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GAME-THEORITIC ANALYSIS OF SUPPLIERS' MARKET POWER IN LOCAL MULTI-ENERGY MARKETS

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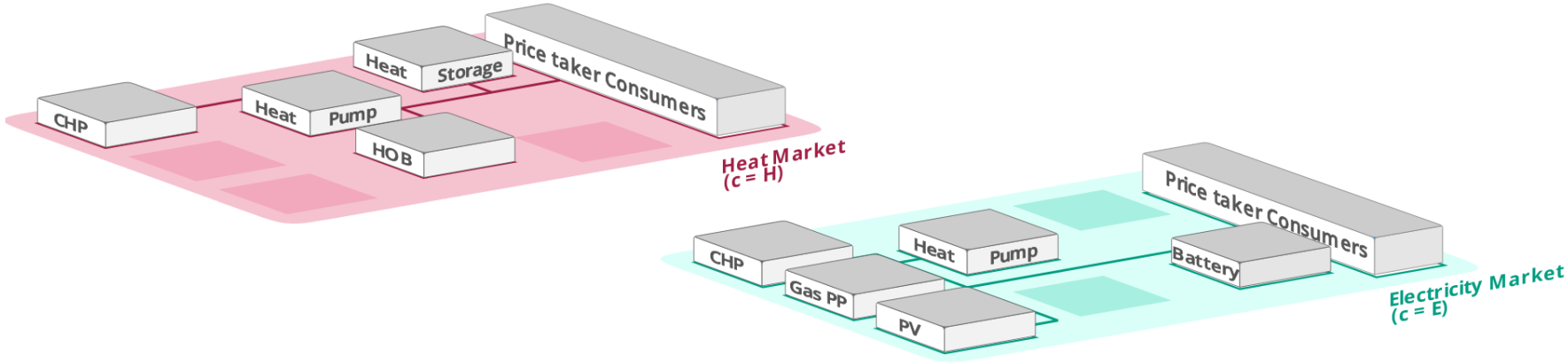
INTRODUCTION

Local Energy Markets (LEMs) are a promising approach to integrating of renewable energy resources:

- Electricity LEMs can help alleviate grid bottlenecks [1]
- LEMs reduce barries to entry of small players [2]
- Mitigates resistence to new RE projects closeby [3]



Thermo-electric LEM.

[1] Dudjak et al. (2021) Impact of local energy markets integration in power systems layer: A comprehensive review. Applied Energy.
[2] Klement et al. (2022) Local Energy Markets in Action: Smart Integration of National Markets, Distributed Energy Resources and Incentivisation to Promote Citizen Participation. Energies.
[3] Hvelplund et al. (2006) Renweable energy and the need for local energy markets. Energy.

INTRODUCTION

Thermal-Electric LEM Design studies often solve the market clearing as an **social-welfare maximization** ([4-5])

Perfect competition assumption is questionable:

- Small number of agents
- Much larger electricity market already suffered from market power abuse (California energy crisis 2000)

Which lead to the question:

How does imperfect competition affect thermo-electric LEMs and how it may be mitigated?

[4] Brolin et al. (2020) Design of a local energy market with multiple energy carriers. International Journal of Electrical Power & Energy Systems.
[5] Huynh et al. (2022) Local energy markets for thermal-electric energy systems considering energy carrier dependency and energy storage systems. Smart Energy.

METHODOLOGY

ENERGY CONSUMPTION MODEL

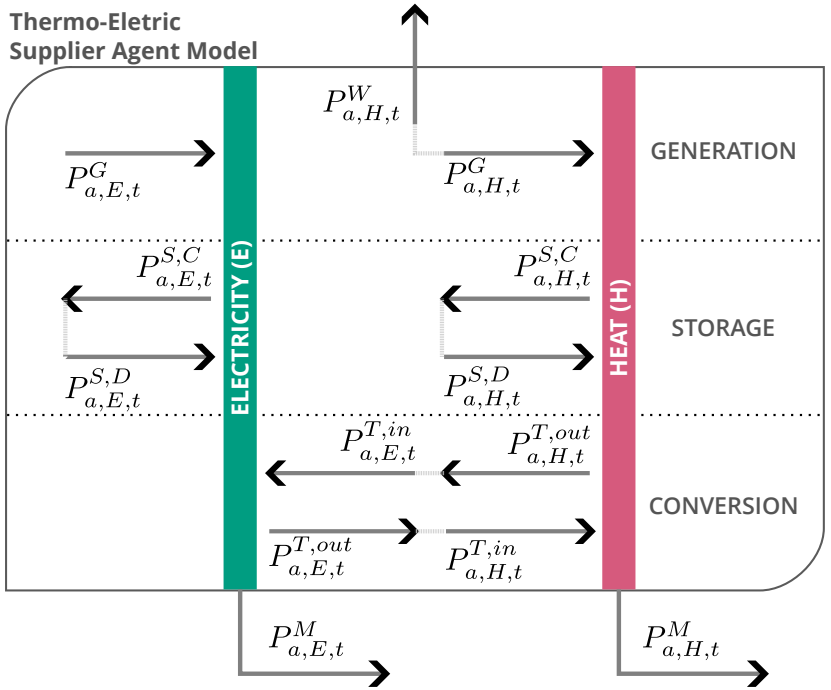
Consumers are assumed price-takers with a quadratic utility function.

