Usability of Flexible Demand and Generation in the BDEW Traffic Light Concept

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Motivation

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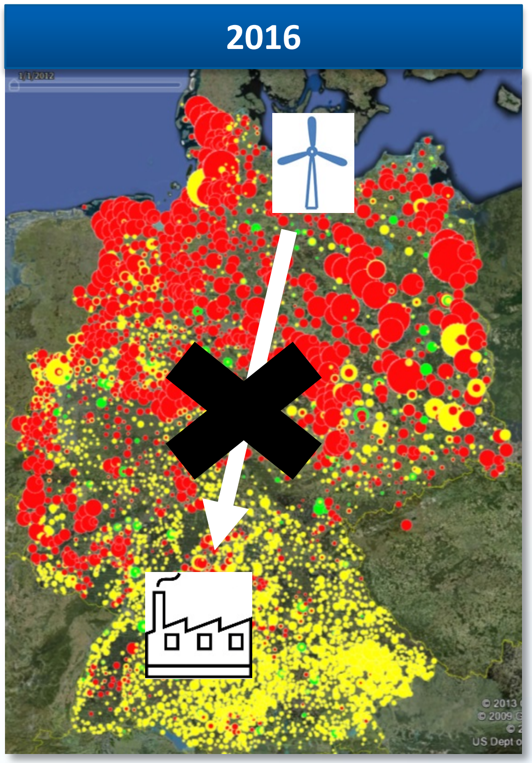
- **How to translate <u>grid congestions</u> into <u>price signals</u>?**



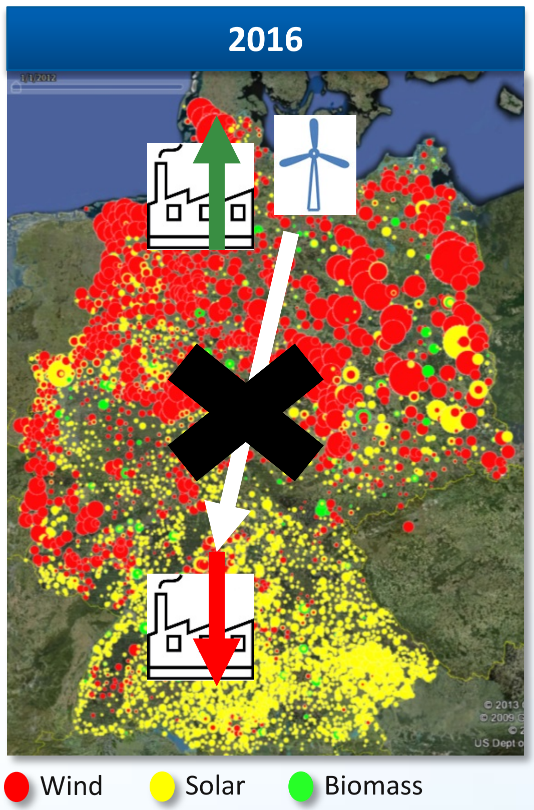
Wind Solar Biomass

⇒ On spot market energy is bought and sold assuming no grid constraints ("copper plate")

