

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

Edwin S. Pinto^{1,2}, Beatriz Amante¹

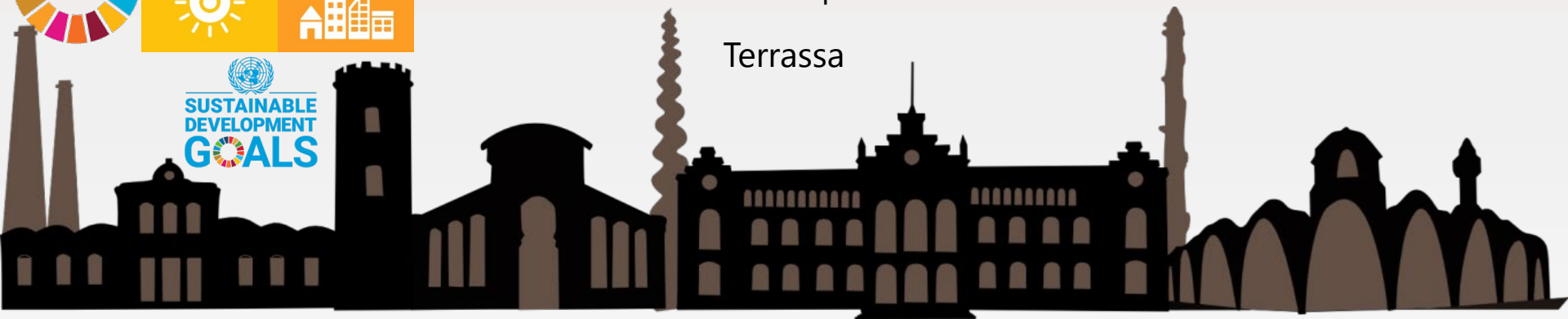
¹Polytechnic University of Catalunya, Terrassa-Spain

