Initial Case Studies conducted on Cellular Energy Systems at the District Level

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Agenda

Initial Case Studies conducted on Cellular Energy Systems at the District Level

- Introduction
- Study I: Cellular District – Future Energy Supply in a Suburban District
- Study II: Electric City Neuss – Multi-Energy Carrier Districts of the Future
- Comparison of the Case Studies
- Conclusion and Outlook

Introduction

- Motivation: climate-neutral energy system
- Reduction of greenhouse gases is necessary
- Expansion of renewable energies
- Usage of decentralised potentials
- Local energy balancing to avoid grid expansion

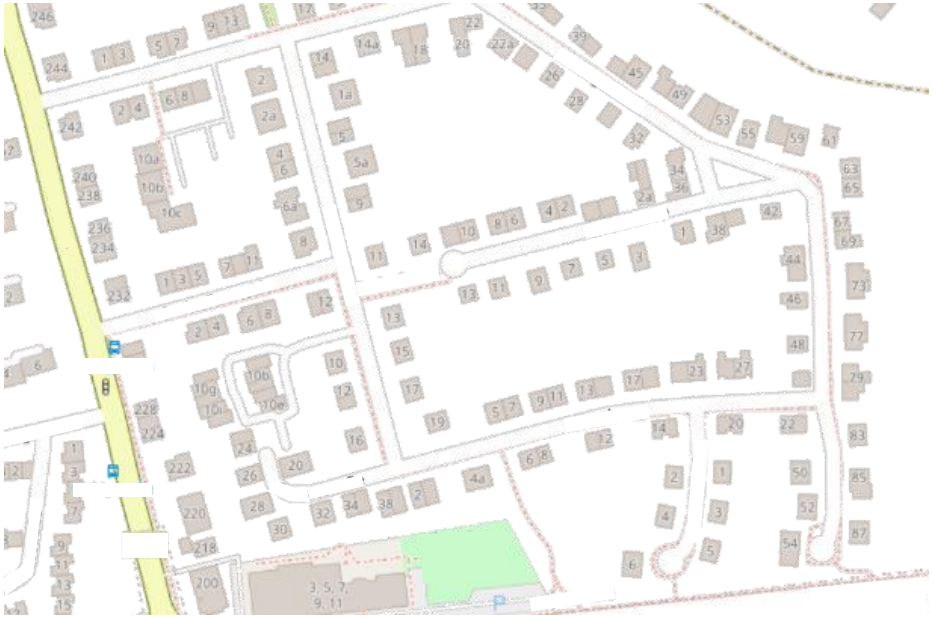
The aim of this study is the presentation of two initial case studies conducted on Cellular Energy Systems at the district level

Study I: Cellular District – Future Energy Supply in a Suburban District

Characterisation of the district

Study I: Cellular District – Future Energy Supply in a Suburban District

- 175 Buildings
- Heterogeneous structure: Single-family, two-family and apartment houses with different building fabric and different state of renovation
- 3 local grid substations
- 3 PV systems
- 1 gas pressure regulating station



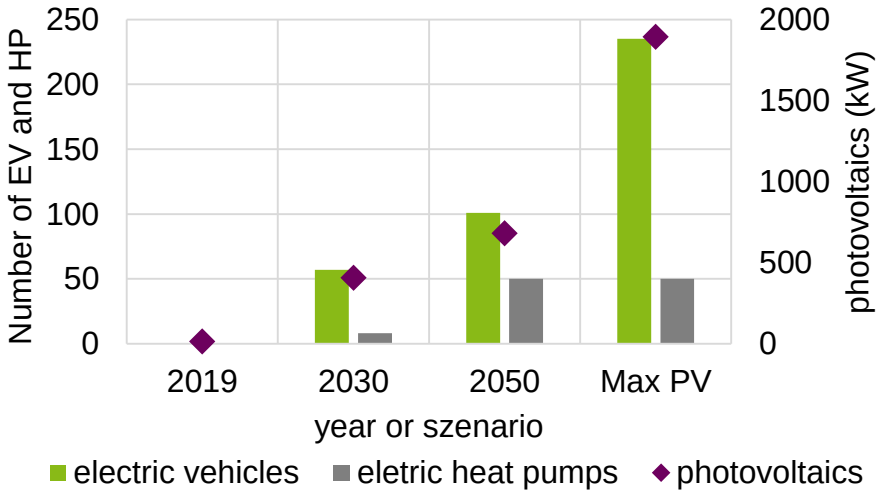
Investigated use cases and scenarios

Study I: Cellular District – Future Energy Supply in a Suburban District

5 use cases with consecutive technologies

Use case / Technology	Base case	Use case I	Use case II	Use case III A	Use case III B
PV	x	x	x	x	x
EV	x	x	x	x	x
BESS		x		x	
CHP & HP			x	x	x
PtG				x	x

