46750 - Optimization in Modern Energy Systems
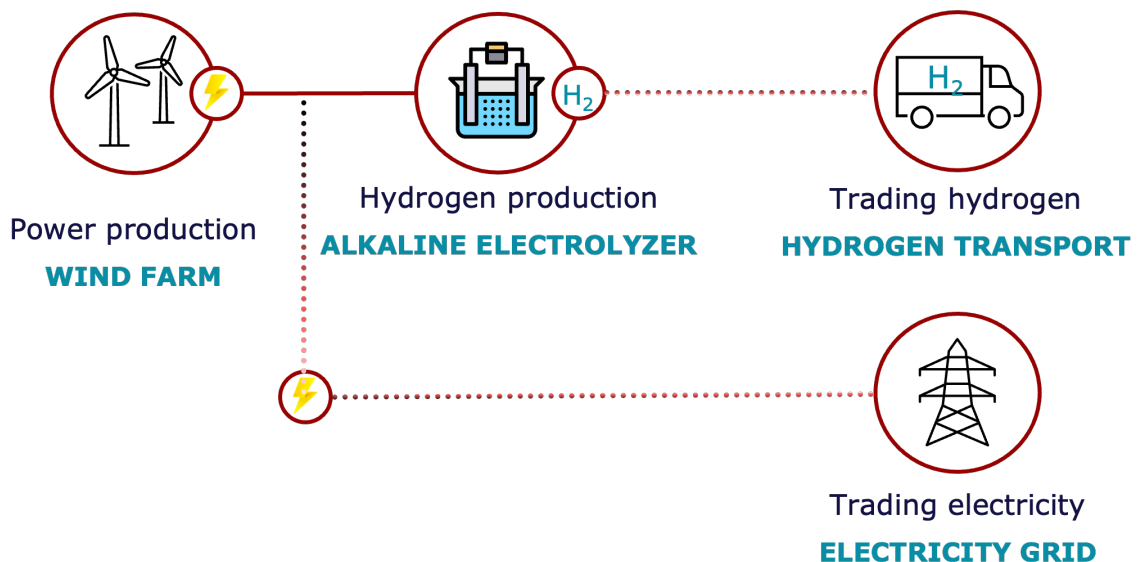## Exercise 1

Name:

Student Number:

1. **Bestas' Problem**

Bestas Energy is an energy utility company that operates a hybrid power plant consisting of two main components: a wind turbine and an electrolyzer. The wind turbine generates $\overline{W} = 200$kWh of electricity. The company has two options for utilizing this energy:

1. Sell the electricity directly to the grid at a rate of $\lambda^E = 10$DKK/kWh. However, the amount of electricity that can be sold directly to the grid is restricted by the grid connection capacity, which is limited to $\overline{E} = 100$kWh.

2. Convert the electricity into hydrogen and sell it at a rate of $\lambda^H = 15$DKK/kWh. The electrolyzer uses electricity to produce hydrogen with a conversion efficiency of $\rho^H = 0.8$ and has a maximum hydrogen production capacity of $\overline{H} = 100$kWh.

Power production
WIND FARM

Hydrogen production
ALKALINE ELECTROLYZER

Trading hydrogen
HYDROGEN TRANSPORT

Trading electricity
ELECTRICITY GRID

Bestas wants to optimize its production of electricity and hydrogen to maximize its profits.

(a) Formulate this decision-making problem as an optimization problem, and detail its decision variables, objective, and constraints.

(b) Plot the feasible region of this optimization problem and solve it graphically. What can you say about the existence and uniqueness of an optimal solution?

(c) Now consider that the electricity price is $\lambda^E = 12\mathrm{DKK/kWh}$, while all other parameters remain unchnaged, and answer Question (b) for this new value.

(d) Complete the Gurobipy tutorial provided on DTU Learn where the optimization problem from Question (a) will be solved using Python.