²University of Zaragoza



11 de Noviembre de 2022 | 11th November 2022

Terrassa



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Motivation



Climate Change effects



Glaciers melting



Wildfires



Longer droughts

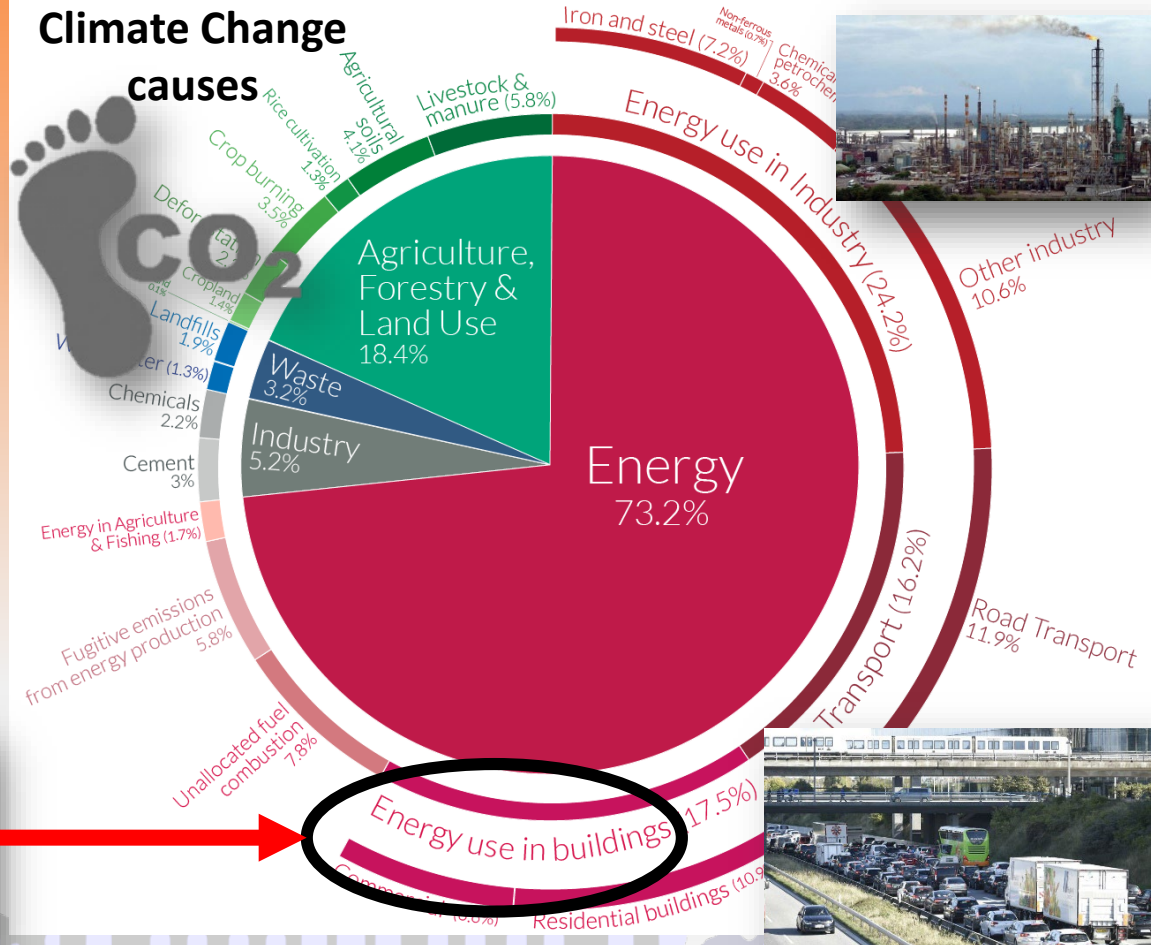


Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO₂eq.

Our World in Data

Climate Change causes



Objective



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

PV panels BB Biomass ST Solar thermal collectors

Renewable energy technologies

Technologies to produce electricity/heat/cooling

CM ACH Mch GB

Cogeneration Absorption chiller Mechanical chiller Gas Boiler

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



Electric Grid

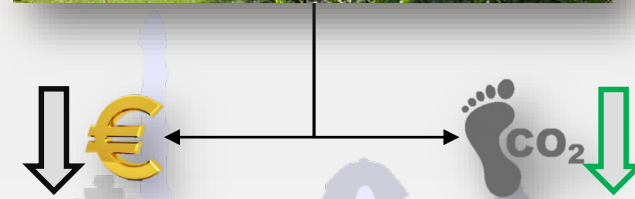
Natural gas

Energy storage

TSQ TSR BAT

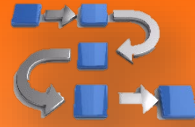
Heat Cooling Batteries

Thermal energy storage



To reduce...

Methodology



Data processing

Superstructure

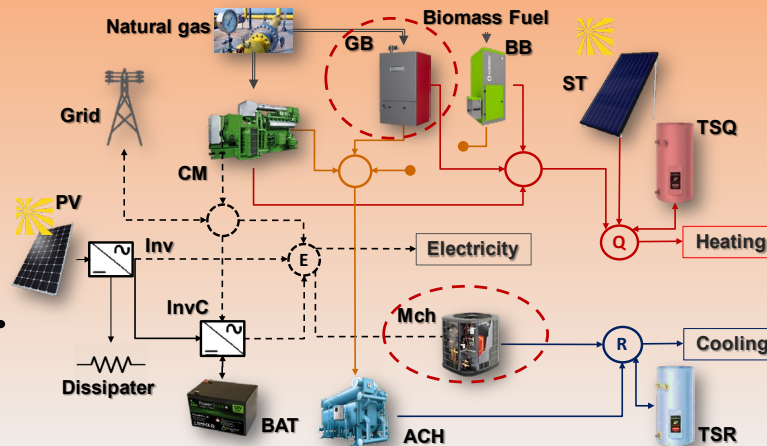
Optimization
model

Energy
demands

Renewable
Energy
production

Hourly CO₂ emissions
from the electric grid

Electricity prices



MILP model

Objective function

$$\begin{aligned} \text{Min } f(x) &= \text{€} \\ \text{Min}(\text{Total annual cost}) \end{aligned}$$

