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## Potential of vehicle to grid charging control of electric vehicles in congestion management

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# Agenda



1

Motivation

2

Methodology

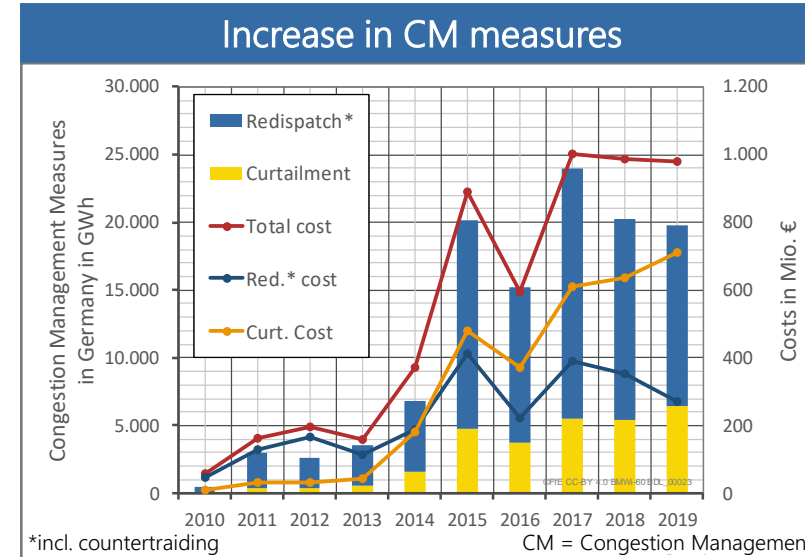
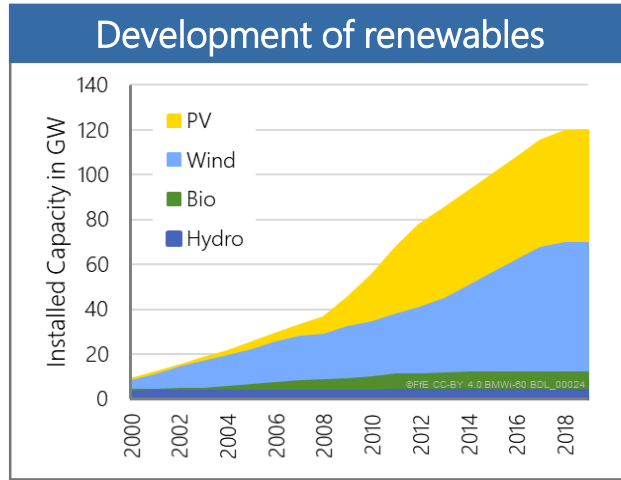
3

Results

4

Outlook

# German Challenge: Network Congestion



Delayed grid expansion

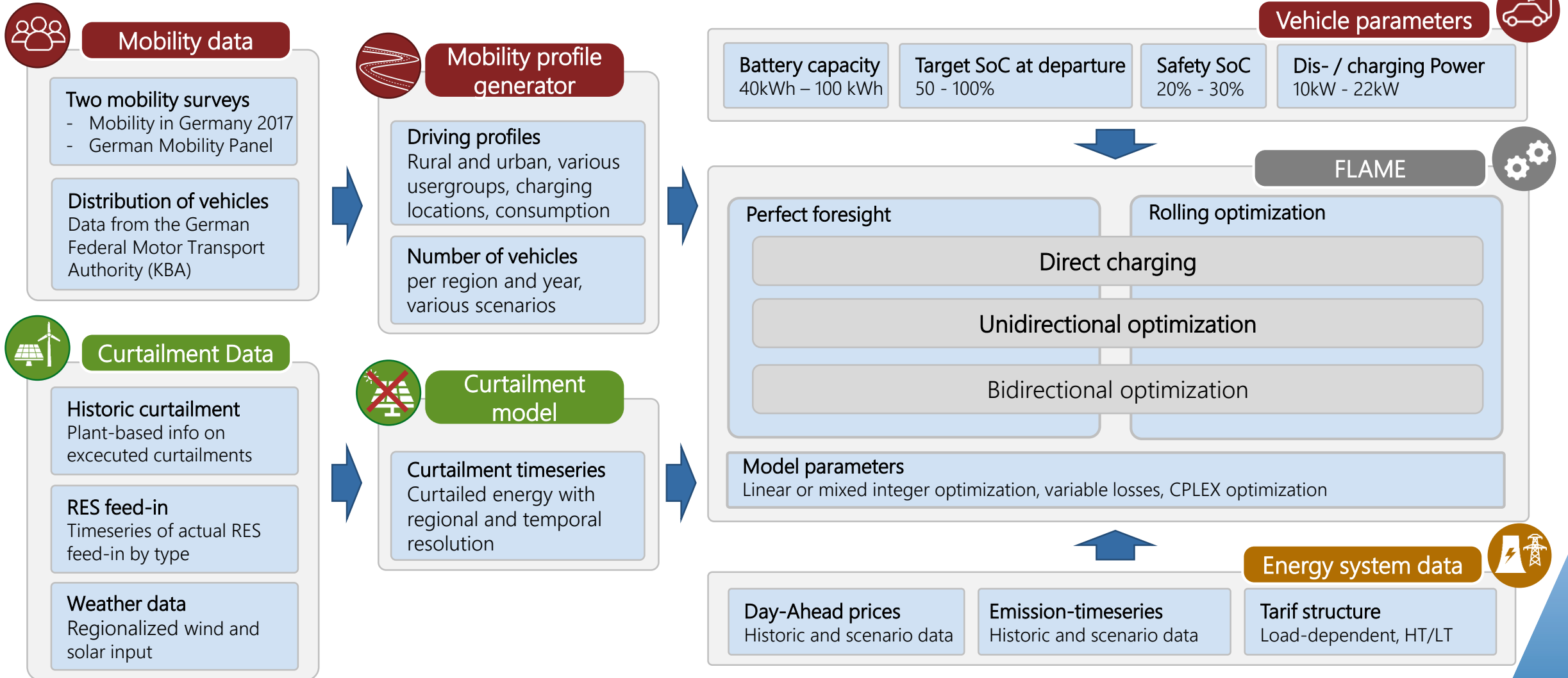
### Curtailment 2019 – distribution & causes

