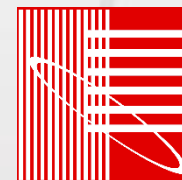


**BS**  
2019  
2-4 SEPT  
ROME



**16th IBPSA**  
INTERNATIONAL  
**CONFERENCE**  
AND EXHIBITION



INTERNATIONAL  
BUILDING  
PERFORMANCE  
SIMULATION  
ASSOCIATION



**OMEGAAlpes**

## Energy Model Generation Tool for Optimization

Speaker:

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1. Univ. Grenoble Alpes, CNRS, Grenoble INP, G2Elab, 38000 Grenoble, France

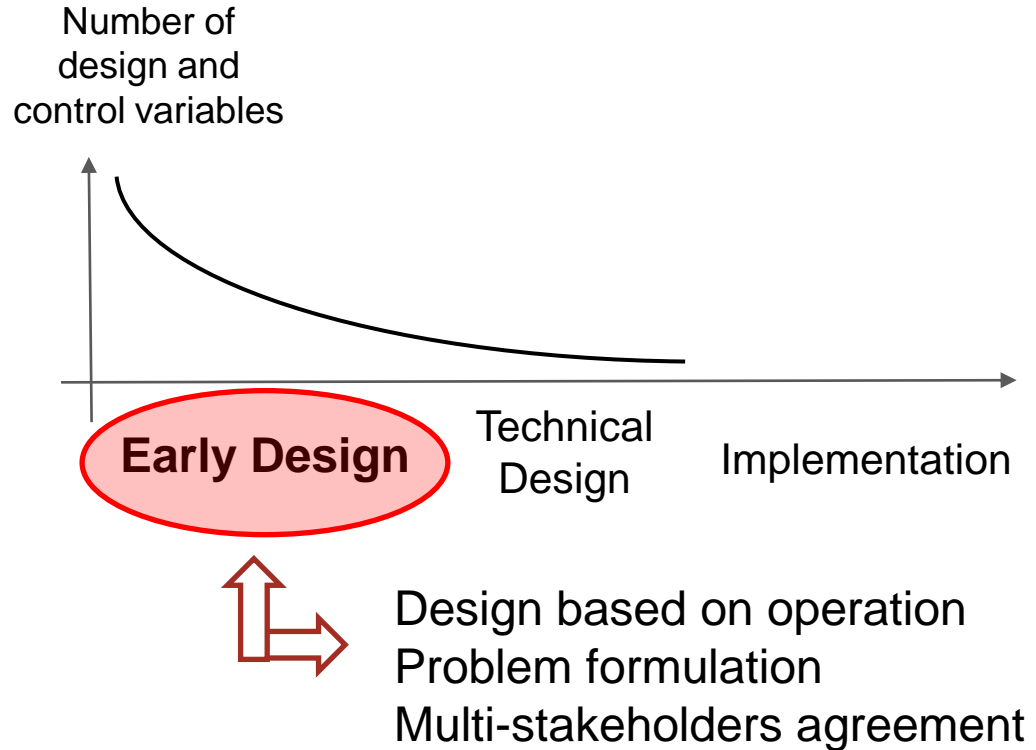
2. Sorbonne Univ, Univ Paris Saclay, Univ Paris Sud, Grp Elect Engn Paris,  
CNRS, Cent Supélec, 91192 Gif Sur Yvette, France

# Early Design for Urban Energy Project

- Urban scale
- Multi-energy
- New stakeholders

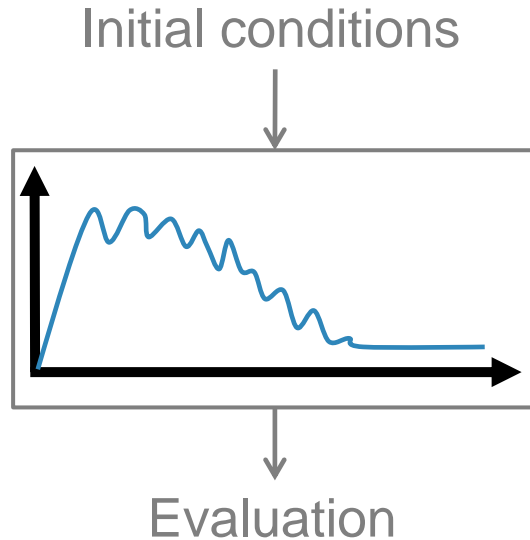
## Motivation:

- Assist energy project decision makers

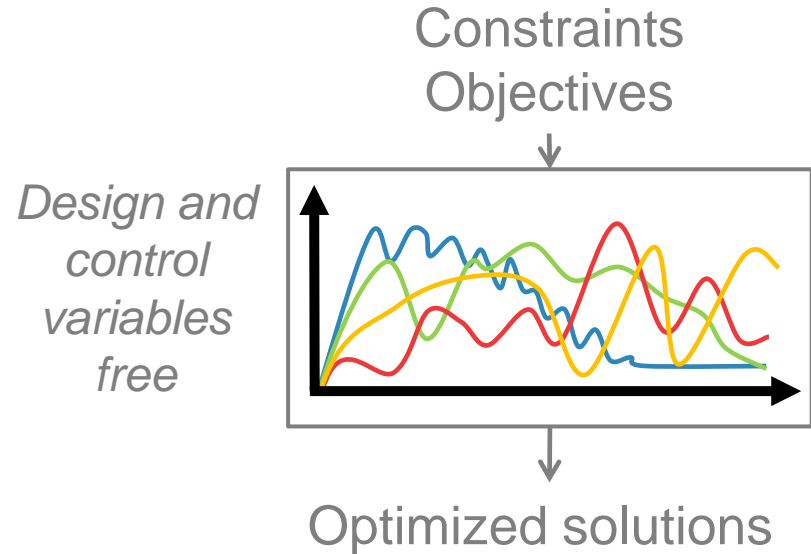


# Optimization for Early Design of Urban Energy Projects

- Simulation (One Scenario)



