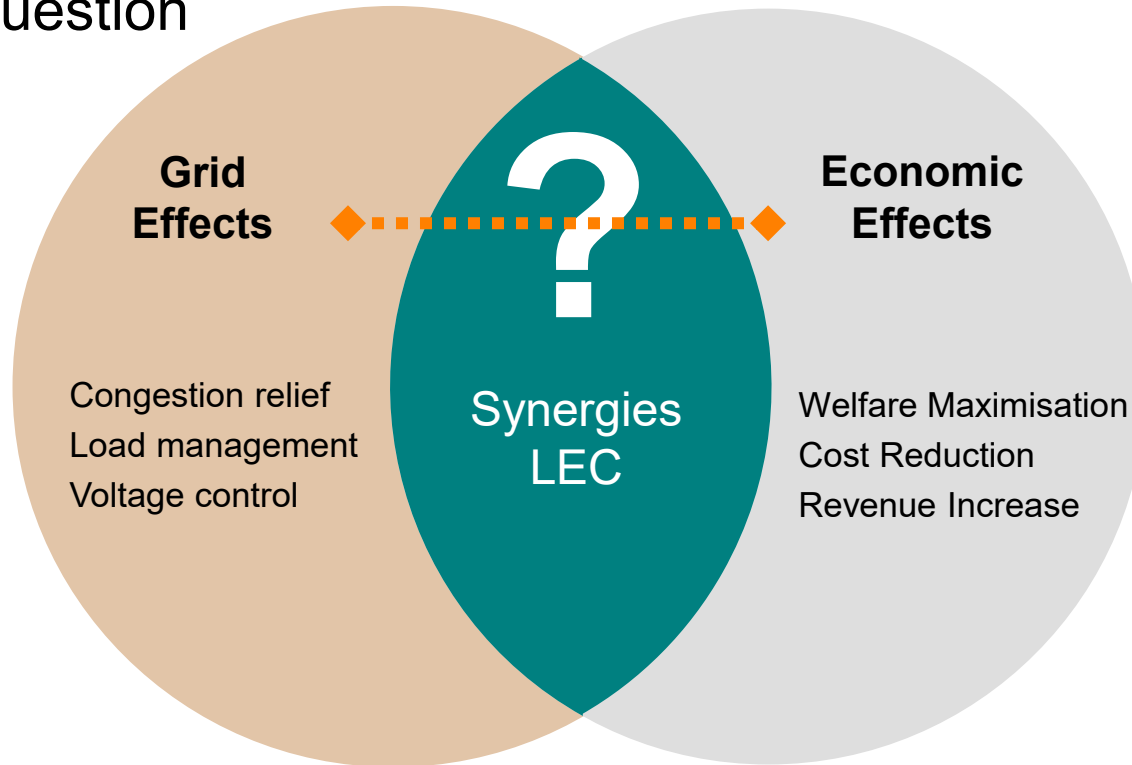


ECONOMIC AND GRID IMPACTS OF SMART AND SHARED FLEXIBILITY IN PRIVACY-CONSTRAINED LOCAL ENERGY MARKETS

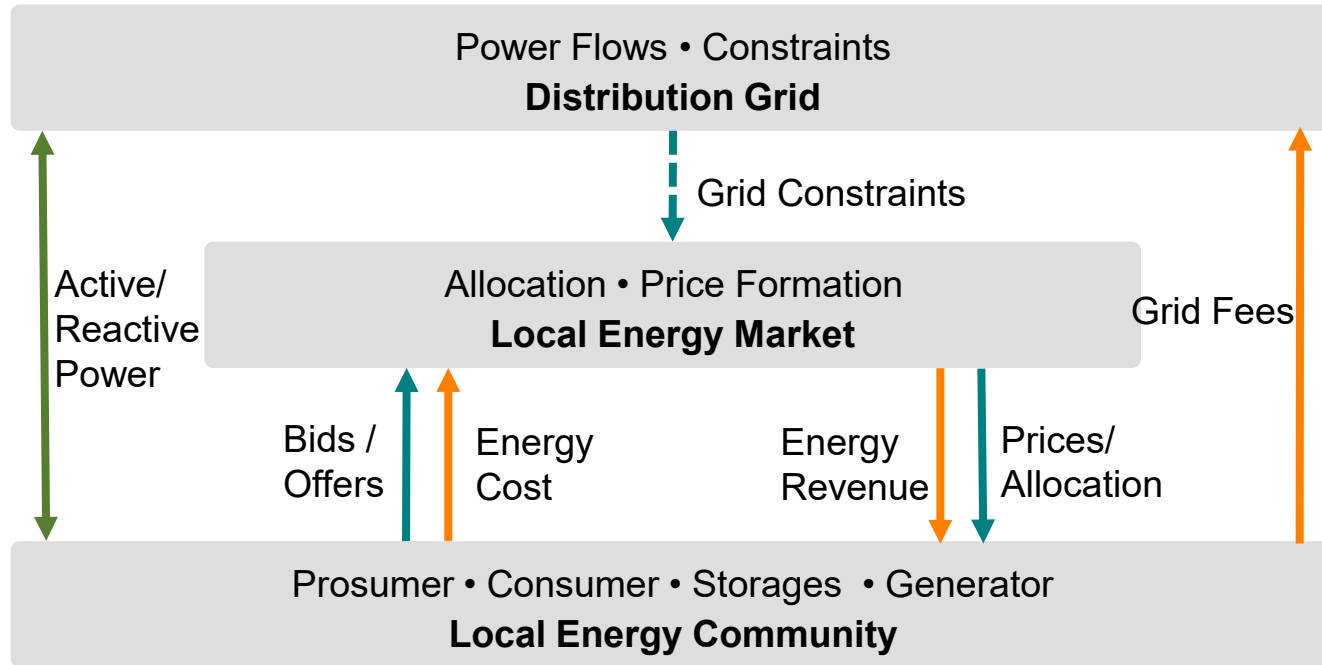
Julia Schmeing
TU Dortmund University



