



Chair of
Sustainable Electric Networks
and Sources of Energy (SENSE)



Prof. Kai Strunz, TU Berlin

Service-Centric Virtual Power Plants

Smagrinet Webinar



23 September 2020

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Overview

1. Introduction
2. Operation of Virtual Power Plant
3. Conclusions
4. Selected Reference



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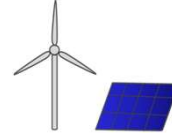


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1. Introduction

- Distributed energy resources (DER) cannot directly bid into market due to their relatively small sizes
- Furthermore, **curtailments** of renewable generation in distribution networks **have risen dramatically**
- **An aggregator** could address these issues through dedicated services
- Aggregator **groups and coordinates various DER units**
- Aggregator **acts on behalf of this pool** of controllable dispersed generators, storage, and loads



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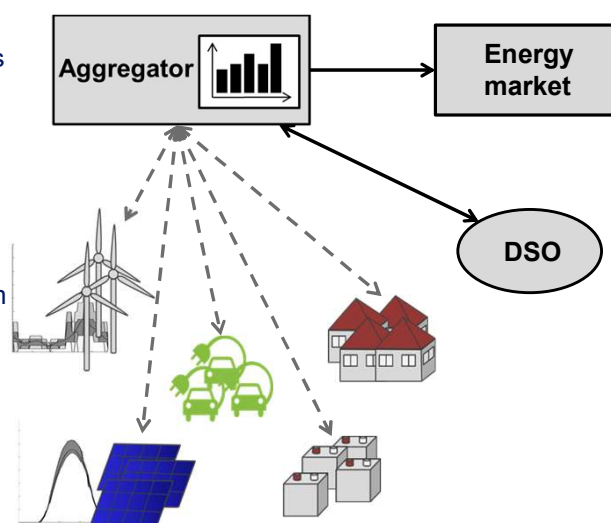
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2. Operation of Virtual Power Plant: **Dual Roles**

Service-centric aggregator offers two roles on behalf of its pool:

- **Role 1:** Energy market participation service to resources
- **Role 2:** Congestion relief service to Distribution System Operator (DSO)



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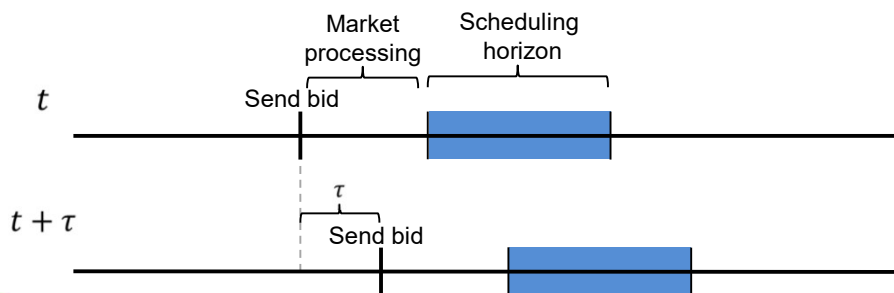
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2. Operation of Virtual Power Plant:

Role 1: Access to Day-ahead and Intraday Energy Markets

- Day-ahead operation: stochastic optimization with the objective to minimize operational cost for the pool
- Intraday operation: deterministic optimization to minimize operational cost and minimize imbalances from updated forecasts
- In intraday operation, rolling horizon approach is followed:



