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# Multi-actor modelling for MILP energy systems optimisation: Application to collective self-consumption

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## ABSTRACT

We aim to propose a **multi-actor modelling** based on **stakeholders' objectives and constraints** and to apply it on the optimisation model generation tool OMEGAlpes. Based on **social science literature**, this modelling aims to help stakeholders to formalise their constraints and objectives and to **negotiate** them in a **multi-stakeholders problem setting process**. This modelling has been applied to a simplified collective self-consumption project.

## 1 – Problematic: Reduce the Socio-technical Optimality Gap

- Social science literature highlights that energy project should be considered as socio-technical as it depends on (Akrich, 1989) :



- Decision support tools only focus on technical optima creating a socio-technical optimality gap defined by Hinker et al. (2017) as:

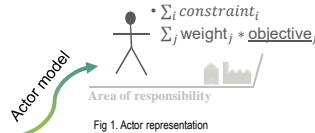
A socio-technical optimality gap is said to be existing for an optimization problem if the solution found is non-optimal because of an imprecise problem formulation, or if the optimum found is rejected due to non-feasibility in practice.

## 2 – From Social Science concepts to Object Oriented Actor Modelling with constraints and objectives

**Social science literature tells us**  
Stakeholders are one of the barriers of urban renewable energy development (Soshinskaya et al., 2014).  
Stakeholders are divided in two categories (North 1990; Moss 2009)

- Regulators** who lay down rules and procedures
- Operators** who operate energy units while respecting the regulators' constraints

Operators operate energy units in their **area of responsibility**, considered as a **Socio-Energy Node (SEN)** (Debizet et al., 2016)  
SEN: Group of physical elements collecting, converting, and/or supplying energy, built (or operated) by the same decision-maker



**Our modelling**  
Actor model of a decision-maker or set of decision-makers with the availability to have a consistent influence on the final solution of the energy project.  
Actors' influence is modelled as **constraints and objectives**

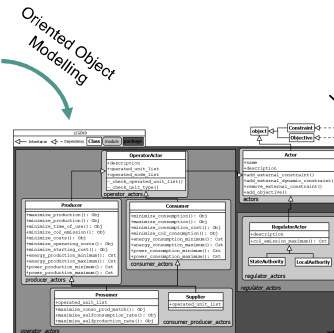


Fig 2. Pre-modelled actor classes in OMEGAlpes – UML representation

- Model Generation Tool for energy projects**  
improving decision makers' understanding and discussion based on various study case
- MILP Optimisation**
  - numerous decision variables -> Optimisation
  - continuous and discrete variables -> MILP (Mixed-Integer Linear Programming)
- Open source**  
facilitating the model and tool access and modification to stakeholders and energy project designers

**OMEGAlpes**  
Python 3.6 (Pajot et al., 2019)  
Actor modelling available at:  
<https://gricad-gitlab.univ-grenoble-alpes.fr/omegalpes>

## 3 – “Problem setting” step & stakeholder negotiations

Multi-stakeholder projects in pre-study phases require to help stakeholders to :

- understand the impact of their requirements – constraints and objectives – on the solution (Fig 4)
- discuss and coordinate on possible and satisfactory solutions mainly negotiating their constraints and objectives (Fig 3)

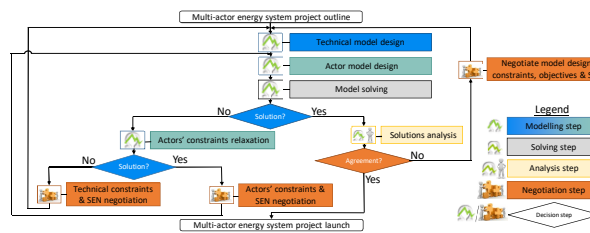


Fig 3. Proposition for a multi-stakeholder energy project design step

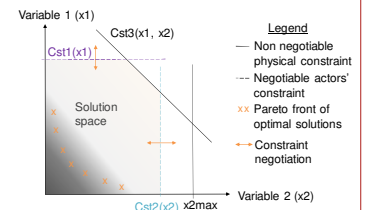


Fig 4. Impact of constraints negotiation on the solution space

## 4 – Application to Collective self consumption

In France, the collective self-consumption act enables prosumers to share their electricity production between various consumers connected to the public network  
Study cases available at: [https://omegalpes-examples.readthedocs.io/en/latest/article\\_study\\_case.html](https://omegalpes-examples.readthedocs.io/en/latest/article_study_case.html)

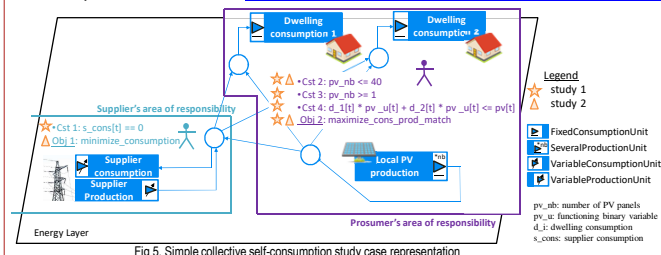


Fig 5. Simple collective self-consumption study case representation



**Resolution data**  
1014 variables  
• 581 continuous  
• 433 integer (432 binary)  
2862 non-zeros  
Generation time : 0,34 s  
Intel bicore i5 2.7 GHz CPU.

## References

- Akrich, M. (1989). La construction d'un système sociotechnique. *Anthropologie et sociétés* 13(2), 31-54.
- Debizet, G., Tabourdeau, A., Gauthier, C., & Menanteau, P. (2016). Spatial processes in urban energy transitions: considering an assemblage of Socio-Energetic Nodes. *Journal of Cleaner Production*, Special Volume: Transitions to Sustainable Consumption and Production in Cities, 134 (October), 330-41.
- Hinker, J., Hemkendreis, C., Drawing, E., März, S., Hidalgo Rodríguez, D.I., & Myrzik, J.M.A. (2017). A novel conceptual model facilitating the derivation of agent-based models for analyzing socio-technical optimality gaps in the energy domain. *Energy* 137 (October), 1219-30.
- Moss, T. (2009). Intermediaries and the Governance of Sociotechnical Networks in Transition. *Environment and Planning A* 41 (6), 1480-95.
- North, D.C. (1990). *Institutions, Institutional Change and Economic Performance*. Cambridge University Press. Cambridge (UK).
- Soshinskaya, M., Crjns-Graus, W.H.J., Guerrero, J.M., & Vasquez, J.C. (2014). Microgrids: Experiences, barriers and success factors. *Renewable and Sustainable Energy Reviews* 40 (December), 659-72.
- Pajot et al. (2019). OMEGAlpes: An Optimization Modeler as an Efficient Tool for Design and Operation for City Energy Stakeholders and Decision Makers. *Building Simulation Conference*. Rome, 1-4 September 2019.

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