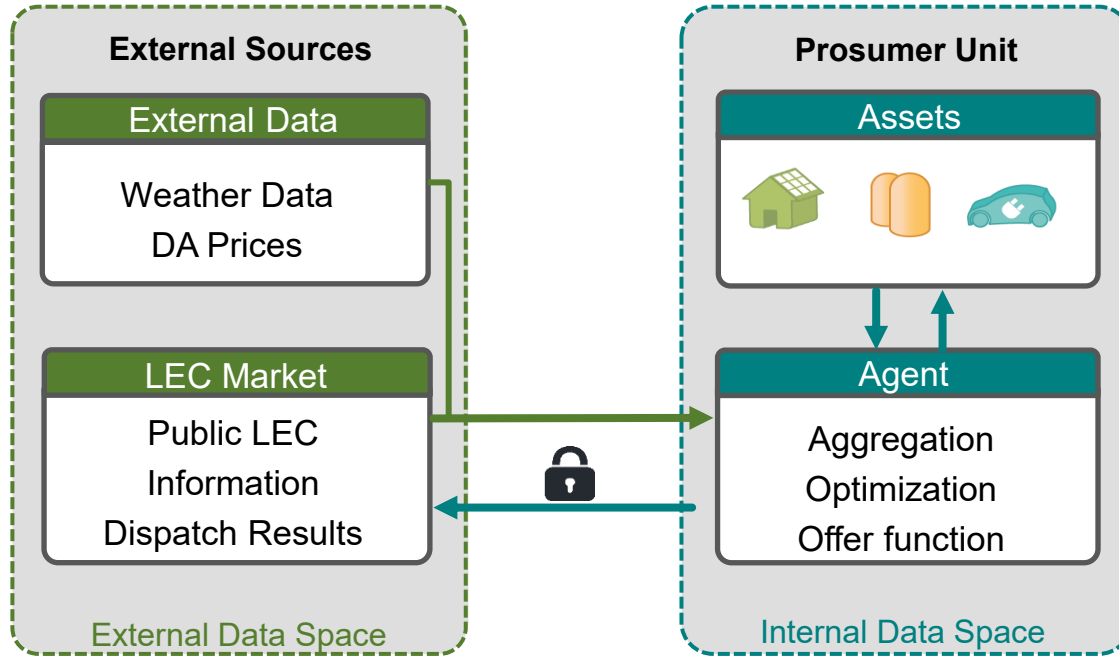
Research Question



General System Architecture

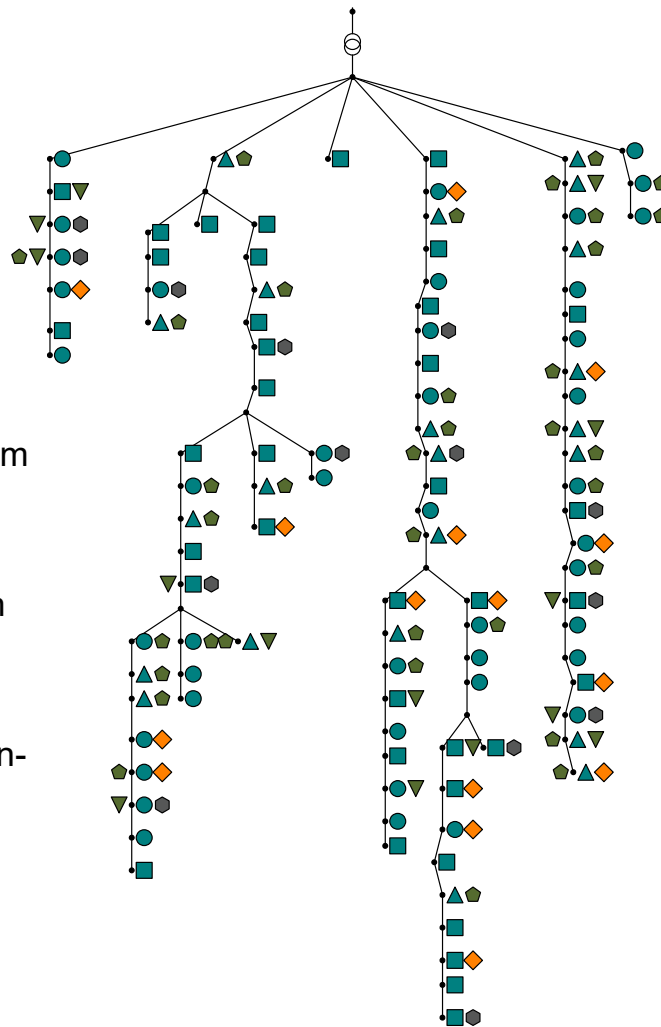


Agent – LEC Interaction



LEC Setup

- LEC grids based on SimBench reference grid
- Scenario data and assets derived from SimBench load and residual profiles
- EVs, heat pumps, and storages modeled as flexible assets (based on previous work by the authors¹)
- Household, industrial, agricultural, loads and photovoltaics assumed non-flexible