⇒ Curtailment of wind power plants is needed due to restricted grid capacity

SOURCE: 50Hertz, Amprion, TenneT, Transnet BW, Google Earth

BDEW Smart Traffic Light Concept



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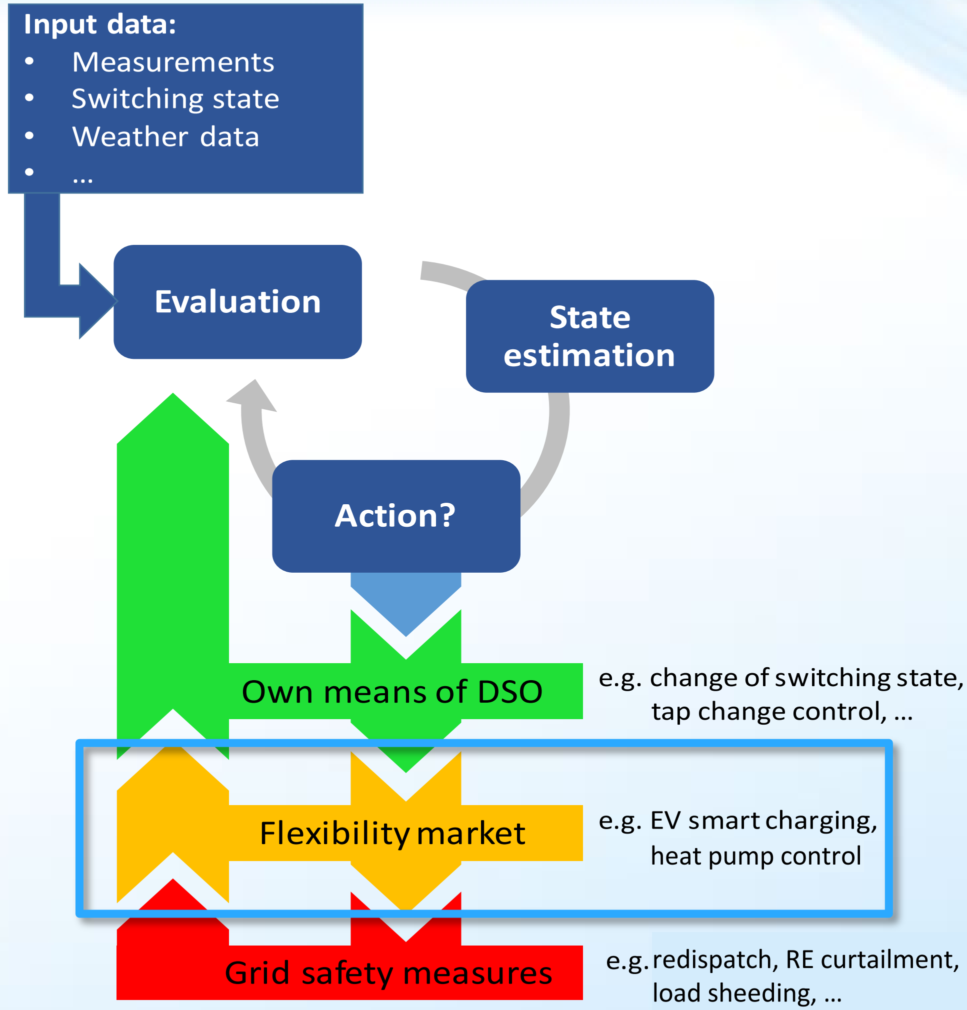
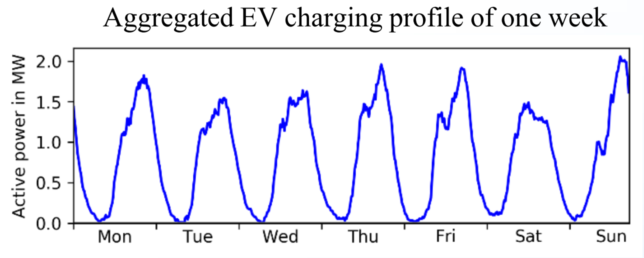