	Affected plants in transmission grid	Affected plants in distribution grid
Curtailed energy in GWh	1,249.63	5,232.77
Percentual distribution	19.3%	80.7%
	Transmission grid	Distribution grid
Causing the measure in GWh	5,349.68	1,132.72
Percentual distribution	82.5%	17.5%

Data: German federal network agency

What contribution could electric vehicles possibly provide?

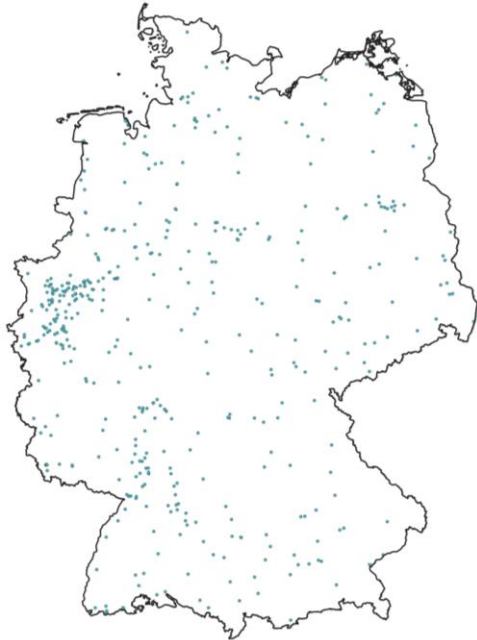
# Modelling of vehicle fleet and charging optimization