- **Optimization (Multiple scenarios)**



# Optimization for Early Design of Urban Energy Projects

- **Optimization (Multiple scenarios)**

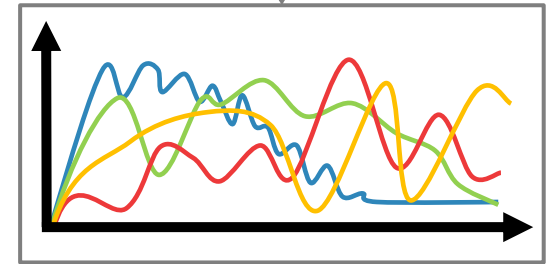
## Linear Programming (LP)

numerous decision variables

## Mixed Integer (MI)

continuous and discrete variables

*Design and  
control  
variables  
free*



Optimized solutions

# What does energy model generation means ?

Minimise  $c^T x + d^T y$

Subject to:  $Ax + By \leq b$

$x_{\min} \leq x \leq x_{\max}$  ,  $y \in \{0,1\}^m$

With:

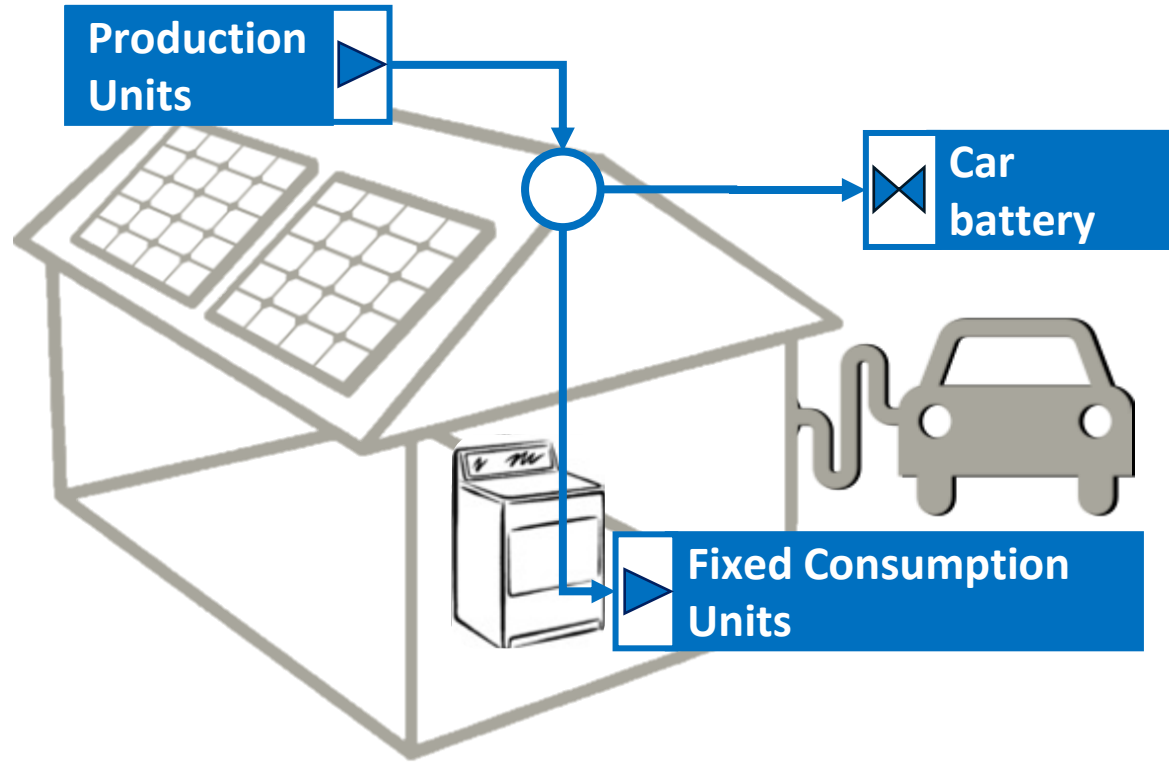
$c \in \mathbb{R}^n$ ,  $d \in \mathbb{R}^m$ ,  $b \in \mathbb{R}^p$  data vectors

