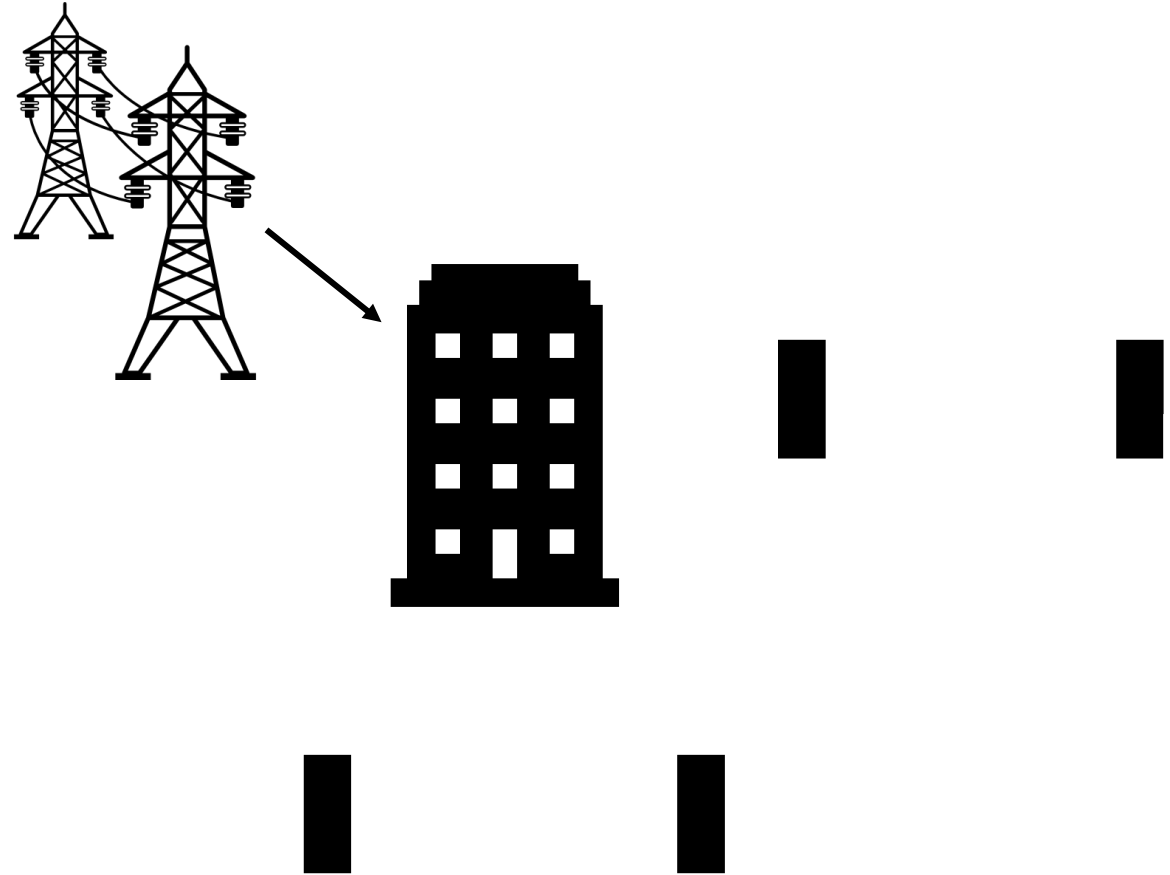
## The Case

- Medium-sized IT company in own office building
- Low voltage grid with no other participants



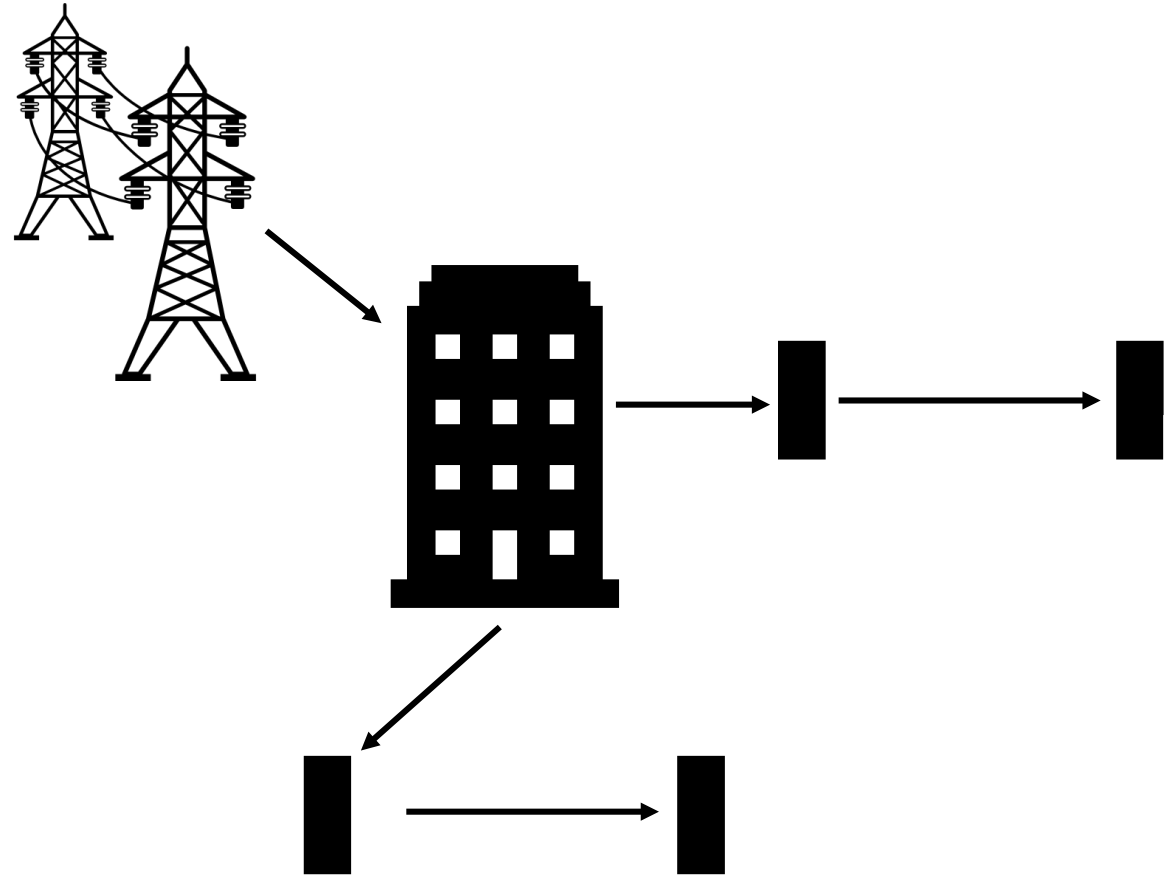
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- Medium-sized IT company in own office building
- Low voltage grid with no other participants
- 4 EV charging stations



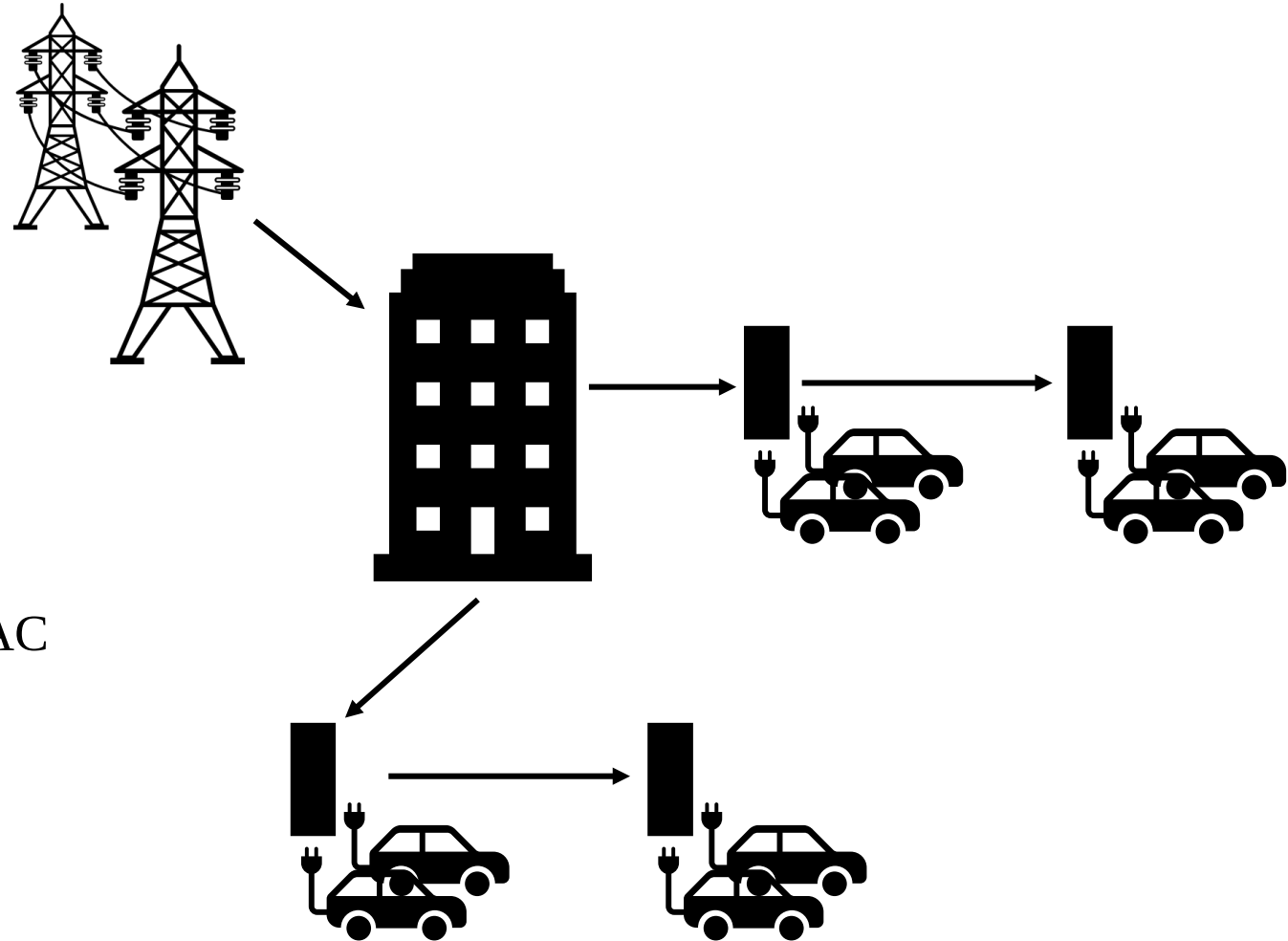
## The Case

- Medium-sized IT company in own office building
- Low voltage grid with no other participants
- 4 EV charging stations  
2 charging stations per string



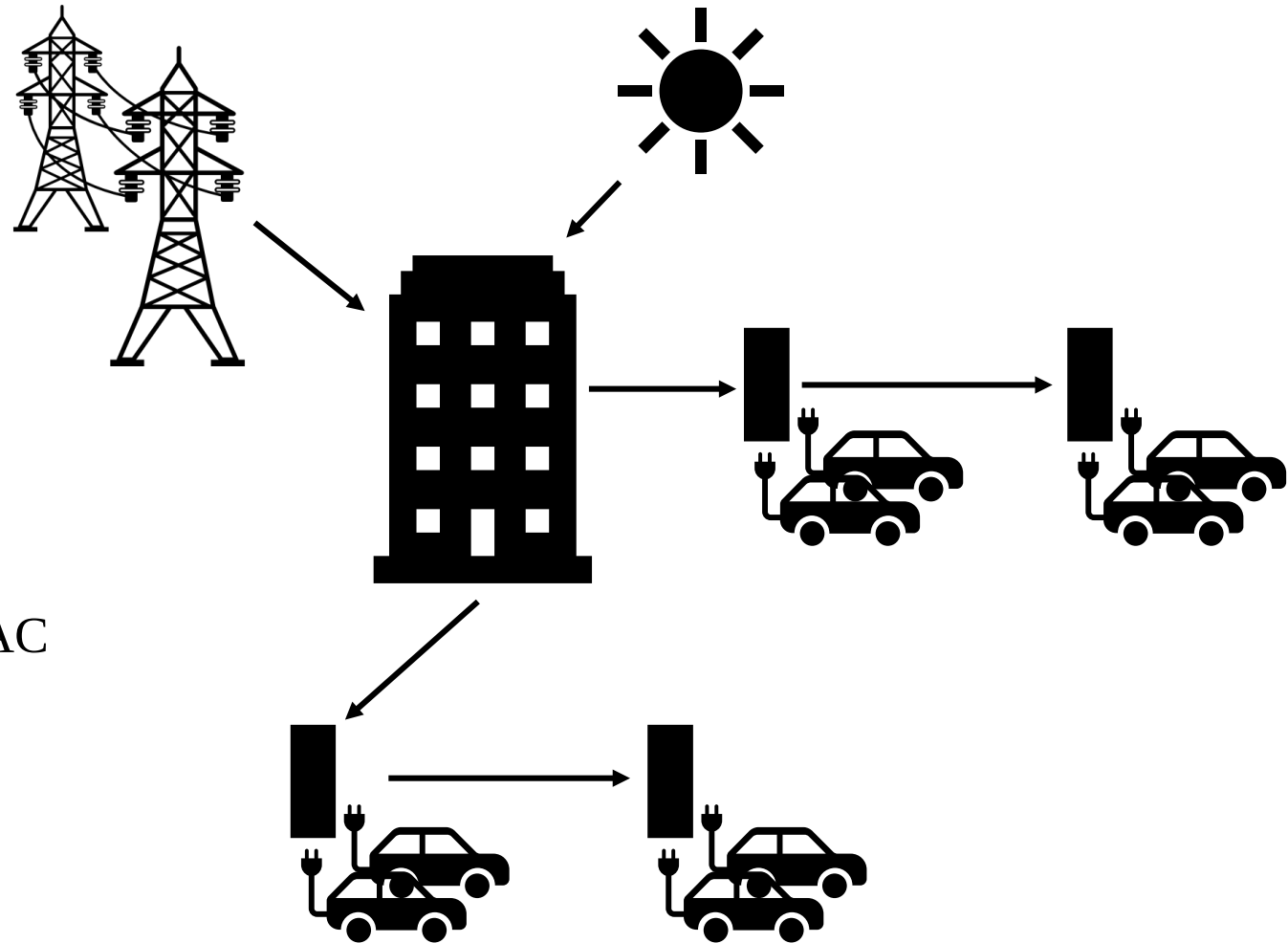
## The Case

- Medium-sized IT company in own office building
- Low voltage grid with no other participants
- 4 EV charging stations
  - 2 charging stations per string
  - 2 charging ports per station at 22kW AC
  - 44kW max. power per string



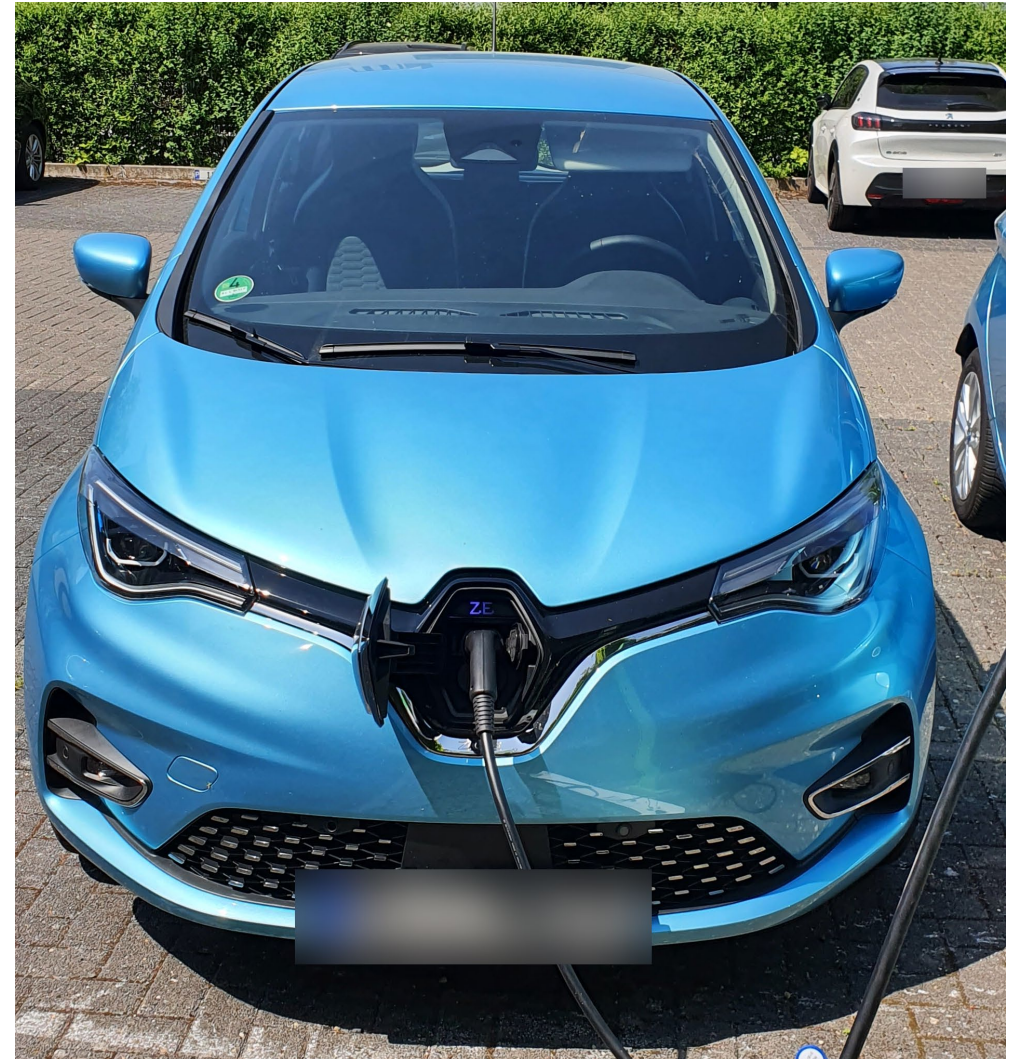
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- 4 EV charging stations
  - 2 charging stations per string
  - 2 charging ports per station at 22kW AC
  - 44kW max. power per string
- 15kWp of photovoltaic generation