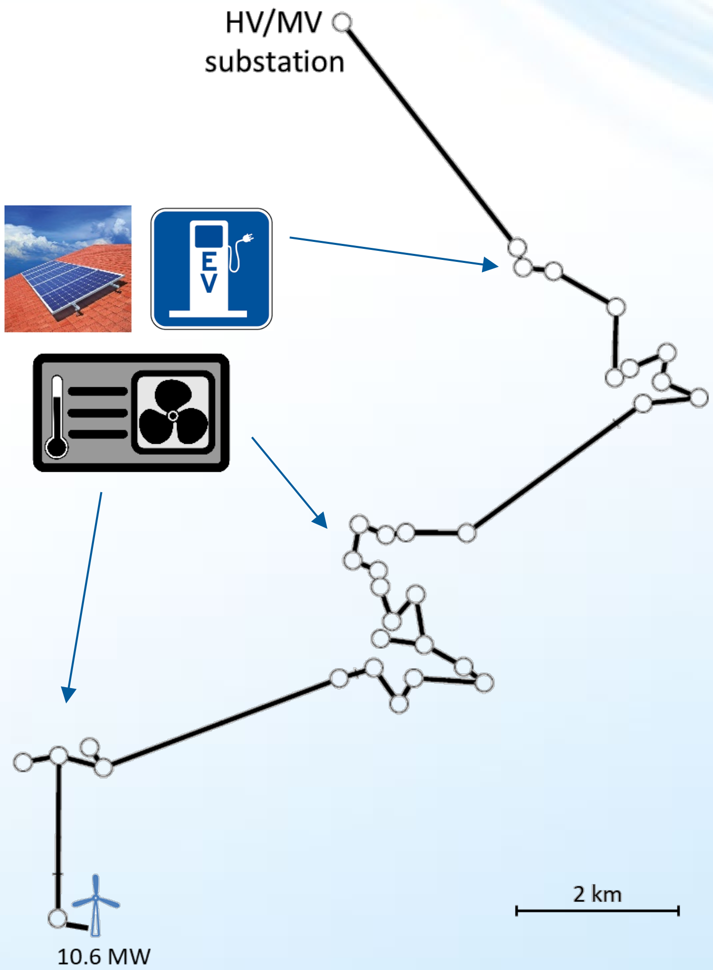
Simulation setup

- **Study case: rural MV feeder with**
  - increased wind power plant capacity
  - increased rooftop PV capacity
  - 75 % electric vehicle share
  - 75 % heat pump share

→ aggregated at the secondary substations



based on: T. Schlößer, E. Tröster, and T. Kurpat, "Probabilistic Modelling of Charging Profiles in Low Voltage Networks," *2nd E-Mobility Power Syst. Integr. Symp.*, 2018.



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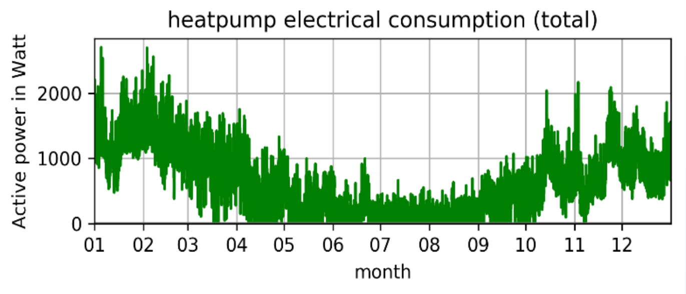