Asset Types

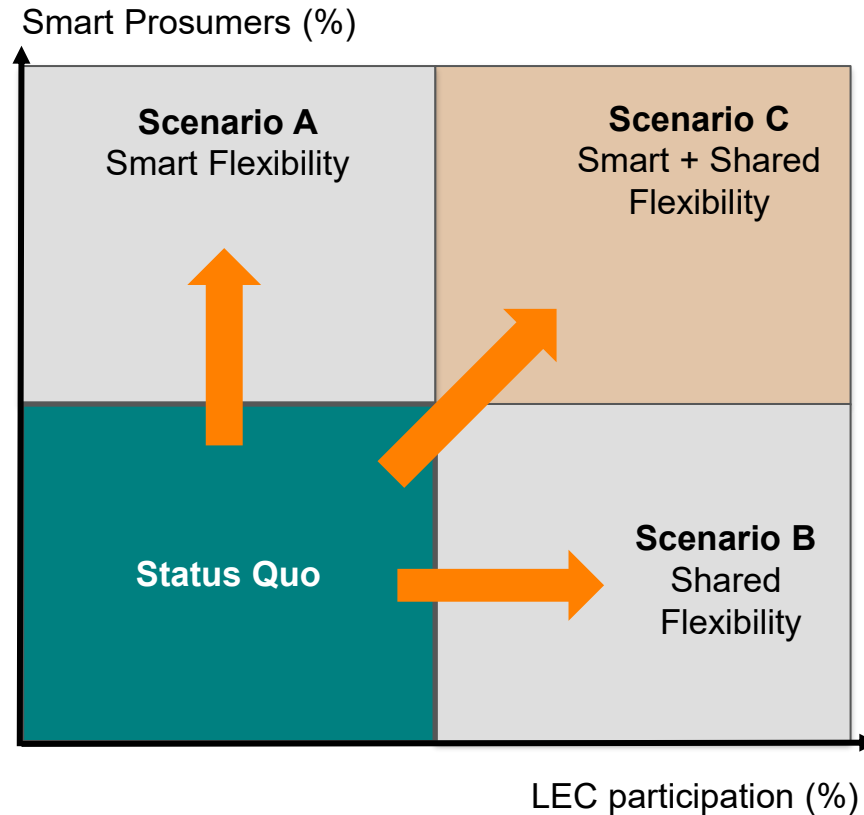
- Household Load
- Industrial Load
- ▲ Agricultural Load
- ◆ Photovoltaic System
- ▼ Electric Heat Pump
- ⬠ Electric Vehicle
- ⬡ Battery Energy Storage System

¹J. Schmeing, R. Jahn and U. Häger
Smart grid tariffs for preventive congestion management
an impact analysis for a German distribution system
2025 ISGT Europe, Valletta, Malta, 2025