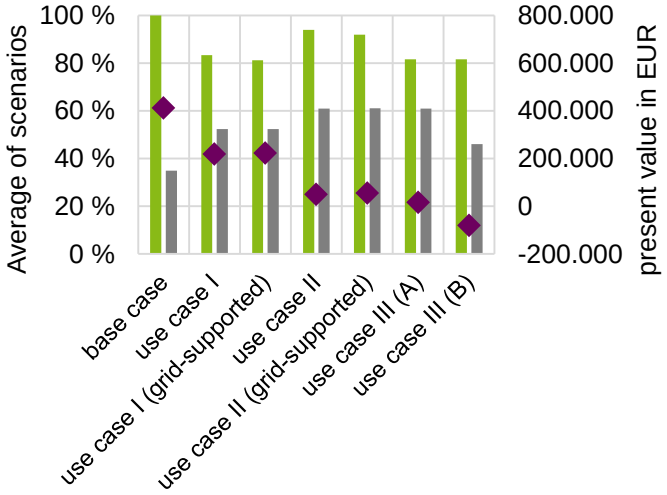
4 scenarios with raising number of electric vehicles, heat pumps and photovoltaics



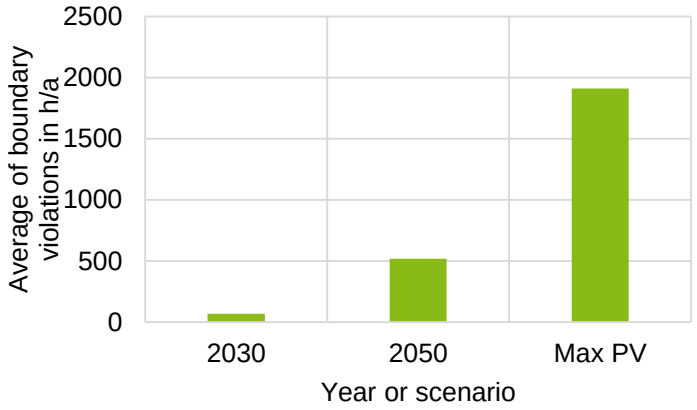
Results of self-supply, limit violations and costs

Study I: Cellular District – Future Energy Supply in a Suburban District

A higher degree of self-supply can lead to lower grid limit violations and the total costs can be lower.



In realistic scenarios, the violations of limit values are marginal. In case of maximum expansion of photovoltaics, they are significantly high.



Study II: Electric City Neuss – Multi-Energy Carrier Districts of the Future

Characterisation of the district

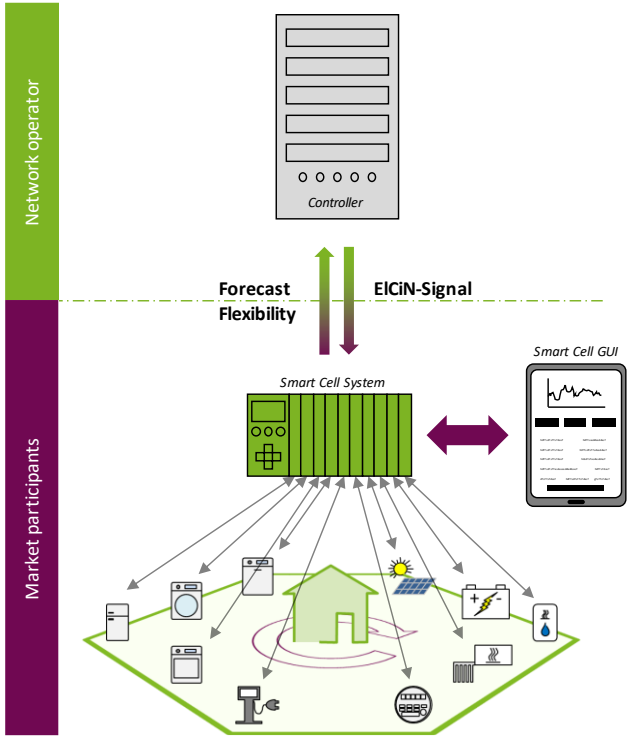
Study II: Electric City Neuss – Multi-Energy Carrier Districts of the Future

- ~ 600 Buildings
- Heterogeneous structure: Single-family, two-family and apartment houses with different building fabric and different state of renovation
- Several local grid substations
- Natural gas and district heating

Concept for grid estimation and flexibility usage

Study II: Electric City Neuss – Multi-Energy Carrier Districts of the Future

- In “Electric City Neuss (ElCiN) - Multi-Energy Carrier Districts of the future”, it is investigated how flexibility can be integrated into the energy system using smart grid controllers.
- The focus here lies particularly on the combination of decentralized generation on the outskirts of the city (wind, PV) and the flexibilization of loads in households and commerce.
- A smart grid controller (ElCiN-System) with energy and grid forecasts characteristics is intended to react to boundary violations in the grid caused by peaks in generation and demand.