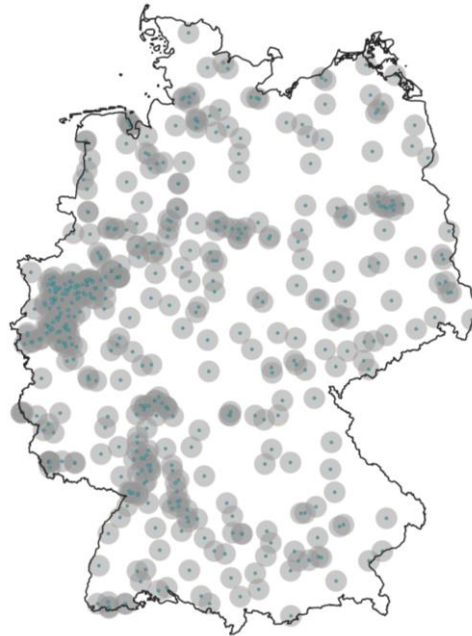
# From Grid Nodes to Voronoi-Regions



450 extra-high voltage  
grid nodes



Buffers

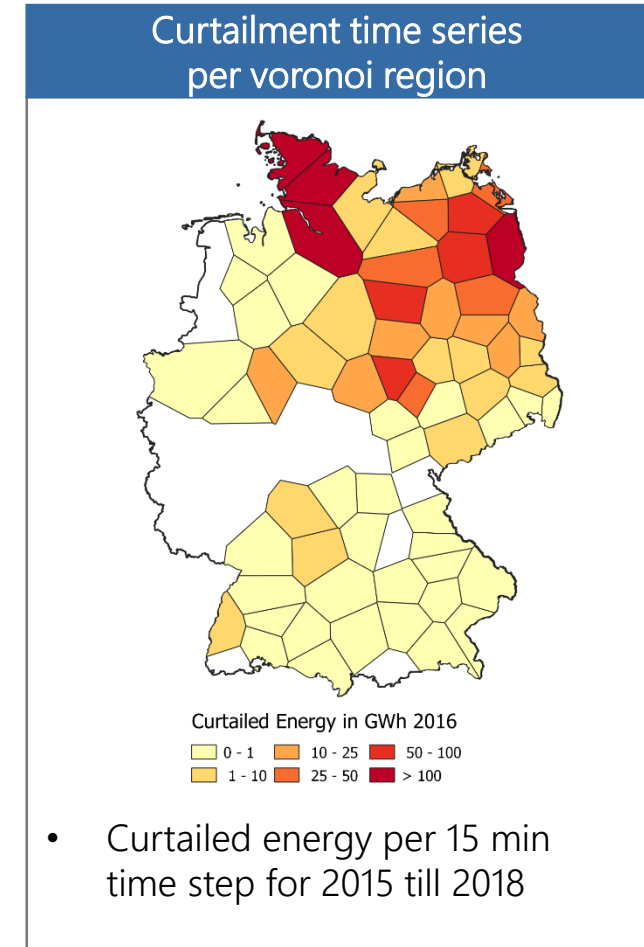
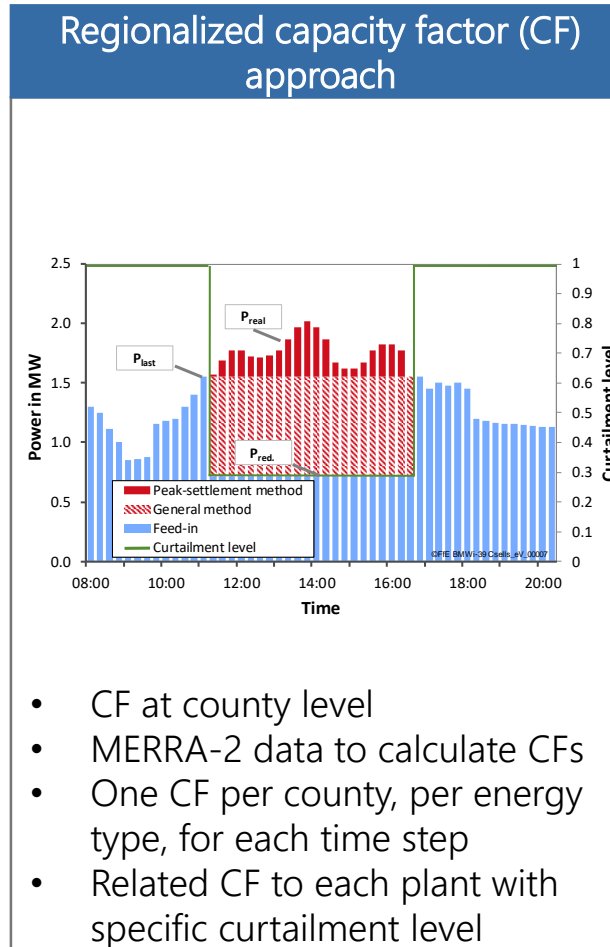
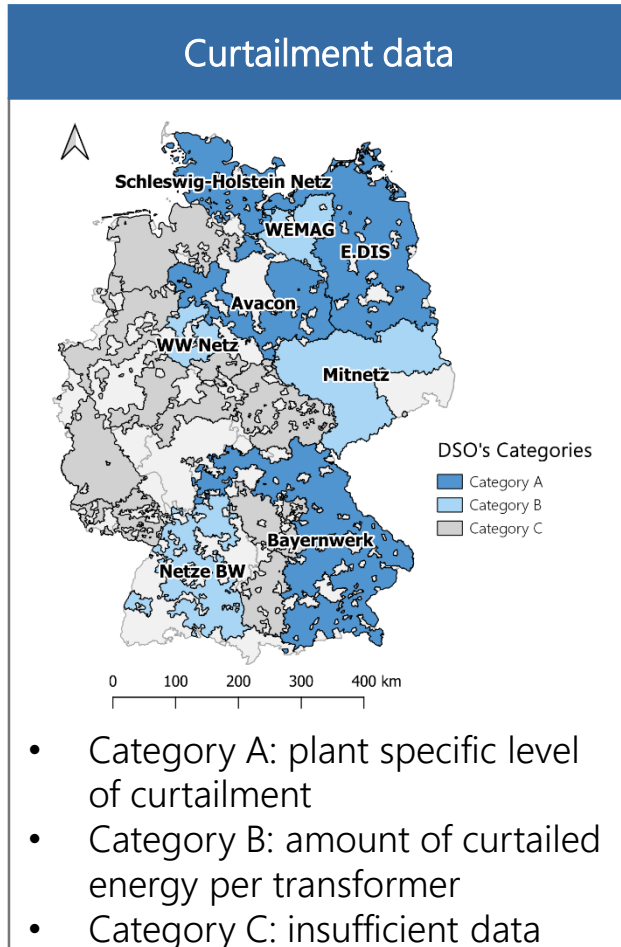


