

Adaptive Multi-Agent System for Smart Grid Regulation with Norms and Incentives

Thiago R. P. M. Rúbio
Henrique Lopes Cardoso, Eugénio Oliveira

LIACC/FEUP, University of Porto

Introduction

- **Traditional Electricity Grids** → **Smart Grids**
 - Consumption + Production + Storage + Renewables + Distributed IoT
- Traditional **regulation is not sufficient**
 - Management, Tariffs, Network imbalances
- Needs distributed/**decentralised coordination**
 - Shape actors conducts by prohibiting, sanctioning or incentivising specific behaviours
 - Leading to more efficient utilisation of resources

I. In which way is it possible to influence actors' behaviours?

II. How effective can be the system coordination?

III. How could adaptive regulation strategies support managers in real-world's decision processes?

Multi-Agent Systems and Simulation

Simulation is required

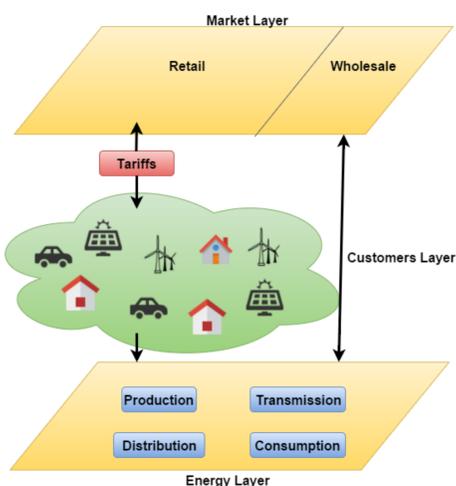
- Autonomous decisions and actions
- Self-interested goals
- Decentralised coordination

Multi-Agent Systems

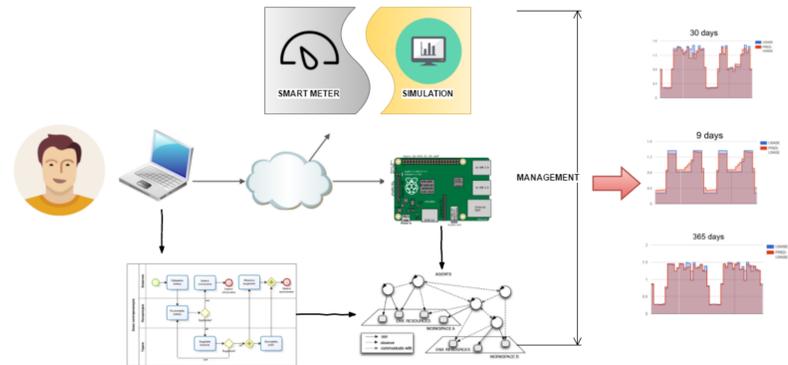
➢ Actors → Agents

- **Brokers** (operator companies),
- **Providers** (generator companies)
- **Customers** (household, small business, electric vehicles...)

➢ Represent internal reasoning processes for regulation decisions



If agent's are regulation-aware, managers could devise new regulation strategies through market artifacts as tariffs and customers could benefit from regulation in order to reply with a more racional social participation.



Preliminary Analysis and Results

PowerTAC simulation study-case:

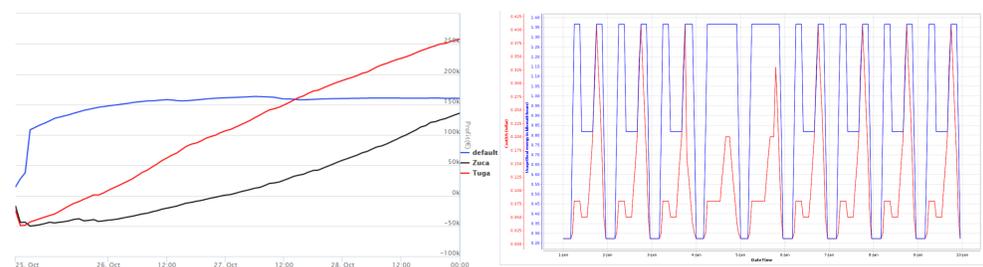
- Existing smart-grid simulation framework
- Tariff Problem → Create tariffs that incentivise behaviours
- **Results: Applying market-based regulation as soft-control strategy is feasible**

1) Relationship between consumption and price:

- Real consumption data-sets
- Data-mining approach to predict consumption and price models
- **Results: Real world consumption is sensible to tariff changes, but simulation models no.**

2) Future work:

- Create regulation-aware agent models
- Devise new regulation models with norms and incentives
- Analyse the impact of regulation in customer's actions
- Explore personal preferences vs. regulation policies



Conclusions

Overall research efforts intends to **propose new regulation mechanisms** that make the demand-supply adjustment more feasible, establishing **adaptive processes that allow coordination and optimisation**. Such regulation mechanisms are based in combination of **norms and incentives**. Here, a flexible process-oriented approach for regulation in multi-agent systems is proposed, describing how management on the business layer can include a **process reasoning model for agent's decisions**.

References

Ramchurn, Sarvapali D., et al. "Putting the'smarts' into the smart grid: a grand challenge for artificial intelligence." Communications of the ACM 55.4 (2012): 86-97.

Rúbio, Thiago RPM, Henrique Lopes Cardoso, and Eugénio Oliveira. "Adaptive Multi-agent System for Smart Grid Regulation with Norms and Incentives." Doctoral Conference on Computing, Electrical and Industrial Systems. Springer International Publishing, 2016.