



# Decarbonization strategy by optimizing design and operation of an energy concept

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## Energy Concept

An energy concept provides electricity and heat for industrial processes using combination of available different renewable energy sources such as photovoltaic, wind turbine, and solar thermal collector system combined with energy conversion power-to-heat components such as heat pump, electric boiler and gas boiler.

## Objective: minimum CO<sub>2</sub> emission (GWI) and Total Annualized Cost (TAC)

The complex problem of minimizing cost and emission requires two major tasks: (I) modeling of components and (II) multi-objective coupled design and operation optimization of the energy concept.

### ➤ Design Optimization:

Optimal choice and capacity of the components in the superstructure.

### ➤ Operation Optimization:

Optimal schedule and physical conditions under which the energy components are operated.

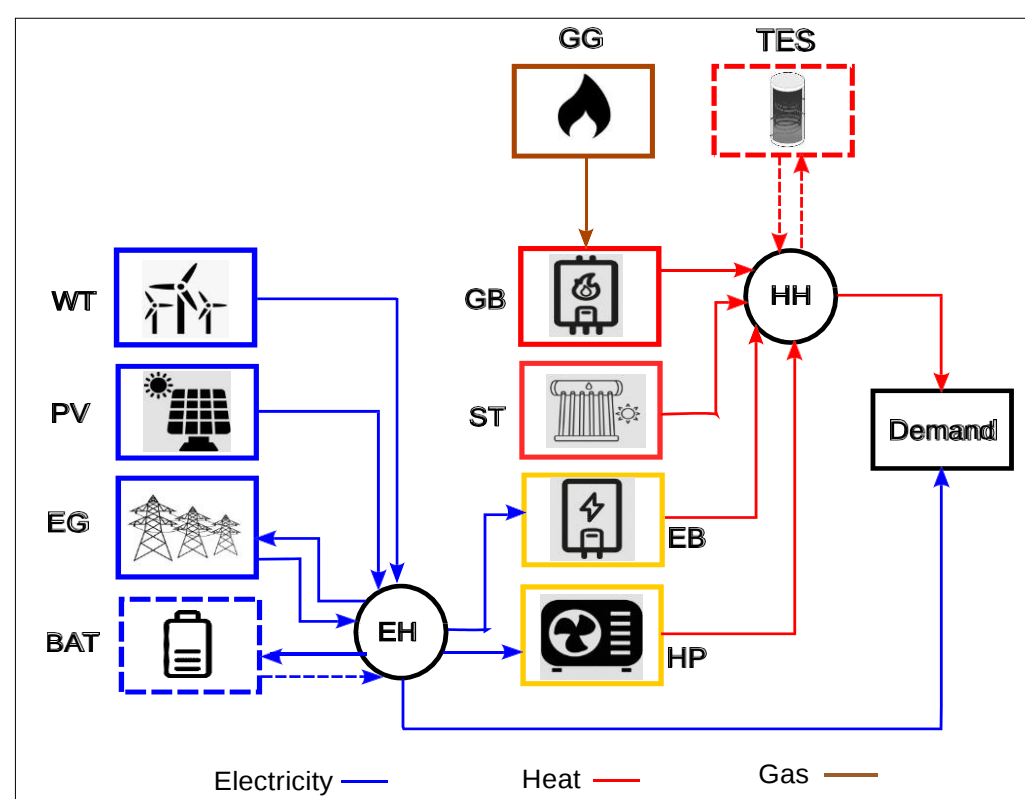


Figure 1: Concept of Integrated Energy System

### Optimal Design of Energy Components:

Optimal capacity of the components at different pareto-front results of multi-objective coupled optimization.

### Different Scenarios:

Pareto-fronts of the different design scenarios of the energy concept compared to the status-quo, which includes GB and PV at certain capacity.