85 Voronoi-regions

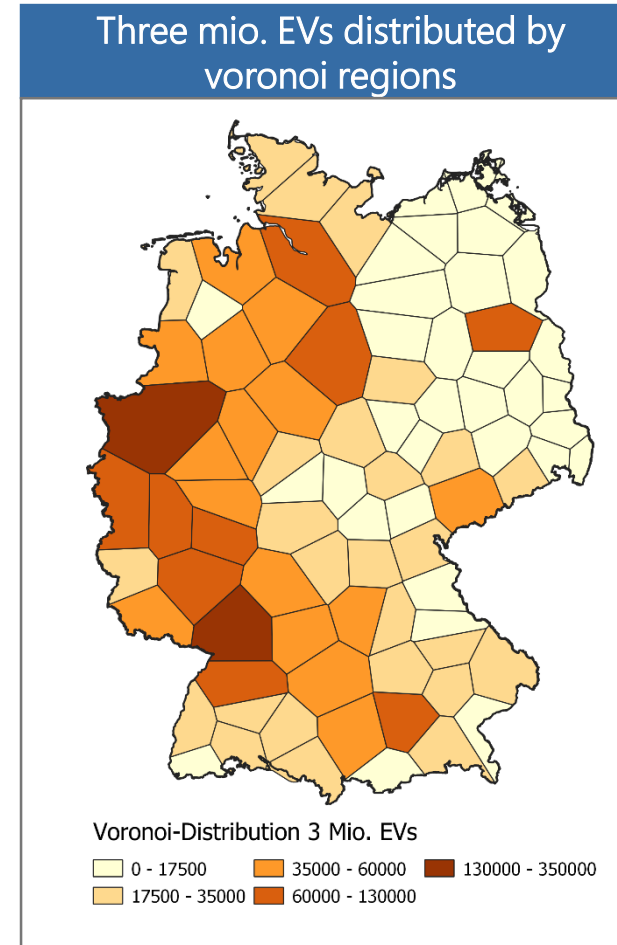
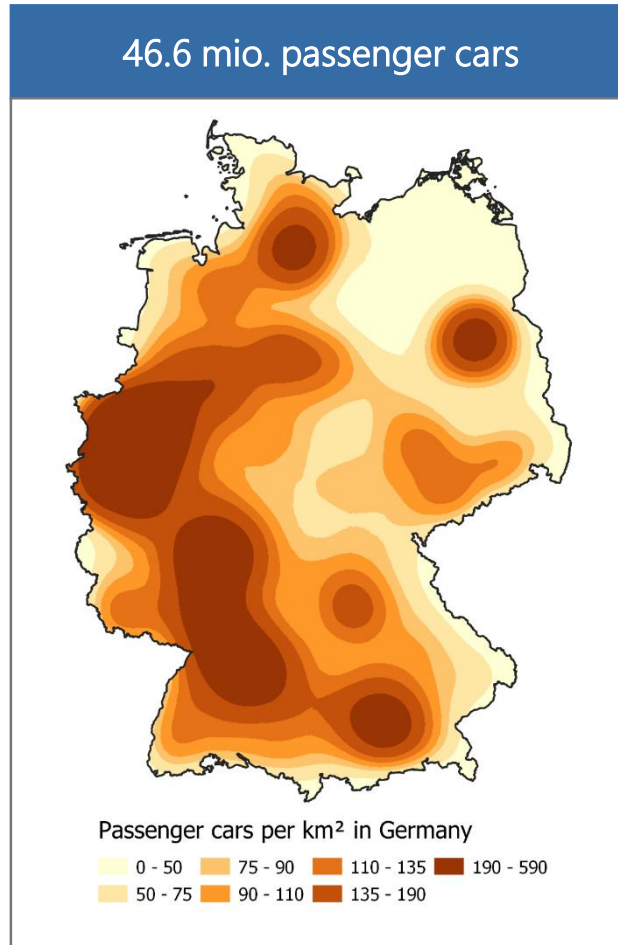


Assumption: Curtailed energy can be used in the immediate vicinity of the extra high voltage grid notes

# Curtailment – Regional and Temporal Resolution

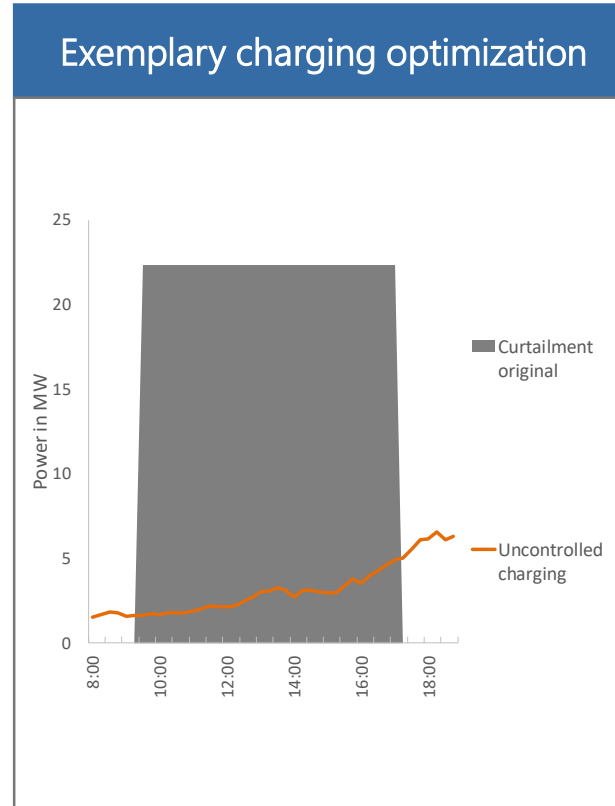
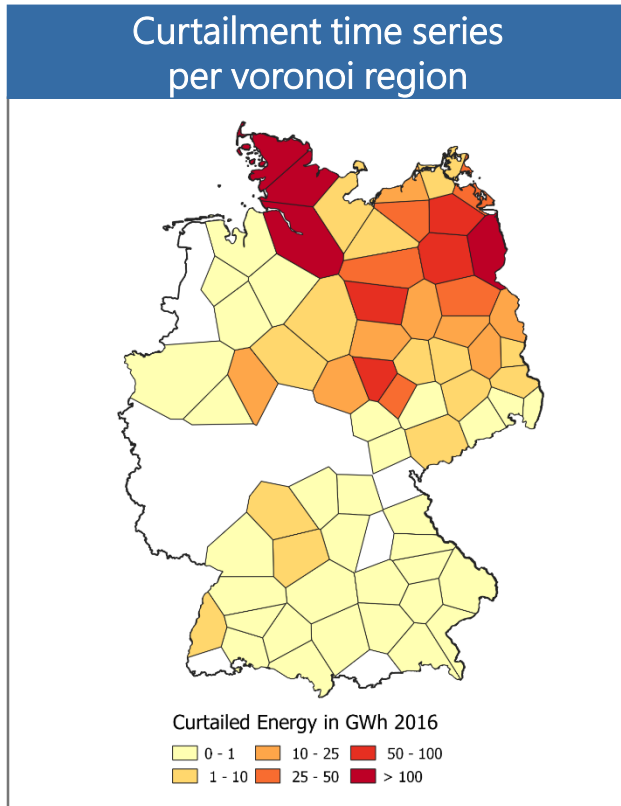