$x \in \mathbb{R}^n$ ,  $y \in \{0,1\}^m$  variables vectors

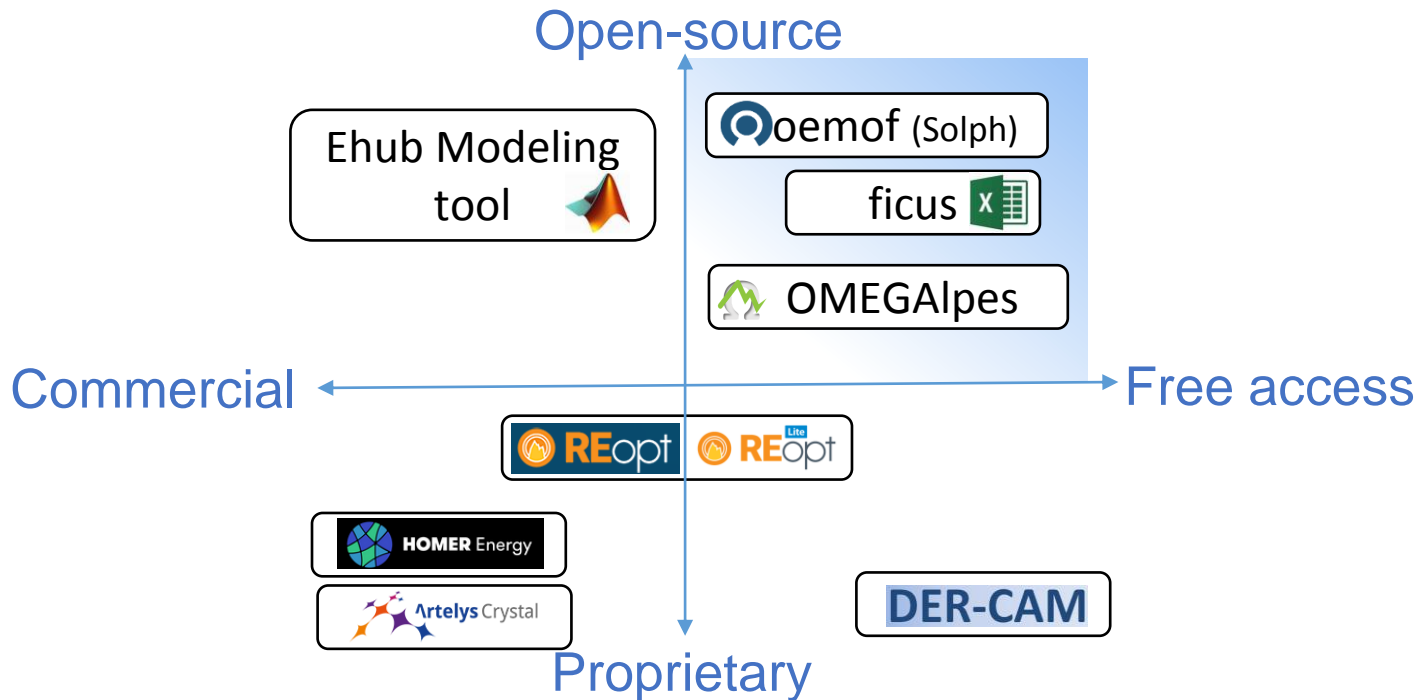
$x_{\min} \in \mathbb{R}^n$ ,  $x_{\max} \in \mathbb{R}^n$  low and up bounds  
vectors

$A \in \mathbb{R}^{p \times n}$  and  $B \in \mathbb{R}^{p \times m}$  matrixes to  
define the variable constraints

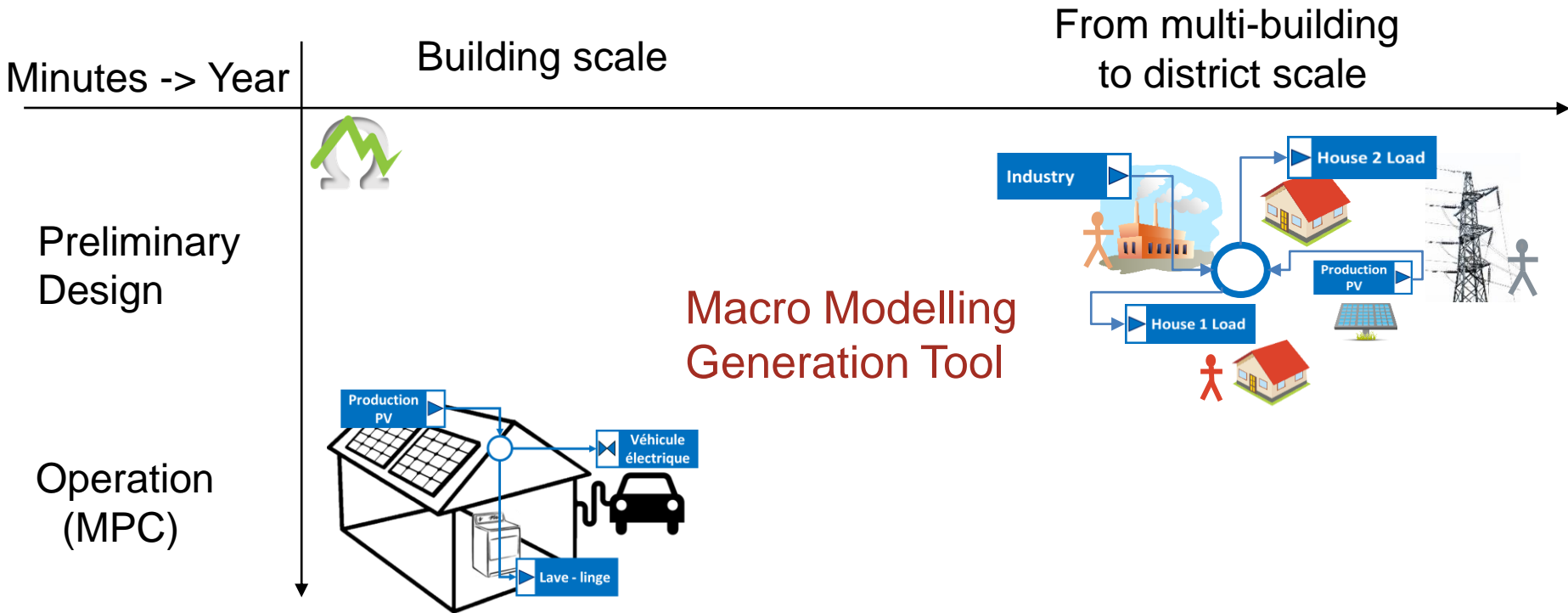
# What does energy model generation means ?