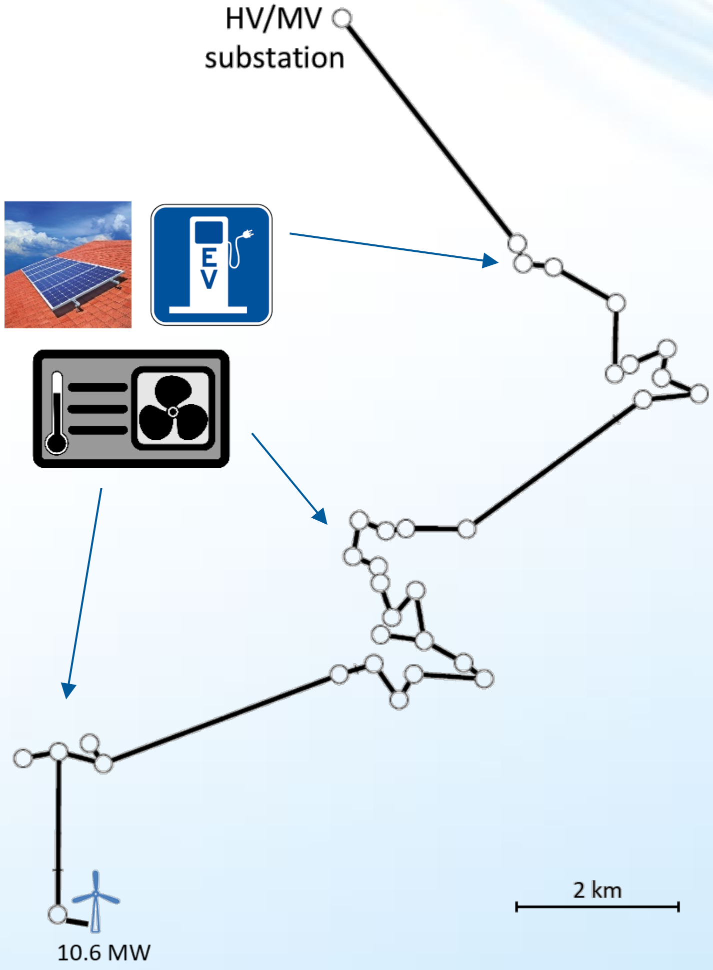

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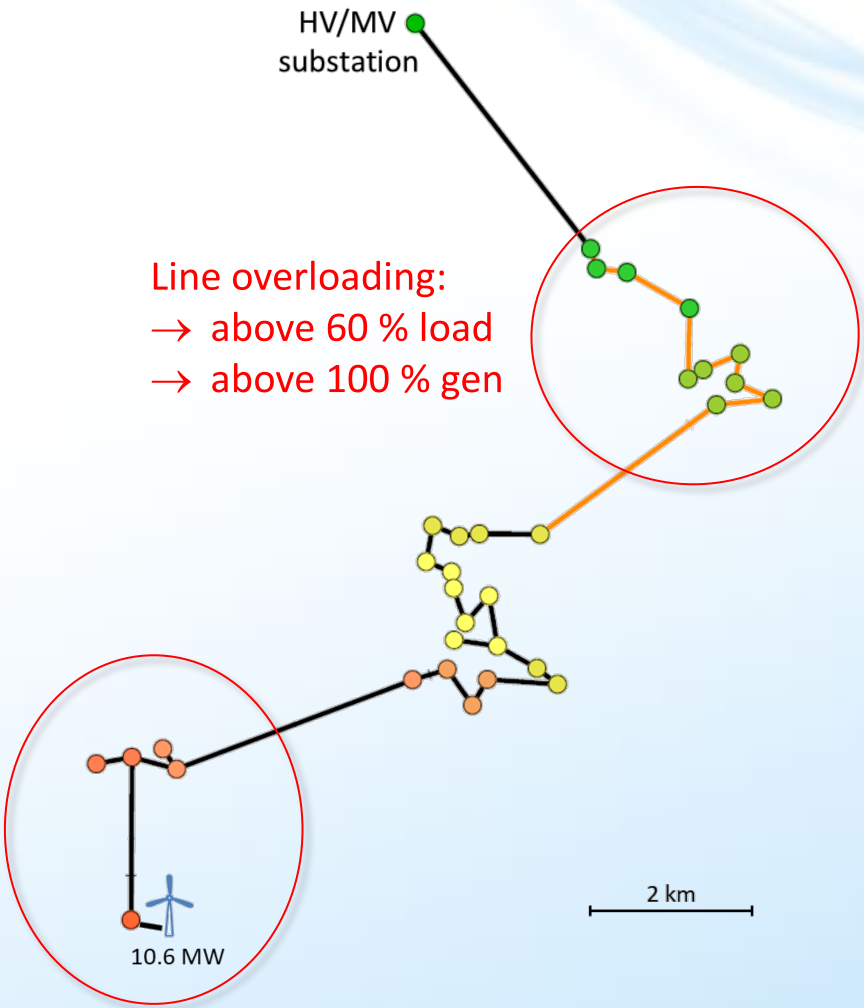
- **One year simulation in PowerFactory**



Voltage problems:
→ outside ± 5 %

Simulation setup

- **Overloading during cold winter evenings**
  - high heat pump consumption AND
  - high EV demand
- **Overvoltage during windy summer days**
  - high wind power and PV production OR
  - high wind power and low load

Flexibility provision

Flexibility by electric vehicles:

- Delay charging during peak demand
- Increase charging during peak generation

Flexibility by heat pumps:

- Vary indoor temperature between 20 and 22 °C by reducing/increasing heat pump consumption