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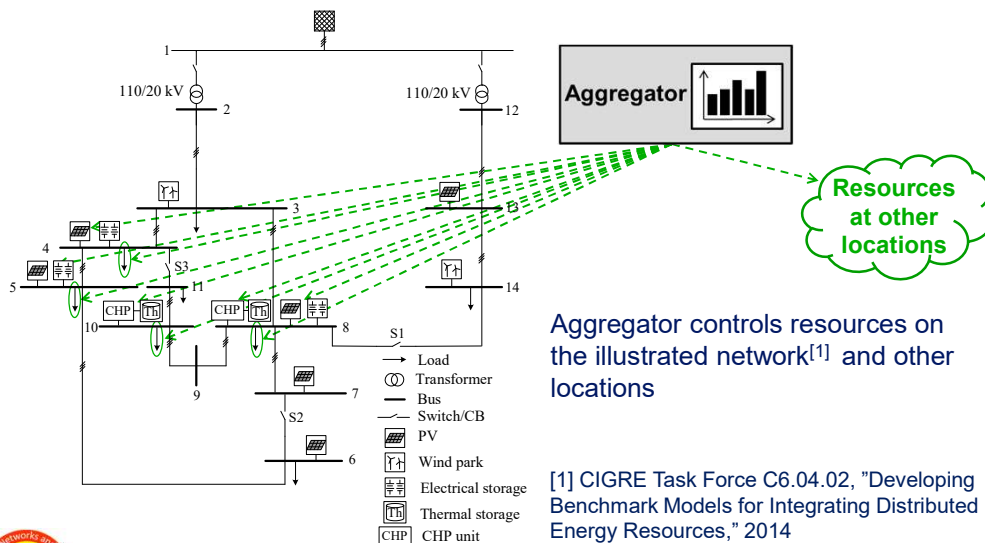


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2. Operation of Virtual Power Plant:

Role 2: Accounting for Network Constraints

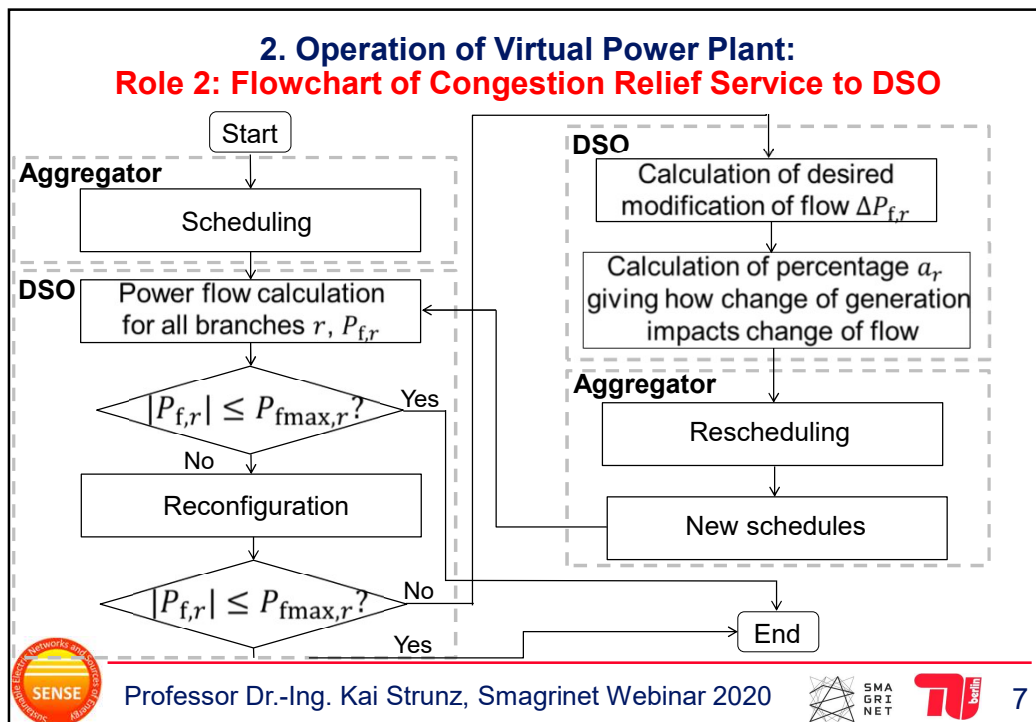


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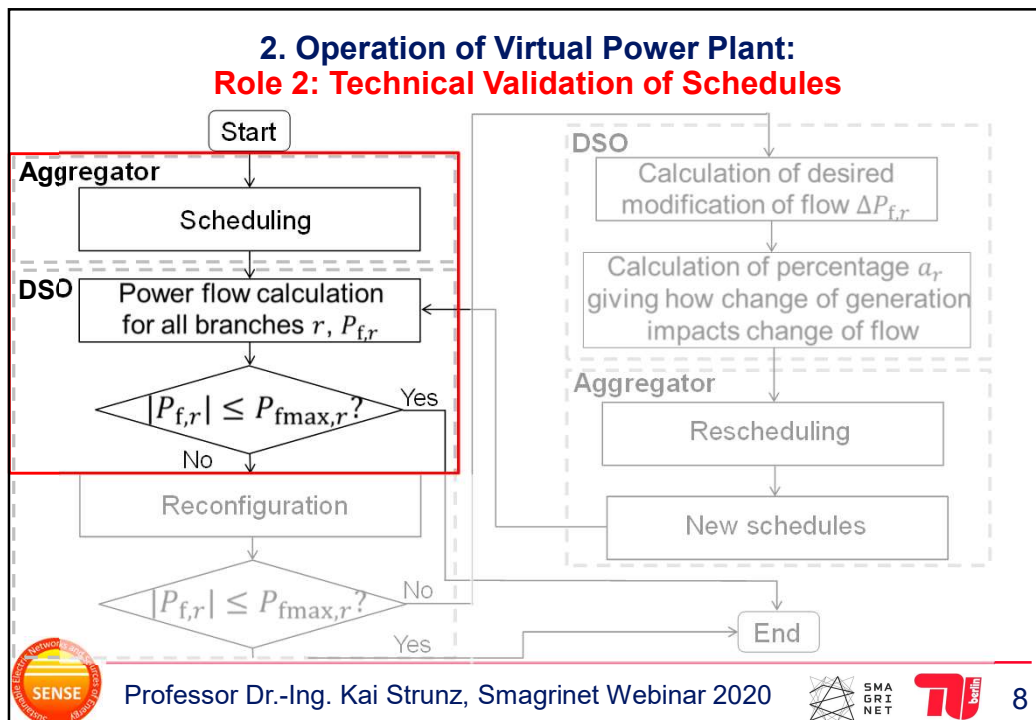


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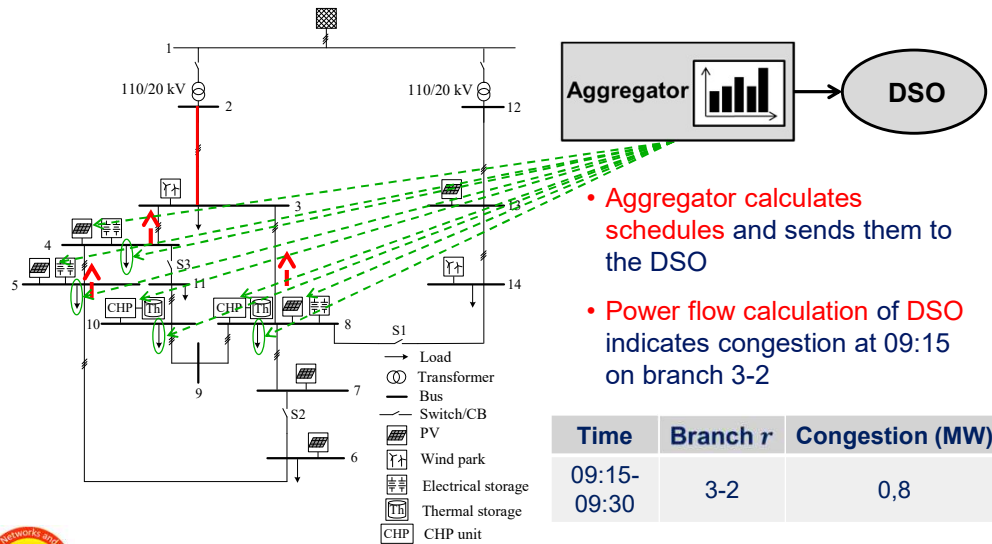


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2. Operation of Virtual Power Plant: Role 2: Technical Validation of Schedules



- Aggregator calculates schedules and sends them to the DSO
- Power flow calculation of DSO indicates congestion at 09:15 on branch 3-2