# Lake of Open Source Multi-carrier Optimization Energy Model Generation Tools



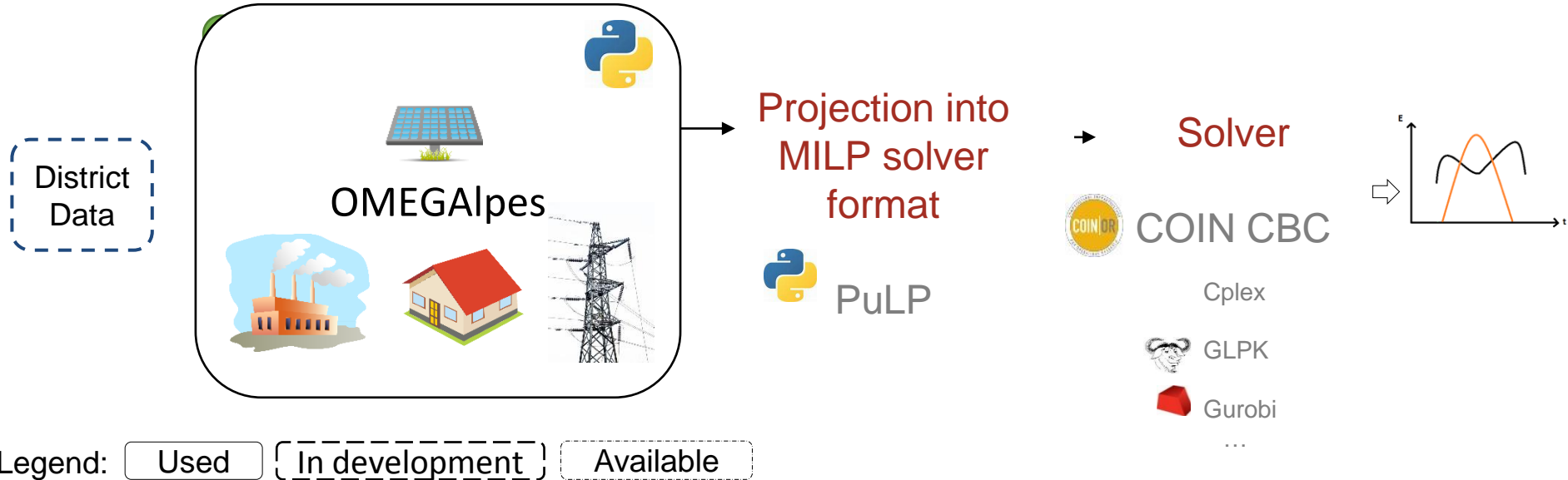
# OMEGAAlpes : Energy Modelling Tool & Applications