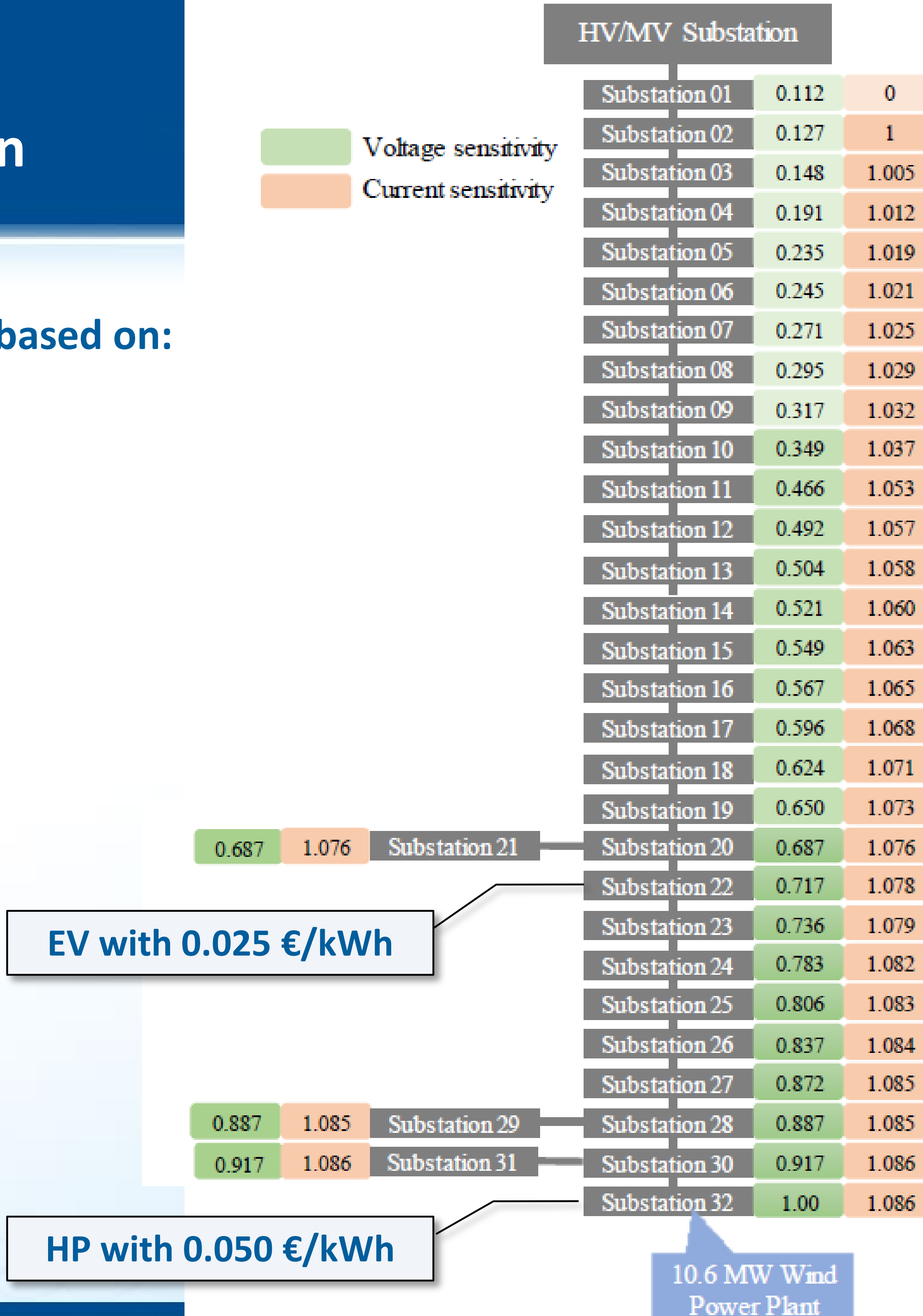
Table 4. Costs for flexibility provision

Flexibility option	Cost for providing flexibility
Heat pumps	0.025 €/kWh
Electric vehicles	0.050 €/kWh
Wind power curtailment	0.090 €/kWh

Flexibility provision

Flexibilities are chosen based on:

- Availability
- Cost
- Sensitivity



Flexibility provision

Idea: For each grid segment exists a flexibility list

Flexibility list		
Grid operator	**Grid segment**	**Time**
EWR Netz GmbH	MV grid ID 1234567	06.07.2018 12:00 – 12:15
Flexibility band	**Voltage violations**	**Current violations**
	Pmin = -4.80 MW Pmax = 5.75 MW	Pmin = -8.04 MW Pmax = 9.04 MW
ID	**Voltage sensitivity**	**Current sensitivity**
HPs @ substation 01	0.112	0
EVs @ substation 01	0.112	0
HPs @ substation 02	0.127	1
EVs @ substation 02	0.127	1
HPs @ substation 03	0.148	1.005
EVs @ substation 03	0.148	1.005
…	…	…
HPs @ substation 30	0.917	1.086
EVs @ substation 30	0.917	1.086
HPs @ substation 31	0.917	1.086
EVs @ substation 31	0.917	1.086
HPs @ substation 32	1	1.086
EVs @ substation 32	1	1.086

= available grid capacity

⇨ **Possibly also sub-flexibility lists are necessary to avoid conflicts between different voltage levels**