## The EV Charging Conditions

- 14x Small EV of french origin





## The EV Charging Conditions

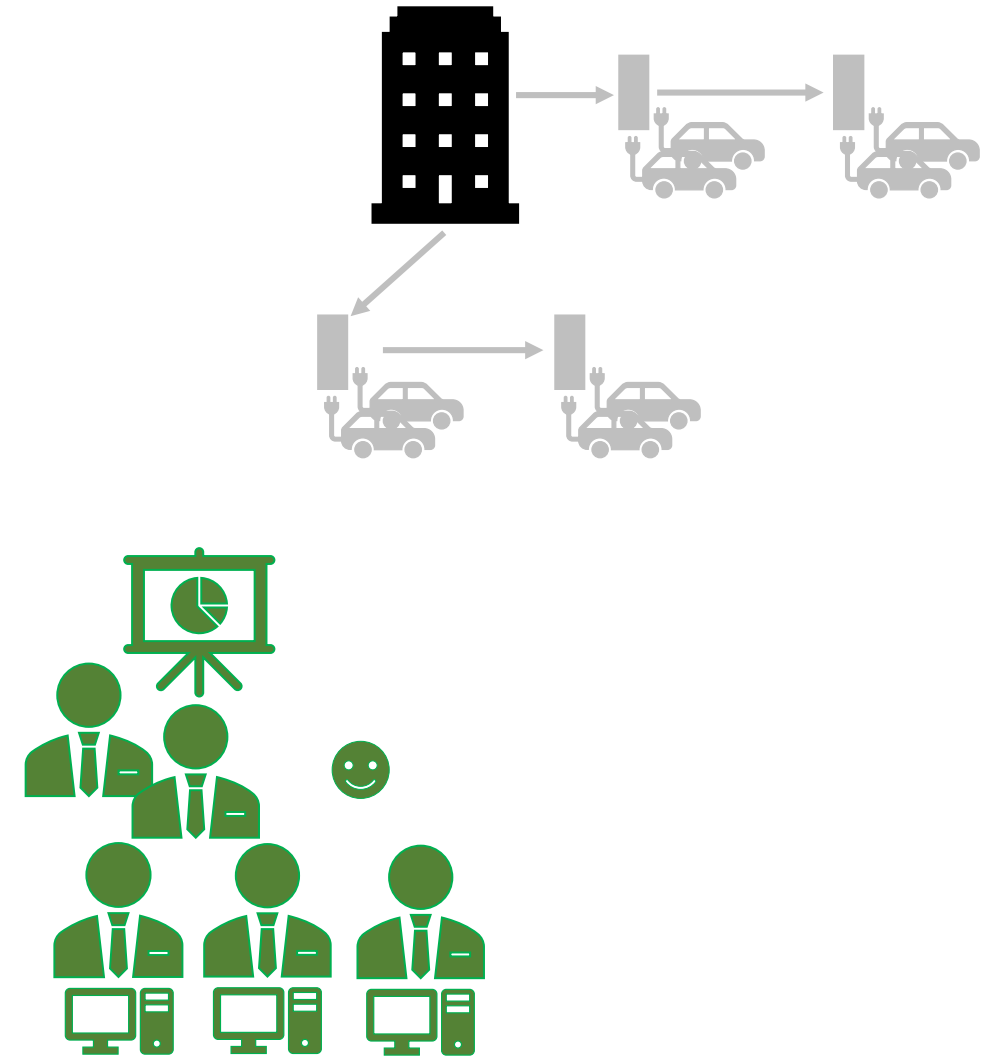
- 14x Small EV of french origin
- 2x 2 charging stations of 2 Outlets of 22kW each
- 2x Master/Slave configuration
- 88kW maximal total charging power





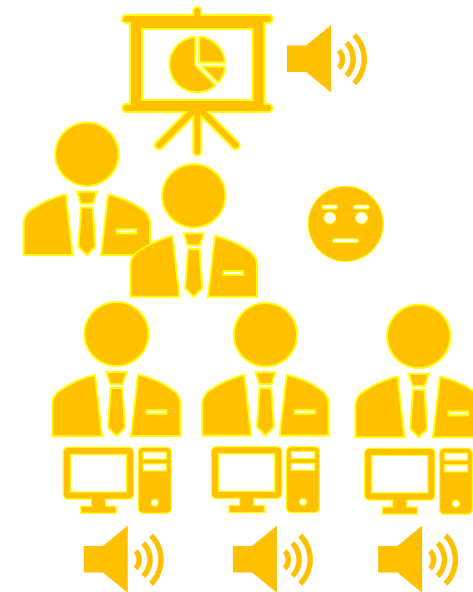
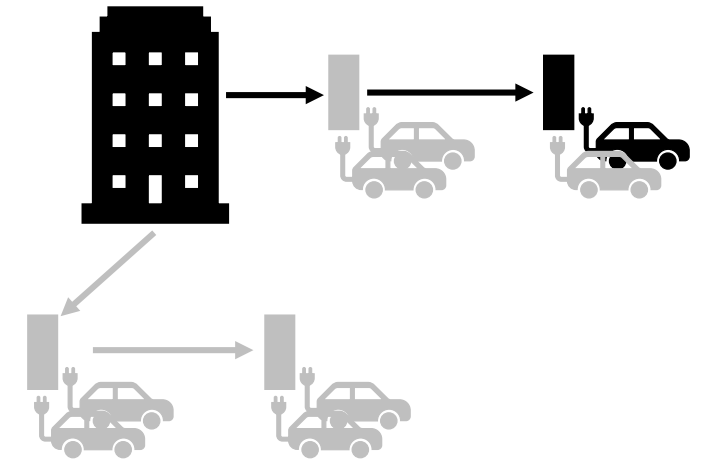
## The Problem

- Normal working conditions if no EV is charging



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- 1 EV charging: High-pitched buzzing sound

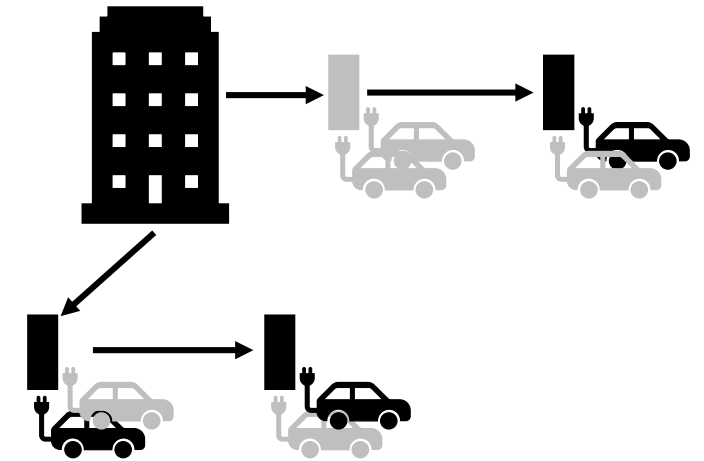


## The Problem

- Normal working conditions if no EV is charging
- 1 EV charging: High-pitched buzzing sound
- 2 or more EVs charging: Oscillating buzzing sound

Influence on the well-being of the employees in the workspace

EV manufacturer denies any responsibility



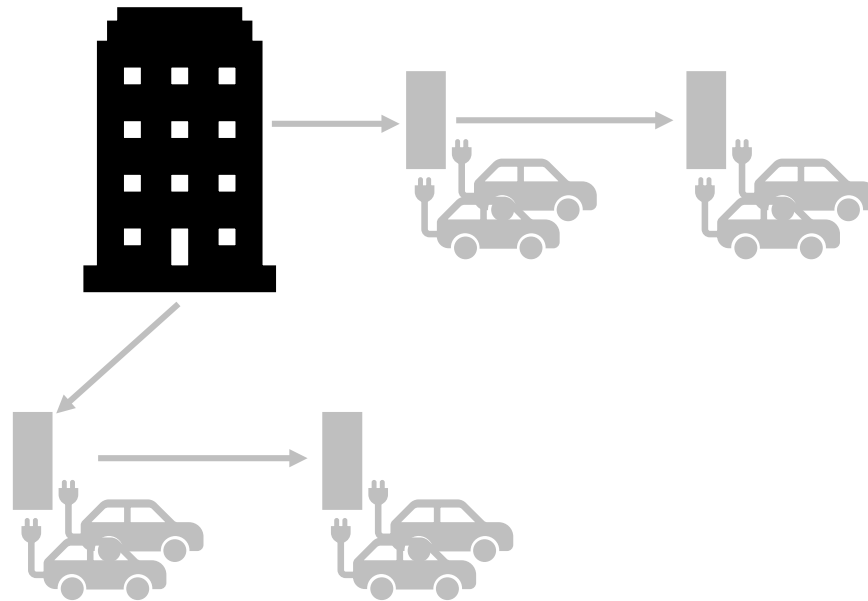
# Measurement Setup: LV Main Distribution Room





# Measurement Setup: Charging Station

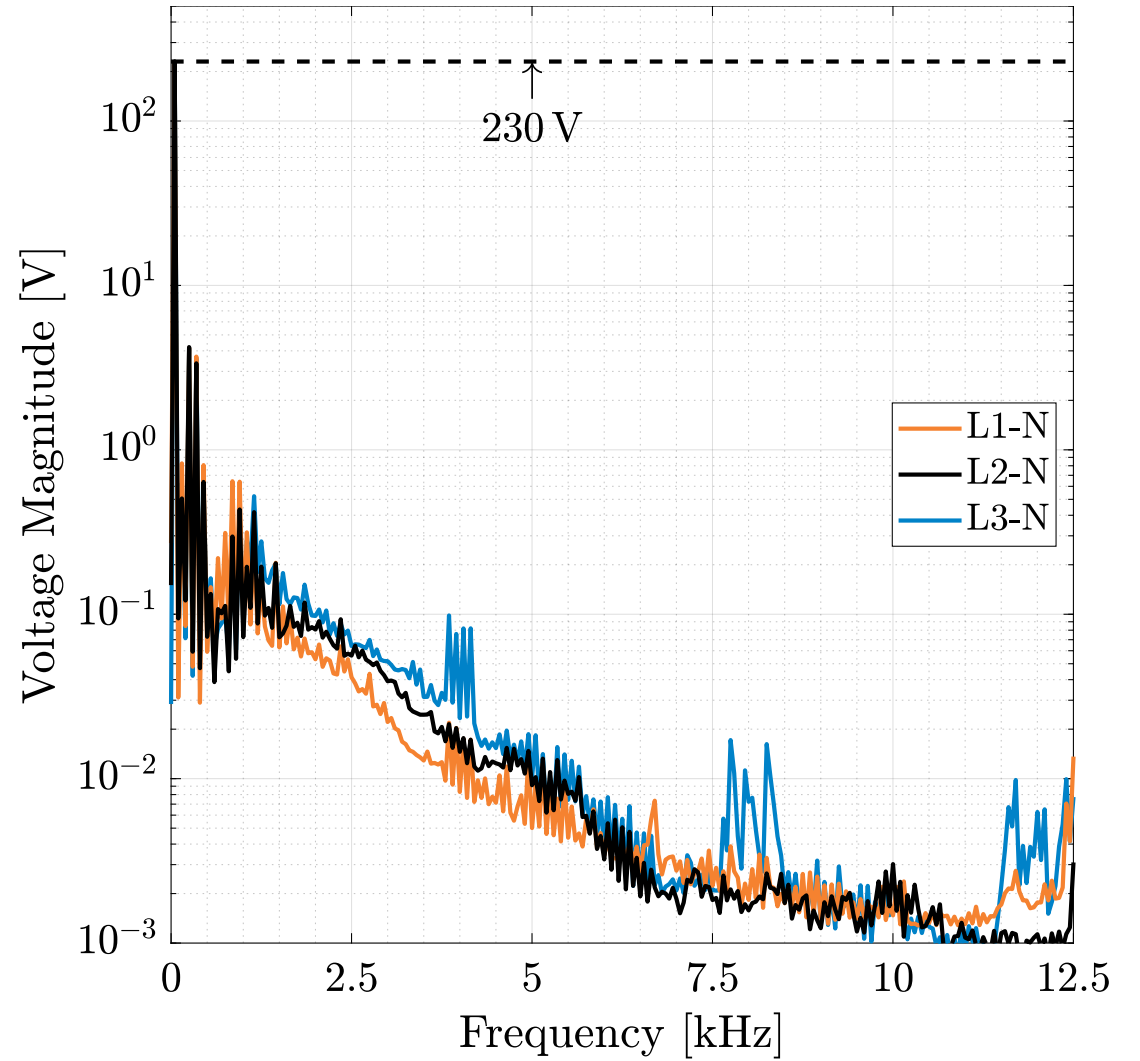
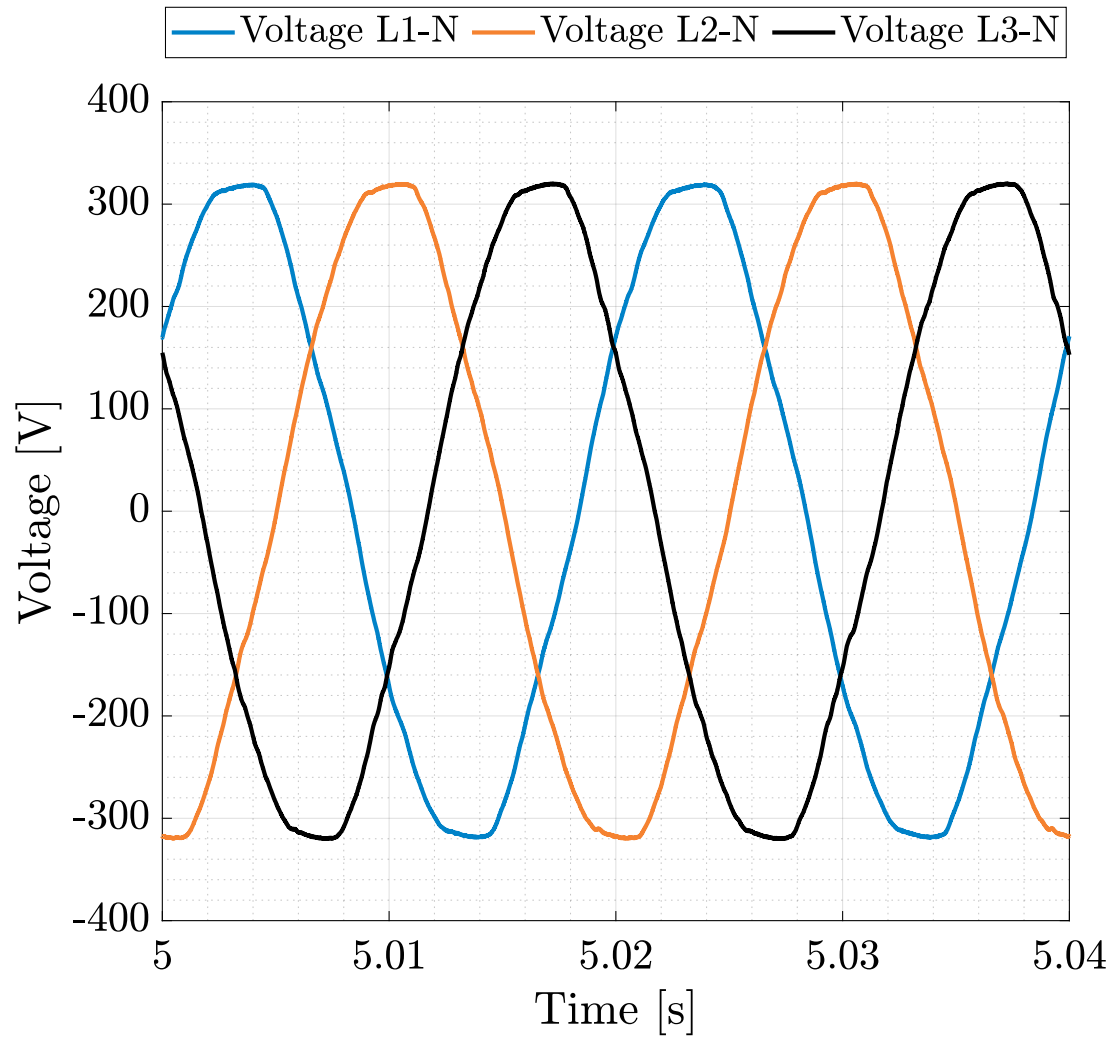