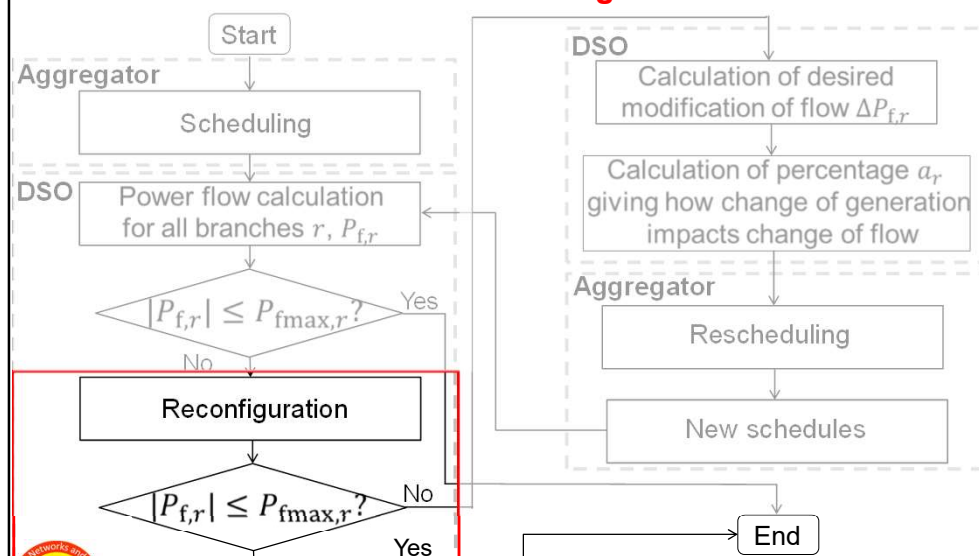
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2. Operation of Virtual Power Plant: Role 2: Network Reconfiguration Action

