

Optimization of a polygeneration system for the TR5 building of the Polytechnic University of Catalunya (UPC) - Terrassa Campus

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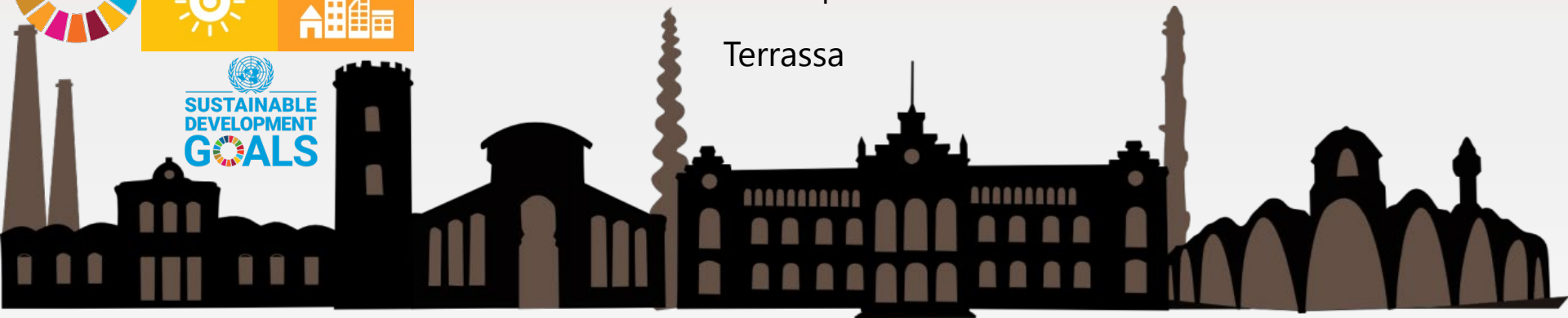
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Terrassa



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Motivation



Climate Change effects



Glaciers melting



Wildfires



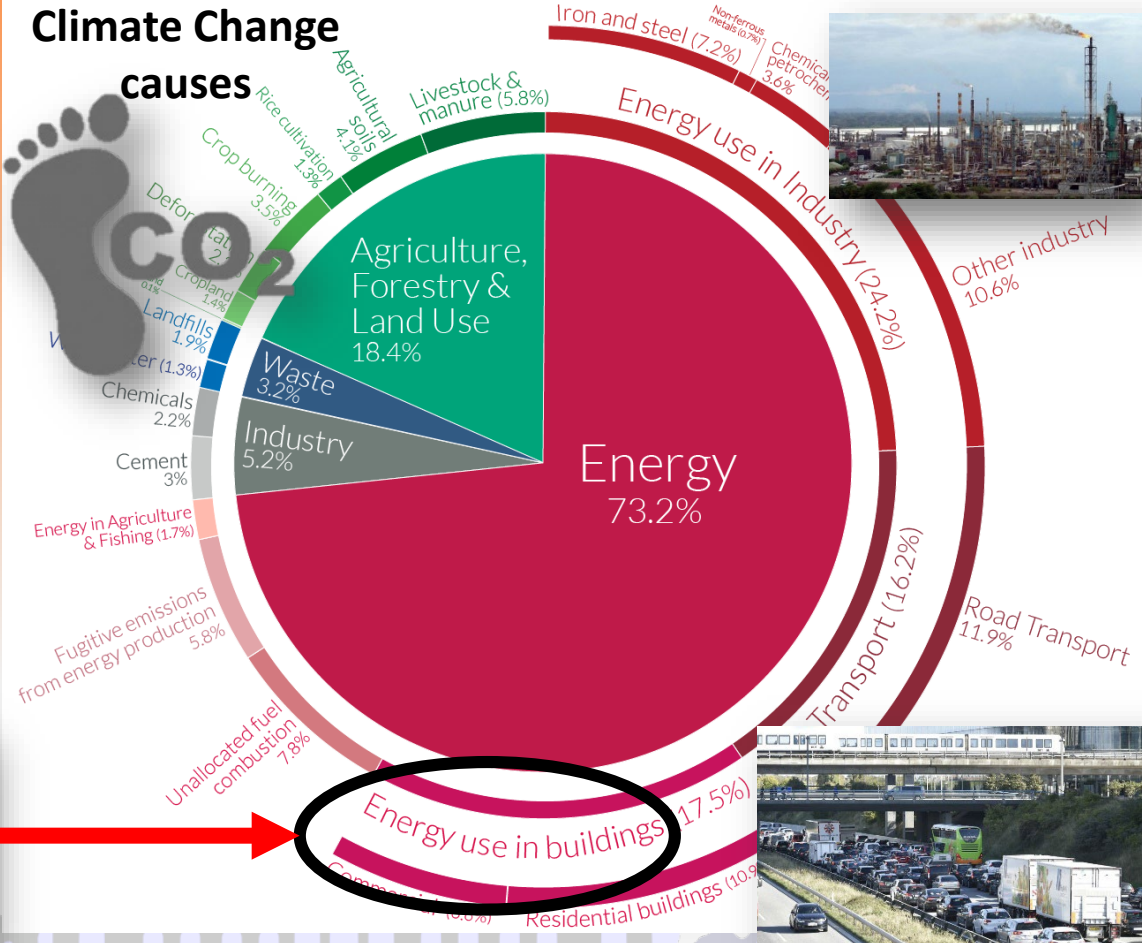
Longer droughts



Global greenhouse gas emissions by sector

Our World in Data

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂e.