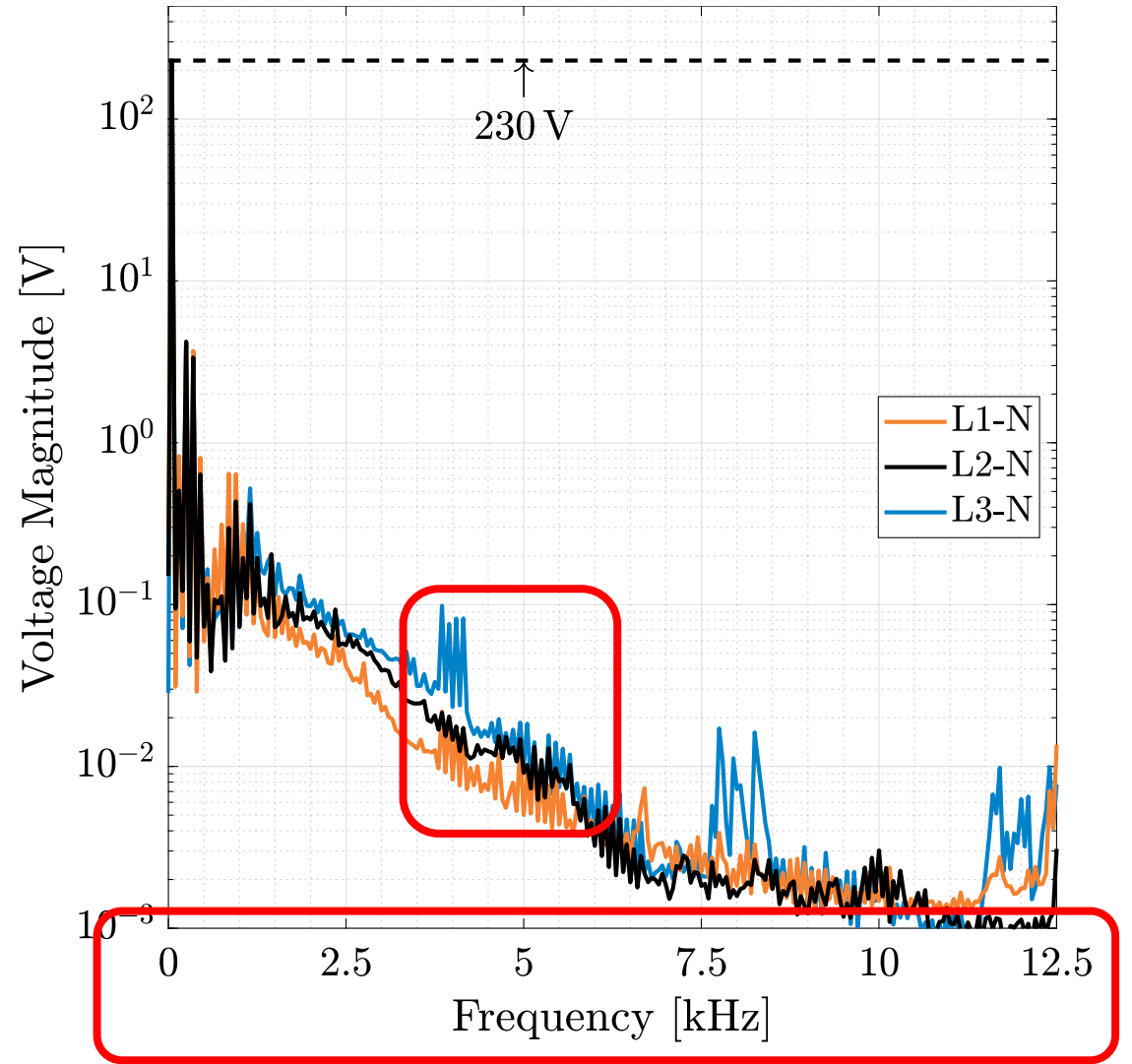
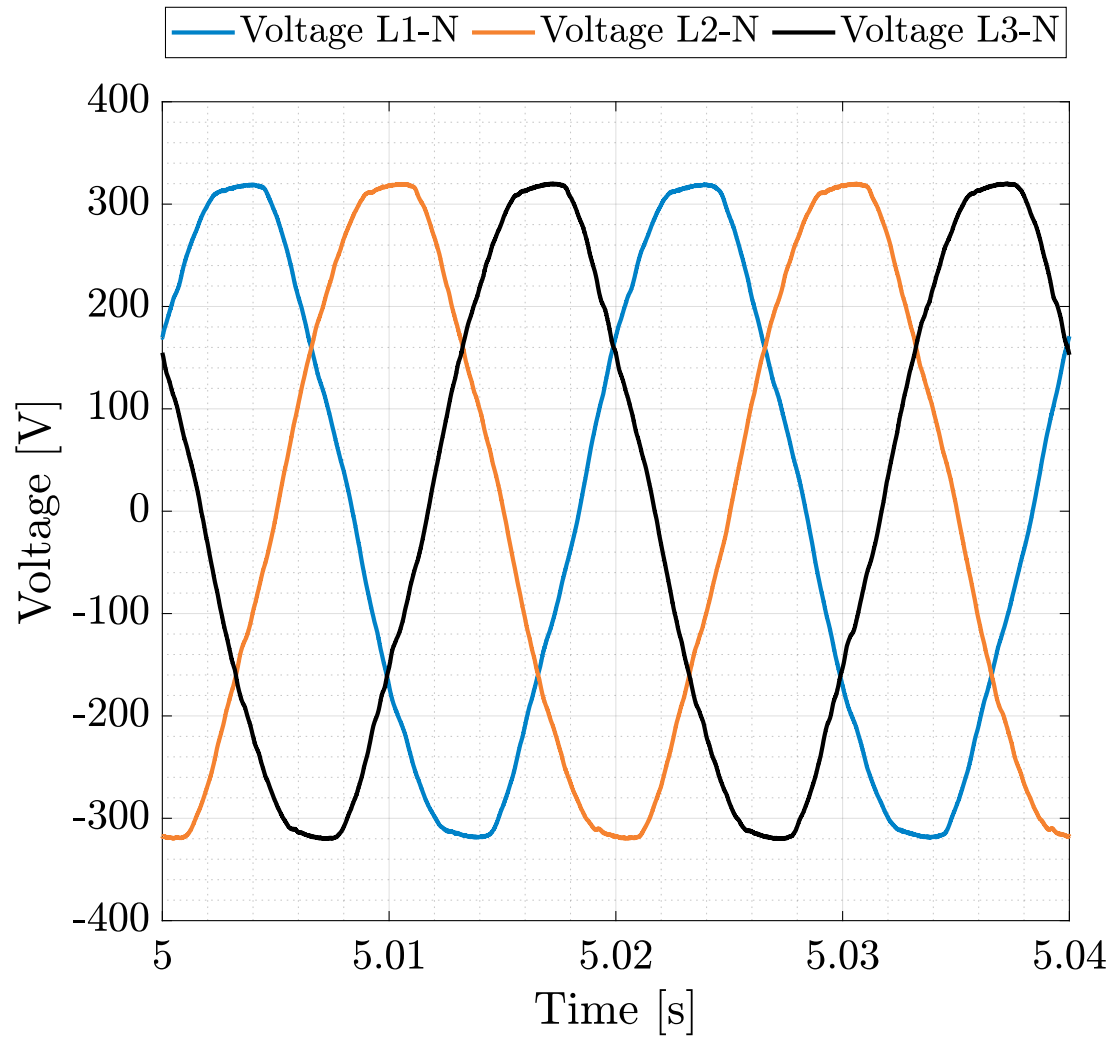
# Results: Power Grid in Idle

Measured in LV Distribution Room

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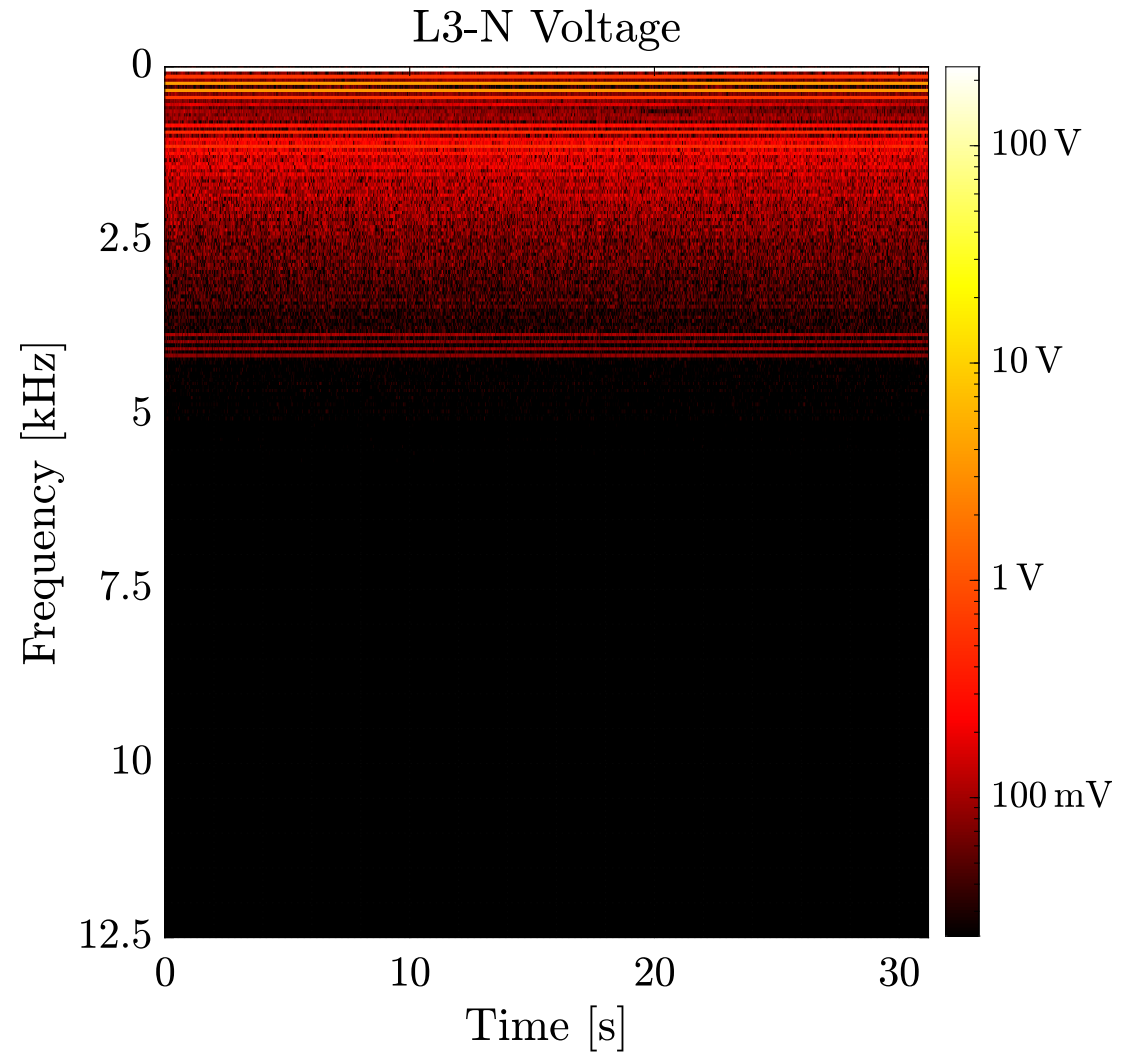
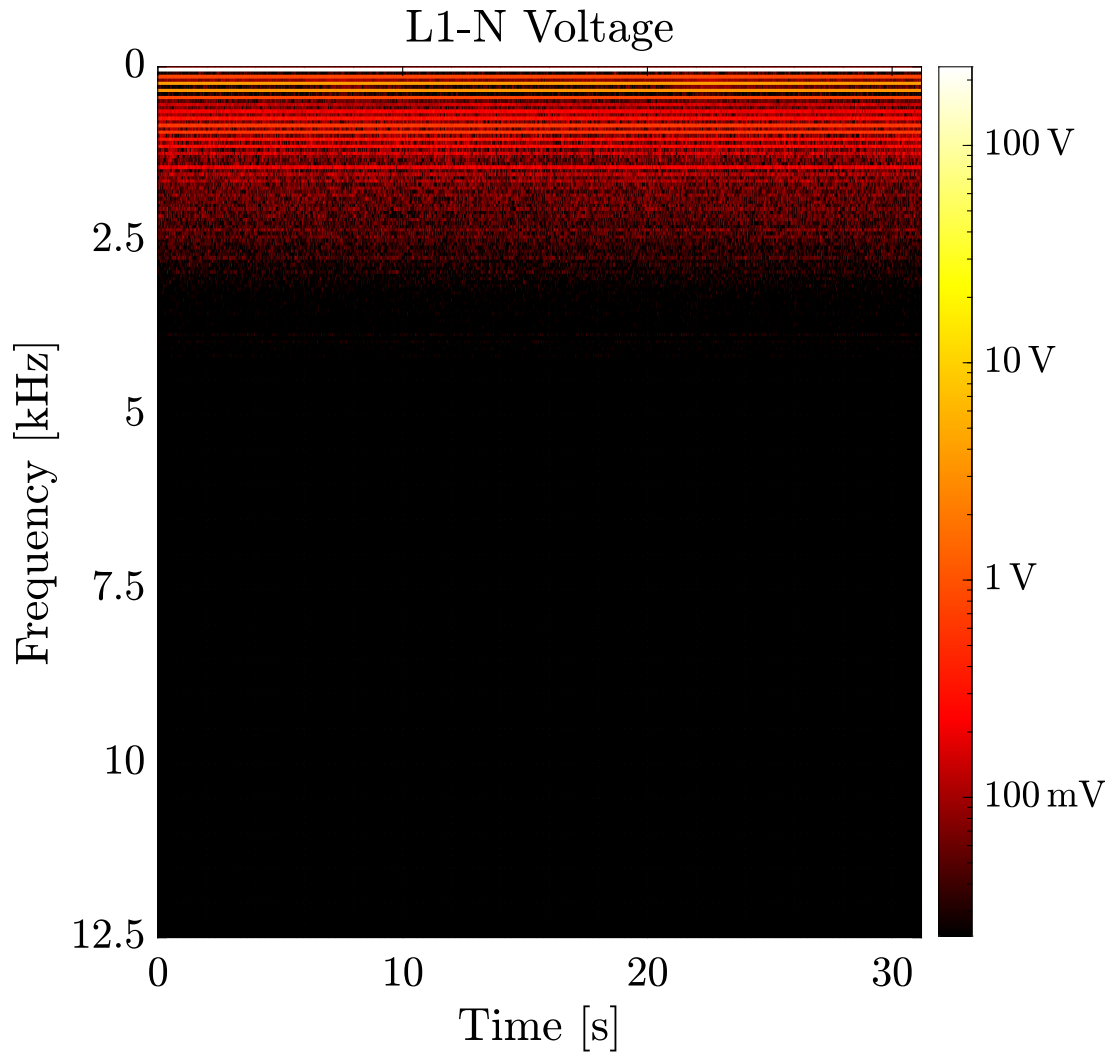


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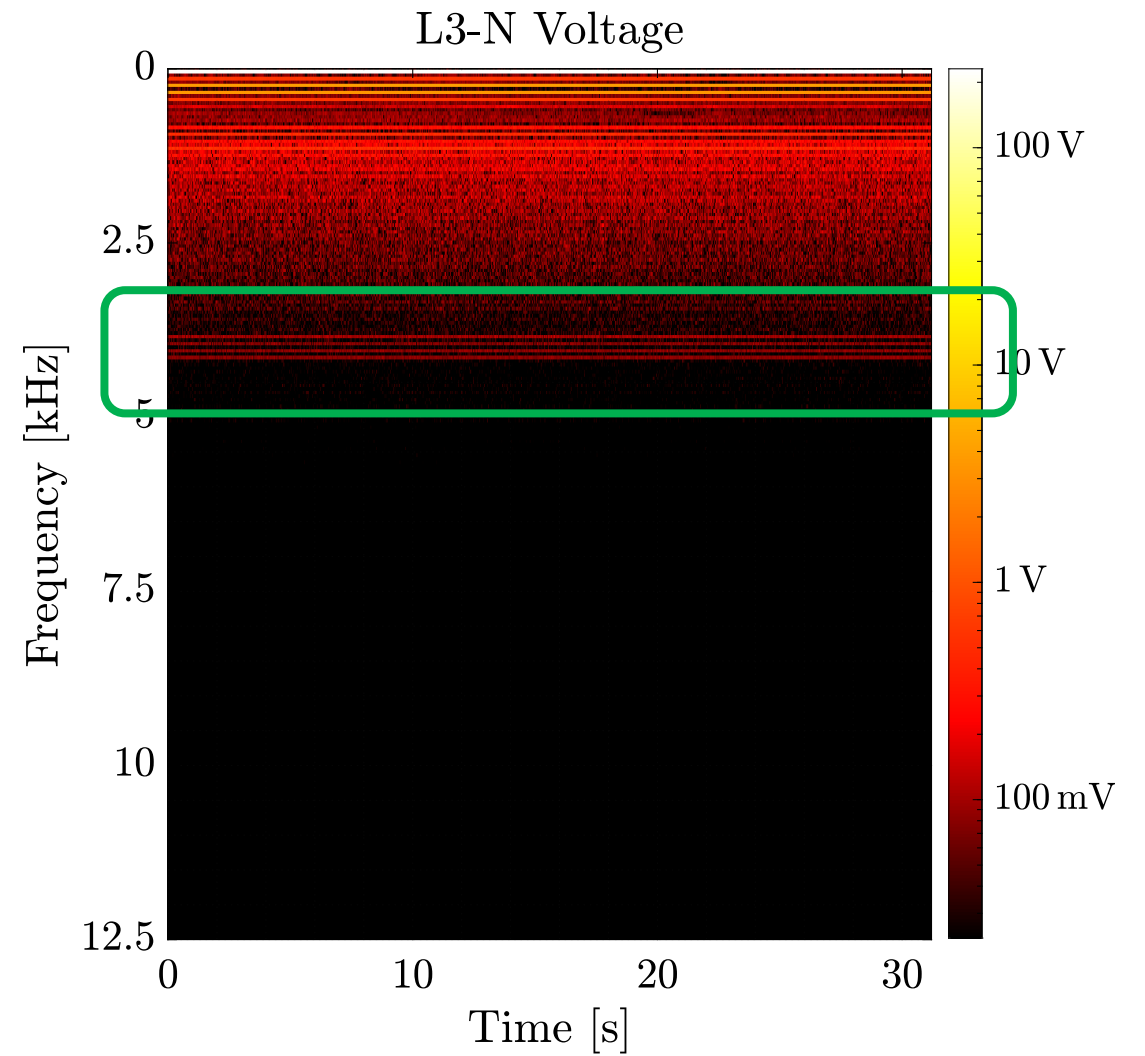
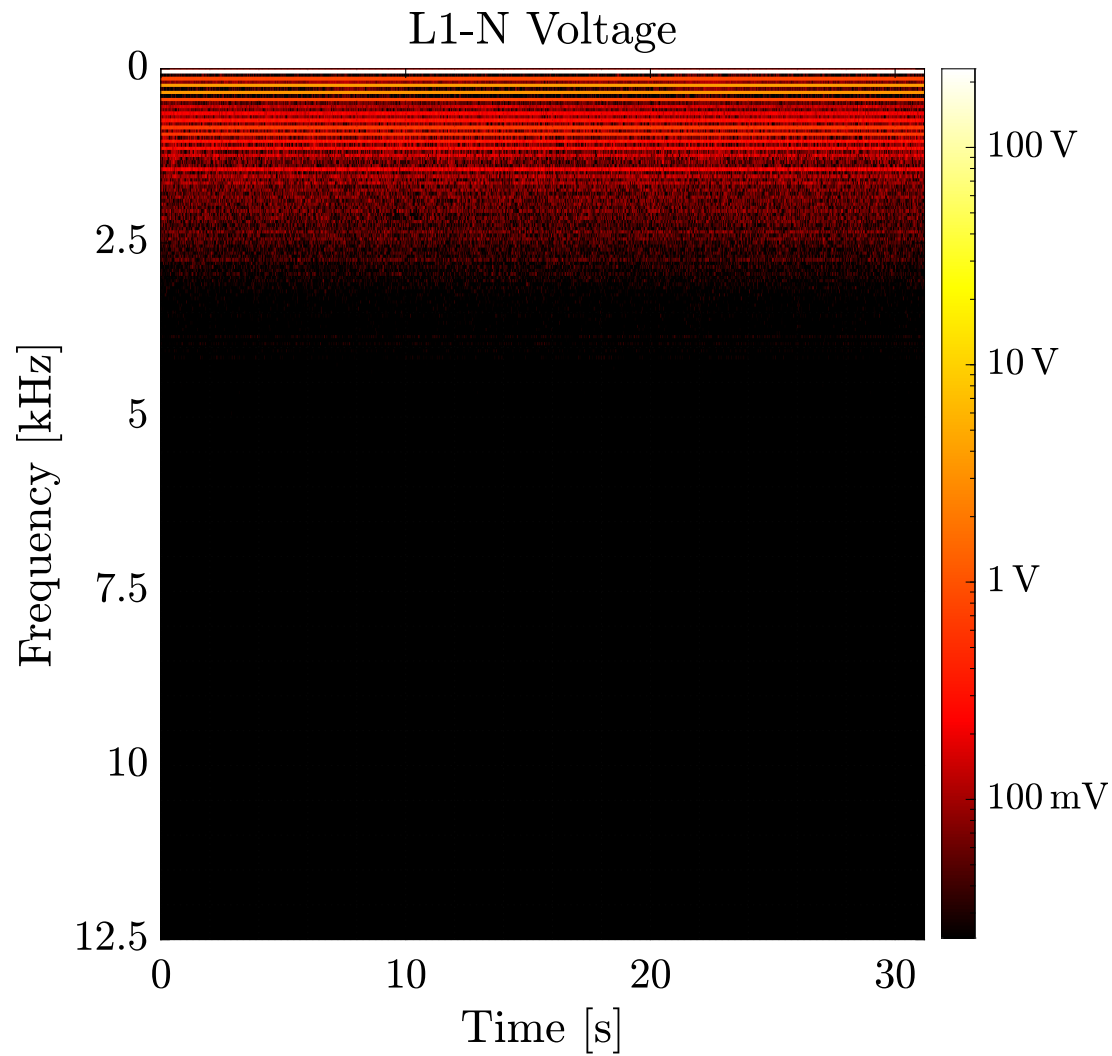