# Scenario: Three Million EVs



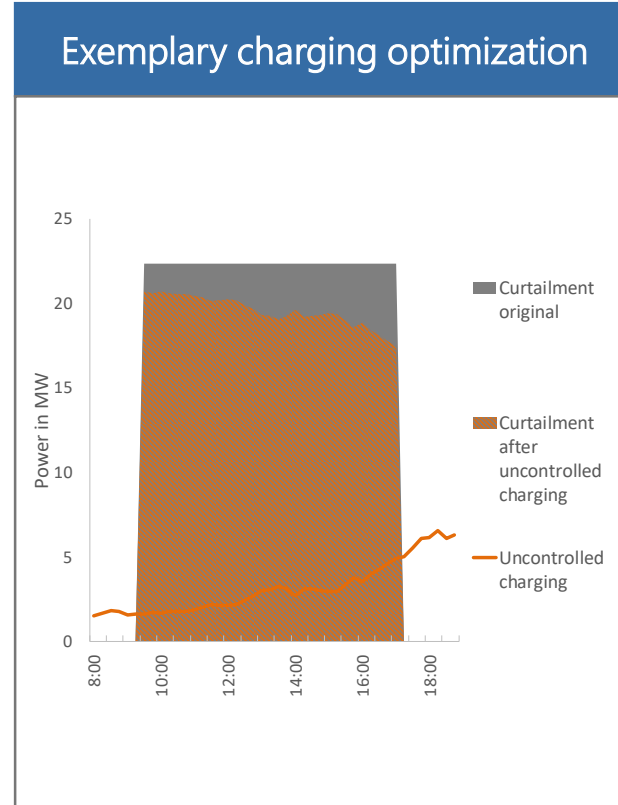
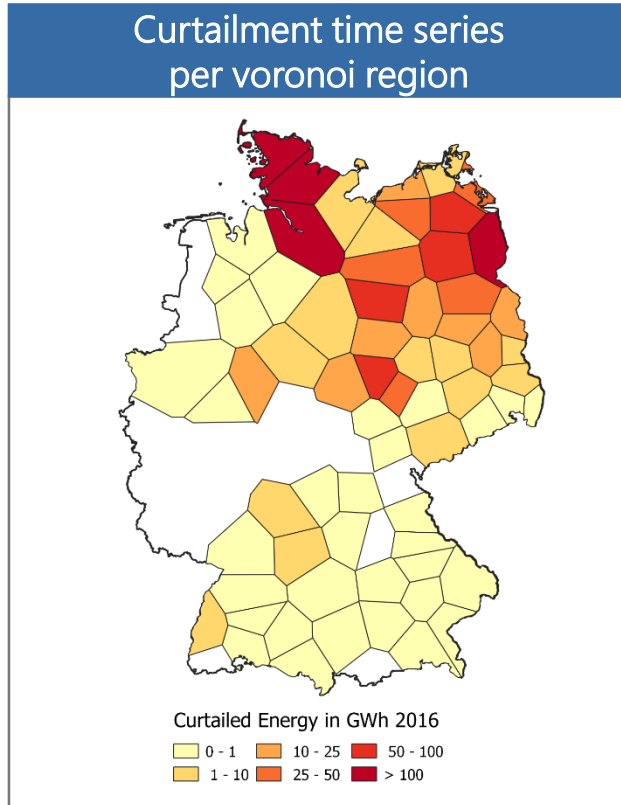
Assumption: With a total of three million EVs, the distribution corresponds to the current distribution of conventional cars