Results

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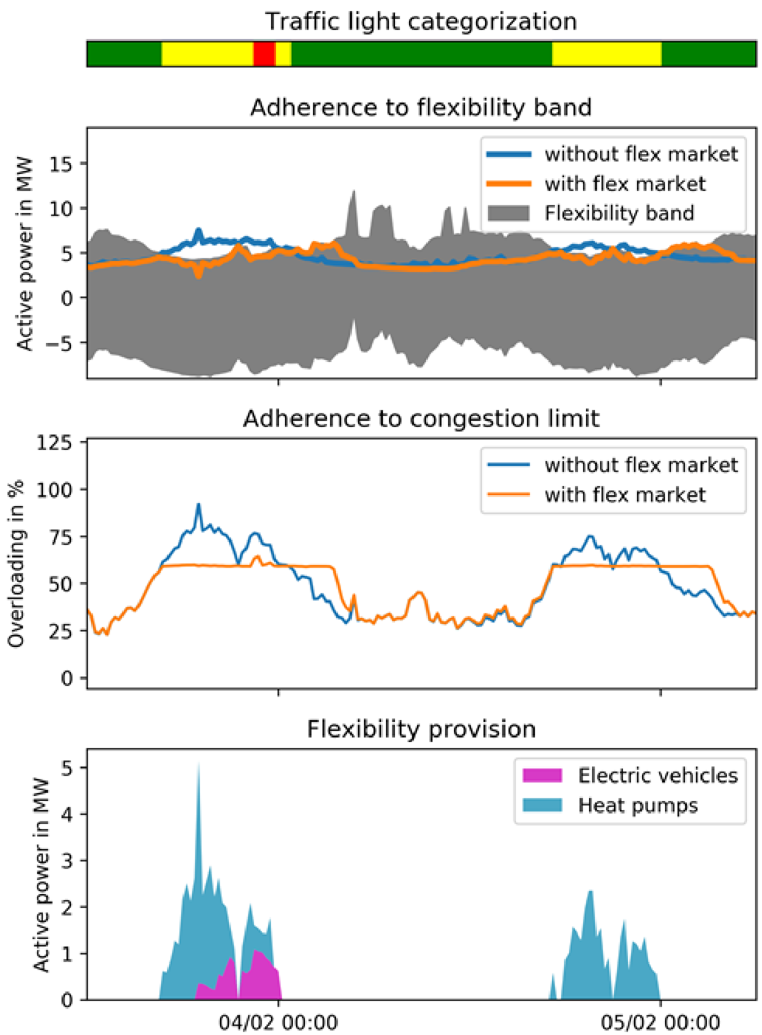
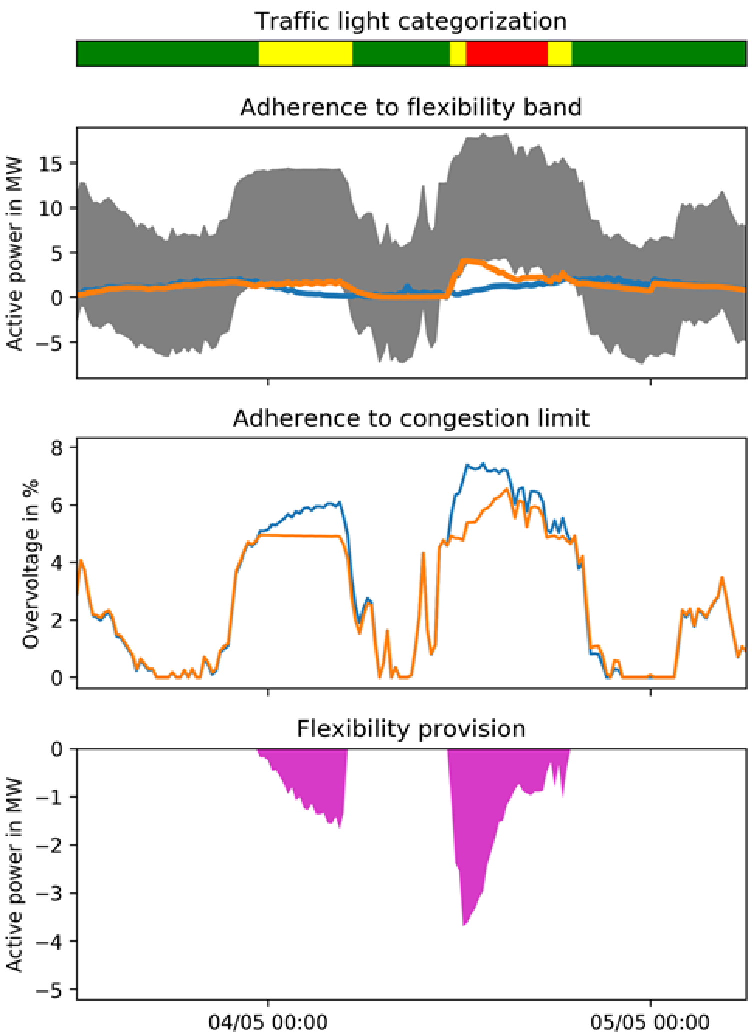
Peak demand (overloading)