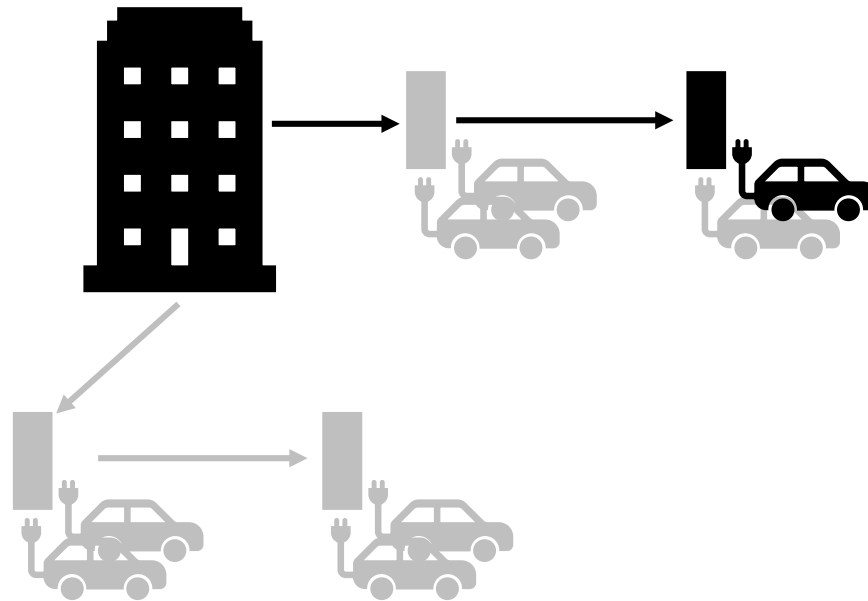


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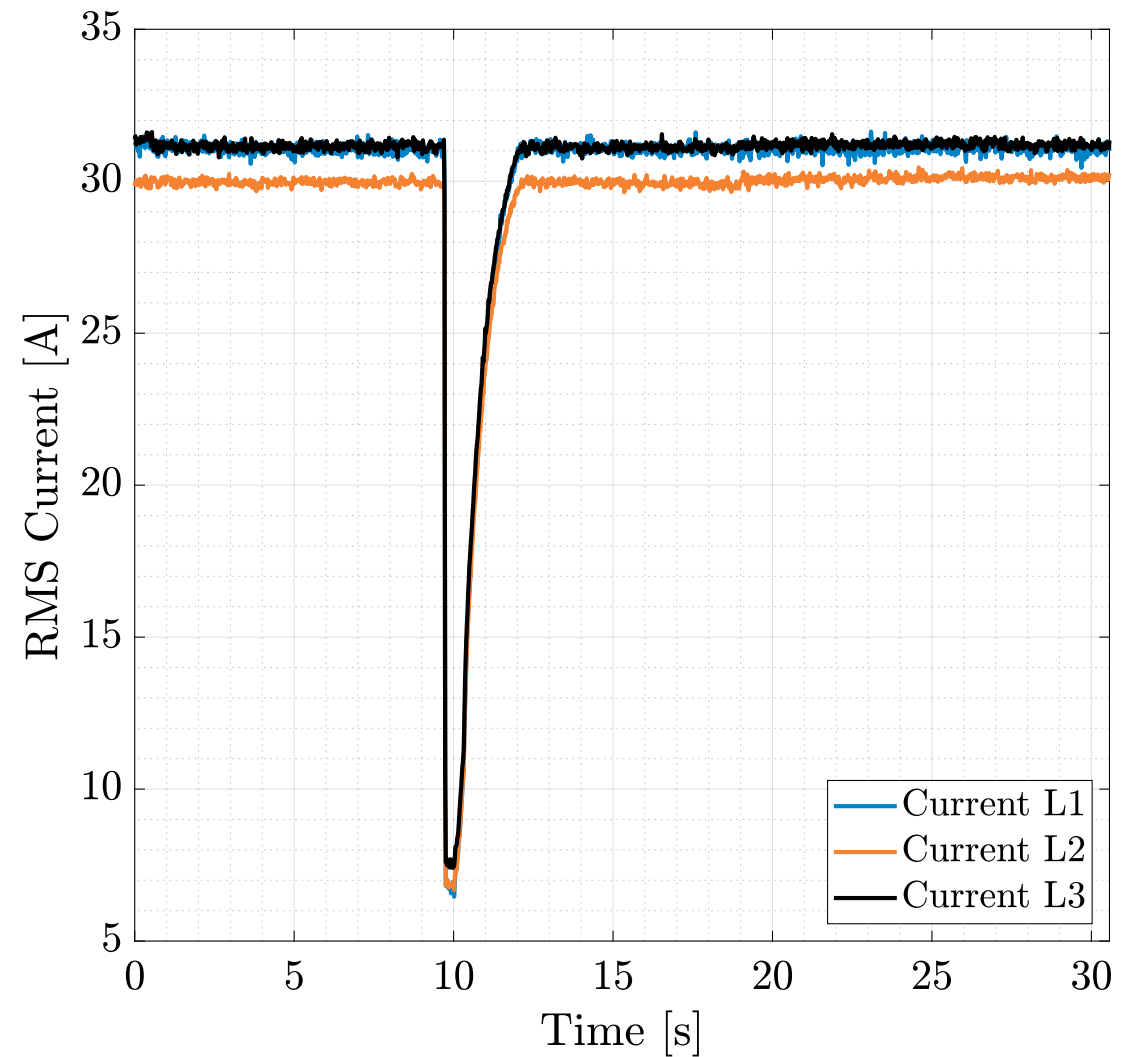
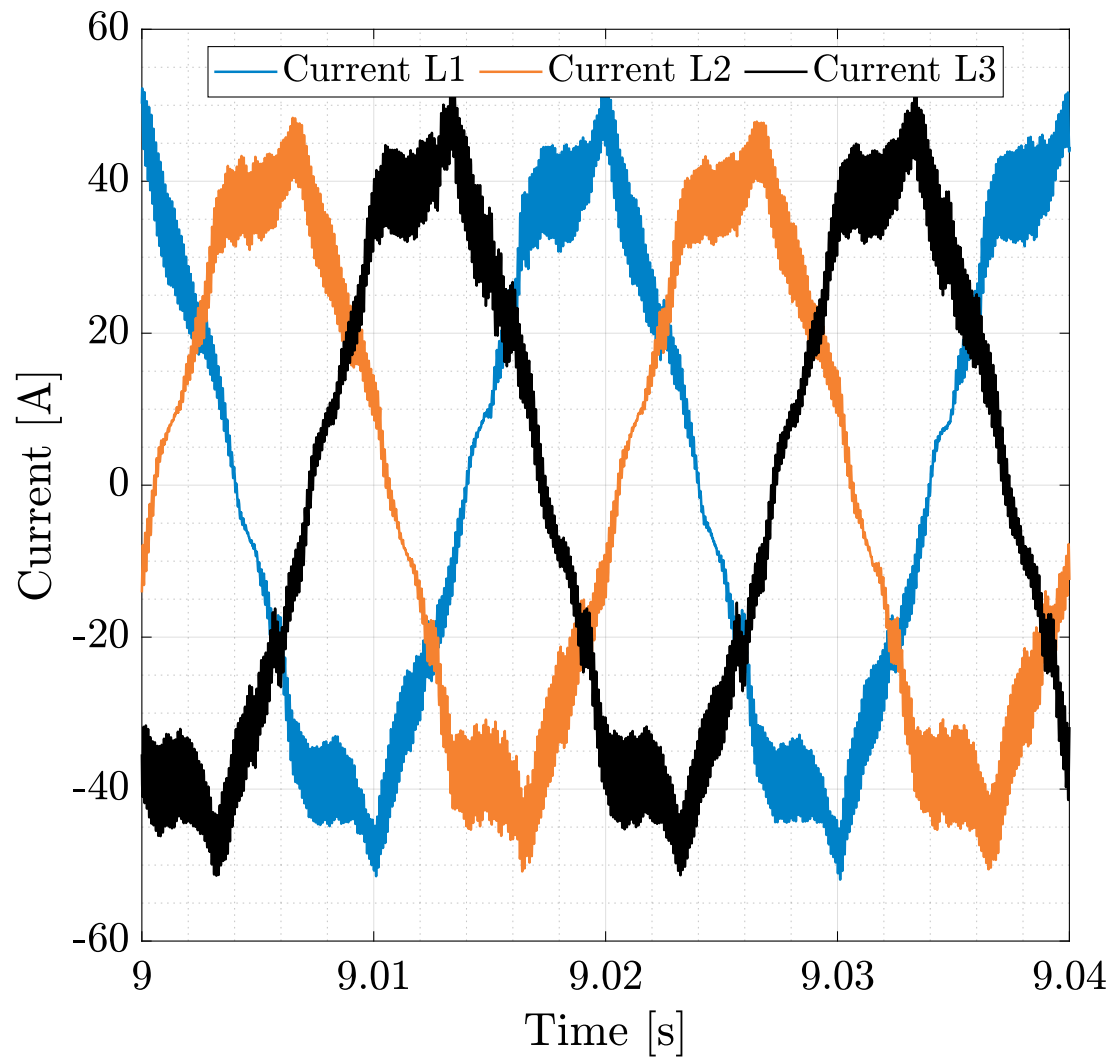




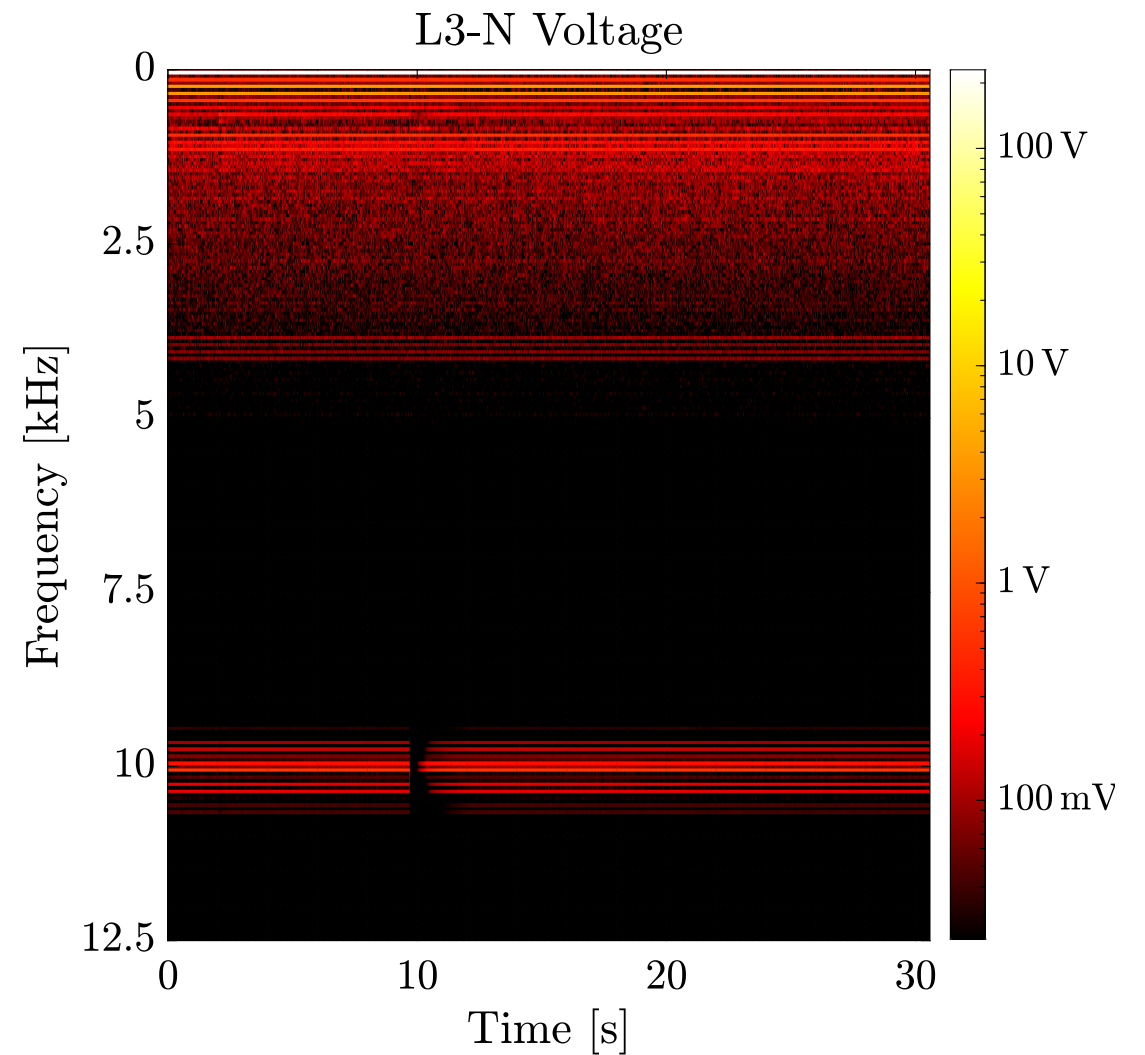
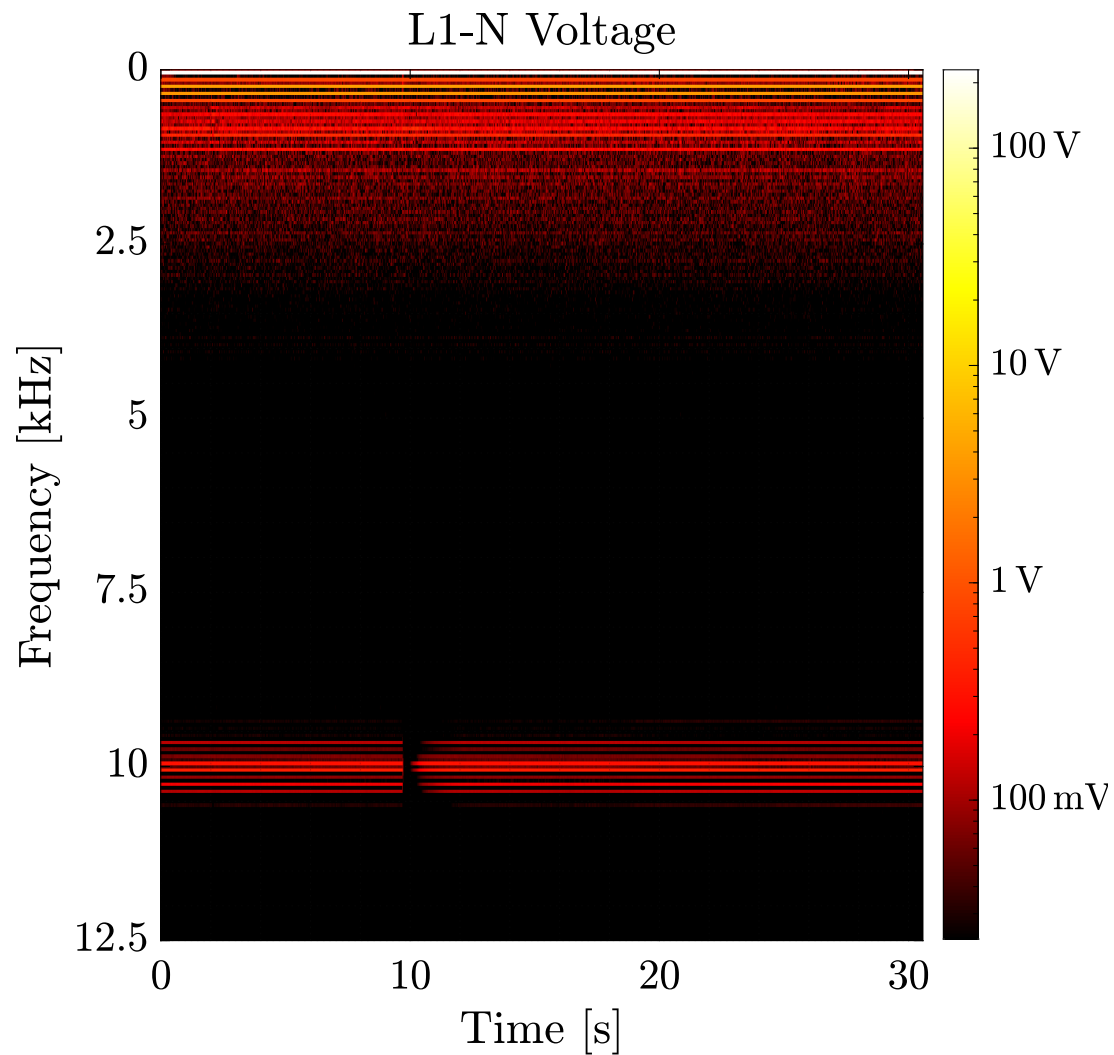
# Results: 1 EV Charging