# Charging Optimization to Reduce Curtailment

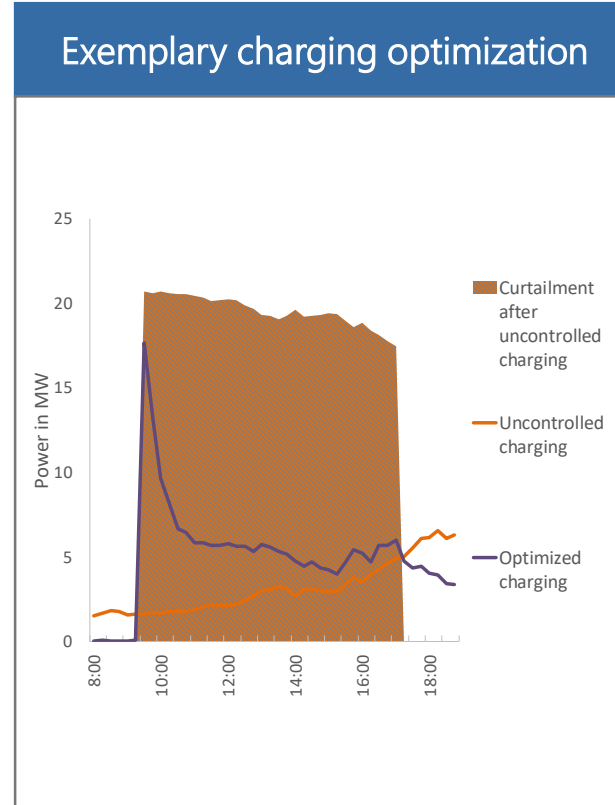
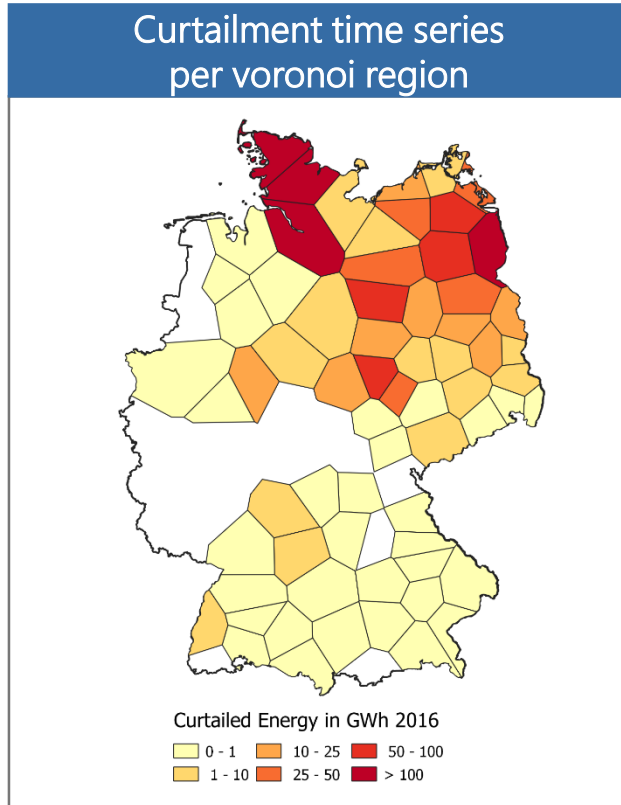




