

How much energy demand-side flexibility can a community deliver? A multi-agent modeling approach



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Motivation

So far, **energy communities** have been modeled as purely **residential settings**. Still, they can include **services, industry** and **cross-sectoral activities**, whose **demand-side flexibility** may be exploited to better take advantage of the **available local energy resources**.

Dimensions exploited in the modeling

Infrastructure + Users

- Residential agents are clustered translating different household profiles.
- Non-residential sector and cross-sectoral activities are included
- Different generation scenarios are exploited.

Optimization

Lower level:

- Minimize costs and/or dissatisfaction taking advantage of the demand-side flexibility of different activities.

Higher level:

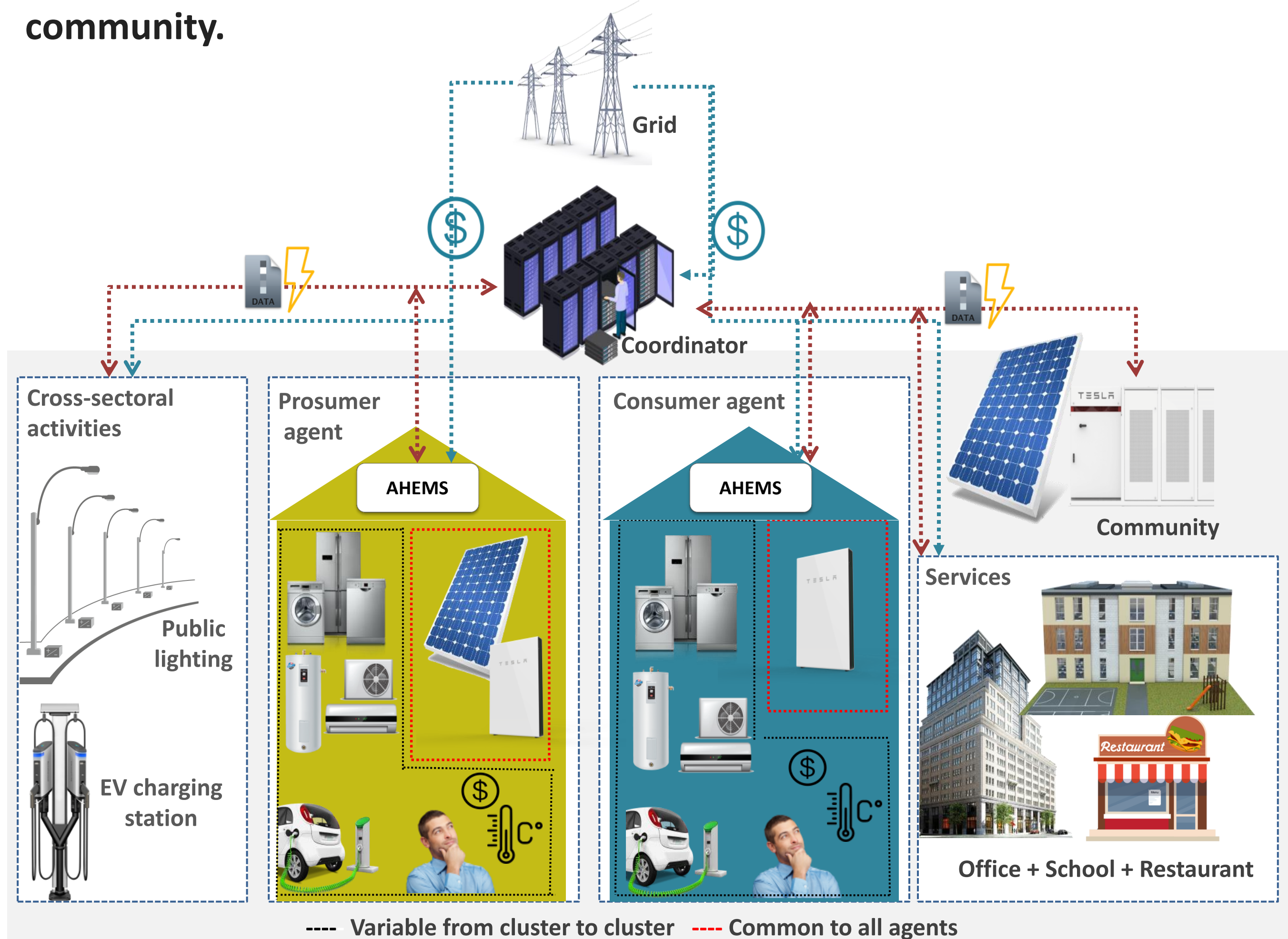
- An algorithm is implemented to minimize community overall energy costs.

Communication and energy exchanges

- All energy exchanges are made with and through the coordinator agent.
- Agents do not communicate directly with each other, only with the coordinator.

Community modeling

A **multi-agent system** (MAS) is combined with optimization techniques – **Genetic Algorithms** (GA) to exploit how the potential **demand-side flexibility** of **different activities** may influence the **self-sufficiency** of an **energy community**.



Conclusions

- Different renewable generation scenarios and shares of residential prosumers are simulated, highlighting the influence of prosumers on community self-sufficiency.
- The different agents' costs and benefits in belonging to an energy community are assessed, proving the added value of being a community arrangement member.
- Future approaches should exploit direct energy trades between community members (peer-to-peer trades) and greater parameters diversity should be introduced in the modeling, bringing it closer to real settings.



See our energy community simulation!