# How does OMEGAAlpes work ?

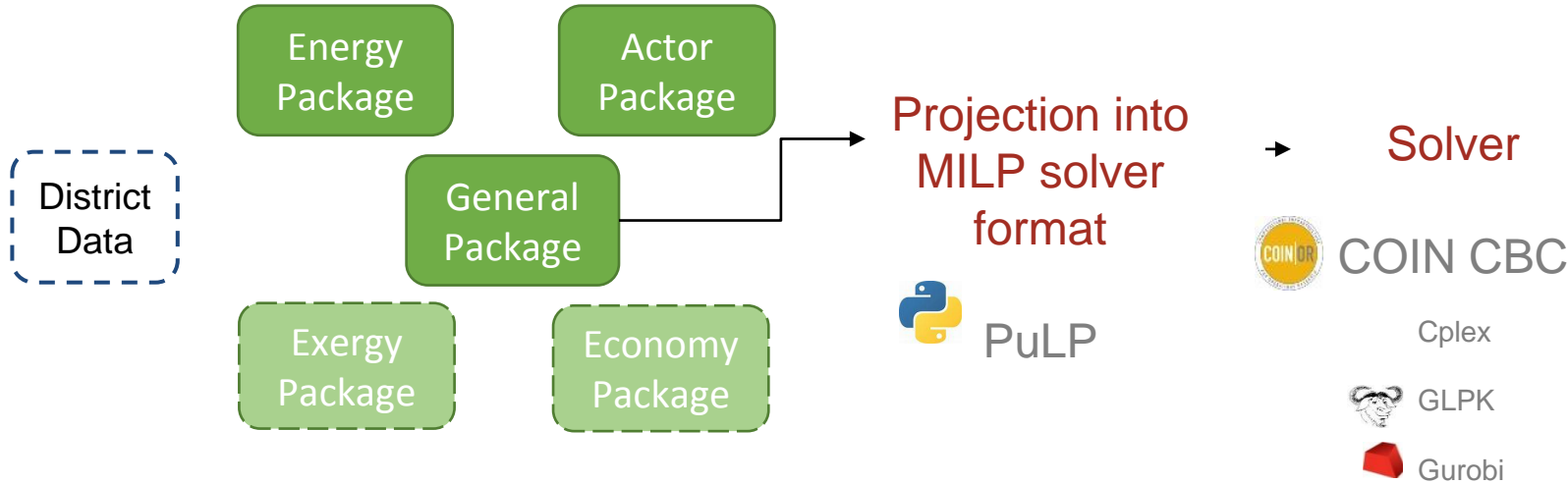
Oriented Object  
Model Generation Tool



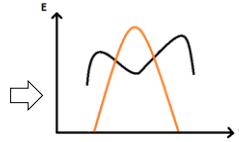
Legend: Used In development Available

# How does OMEGAAlpes work ?

## Oriented Object Model Generation Tool

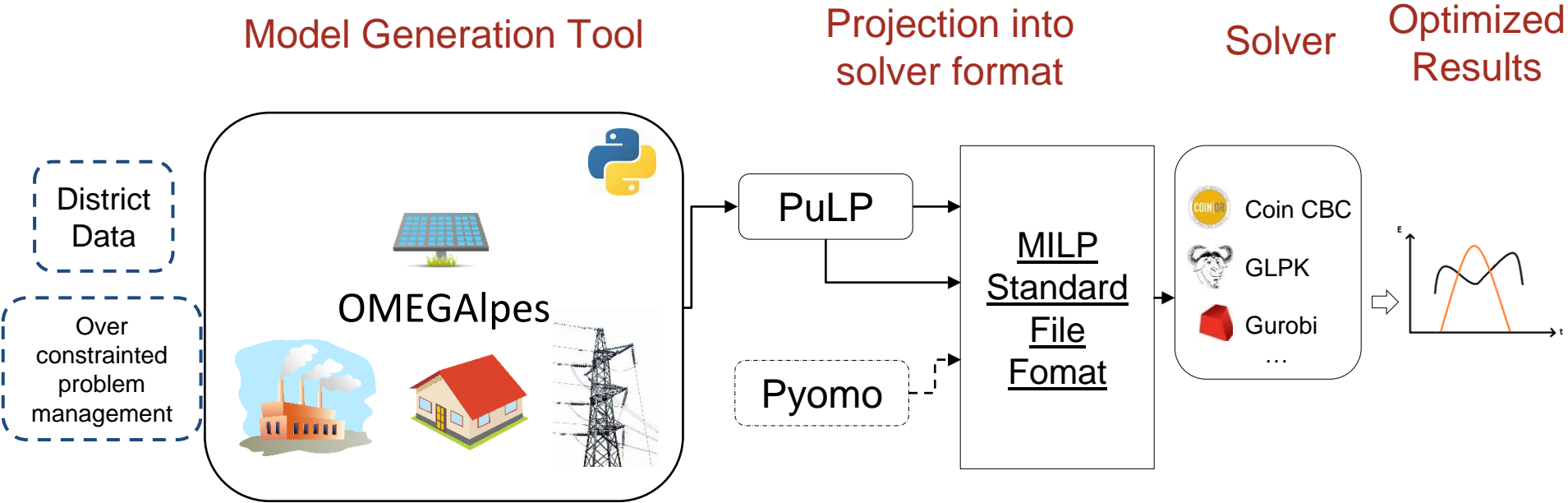


## Optimized Results



Legend: Used In development Available

# How does OMEGAAlpes work ?



# Open source and collaborative development

**Open Source**

**Community**

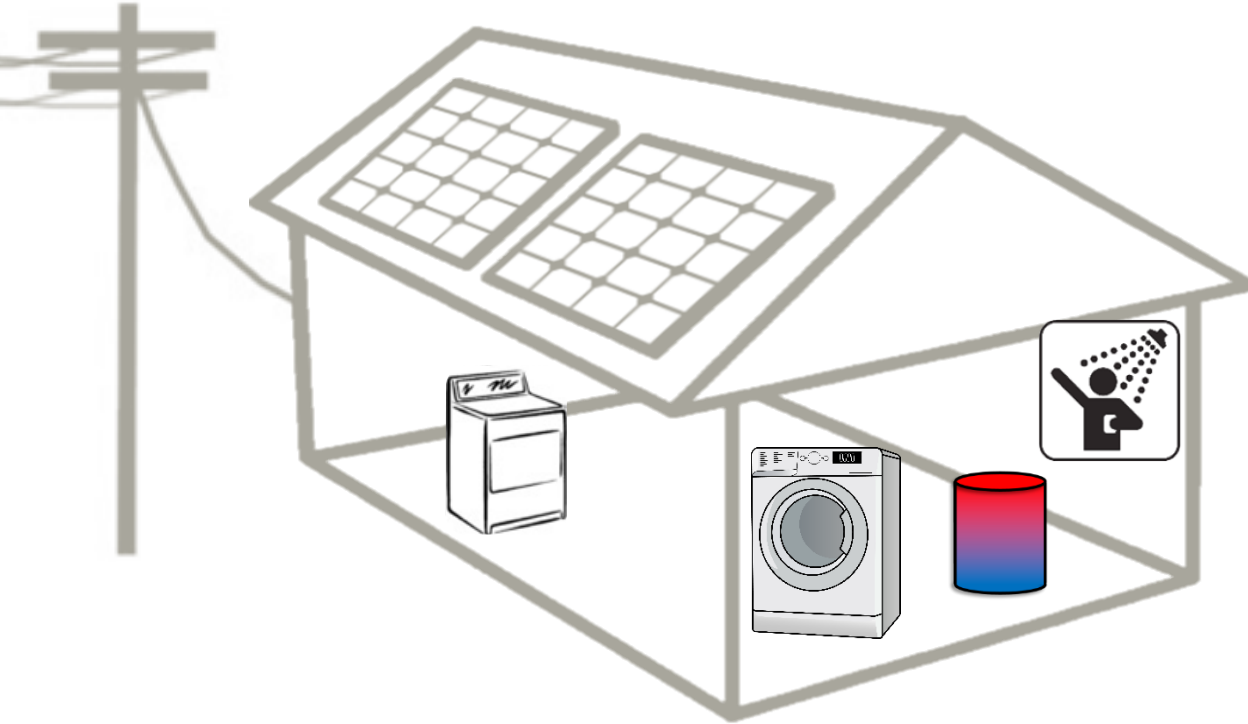
Users  
&  
Developers

**Examples  
&  
Model  
Capitalization**



<https://gricad-gitlab.univ-grenoble-alpes.fr/omegalpes>