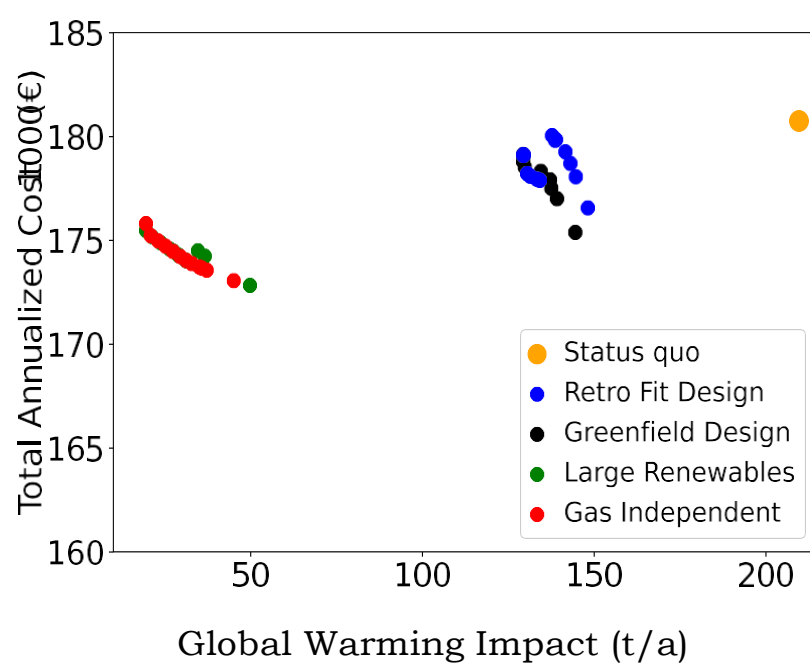


Figure 2: Pareto-fronts of different scenarios

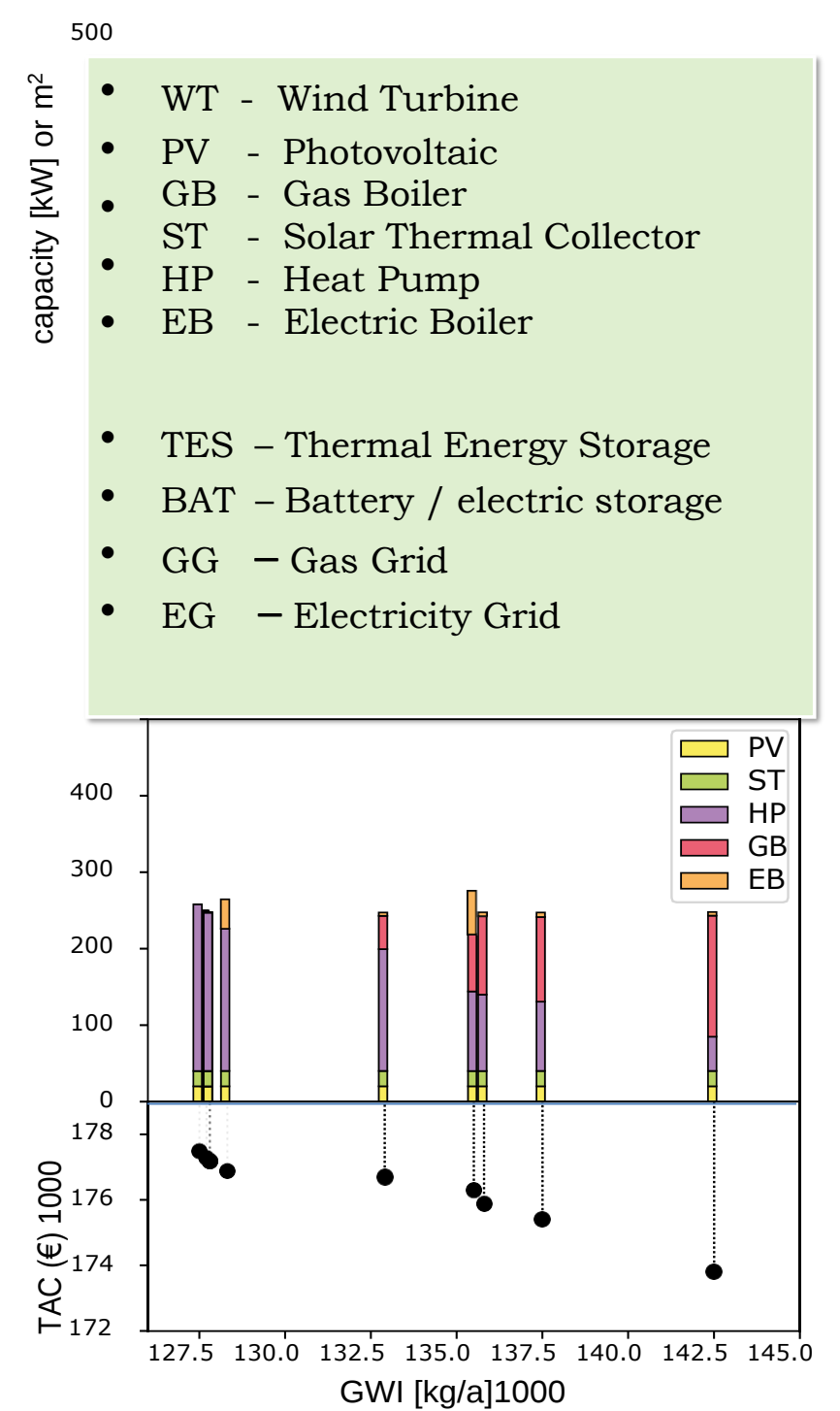


Figure 3: Optimized capacity for Greenfield Design

## Decarbonization and Cost - reduction potential:

| Energy Concept    | Decarbonization | Cost Reduction |
|-------------------|-----------------|----------------|
| Status quo        | 0 %             | 0 %            |
| Retro Fit Design  | 38 %            | 1.2 %          |
| Greenfield Design | 38.5 %          | 2 %            |
| Large Renewables  | 91 %            | 3.4 %          |
| Gas-Independent   | 91.1%           | 3.2 %          |

## Key points:

- Multi-objective coupled design and operation optimization is a complex mathematical problem.
- Different superstructure scenarios are presented for minimum TAC and minimum GWI.
- Maximum decarbonization potential up to 91% is shown by Gas-Independent design and maximum total cost-reduction up to 3.4 % is shown by Large Renewables design.

Decarbonization of the existing industrial processes requires optimization of the operation with the optimal capacity of the newly integrated energy components in the energy concept to achieve minimum total cost. Different scenarios give the industrial stake-holders the opportunity to decide on prioritizing their demands and requirements. Coupled design and operation optimization of the energy concept has shown large potential in decarbonizing the industrial processes.