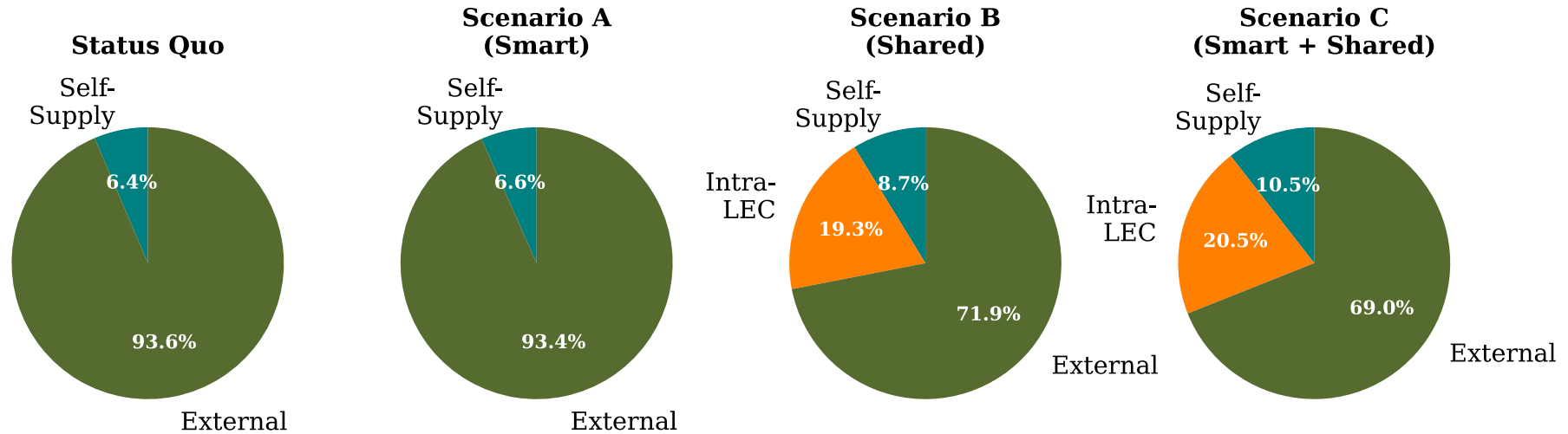
LEC Setup

Asset Types / Quantity	LEC Rural (LV2.101)	LEC Semiurban (LV5.201)	LEC Urban (LV6.201)	LEC Combined
Household Loads	54	43	69	166
Electric Vehicle	39	35	15	89
Agricultural Loads	23	21	20	64
Industrial Loads	21	39	21	81
Photovoltaic Systems	11	15	12	38
Electric Heat Pumps	8	14	14	36
Battery Electric Storages	8	14	7	29
Total Assets	166	182	159	507

Scenarios

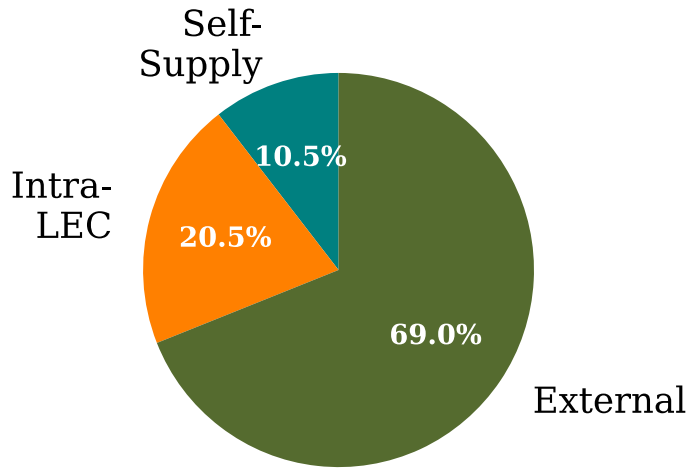


Results – Energy Trading Distribution (Loads)

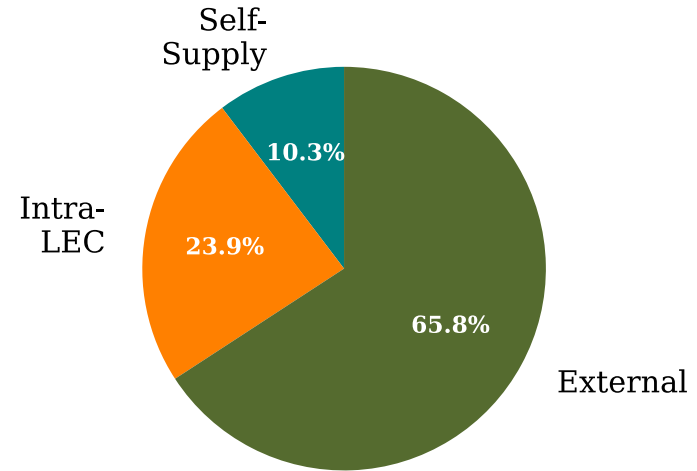


Results – Energy Trading Distribution (Loads)

Scenario C (Smart + Shared)



Individual LECs (averaged)