Measured in LV Distribution Room

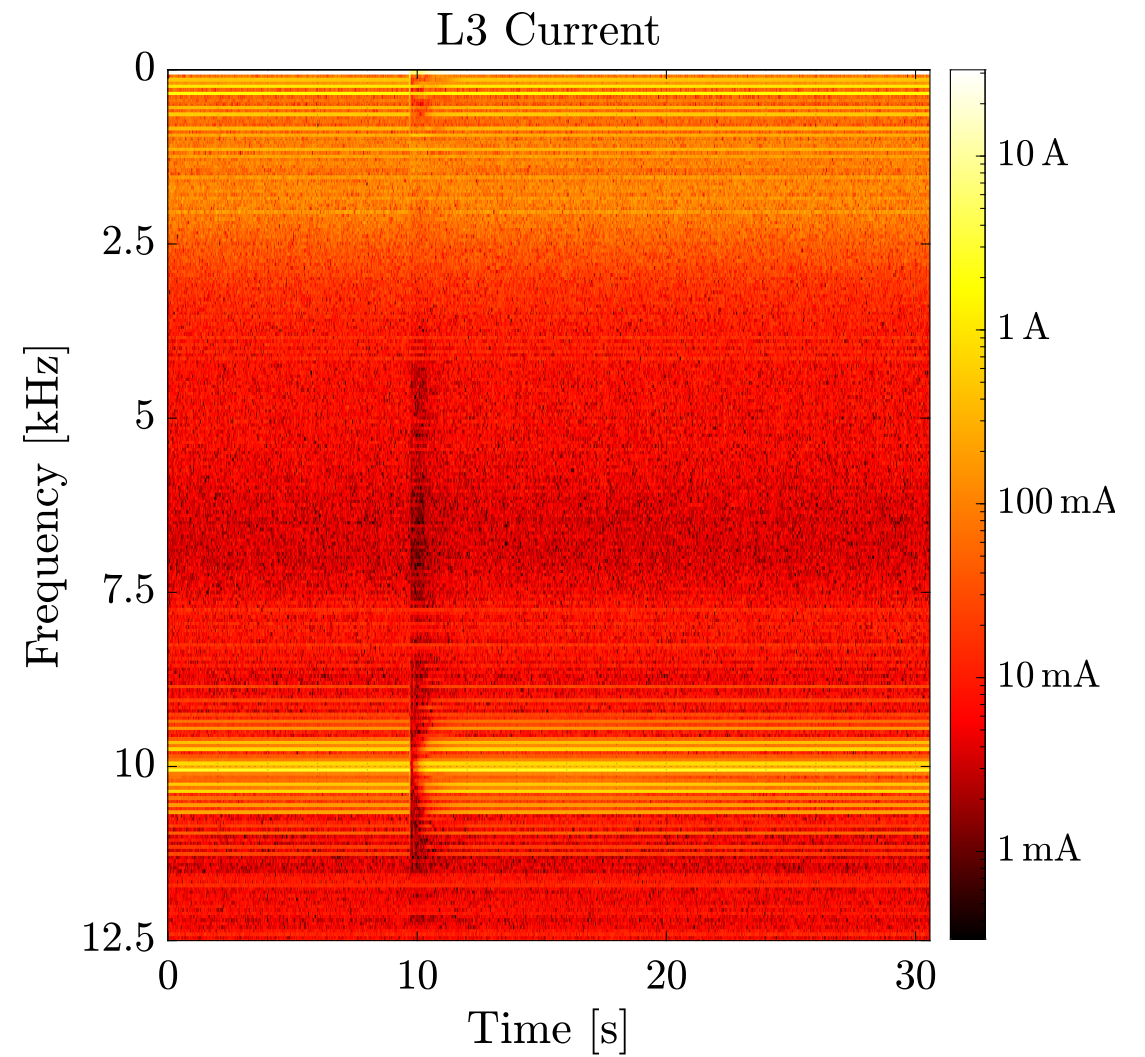
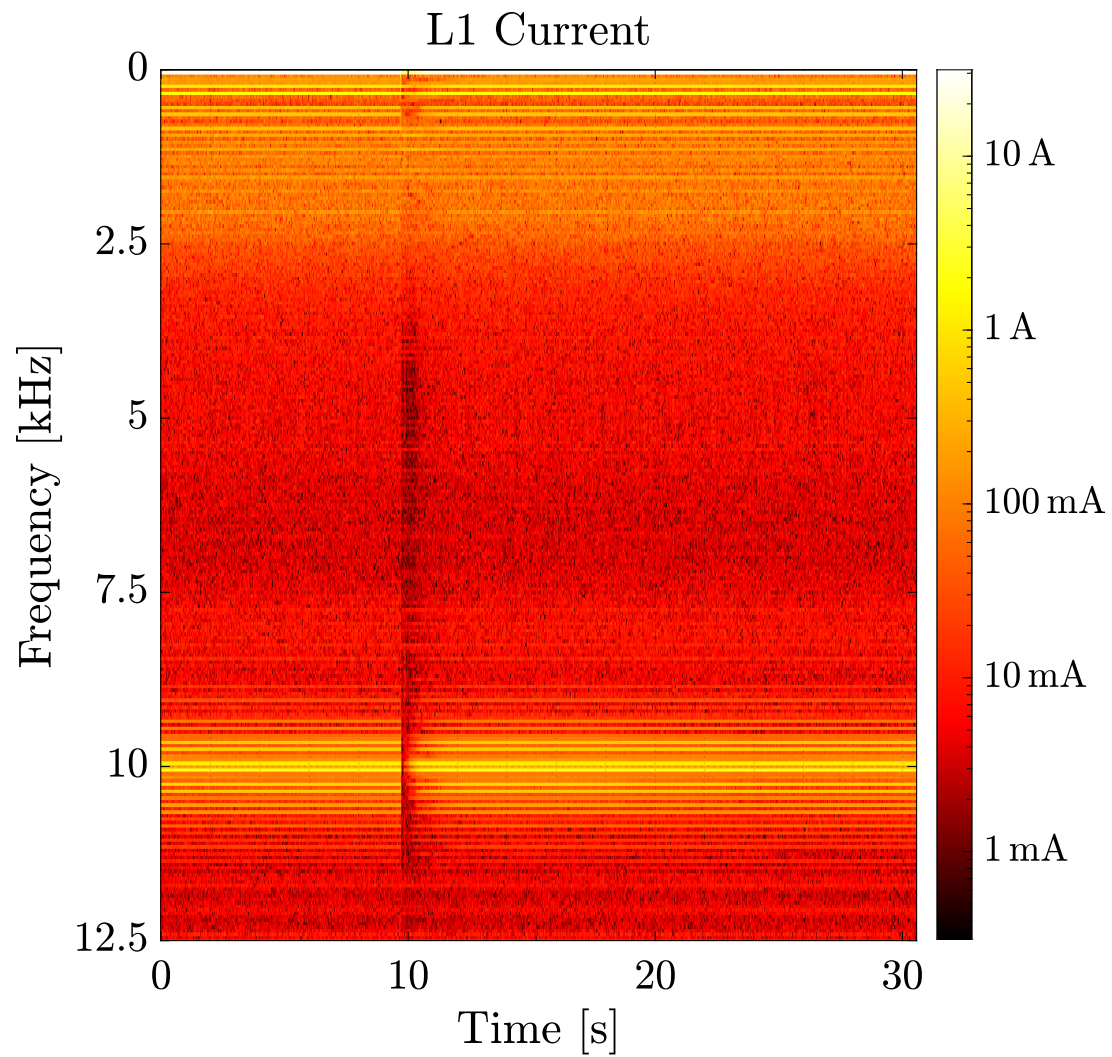
## Results: 1 EV Charging, Measured in LV Distribution Room