# Example on a study case



## Objectif

Maximize self-consumption of photovoltaic



# Create Time and an empty Model

```
time = TimeUnit( periods=24 * 12,  
                 dt=1 / 12)
```

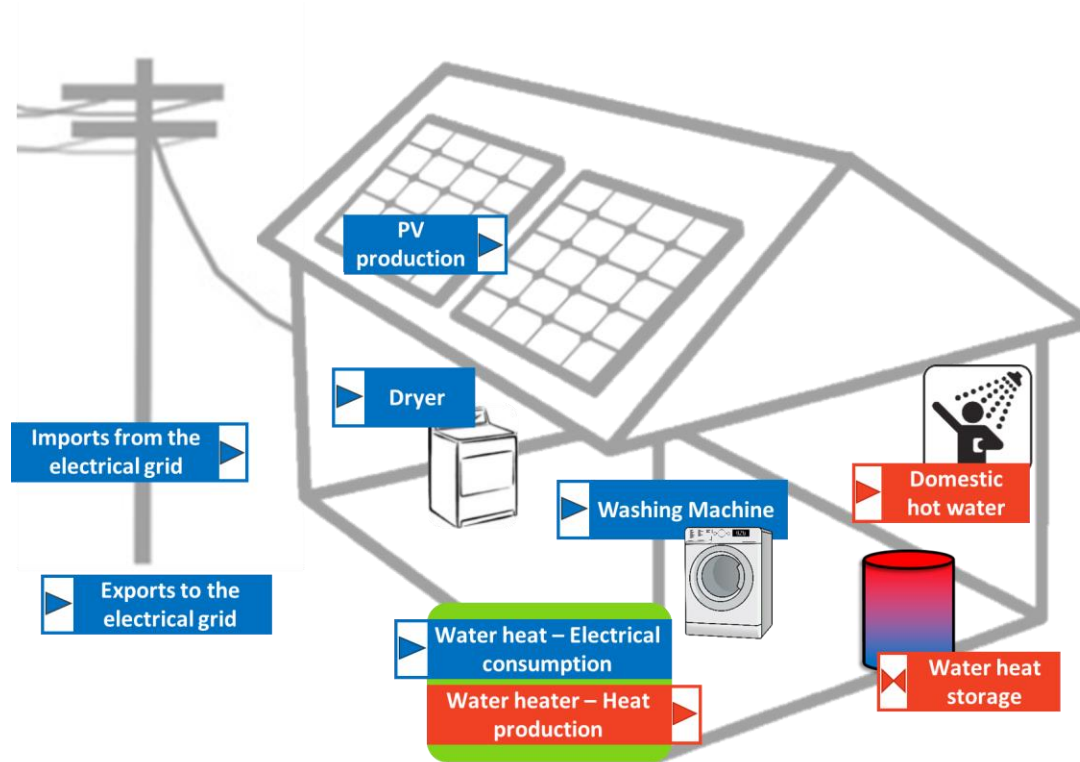
← 24 h period

← 5 min time step

```
model = OptimisationModel(  
    time=time,  
    name='BS_study_case')
```

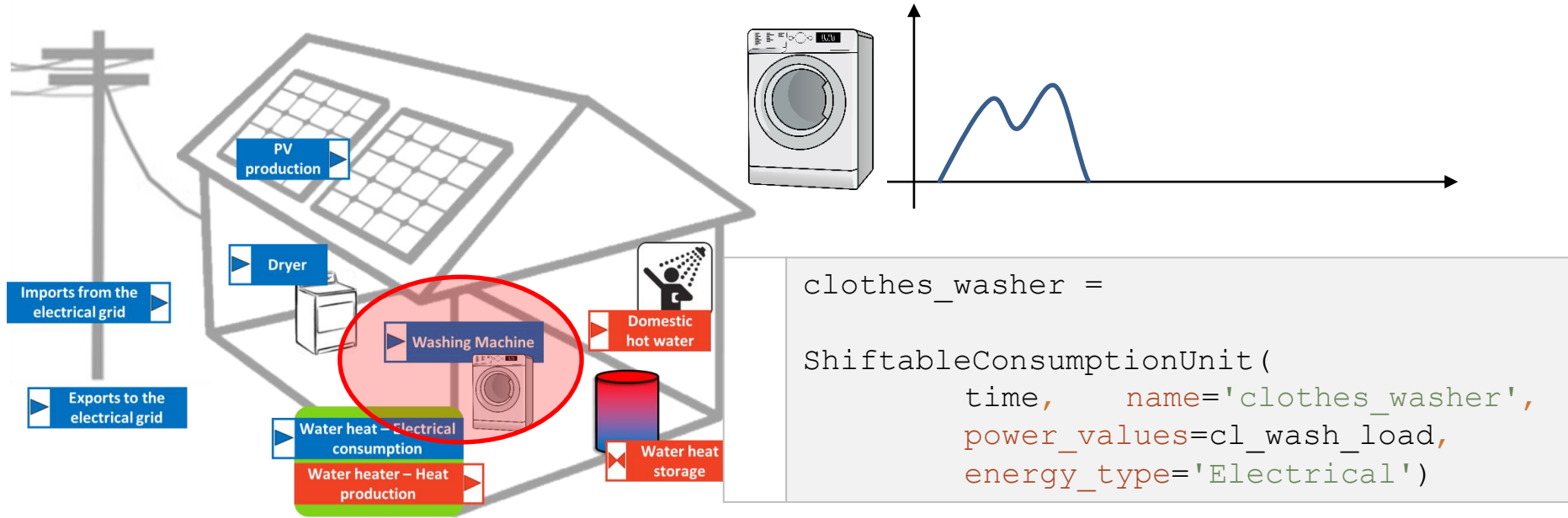


# Create your energy units





# Create your energy units



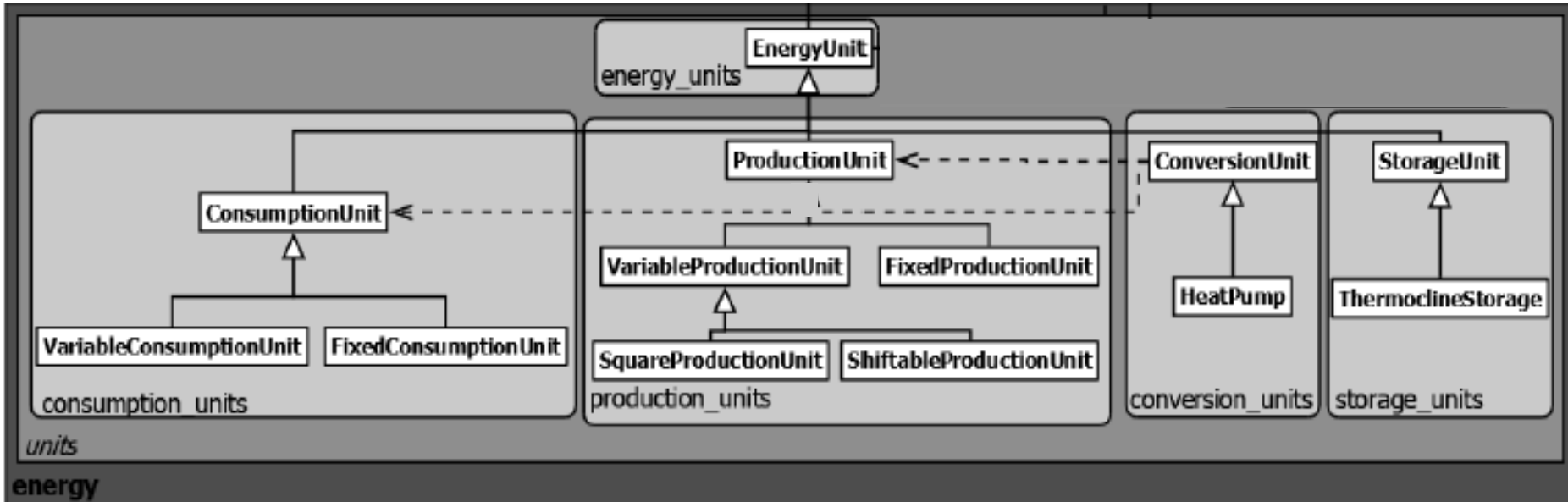
```
clothes_washer =  
  
ShiftableConsumptionUnit(  
    time,    name='clothes_washer',  
    power_values=cl_wash_load,  
    energy_type='Electrical')
```