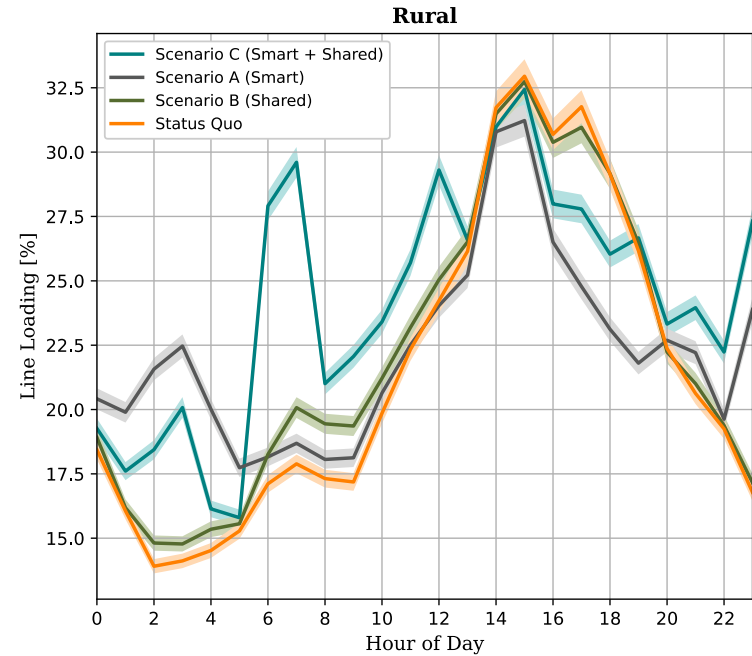
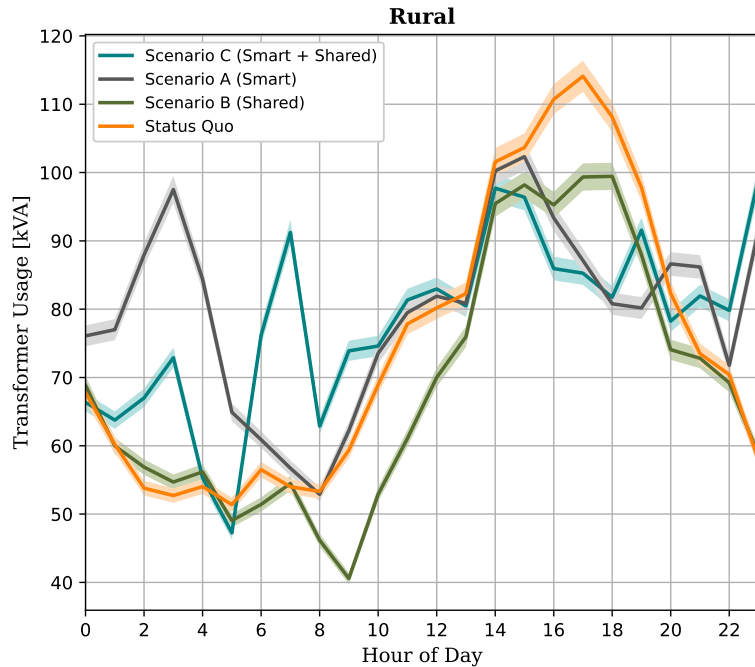
LEC Combined

Results – Economic Impacts

Averaged 3 LECs

	Total Energy Costs	Grid Fees	Levies	Total LEC Costs
Status Quo	180,342.86 €	230,309.29 €	98,404.88 €	509,057.03 €
Scenario A (Smart)	173,999.69 €	234,136.04 €	100,039.94 €	508,175.67 €
Scenario B (Shared)	170,059.12 €	213,233.66 €	91,108.93 €	474,401.71 €
Scenario C (Smart + Shared)	169,209.05 €	213,737.80 €	91,213.42 €	474,160.26 €

Results – Average Hourly Transformer and Line Loading



Results – Constraint violation rate

Scenario	Thermal Violations (%)	Voltage Violations (%)
Scenario C (Smart + Shared)	0.13	0.05
Scenario A (Smart)	0.05	0.03
Scenario B (Shared)	0.04	0.03
Status Quo	0.00	0.03

Conclusions

- Analysis of three LV grids with >500 agents across four scenarios (Status Quo, A: Smart, B: Shared, C: Smart + Shared)
- Self-supply increases from Scenario A to C and is higher than Status Quo in all scenarios
- Share of LEC trades increases when combining sharing and smart control (B → C)
- Total LEC costs decrease from Scenario A to C
- Scenario C shows the lowest energy and total costs, while grid fees and levies increase, indicating higher external grid exchanges
- Average grid loading is similar in Status Quo and Smart scenarios
- Smart and Smart + Shared Scenarios show similar loading patterns
- Asset behavior (conventional versus optimization) has a stronger impact on average loading than the LEC vs. non-LEC setup
- Absolute congestion events increase in all development scenarios compared to Status Quo, indicating more extreme grid stress events

Acknowledgments & Contact

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