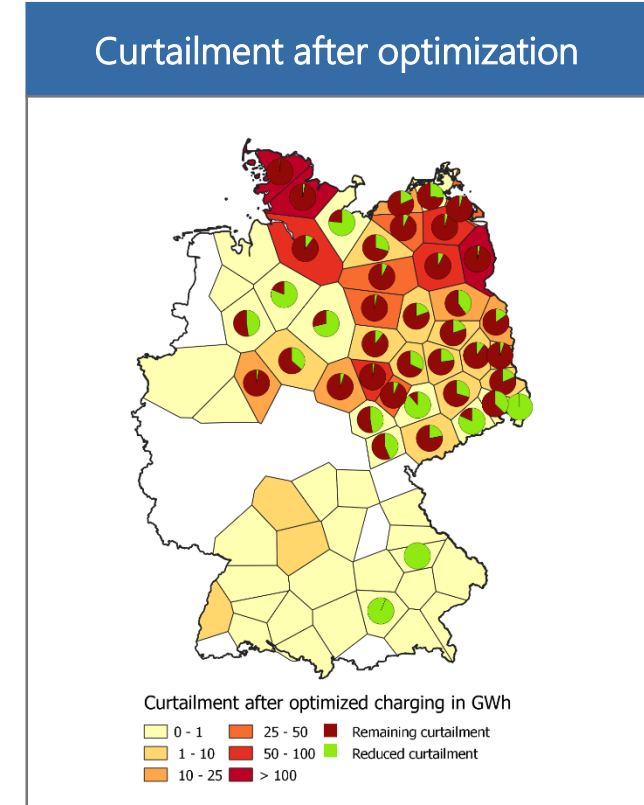
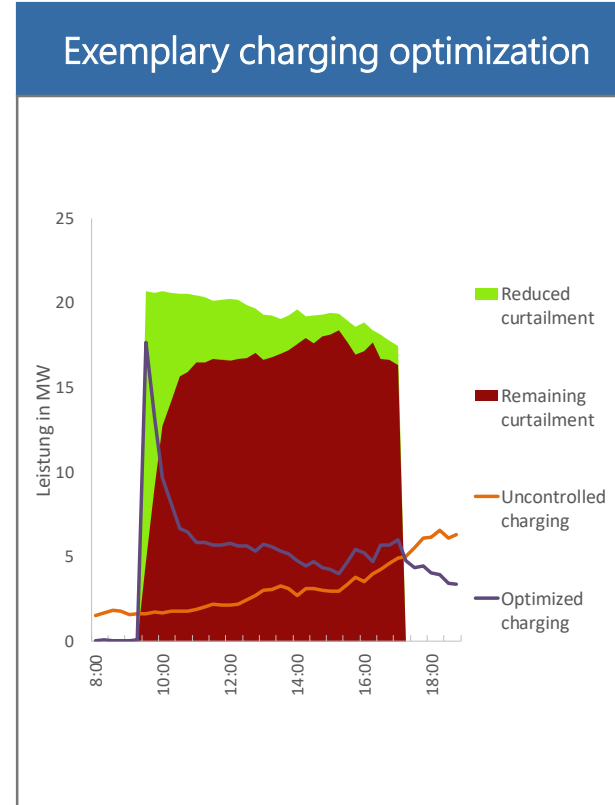
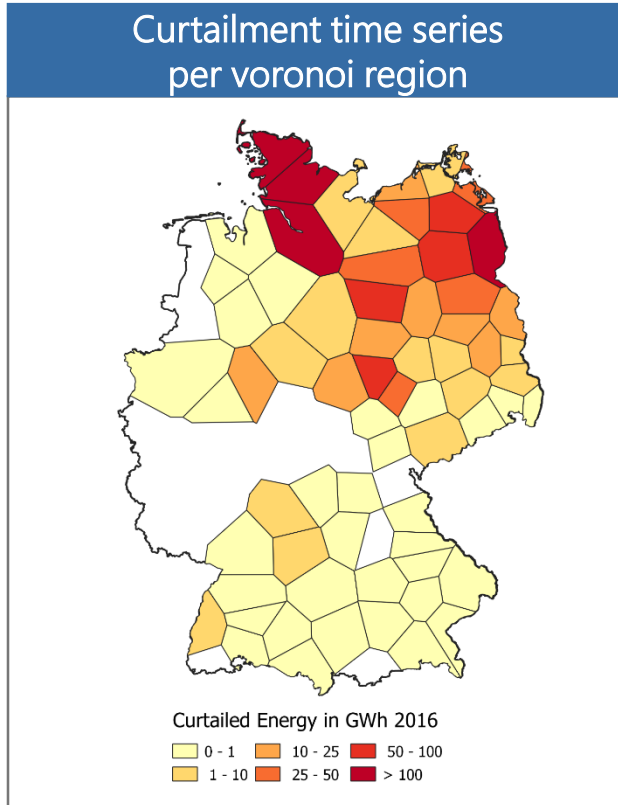
# Charging Optimization to Reduce Curtailment



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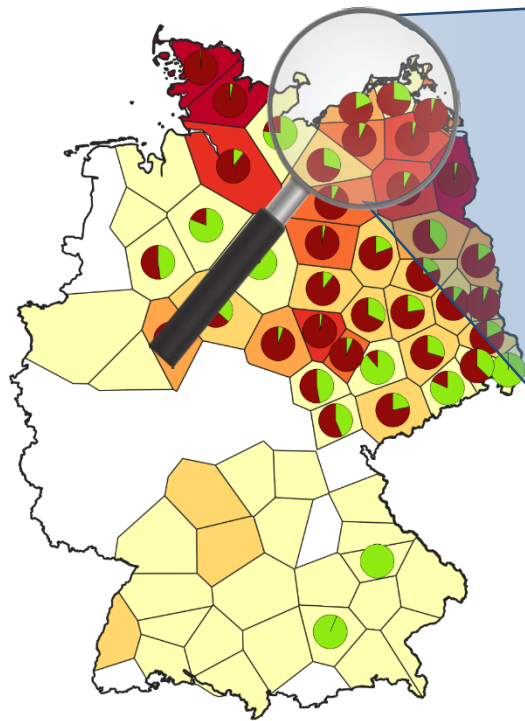


# Charging Optimization to Reduce Curtailment



For every voronoi region reduced and remaining curtailed energy is calculated

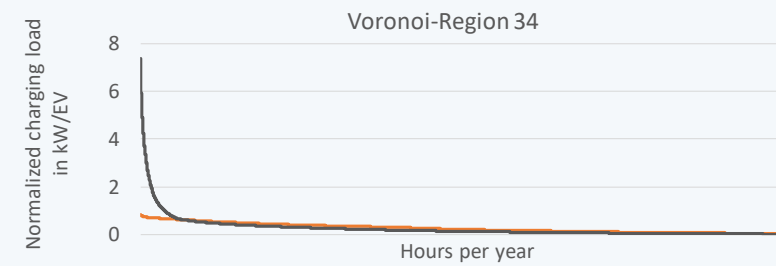
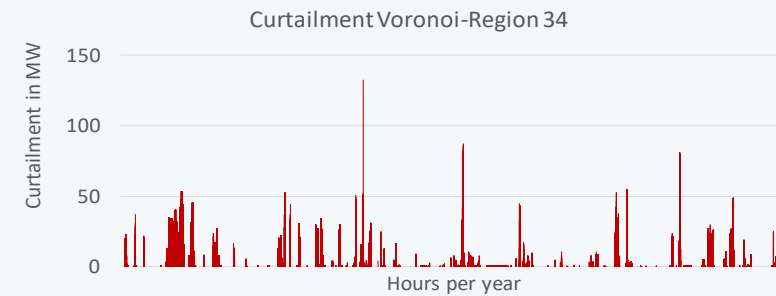
# Exemplary Analysis for Voronoi Region 34 in 2016