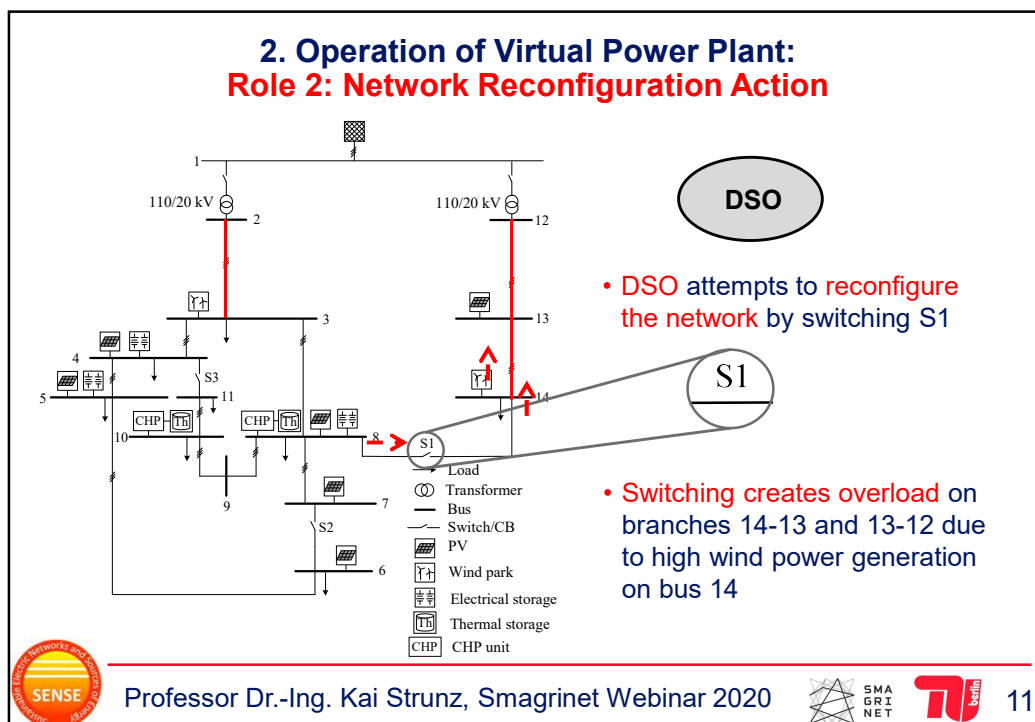


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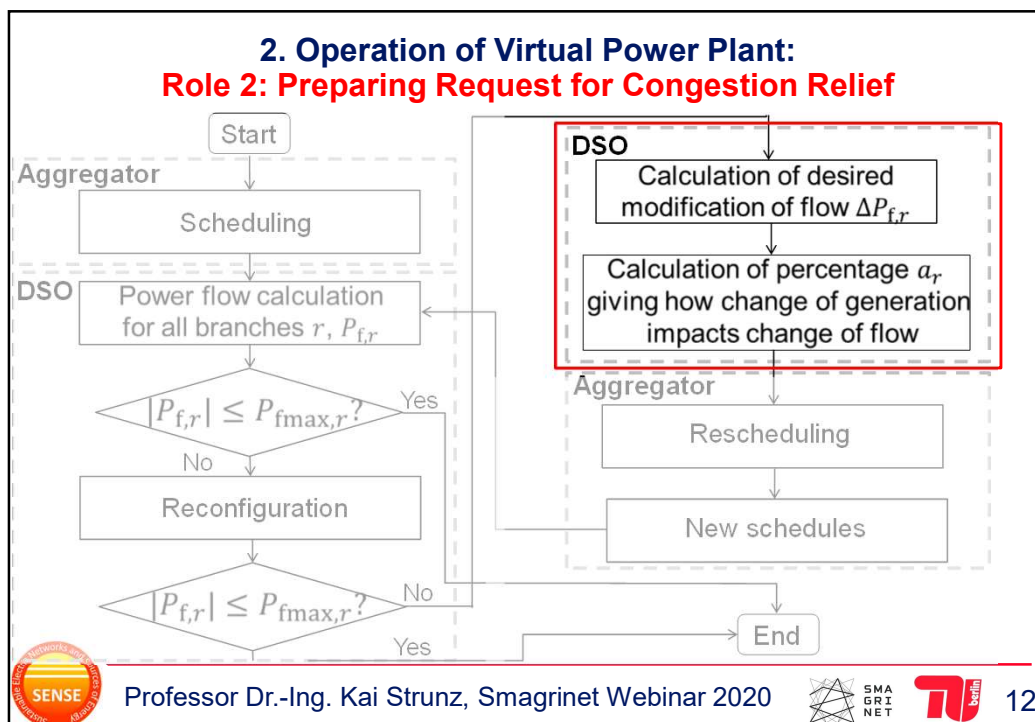


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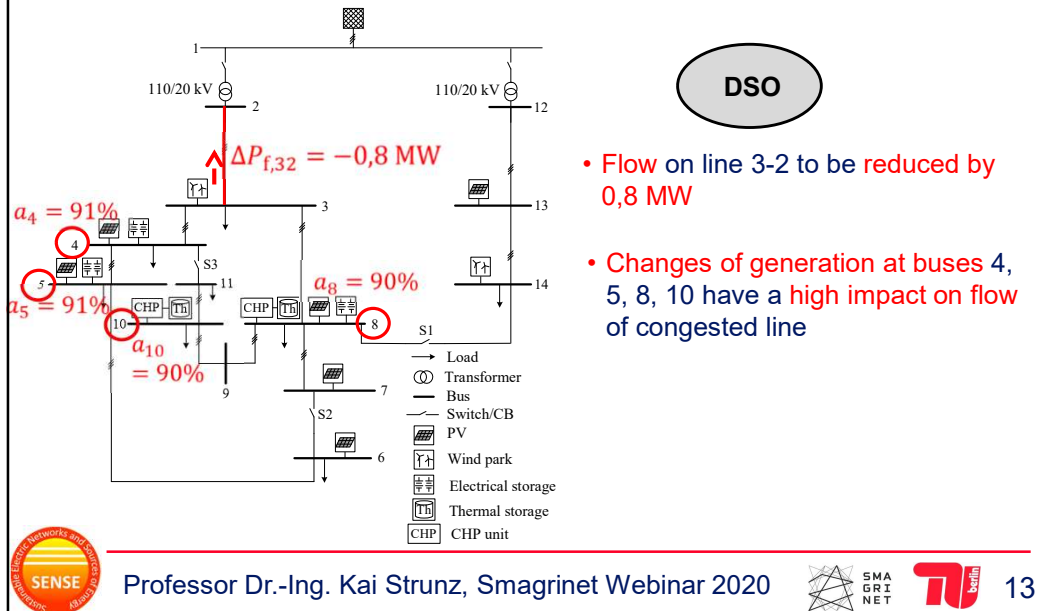