SUPPLIER AGENT MODEL

Generation: Supply of an commodity from some energy form for which no LEM exists.

Storage: Storage energy and retriving at a later time.

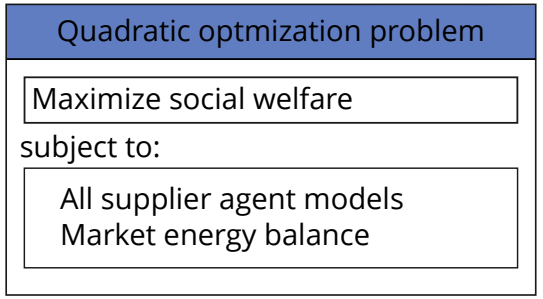
Conversion The trasformation betweem two energy commodities for which a LEM exist.



METHODOLOGY

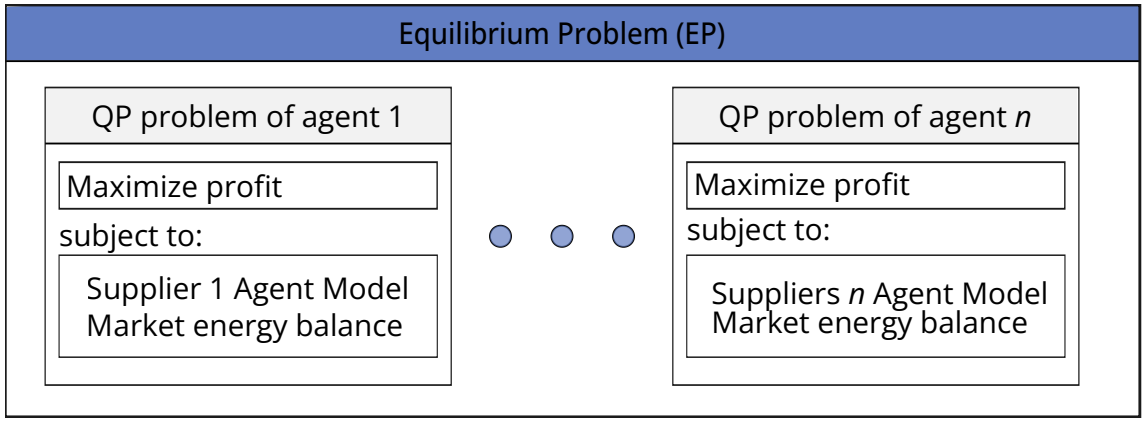
PERFECT COMPETITION

All agents are price-takers and the market outcome maximizes the social welfare.



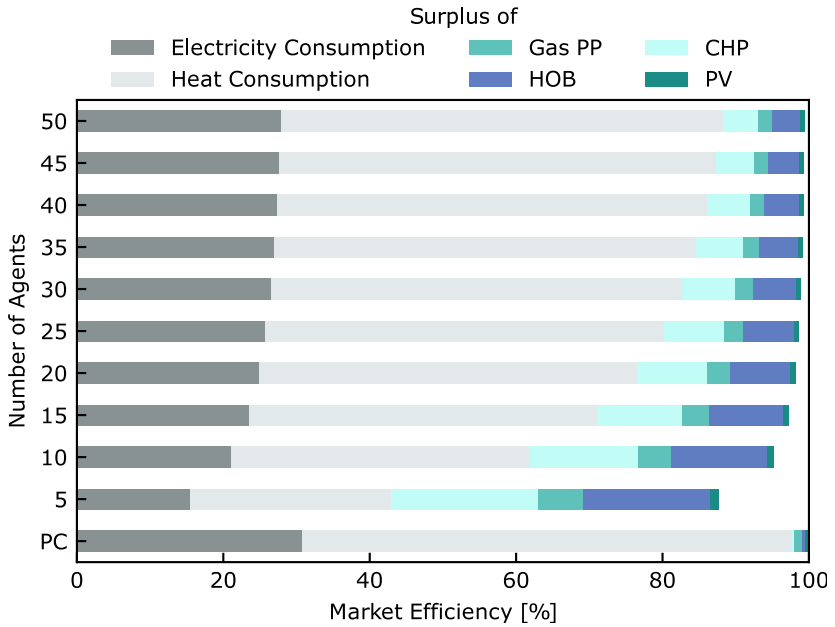
OLIGOPOLISTIC COMPETITION

Suppliers are profit maximizer strategic players



RESULTS:
PERFECT VS IMPERFECT COMPETITION

Repeatedly increased the number of agents of a type, without increasing the total capacity of the type.