# Pre-modelled energy units

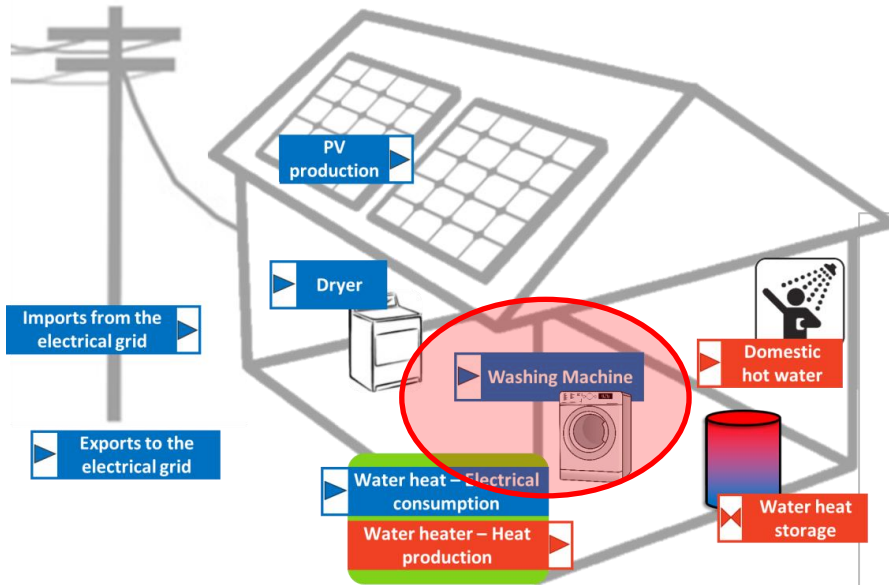
Model  
Capitalization





# Add constraints

Avoid that the dryer starts before the end of the washing



1



clothes\_washer

2



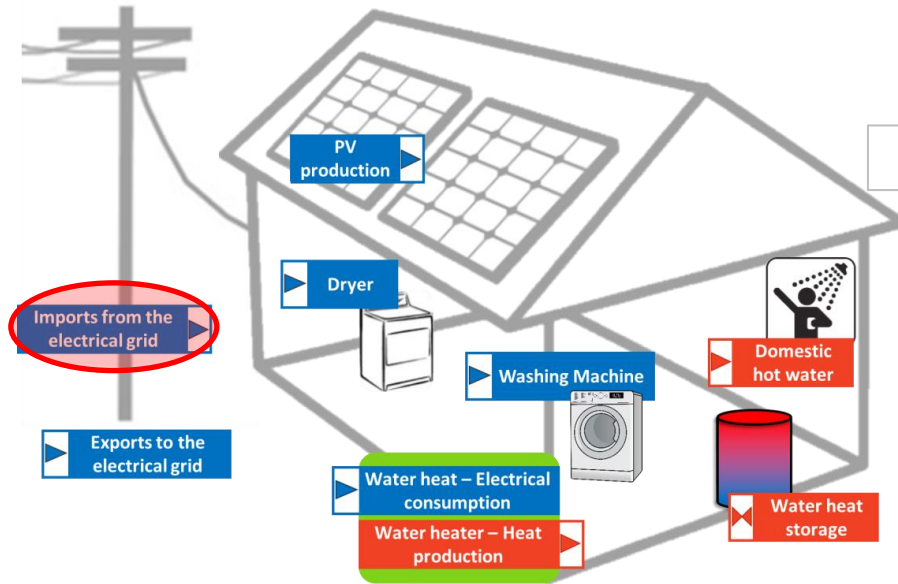
clothes\_dryer

```
wait_to_dry = ExtDynConstraint(  
    name='wait_to_dry',  
    exp_t='clothes_dryer_start_up[t] <=  
        lpSum(  
            clothes_washer_switch_off[k]  
            for k in range(0, t))',  
    t_range='for t in time.I',  
    parent=clothes_dryer)  
  
setattr(clothes_dryer, 'wait_to_dry',  
        wait_to_dry)
```