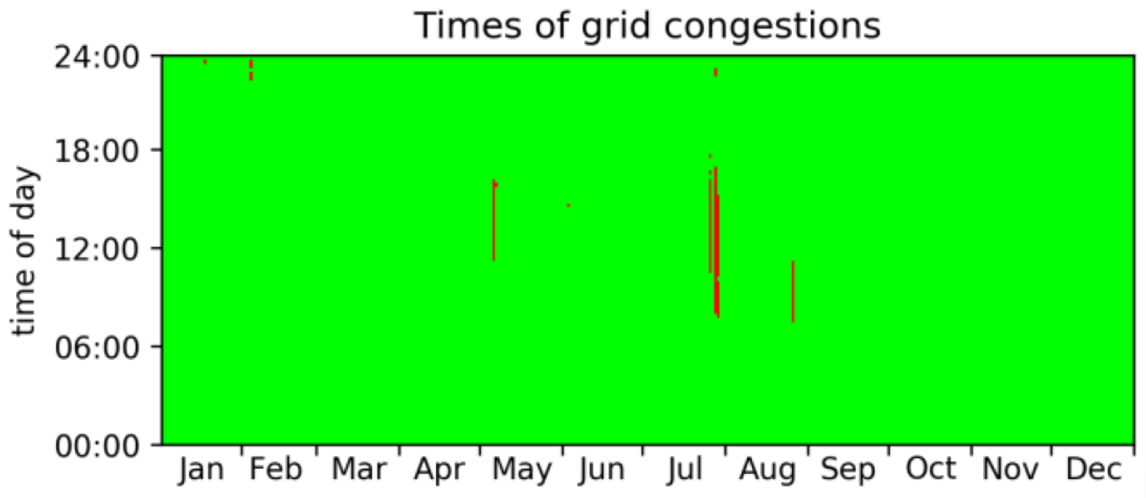


Peak generation (overvoltage)



Results

⇨ **Remaining grid congestions with flexibility market used**



⇨ **Overloading due to peak demand reduced from <u>56 MWh</u> to <u>0.2 MWh</u>**

⇨ **Overvoltage due to peak generation reduced from <u>186 MWh</u> to <u>43 MWh</u>**

Conclusion & discussion

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- With rising RE shares grid congestions are predicted to increase
- Flexibility list/flex market could be an option to organize future flexibility contracting to avoid local grid congestion
- This concept has been simulated on an MV feeder

Advantages:

- Efficient allocation of flexibilities based on market principles and not enforced by the grid operator
- Aggregators could play a major role in enabling this flexibility

Disadvantages:

- In analysed feeder: Flexibility is used only very few times per year

  ⇨ Incentive based on energy not enough (ca. 2€ per year for each flexibility!)
- Potential problems due to limited liquidity

Conclusion & discussion

- **Flexibility list/flex market may only be suitable for large aggregation areas (not single MV feeders as in the analyzed case**

- **Other alternatives are currently discussed in Gemany, e.g.**

  Reduced electricity tariff for flexibility providers
  ⇨ DSO can control flexibilities if necessary (within regulated limits)
  = Quota-based system
  K. Geschermann et al, "PV Integration with Flexible Generation and Consumption Units – Evaluation of a Quota-Based Grid Traffic Light Approach in a Field Test", 8th Solar Integration Workshop, 2018

  ⇨ All flexibilities are curtailed by the same ratio (= avoiding discrimination)

- **Conclusive study from 2017 about different smart market designs in Germany:**

  "Smart-Market-Design in deutschen Verteilnetzen" (English executive summary available)

  https://www.agora-energiewende.de/index.php?id=157&tx_agorathemen_themenliste%5Bprodukt%5D=904

Thank you!

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