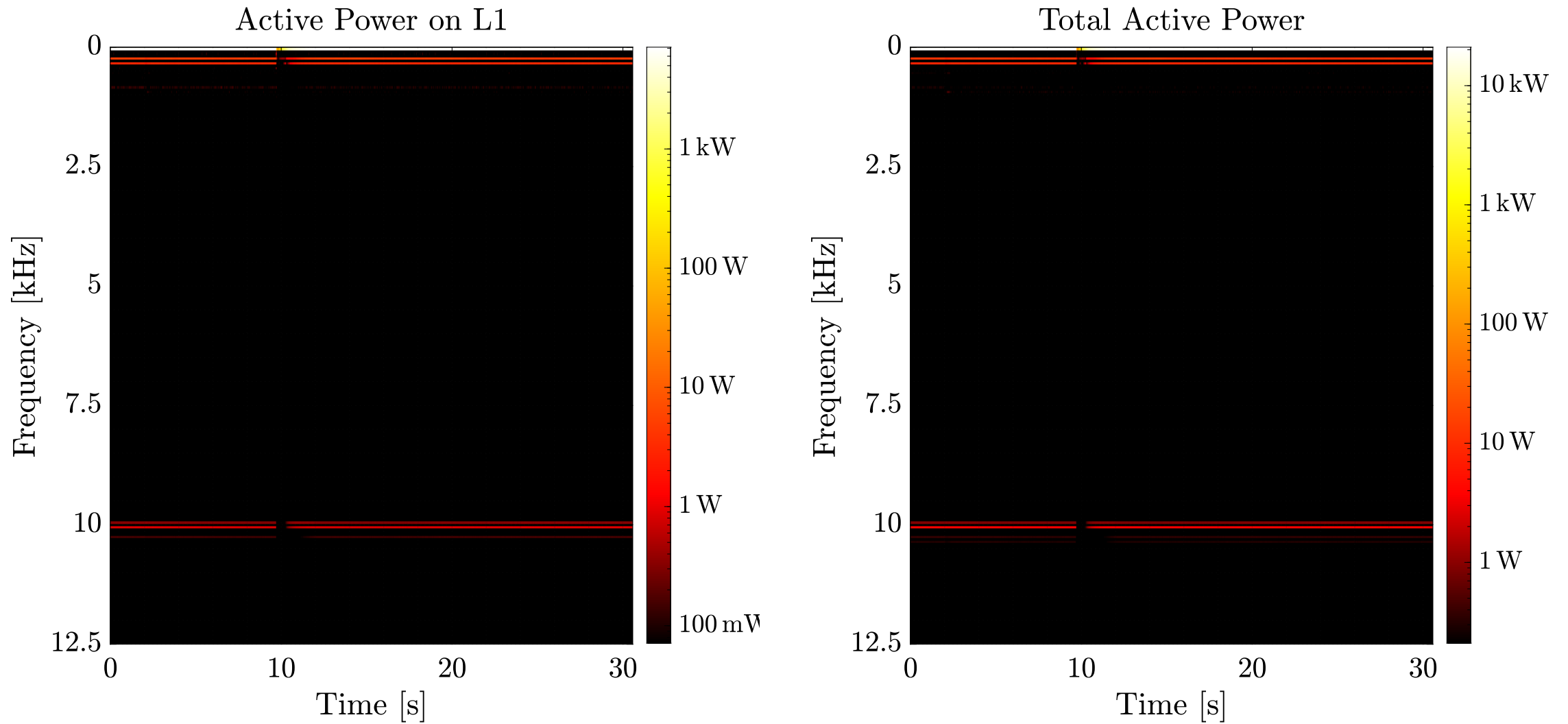
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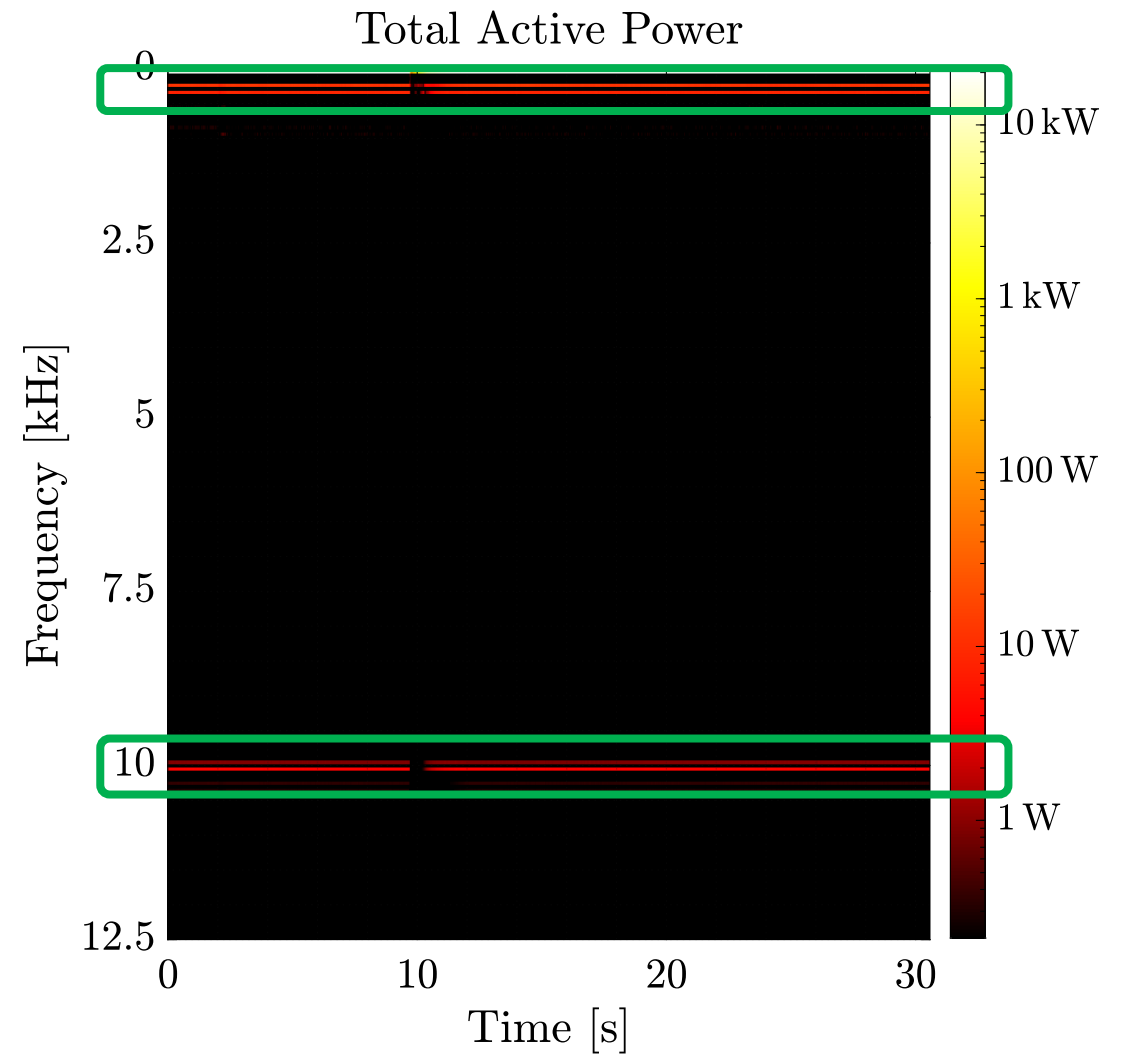
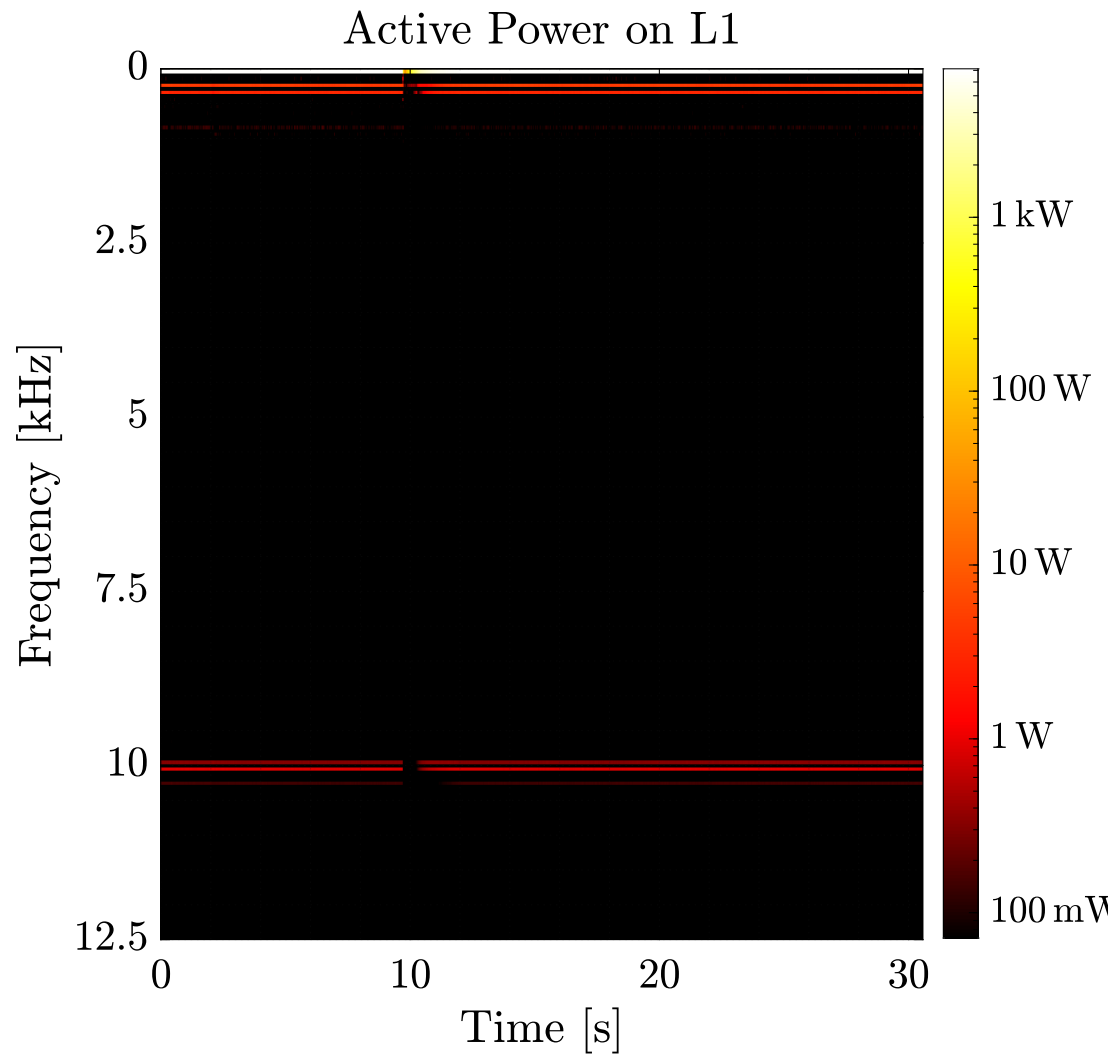
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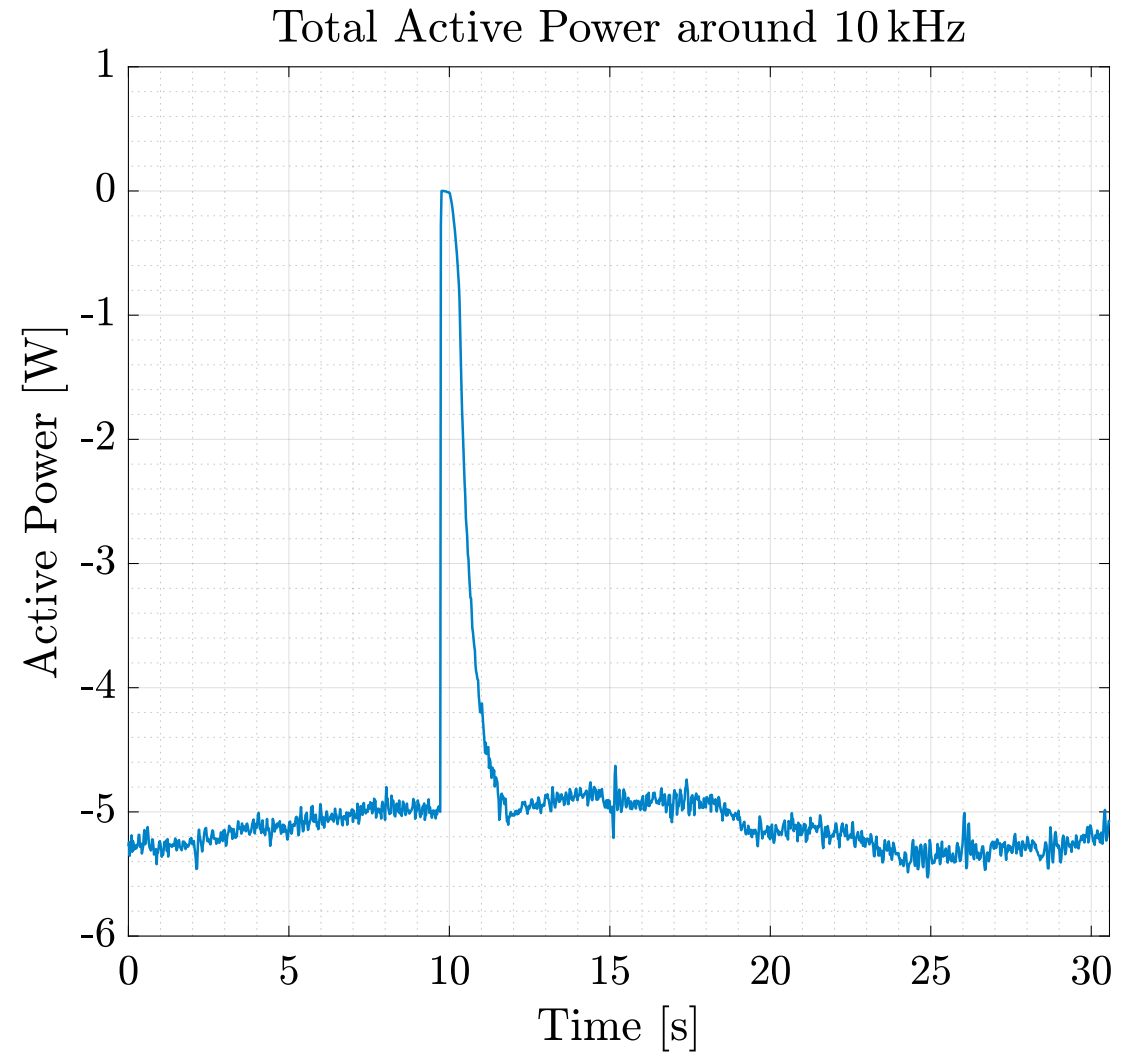
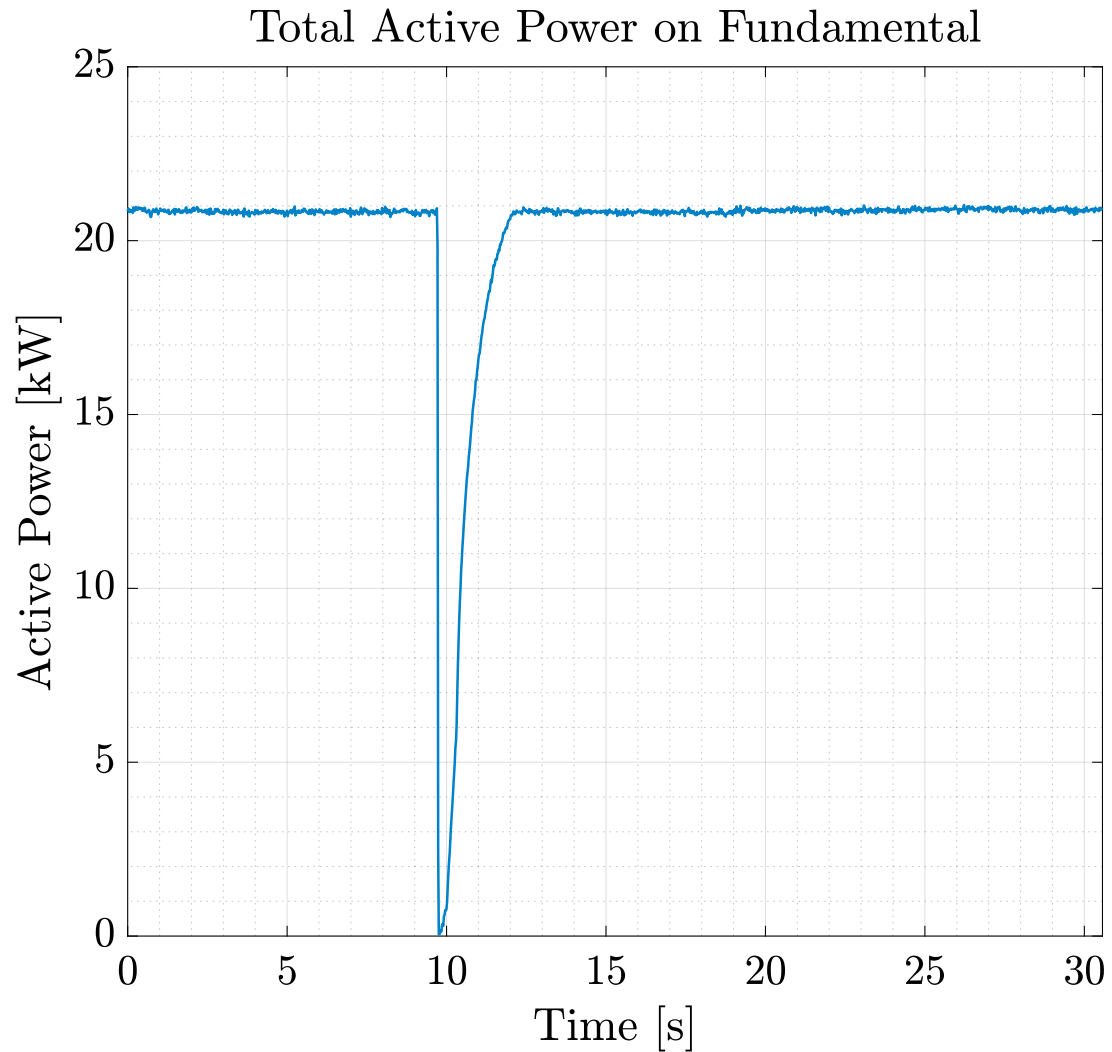


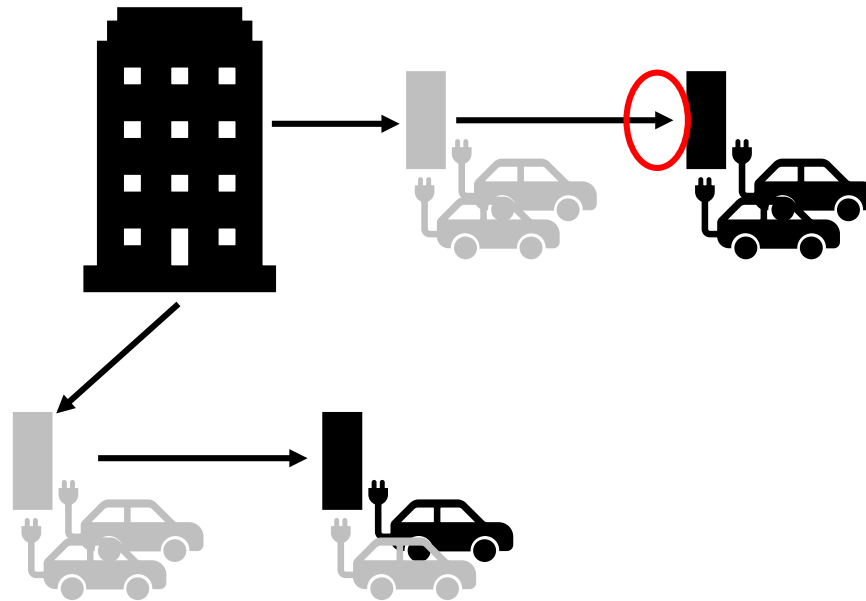
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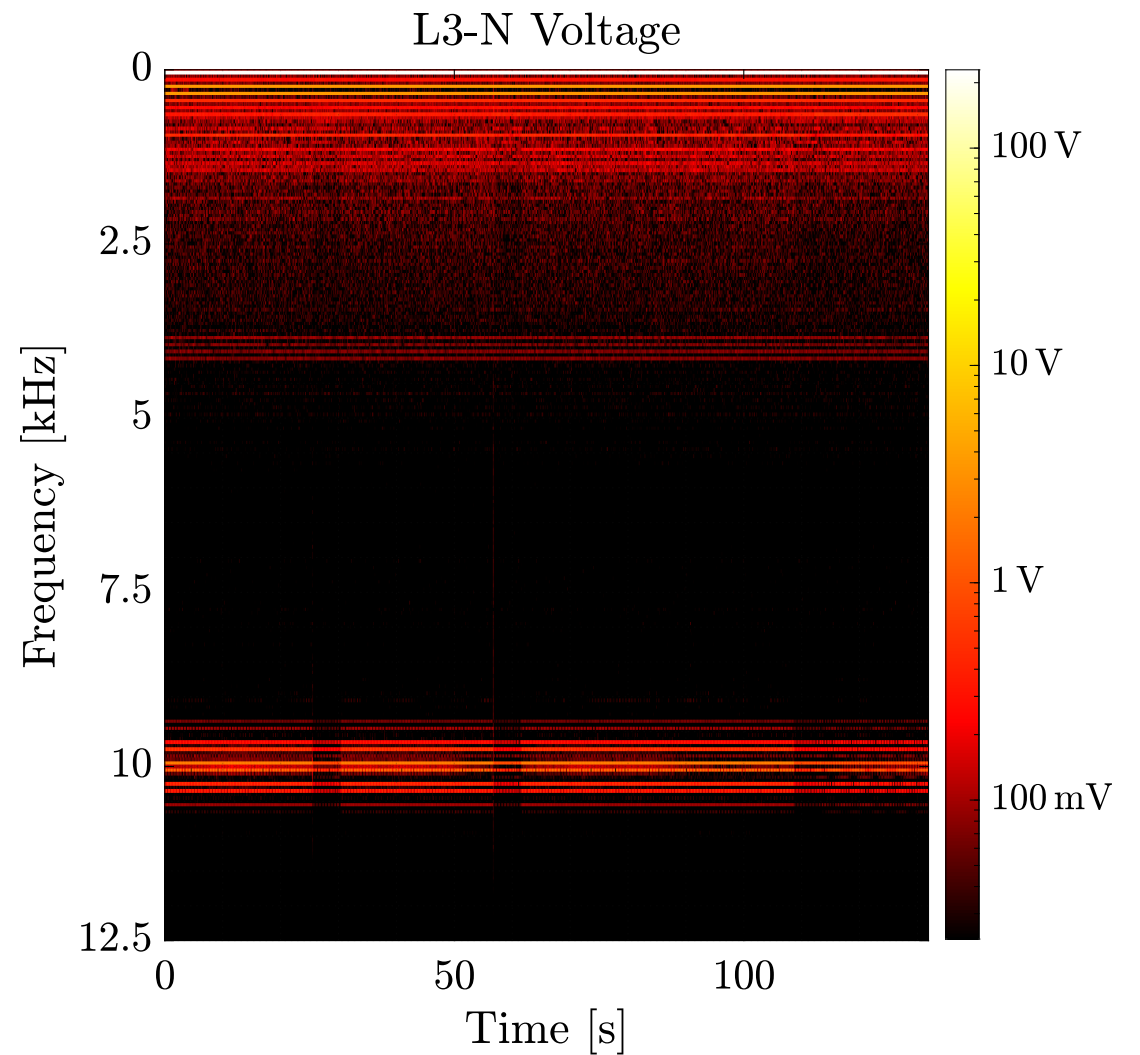
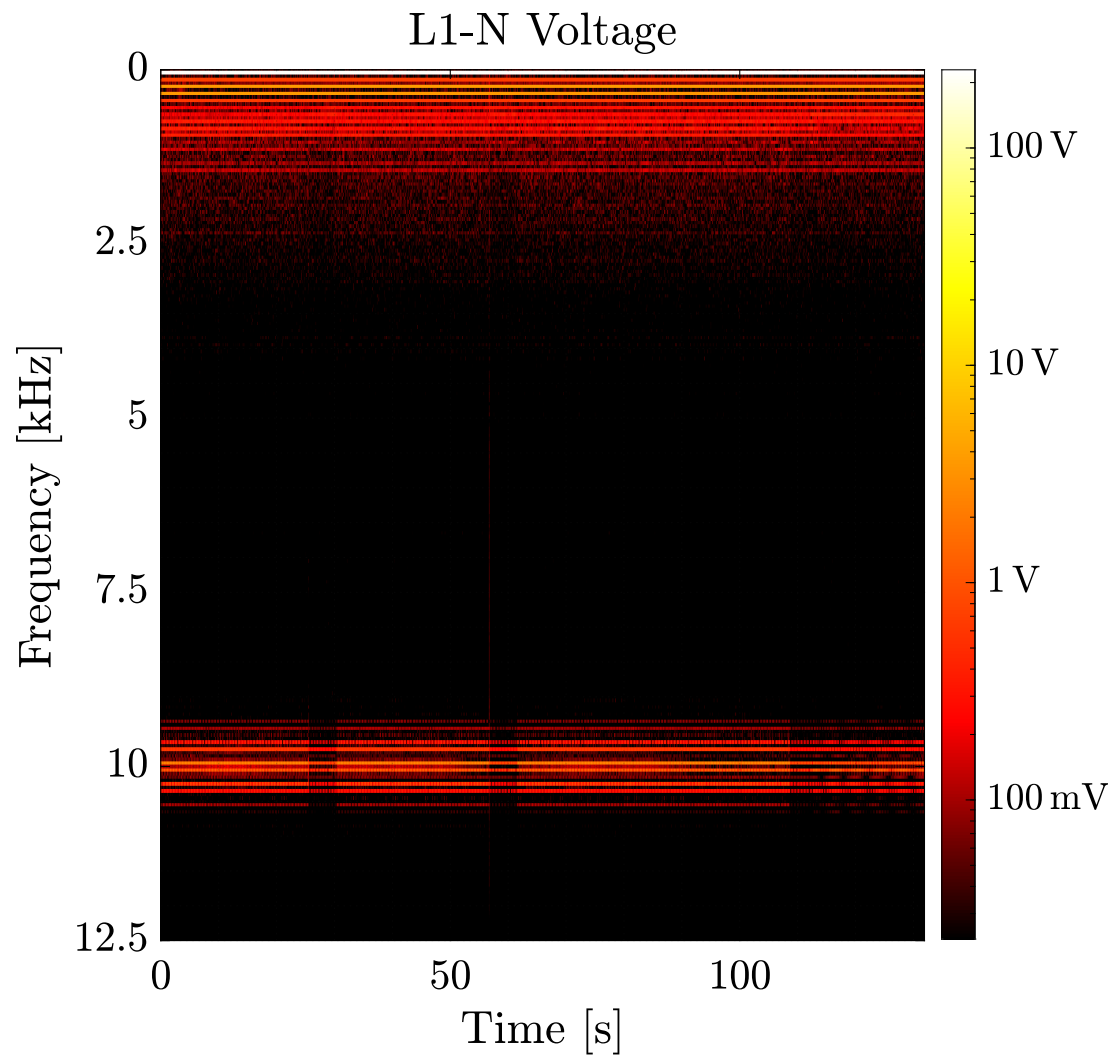