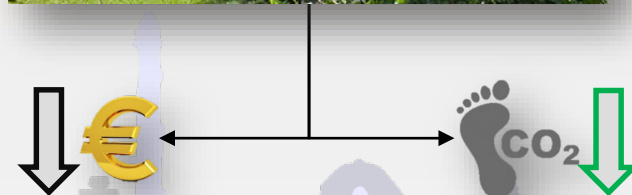


Objective



To optimize a polygeneration system for the TR5 building (UPC) for its energy system retrofit evaluating (to reduce) both economic and environmental impacts.

- **Cooling**
 - **Electricity**
 - **Heating**
- TR5 building**



To reduce...

Technologies to produce electricity/heat/cooling

CM

ACH

Mch

GB

Cogeneration Absorption chiller Mechanical chiller Gas Boiler

Energy storage

TSQ

Heat

TSR

Cooling

BAT

Batteries

Thermal energy storage

PV panels

BB Biomass

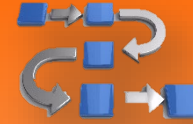
ST Solar thermal collectors

Renewable energy technologies

Electric Grid

Natural gas

Methodology



Data processing



Superstructure



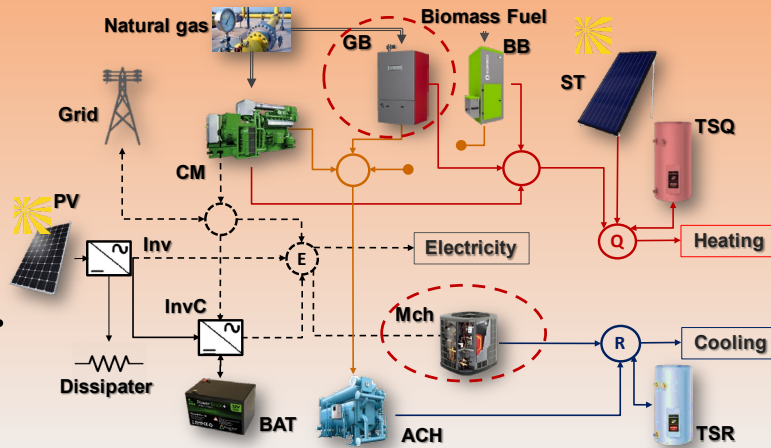
Optimization model

Energy demands

Renewable Energy production

Hourly CO₂ emissions from the electric grid

Electricity prices



MILP model

Objective function

$$Min f(x) = \text{€}$$

$$Min(\text{Total annual cost})$$

Simultaneously Annual CO₂ emissions are evaluated

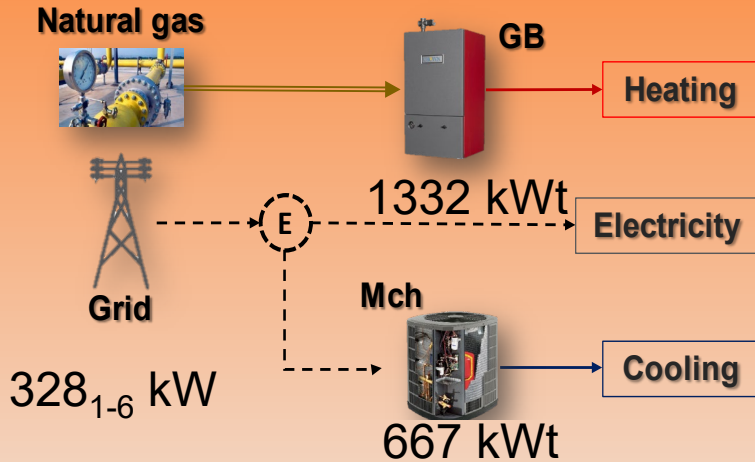


Results

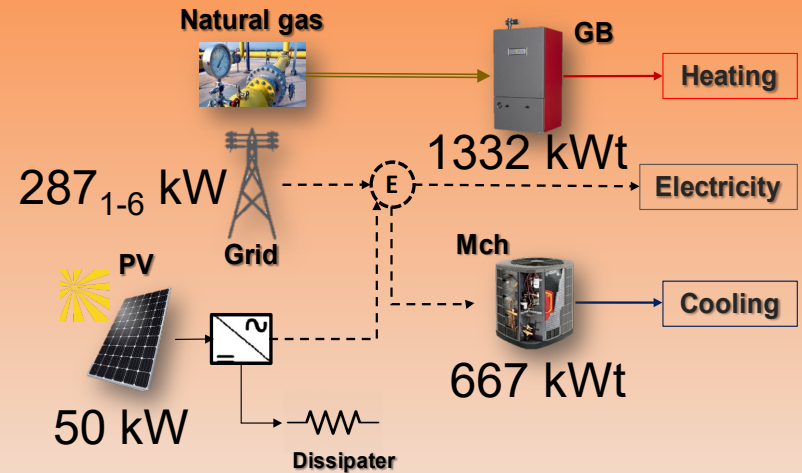


Energy prices 2017...

