Cost efficient use of energy in Spanish ceramic industries

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Introduction

Castelló is one of the fifty provinces in Spain. The province is situated on the East part of the Iberian Peninsula. The population of the province of Castelló is of around 575.000 habitants, and of the municipality of Castelló is around 170.000 habitants, although these values are quite low, they have one of the most powerful ceramic industries in the world.

The goal of this project work is to minimize the use of energy at lowest possible system cost for industry processes in these companies. By doing this we will also helping to reduce CO_2 emissions because those industries are high in energy use.

Most of the industries we are going to deal with are in the municipality of Castelló, therefore the introduction of cogeneration plant is not an unrealizable idea, because the companies are close to each other.

Objectives and limitations

The objective of this project is to find which is the optimal solution (system cost) to produce the energy demand in the ceramic industry in the area close to Castellon city using MODEST.

Following are some limitations:

- The companies, which provided the data, are located in an area of 360 km^2.
- We were able to contact only seven companies to provide the data therefore the analysis of Castelló area is partial.
- Also part of the heat demand cannot be covered with a CHP plant because the process of firing requires a level of temperature that cannot be supplied by the CHP plant.

Research questions

- What does the project discuss?
- How are we going to improve the energy efficiency?
- Can we cover the heat demand by using urban waste?
- Is there a reduction on the CO_2 emissions?
- Does the new installation have a real reduction in the system cost at long term?
- Electricity production - What are the options?

Method

The MODEST energy-system optimisation model calculates how energy demand is covered at lowest possible cost. MODEST can include energy flows from sources via conversion and distribution to demand and measures influencing demand. An analysed energy system can consist of many different kinds of equipment and demand, which are represented with chosen level of details. MODEST is an acronym for Model for Optimisation of Dynamic Energy Systems with Time dependent components and boundary conditions.

The most valuable results that MODEST can offer us are the next ones:

- Best use of energy carriers and demand-side measures in each time period.
- Optimal types, sizes and occasions for investments.
- Time-dependent marginal cost for covering demand.
- Total cost and annual cash flow of costs and revenues.
- Emissions.
- Duration diagram of energy supply.

Case studies

- Case 0: Original case.
- Case 1: Case 0 + natural gas CHP (without investment costs).
- Case 2: Case 0 + urban waste CHP (without investment costs).
- Case 3: Case 0 + biomass CHP (without investment costs).
- Case 4: Case 0 + biomass boiler (without investment costs).
- Case 5: Case 0 + all above technologies (without investment costs).
- Case 6: Case 0 + natural gas CHP (with investment costs).
- Case 7: Case 0 + urban waste CHP (with investment costs).
- Case 8: Case 0 + biomass CHP (with investment costs).
- Case 9: Case 0 + biomass boiler (with investment costs).
- Case 10: Case 0 + all above technologies (with investment costs).

Conclusions

- The earnings with the investment cost are lower because we have to pay for the installation of the plant
- The only technology which doesn't generate earnings is the biomass boiler, so this is the least advisable to implement.
- The best technology in the actual scenario (electricity price = 1000kr/MWh) is the natural gas CHP plant
- If the electricity price goes down low enough (904 SEK/MWh) urban waste CHP plant becomes the first option.
- We can reduce 57.9 thousand tons of CO_2 each year if biomass CHP is chosen. This option is highly recommended in order to reduce CO_2 emissions. Also the biomass can be provided from the Castelló area as 70.000 tons of biomass are available to use for incineration in CHP.
- As we show, each of the technologies provides a benefit in the long term.
- The electricity produced from natural gas CHP plant (257.6 GWh) will be sold to the market.
- For the best case with natural gas CHP plant we have following benefits compared with original case:
    - Profitability of 1395.3 MSEK for 10 years.
    - Emission of 113.000 tons of CO_2 each year. Which are 55.000 tons of CO_2 more than the original case. Compared to the original case this emissions are higher but taking into account that we are also producing electricity we are preventing marginal coal condensing power plants for from emitting more CO_2. The average emission for 1 MWh from marginal coal condensing power plants is 1000 kg of CO_2.
    - The amount of used natural gas in CHP plant is 565.1 GWh/year.
    - The electricity produced from natural gas CHP is 257.6 GWh/year and the CHP plant has a maximum power of 30 MW electricity.