**Course name:** Polygeneration and Advanced Energy Systems

**Project name:** Feasibility Study of SOFC installed on Ivrea WWTP

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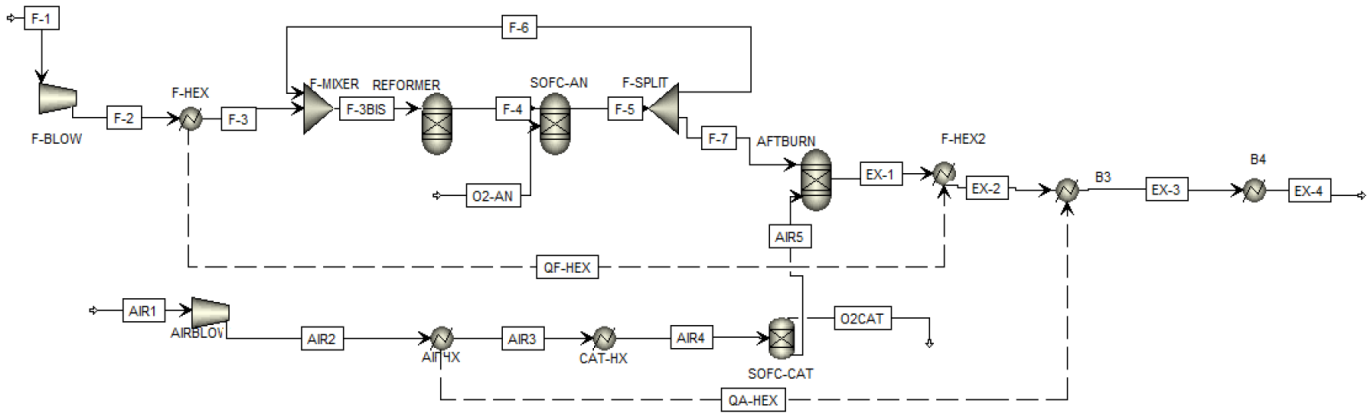
## Introduction:

The aim of this report is to check the possibility of exploiting produced biogas by anaerobic digestion from a wastewater treatment plant (WWTP) to run a Solid Oxide Fuel Cell (SOFC) and obtain heat and electricity. Ivrea, in Italy was chosen as the case study city and its information regarding population and wastewater treatment plant's capacity was used to determine the available biomass. The proposed process is then simulated by Aspen Plus software. Using the information provided by the simulation the amount of heat and electricity produced by the fuel cell is calculated. In the subsequent parts CAPEX and OPEX of this plant are calculated and several strategies to obtain maximum profit from this plant are discussed and, in the end, it is determined whether this plant is feasible or not.