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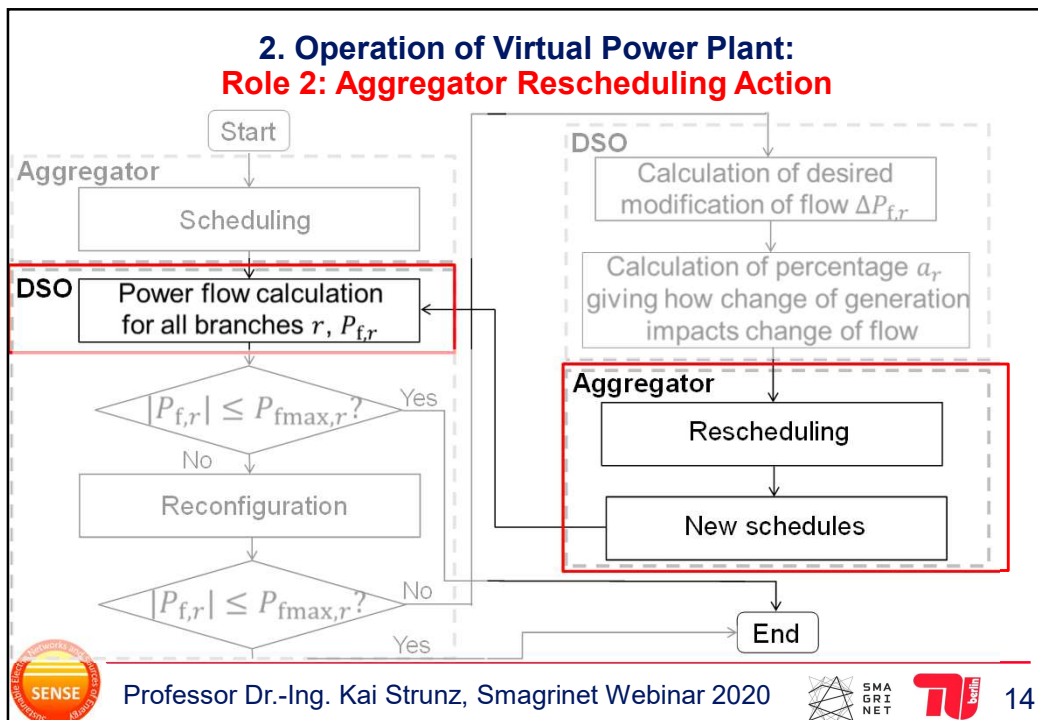
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2. Operation of Virtual Power Plant: Role 2: Preparing Request for Congestion Relief



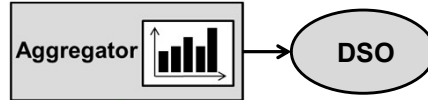
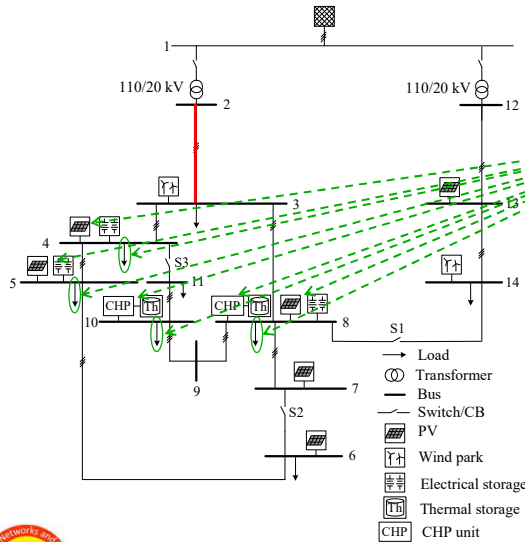
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2. Operation of Virtual Power Plant: Role 2: Aggregator Rescheduling Action



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2. Operation of Virtual Power Plant: Role 2: Aggregator Rescheduling Action



- Aggregator adjusts the schedules of its resources and sends the adjusted schedules to the DSO
- DSO repeats power flow calculation for verification