## Add objectives

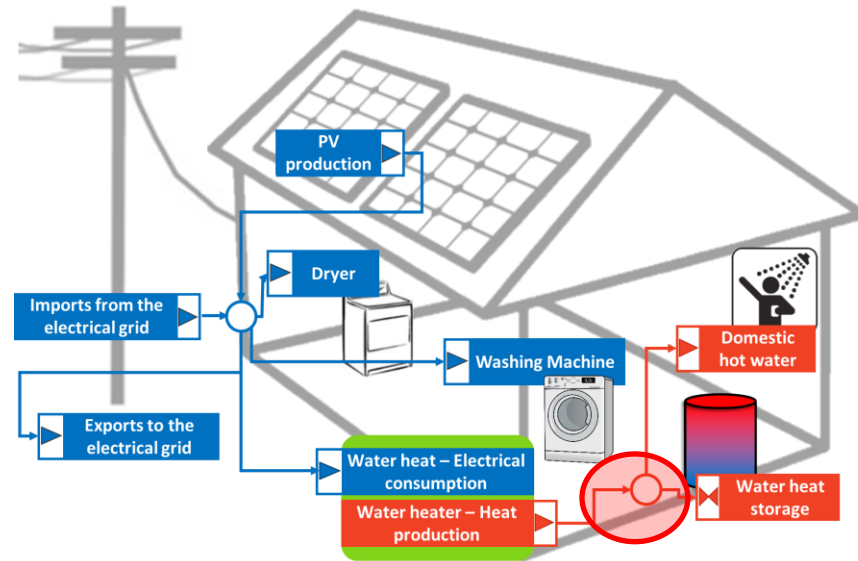
Maximize self-  
consumption of photovoltaic



```
elec_grid_imports.minimize_production()
```



# Create a node and connect the units



```
heat_node = EnergyNode(  
    time,  
    name='heat_node',  
    energy_type='Thermal')
```

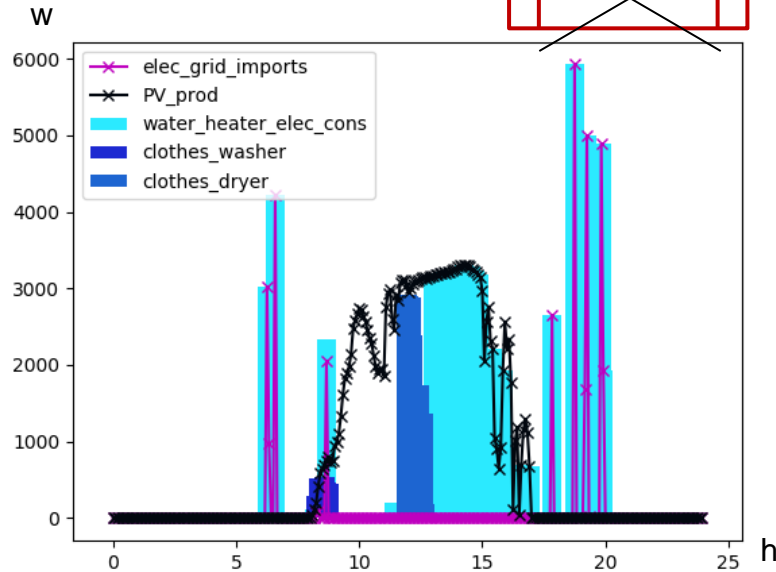
```
heat_node.connect_units(dhw, water_tank,  
    water_heater.thermal_production_unit)
```

```
model.add_nodes(elec_node, heat_node)
```



# Solve and analyse the results

```
model.solve_and_update()
```



## Resolution data

6922 variables

Generation time : 1.2 s

- 2890 continuous

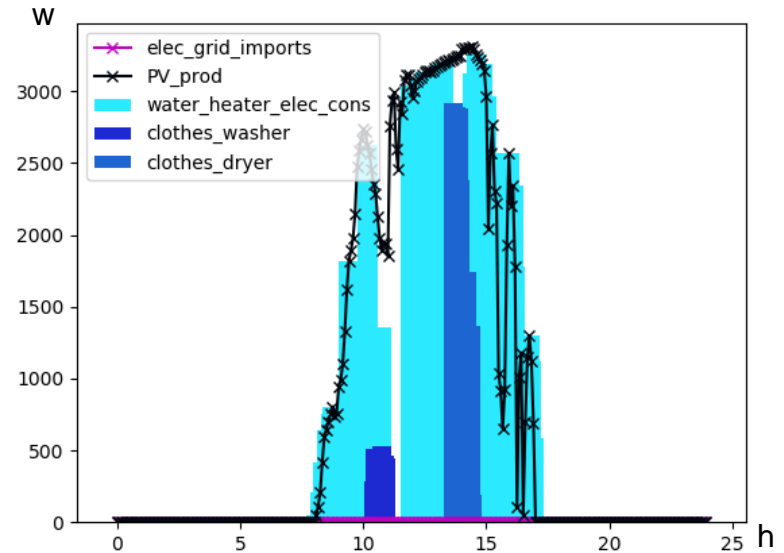
Resolution time:

- 4032 binary

CBC : 43.6 s

Gurobi : 2.5 s

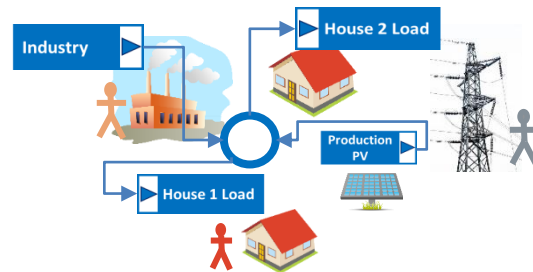
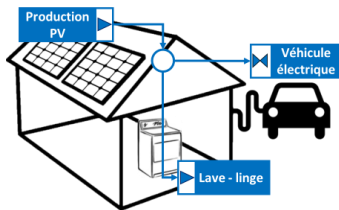
## Min grid import



# Conclusion: OMEGAAlpes

## Energy Model Generation Tool for MILP Optimization

### Macro Modeling: From Building to District scale



**Open Source // Community // Energy Model Capitalization**



<https://omegalpes.readthedocs.io/en/latest/index.html>



**OMEGAAlpes**

Energy Model Generation Tool for Optimization

## Questions and Comments

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<https://omegalpes.readthedocs.io/en/latest/index.html>