- Reduction of consumer surplus in oligopolistic competition.
- Market power reduces as number of agents increases.
- Producer surplus significantly increases with oligopolistic competition.

Thermal-Electric LEMs are not immune to abuse of market power.

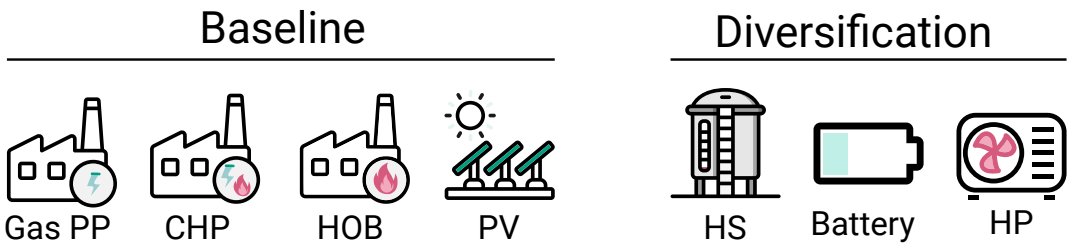
MARKET POWER MITIGATION STRATEGIES

Seler of Last Resort (SLR)

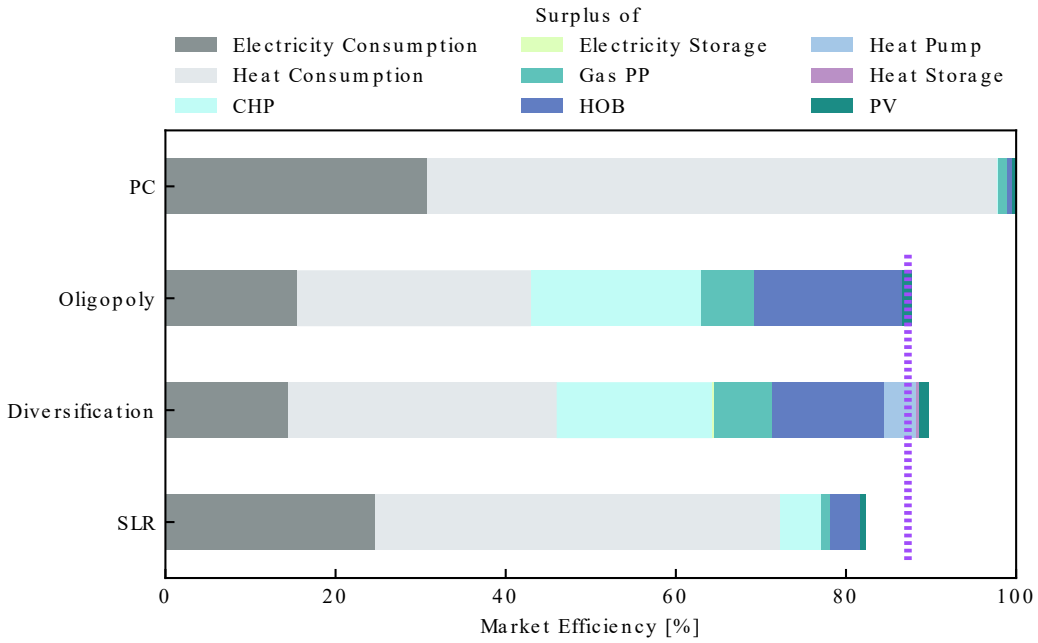
Adding a regulated agent that can place an unlimited supply bid at a fixed regulated price.

Diversification

Diversifying the local energy mix by adding new agent types.



RESULTS:
MITIGATION STRATEGIES



- Both strategies increase consumer surplus, however SLR is significantly more efficient.
- SLR reduces producer surplus and market efficiency.
- Diversification increases market efficiency and producer surplus.

The energy mix impacts the market power of the agents.

OUTLOOK

- Thermo-eletric LEMs are highly succeptible to market manipulation, which should be considered in the design of such markets.
- A well choosen mix of technologies in a LEM can contribute to avoiding abuse of market power.
- What is the energy mix that best mitigates market power?

THANK YOU!

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