Curtailment after optimized charging in GWh

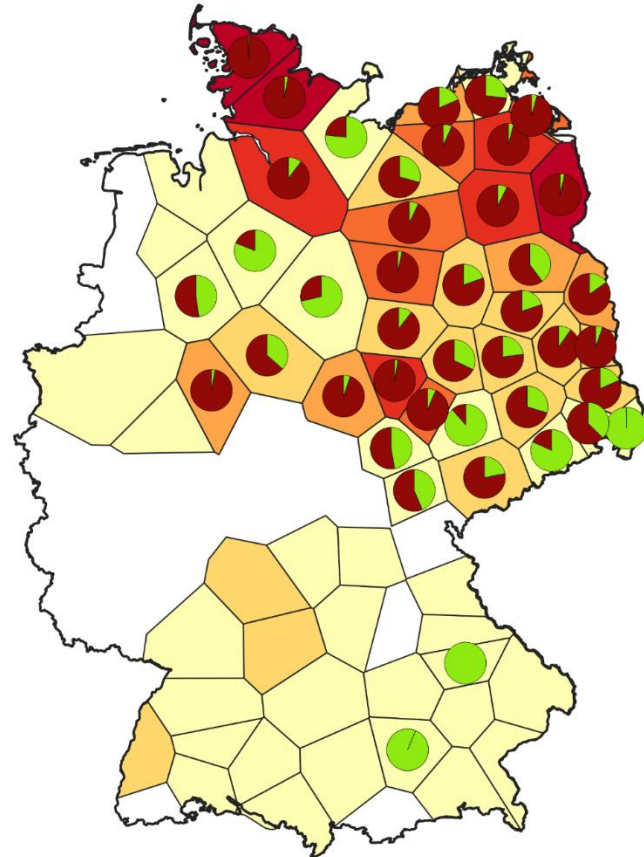


- Simulated EVs: 9,855
- Curtailed energy pre optimization: 13.7 GWh
- Curtailed energy after optimization: 11.2 GWh
- Optimized charging leads to reduction of 18 %
- BUT: Peak load increase of ~ 800 %!



Simultaneity leads to significant peak loads in certain regions!

# Overview and Outlook



Curtailment after optimized charging in GWh



## Overview

- Depending on the region and number of EVs a significant reduction in curtailed energy can be achieved (average about 4%)
- Optimization leads to significant peak loads

## Outlook

- Reduction of charge peaks through "intelligent" charge control
- Sensitivity analyses with regard to available charging locations/charging capacities/plug-in behavior...
- Integration of Redispatch
- Integration Evaluation of Vehicle-to-Grid

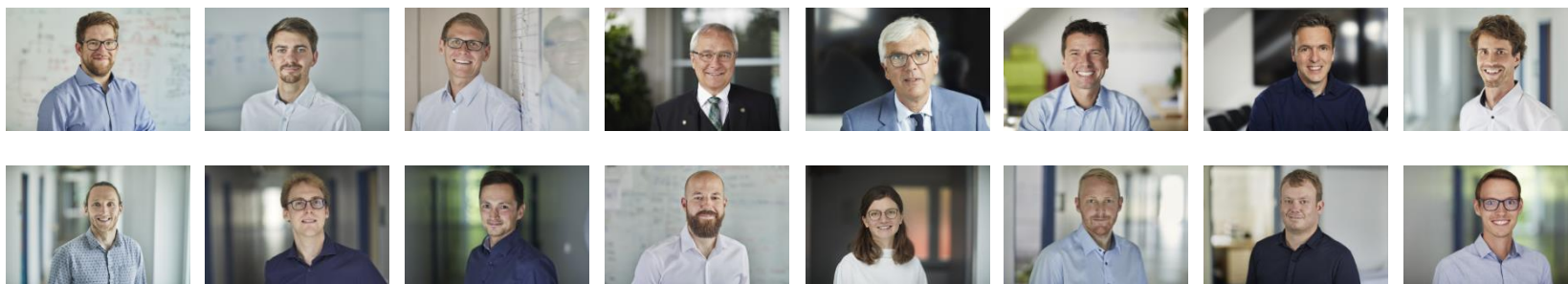
# Project Bidirectional Charging Management (BCM)



## 9 Consortium Partners



## 11 Joint-Project-Partners



Portraits: ©Enno Kapitza

Gefördert durch:



Bundesministerium  
für Wirtschaft  
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aufgrund eines Beschlusses  
des Deutschen Bundestages

This work is part of the ongoing project BCM  
Please visit [www.ffe.de/en/bcm](http://www.ffe.de/en/bcm) for further Information





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