Simultaneously Annual CO₂ emissions are evaluated

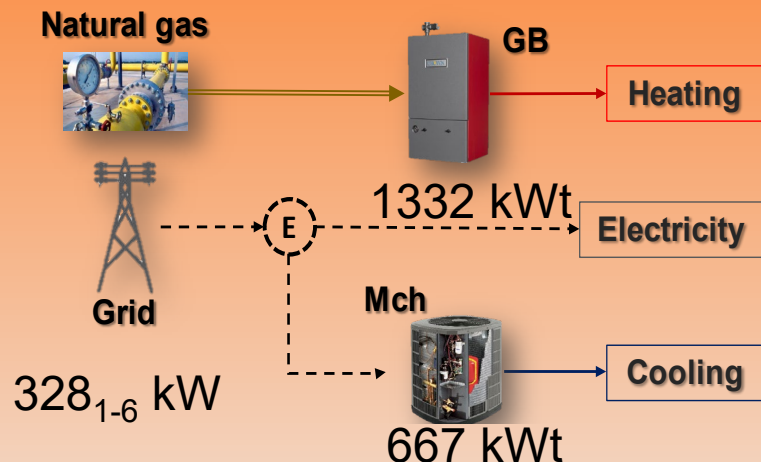


Results

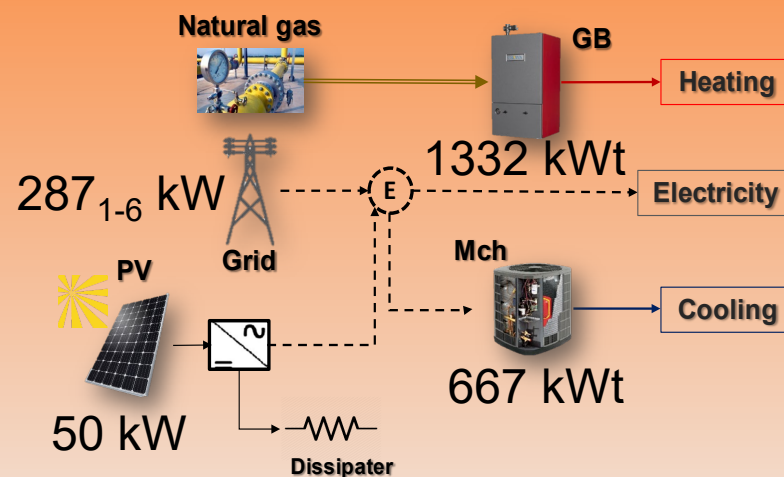


Energy prices 2017...

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



-1%



56%



-8%



-4%

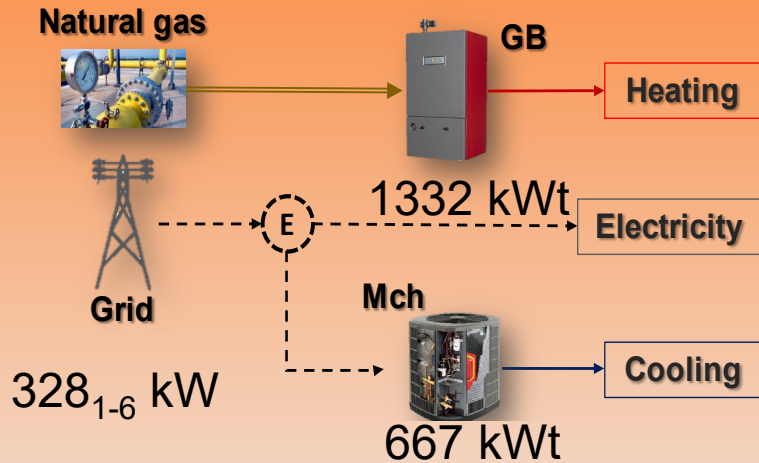
Results



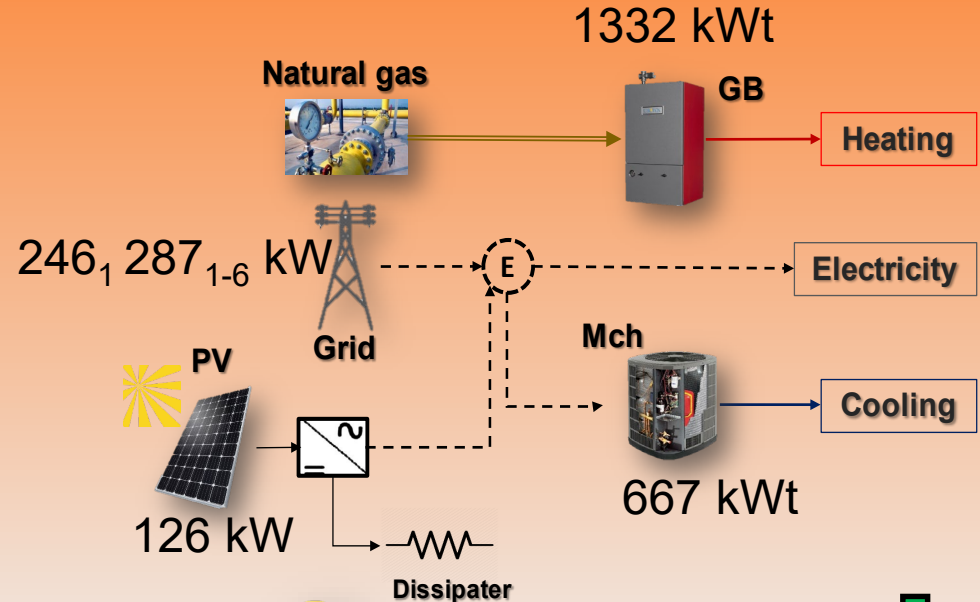
What if...

...Double both electricity and natural gas prices

Current energy system



Optimal polygeneration system



315600 €/yr

Simple payback ~ 8 years



300132 €/yr

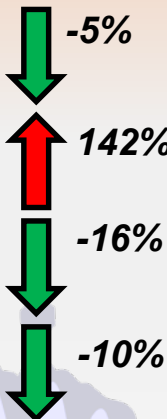
Fixed 21682 €/yr

Operational 293918 €/yr

CO₂ 438896 kgCO₂eq/yr

Fixed 52371 €/yr

Operational 247761 €/yr

CO₂ 396653 kgCO₂eq/yr

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!

Edwin S. Pinto^{1,2,*}, Beatriz Amante¹

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Any question??



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