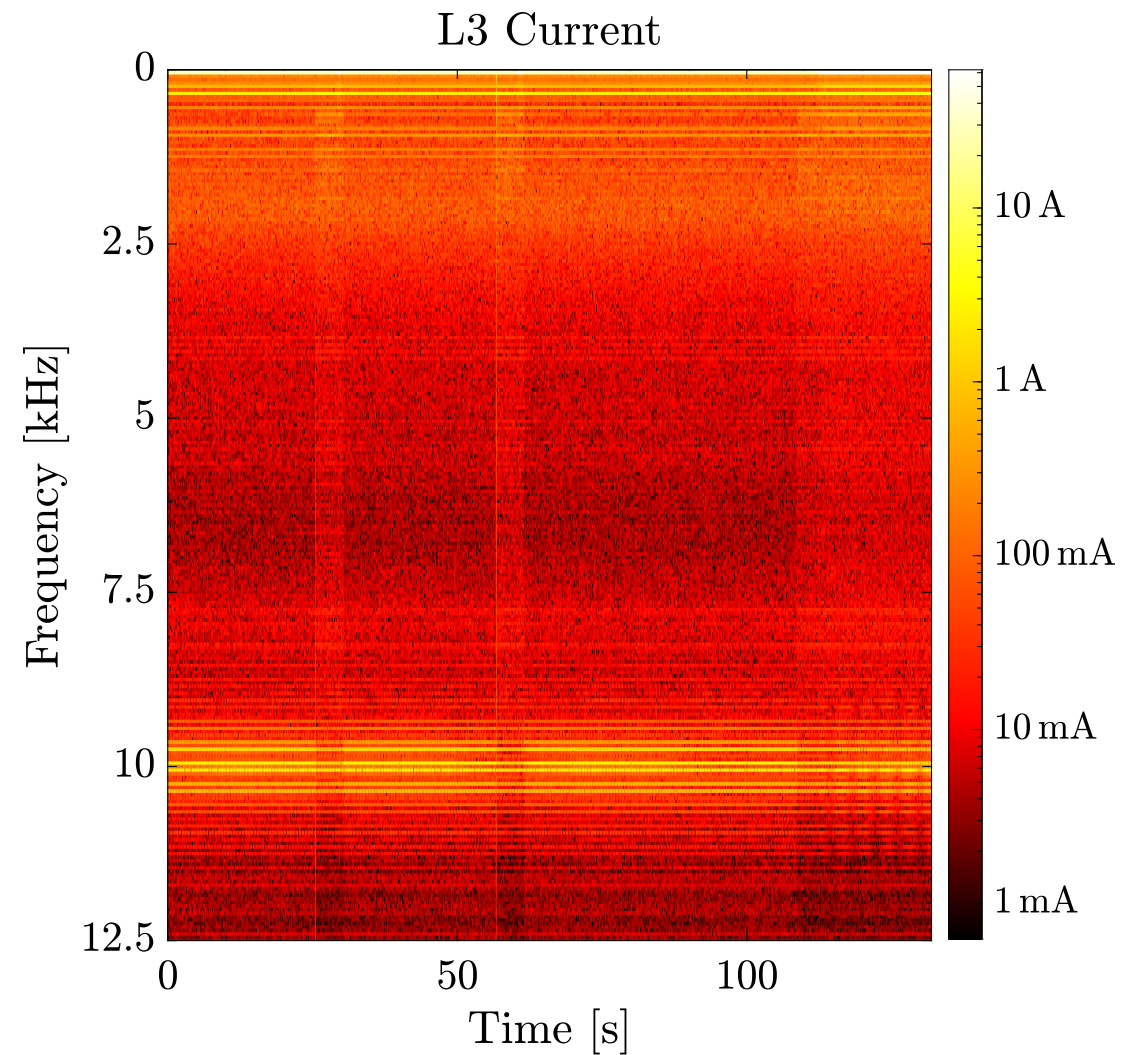
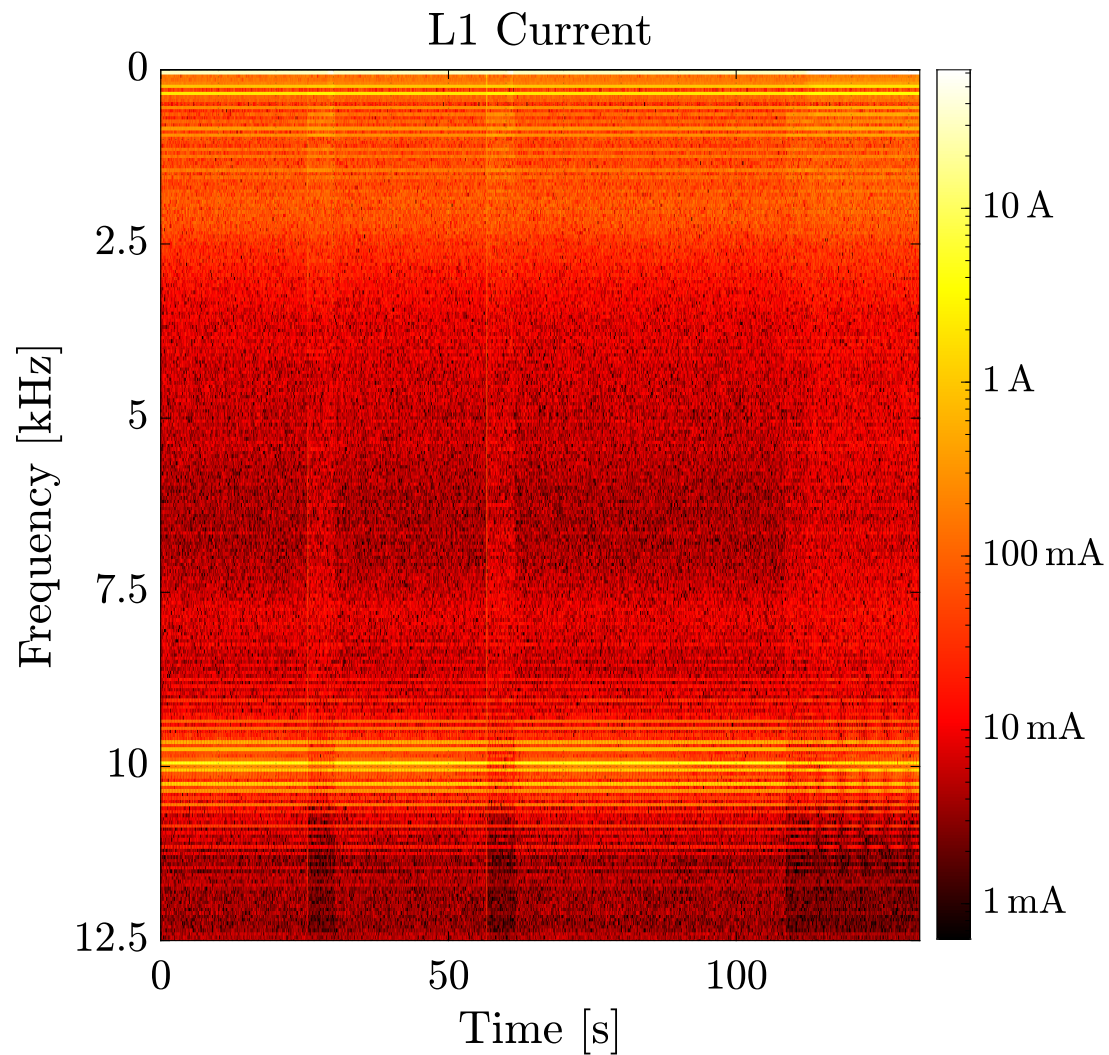
# Results: 2+1 EV Charging

Measured at Charging Station

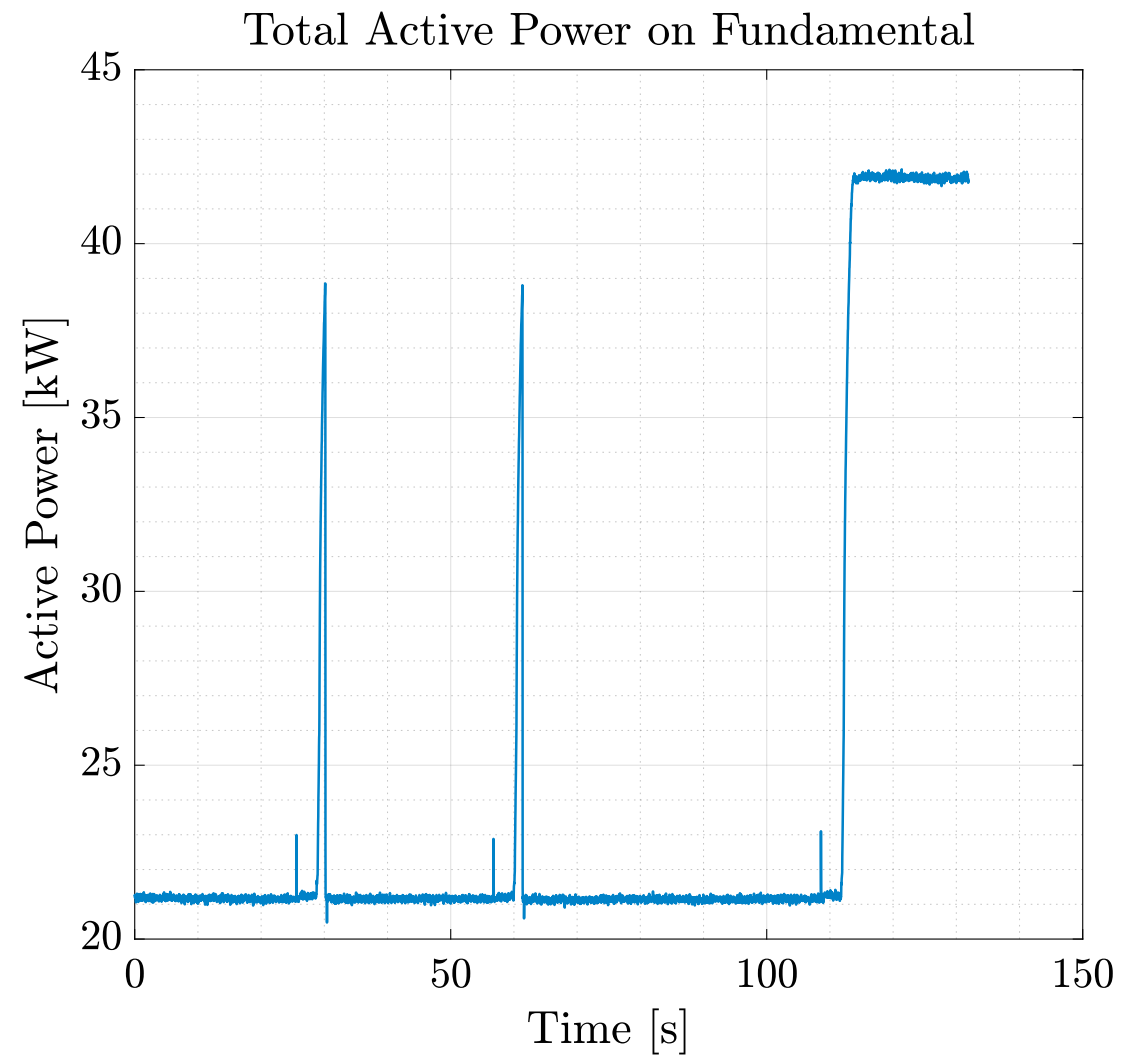
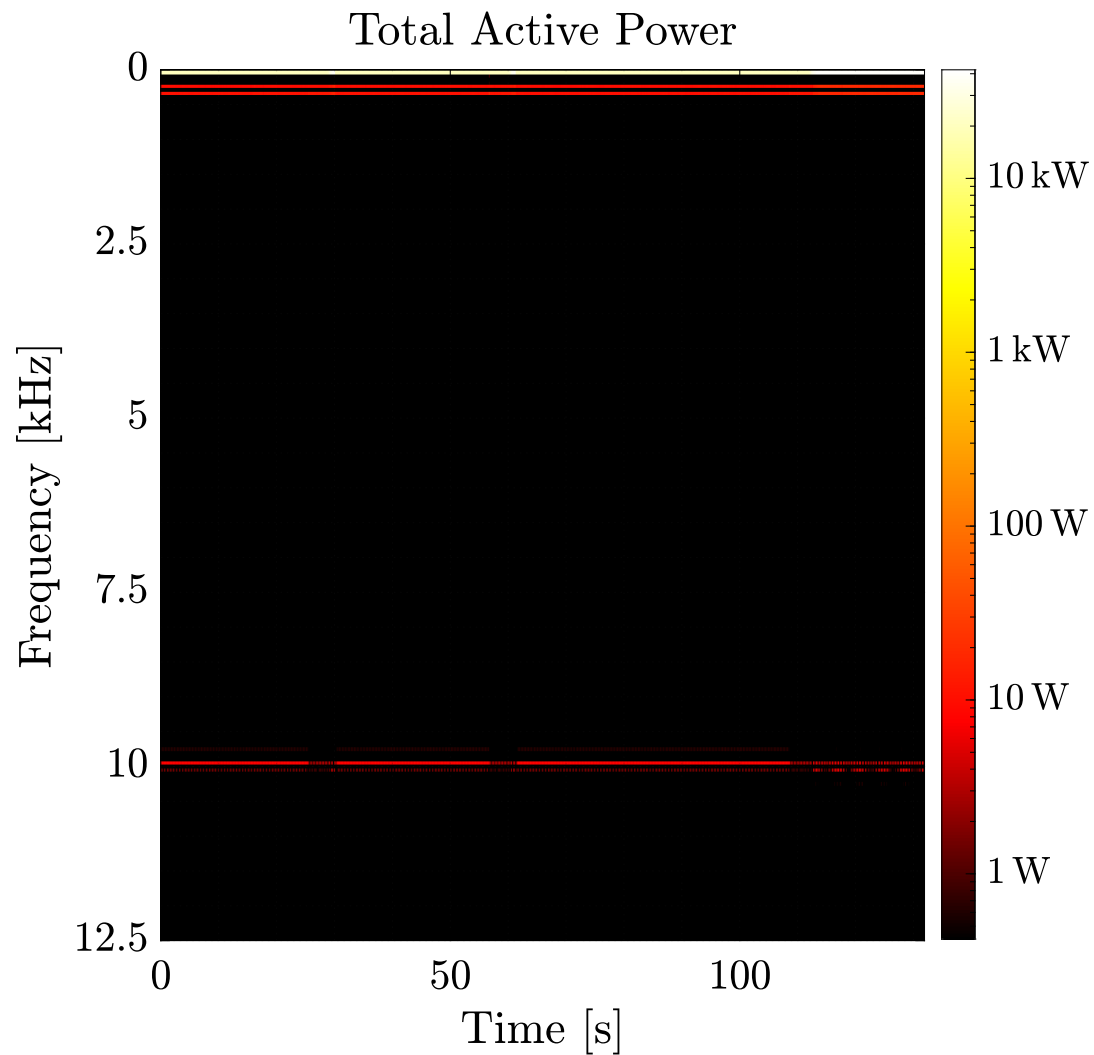
# Results: 2+1 EV Charging, Measured at Charging Station



