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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:

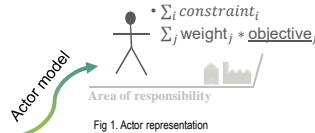
A socio-technical optimality gap is said to be existing for an optimization problem if the solution found is non-optimal because of an imprecise problem formulation, or if the optimum found is rejected due to non-feasibility in practice.

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**

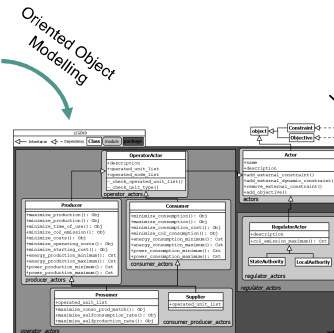


Fig 2. Pre-modelled actor classes in OMEGAlpes – UML representation

- 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)

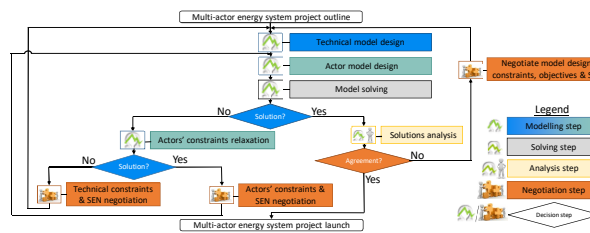


Fig 3. Proposition for a multi-stakeholder energy project design step

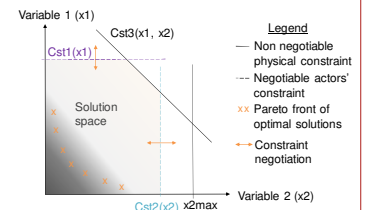


Fig 4. Impact of constraints negotiation on the solution space

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

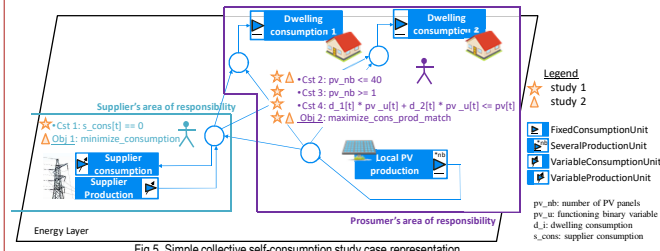


Fig 5. Simple collective self-consumption study case representation



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.

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