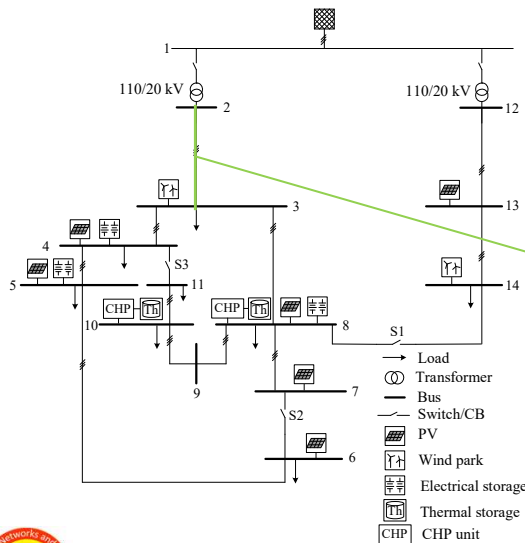
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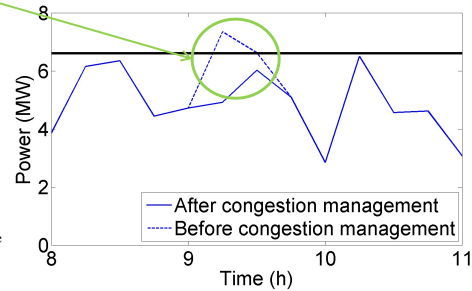
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2. Operation of Virtual Power Plant: Role 2: Successful Congestion Relief



Congestion relieved without
curtailment of renewables



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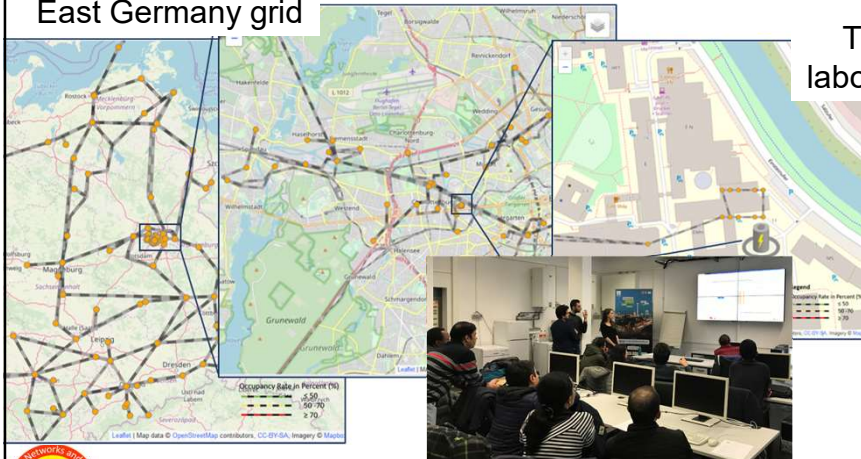
2. Operation of Virtual Power Plant: Laboratory Validation at TU Berlin



East Germany grid

Berlin grid

TU Berlin
laboratory grid



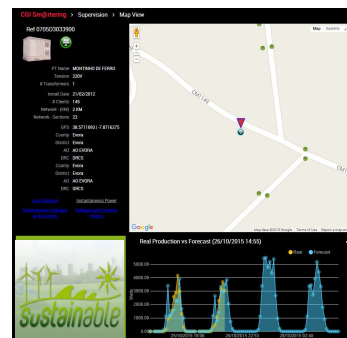
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2. Operation of Virtual Power Plant: Field Validation in Evora, Portugal, Through EU Project SuSTAINABLE



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3. Conclusions

The concept of a **service-centric virtual power plant** that cooperates with the distribution system operator shows to:

- Support the **market integration** of distributed energy resources
- **Increase the share of renewable power generation**
- Contribute to secure system operation through the **provision of a coordinated congestion management service**



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4. Selected Reference of Talk

Koraki, Strunz: Wind and Solar Power Integration in Electricity Markets and Distribution Networks Through Service-centric Virtual Power Plants.
IEEE Transactions on Power Systems, 2018.

Thank you



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