Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
XXXVI cycle

Supervisor
Enrico Macii
Edoardo Patti

Modelling, simulation and analysis of residential Demand-Side Management strategies

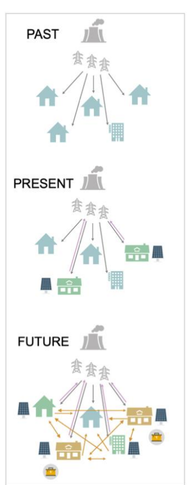
PhD Candidate: *Claudia De Vizia*

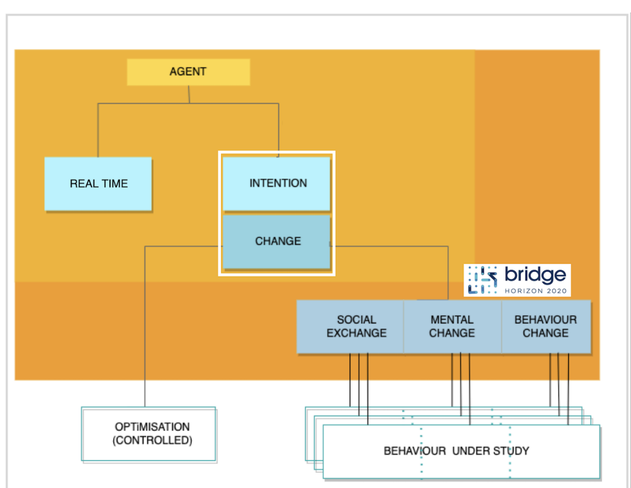
1.Context

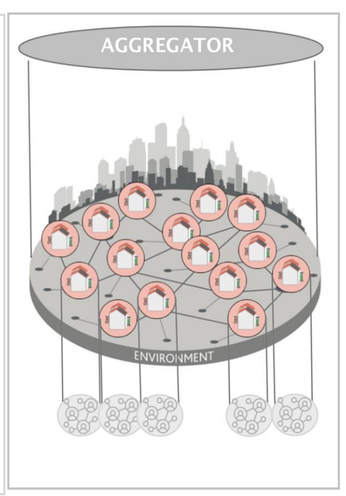
The traditional power system is evolving towards the so-called Smart Grid, an upgraded electricity network with a reorganised architecture and new actors. These participants include the consumer itself, whose role is turning from passive to active. Besides pilot projects, a complementary way to analyse the consequences of this shift is represented by simulation tools.

2.Goal

This thesis aims at developing a hierarchical and modular agent-oriented framework to support the energy transition. It should ease the test and the comparison of new residential strategies by adding models that tackle different aspects of the agent or changing simulators via a plug-and-play mode.



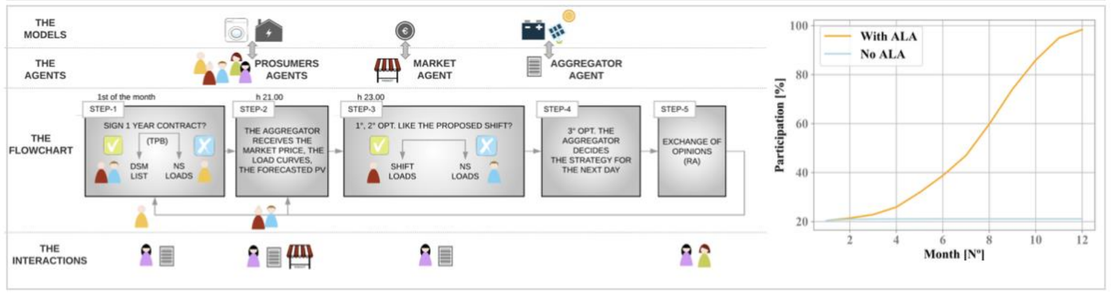




3. Novel Contributions

The proposed models allow the study of :

Energy Communities (EC). A flexible formulation to analyse many EC typologies was developed [1]. Several EC pricing mechanisms led to similar results from the aggregate point of view, but important differences were found at the individual level. As an example, the daily load profile of a Non-Shared Resources EC is shown.



Residential users. A framework that considers a realistic model of the user, social and psychological factors in consumer energy choices was proposed to study the diffusion of DSM programs [2]. Results demonstrate that a high initial financial gain for the utility does not translate into higher economic benefits in time if the users are not understood, kept motivated and engaged.

Thermal Flexibility. A framework that can estimate the thermal flexibility of residential buildings and manage unbalances at the primary substation was proposed. Simple users can provide flexibility with minor temperature set-point deviations.

4. Conclusion and Future Works

The framework helps to understand the consequences of what-if scenarios based on behavioural changes and technological diffusion observed or predicted. In the next phase, electric vehicles will be analysed.

5. References

1. Schiera D.S., De Vizia et al. (2022) Modelling and techno-economic analysis of Peer-to-Peer electricity trading systems in the context of Energy Communities. In: 2022 *EEEIC / I&CPS Europe*
2. De Vizia C., Patti E., Macii E., Bottaccioli L. (2022) A User-Centric View of a Demand Side Management Program: From Surveys to Simulation and Analysis. In: IEEE SYSTEMS JOURNAL, vol. 16, pp. 1885-1896.