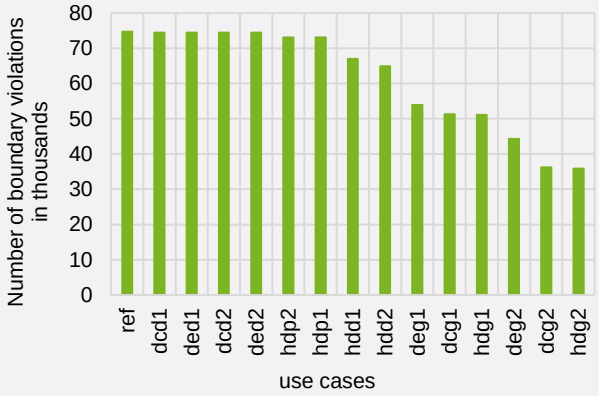


Results for BESS and PtG in the district

Study II: Electric City Neuss – Multi-Energy Carrier Districts of the Future

BESS investigation

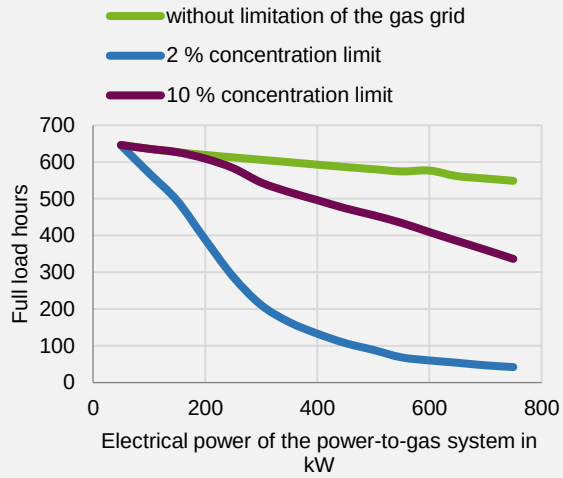
A sensible configuration and the grid-oriented use of BESS in districts can reduce boundary violations, but cannot avoid them.

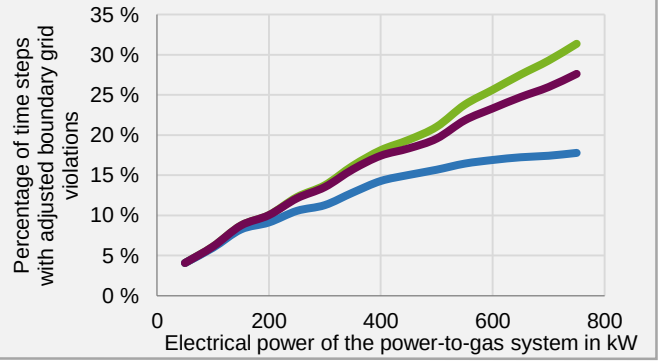


First character → storage concept
(d ≙ district, h ≙ household)
Second character → site configuration
(c ≙ central, e ≙ end of grid and d ≙ distributed)
third character → charging strategy
(d ≙ direct, p ≙ peak shaving and g ≙ grid-serving)
Last character → capacity of the BESS
(1 or 2 kWh/kW of PV).

PtG investigation

The PtG unit cannot avoid the full amount of grid violations and the full load hours are not enough for an economical operation





Comparison of the Case Studies

Boundary violations in low voltage grids

Comparison of the Case Studies

	Cellular District	Electric City Neuss
Focus	Different technology combinations in households and impact on the medium and low voltage grid	Dimensioning and positioning of BESS and PtG units and impact on the medium and low voltage grid
Result on prevention of boundary violations	Grid expansion cannot be prevented economically only by flexibility options	
Reason	To avoid any boundary violations, overdimensioning would be necessary, which is not economical.	
Conclusion	Flexibilities are a useful way to utilize the grids more efficiently and to delay but not avoid grid expansion	

Conclusion and Outlook

District energy systems

Conclusion and Outlook

- It was shown that there are many technically feasible options to produce and consume parts of the required energy even at the lowest energy cell level.
- BESS can increase efficient grid utilization, but cannot prevent limit violations beyond a certain level of new loads and feeders.
- PtG units can convert excess renewable energy to hydrogen and thus prevent curtailment, but the available full-load hours are so low that economic operation is not possible in the considered cases.
- In addition, grid expansion could not be prevented here either. In the future, more districts and urban areas will approach the aim of a sustainable cellular energy supply.

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