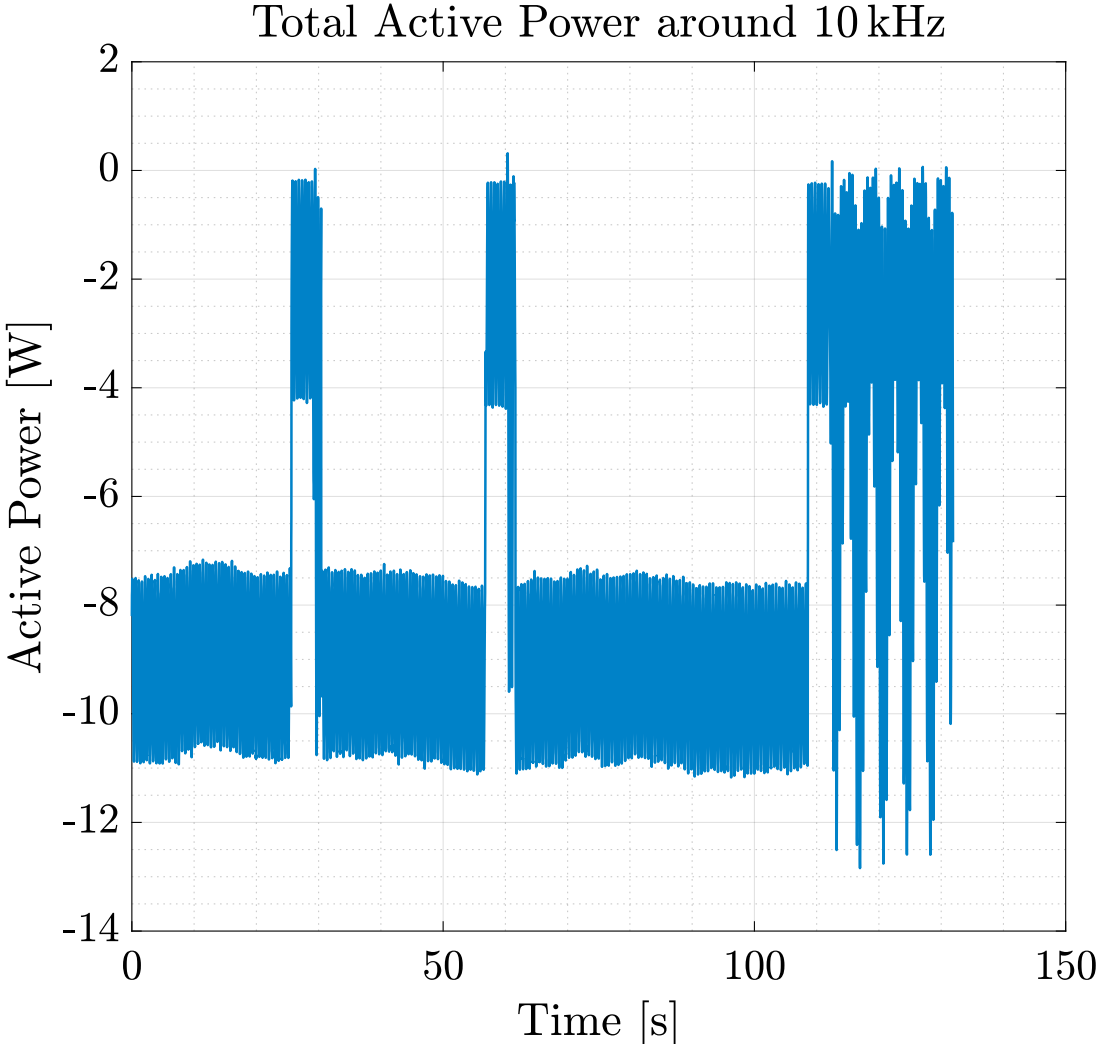
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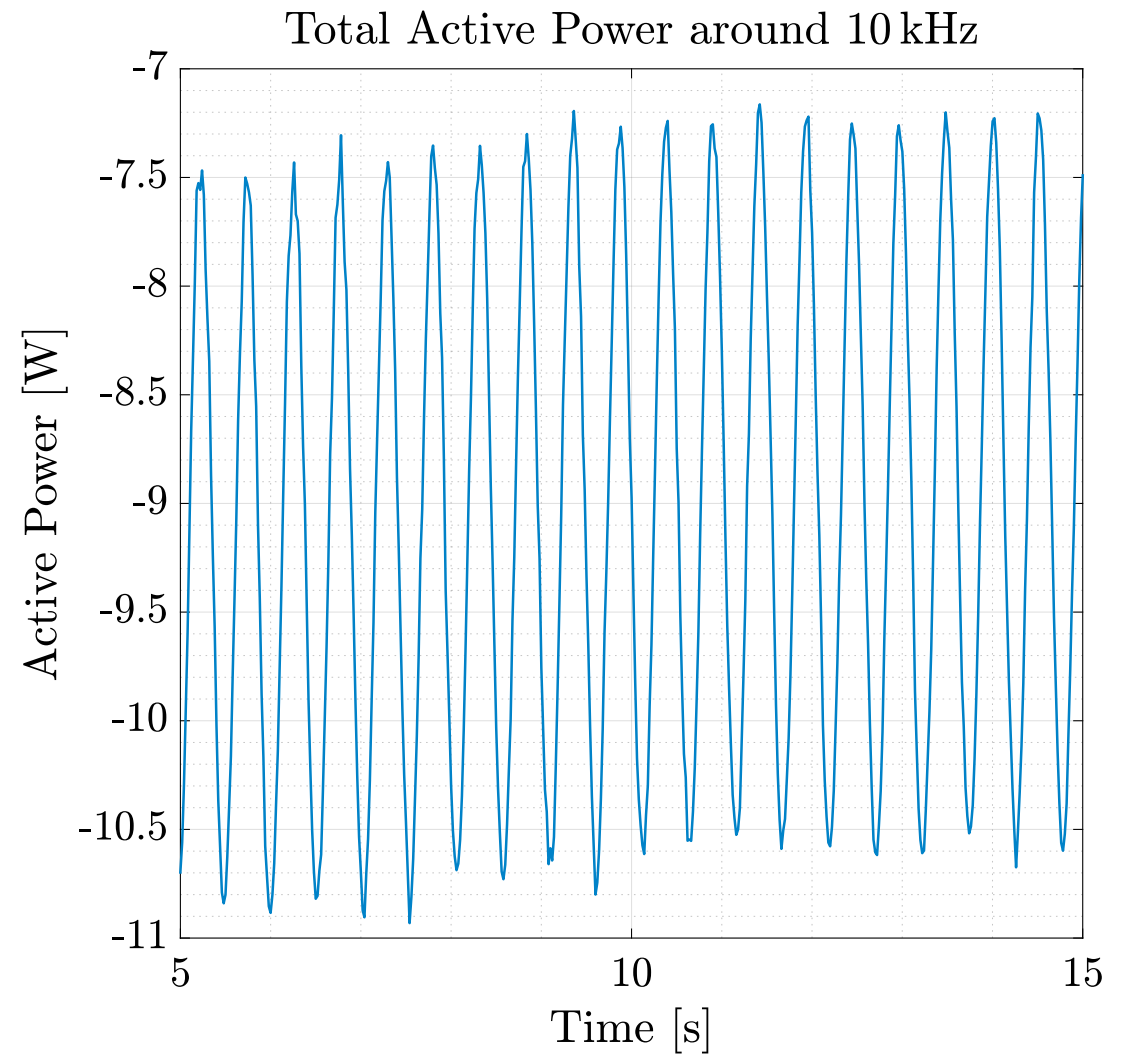
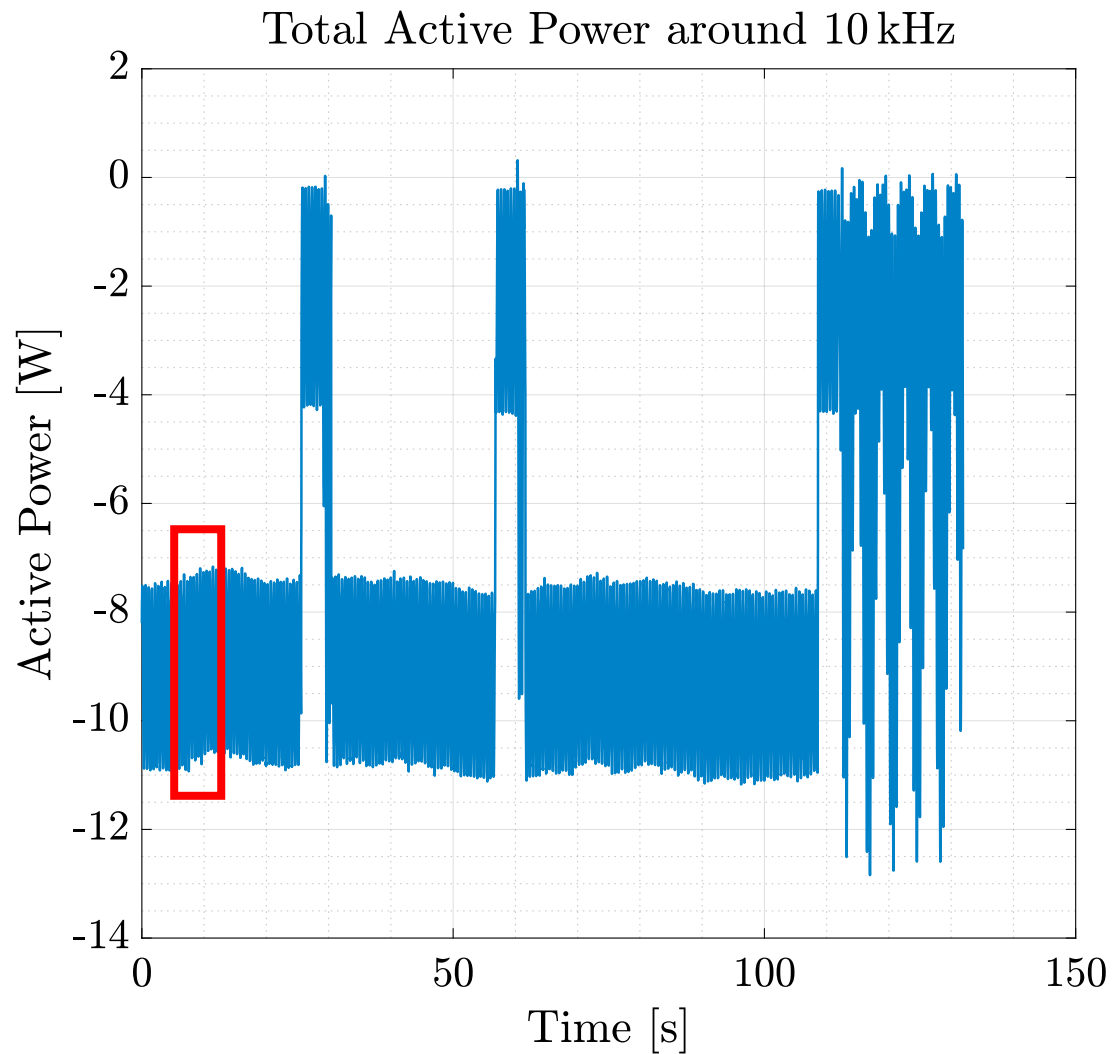
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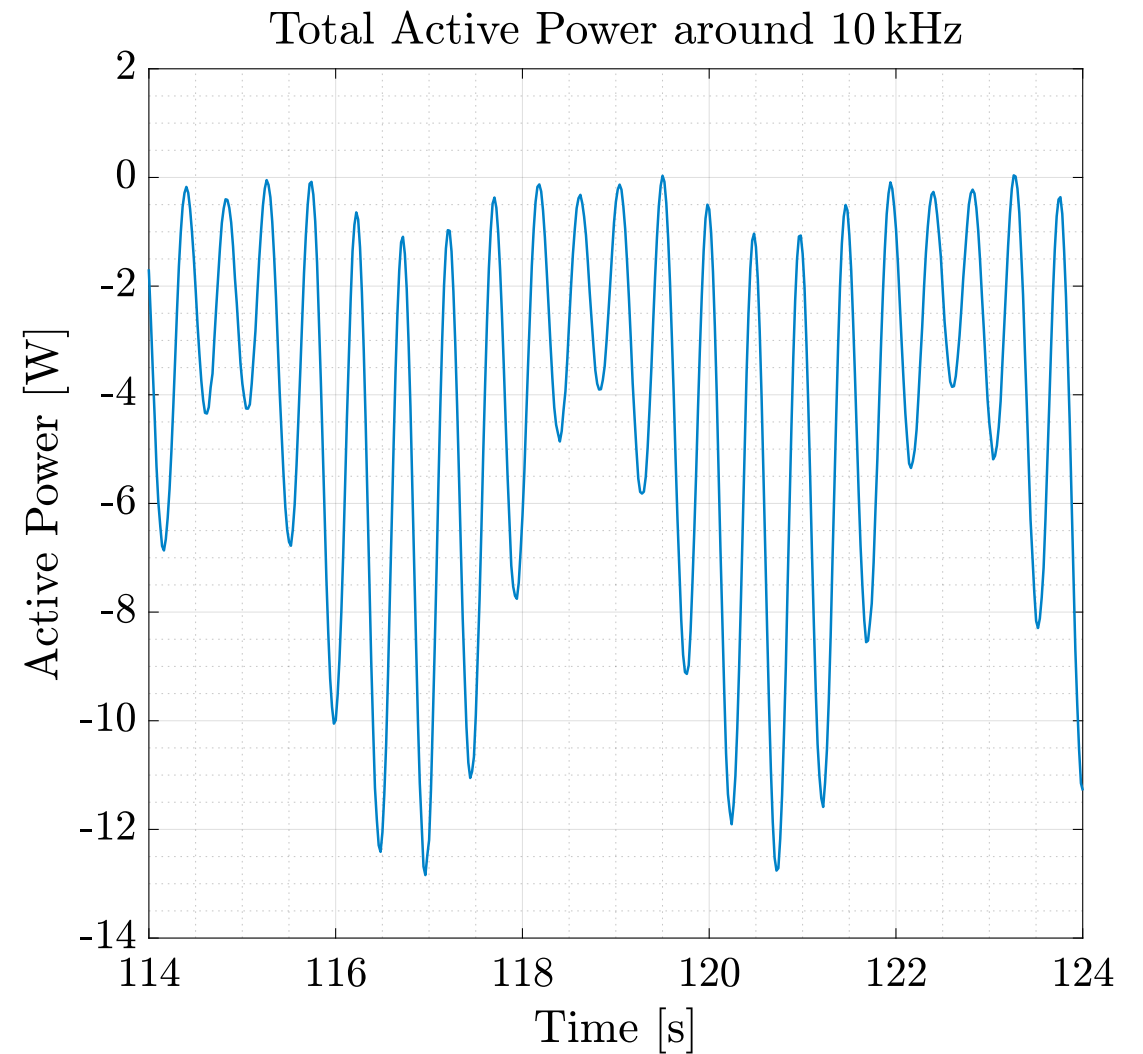
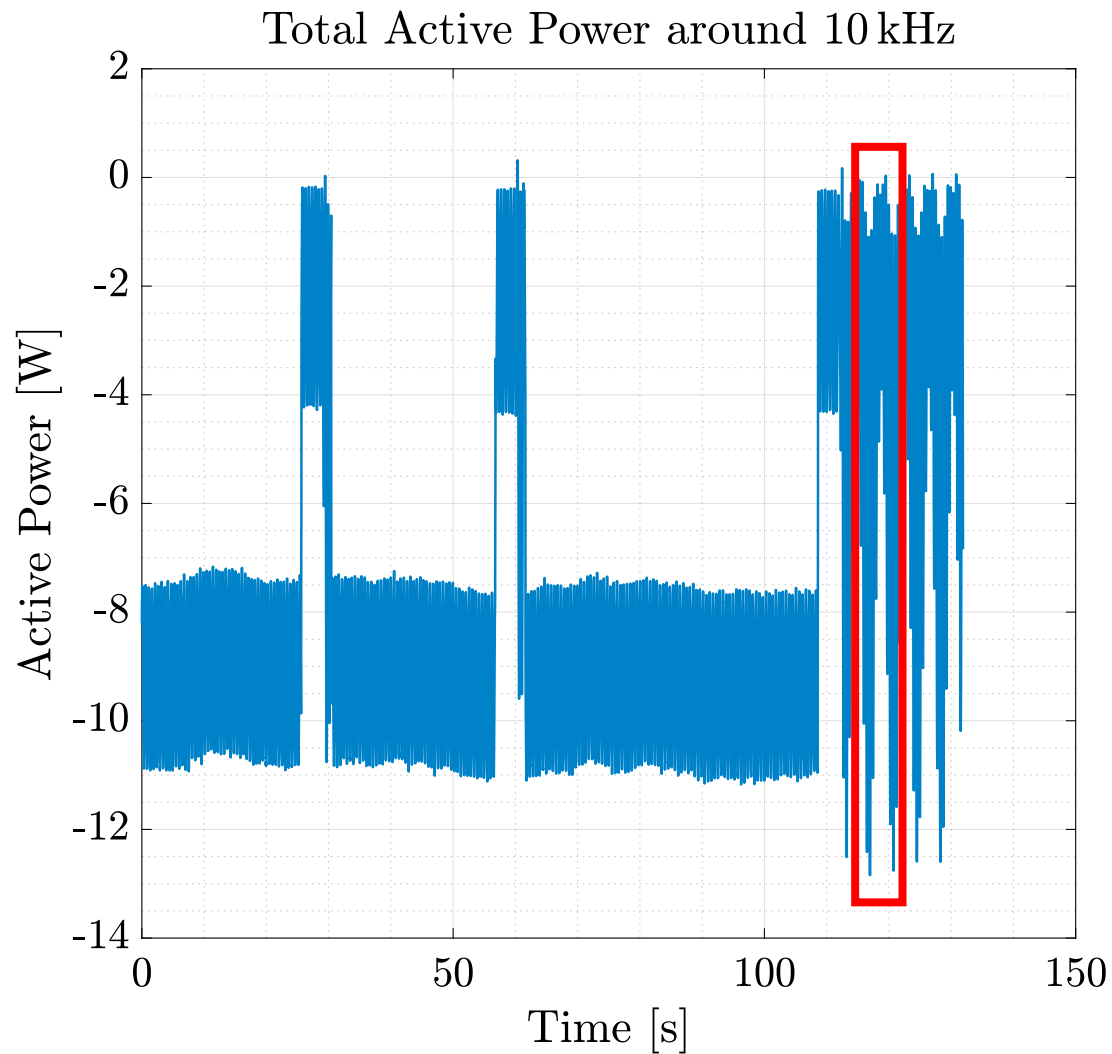
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# Conclusions

- EVs are cause of the disturbances
- PQ disturbances are cause of the noise immissions
- Charging stations themselves are not part of the problem

## References

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Thank you  
for your attention!

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2021

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