Current energy system



Optimal configuration of the polygeneration system



196808 €/yr

Simple payback ~ 11 years



195694 €/yr

Fixed 21682 €/yr

Operational 175125 €/yr



Fixed 33951 €/yr

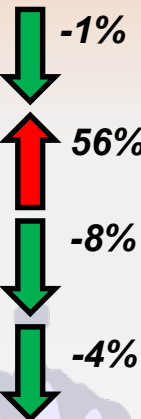
Operational 161743 €/yr



438896 kgCO₂eq/yr



421731 kgCO₂eq/yr

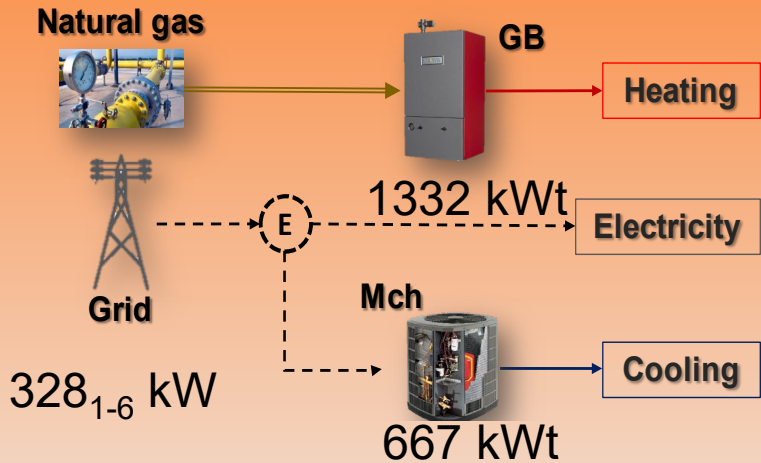


Results

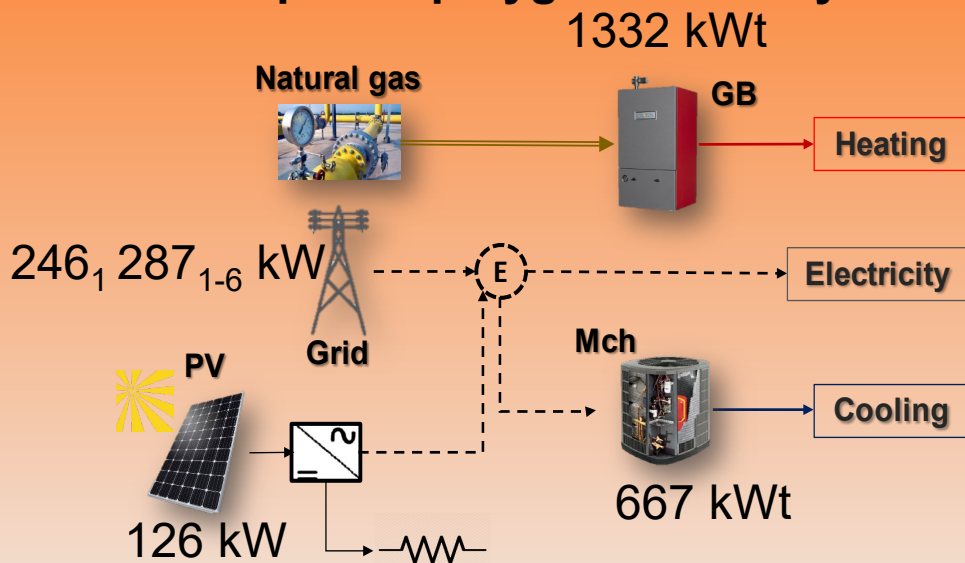
What if...

...Double both electricity and natural gas prices

Current energy system



Optimal polygeneration system



315600 €/yr

Simple payback ~ 8 years



300132 €/yr

Fixed 21682 €/yr

Fixed 52371 €/yr

Operational 293918 €/yr

Operational 247761 €/yr



438896 kgCO₂eq/yr



396653 kgCO₂eq/yr



-5%



142%



-16%



-10%



Conclusions

- A MILP model was applied to evaluate the energy system retrofit of the TR5 building. The results have shown that Polygeneration systems allow to reduce both economic and environmental costs.
- PV panels was the technology selected in all cases allowing the reduction of both economic and environmental costs
- *Although this work was focused on a building, in a similar way the methodology could be applied to the industrial sector, for instance **textile industry**, in order to reduce both economic and environmental costs.*



Moltes Gràcies!

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Any question??



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