## SOFC Simulation in Aspen Plus:



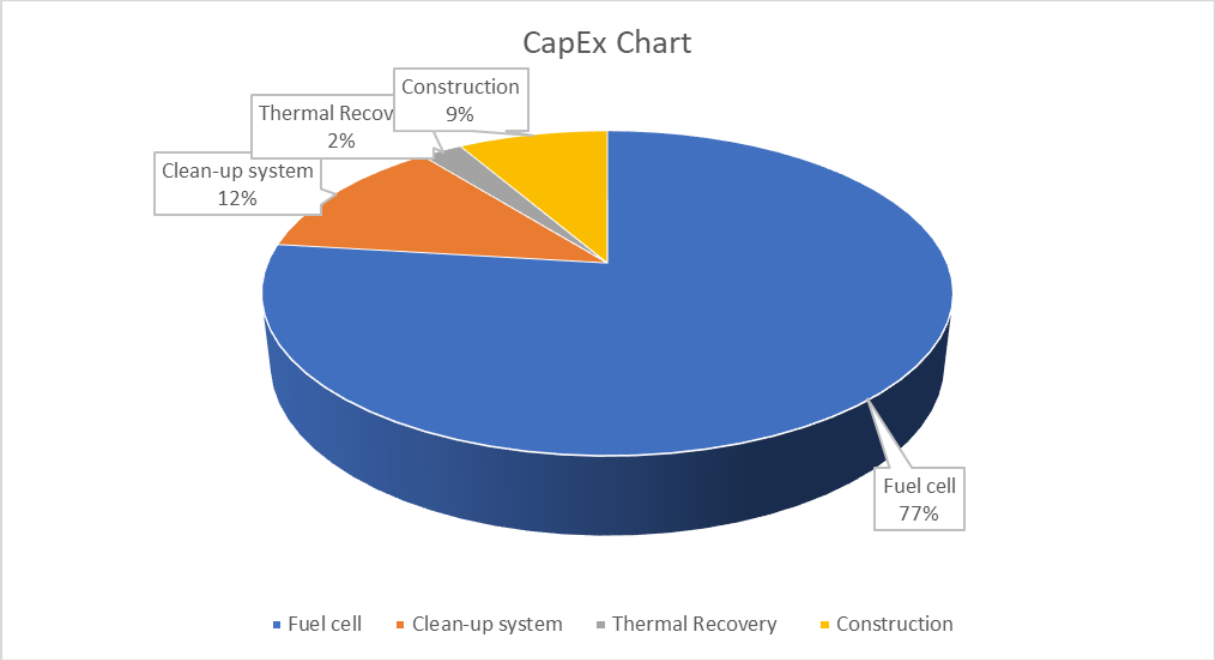

*The overall simulation is Aspen Plus.*

Biogas and air are the primary feed streams. Before entering both streams are pressurized by a blower and heat up using the available heat from fuel cell. Biogas is then converted to Hydrogen over catalyst in Methane Reformer after it is mixed with steam and heat which are coming from the fuel cell.
Since there weren't any fuel cell unit available in Aspen Plus, two Gibbs equilibrium reactors and a heater is used to represent the fuel cell. Products exiting from outlet are separated. One stream is recycled to Methane Reformer, while the other stream is burnt in Afterburner to produce the necessary heat.

| Parameters | Values | Unit |
|---|---|---|
| Biogas stream | 25 | m3/h |
| Mass flow | 0.008 | Kg/s |
| Electricity Produced | 98.4 | kW |
| Blower (Air) | 1.5 | kW |
| Blower (Fuel) | 0.3 | kW |
| Thermal power available | 38.9 | kW |
| AC net | 91.8 | kW |

*Overall summary of power production*

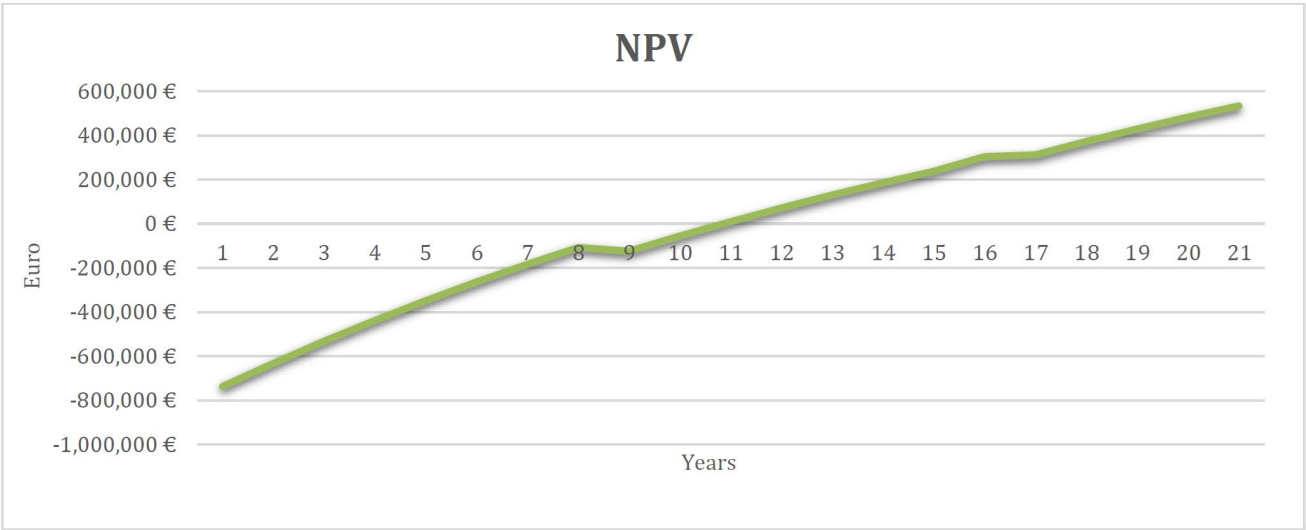
## Economic Analysis:



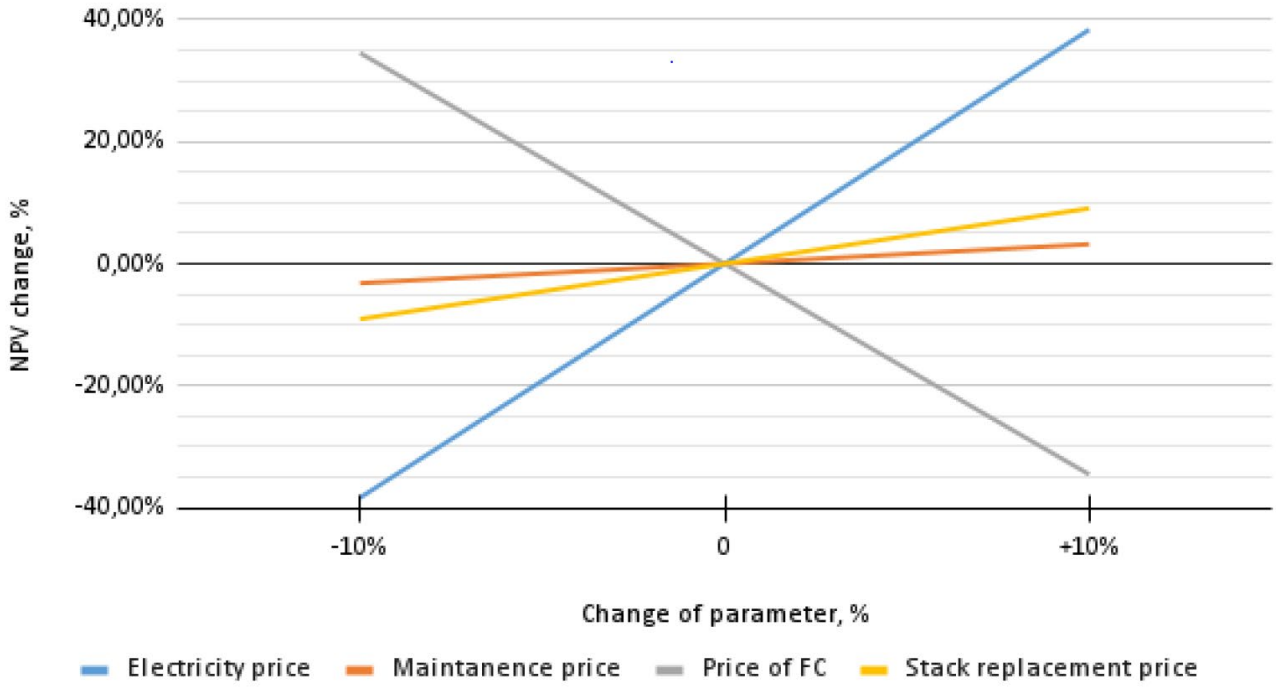

*CapEx Composition.*

| OpEx | Amount, € | Frequency |
|---|---|---|
| Wage of operator | 600 | Every week |
| Catalyst refresh | 208 | Annually |
| Maintenance | 29,838 | Annually |
| Stack Replacement | 275,414 | Every 5 years |

*OpEx for each part.*




*Cash flow of the plant.*




*Sensitivity analysis.*

## Conclusion:

Biogas and air are the primary feed streams. The proposed plant was successfully simulated using Aspen Plus. From the economic and subsequent sensitivity analysis, it can be seen that electricity price and price of Fuel Cell have a great impact on NPV after 20 years. By changing either of them by 10%, variation of 38% in NPV can be obtained. This means that such project will become very interesting from financial point of view as SOFC price goes lower.