1. Onsite electrolysis => exercise

- Q: How big an electrolyser is needed to produce the daily amount of H_2 for a filling station (HRS), under the following assumptions?:
  - 1000 cars/day, equivalent of 50 L gasoline/car (LHV_gasoline: 33MJ/L
  - car average consumption : 7L/100km
  - a FCEV consumes 1 kg H_2/100km (HHV_H_2 : 142 MJ/kg)
  - electrolyser efficiency 78% HHV
  - compression energy needed to 400 bar
  - the electrolyser operates 50% of the time

Answers

- filling station, 1000 cars/day, 50 L gasoline/car
- 50’000L gasoline/day yields 50000/7 = 7143 kg H_2 /day in terms of equivalent consumption = 1014 GJ/day
- electrolyser efficiency 78% →1300 GJ/day
- compression to 400 bar : roughly 8% of HHV needed=> requires 126 (from equation)
- total need of 1400 GJ/day
- 50% load = 12h : 1400 GJ/12h = 32 MW electrolyser

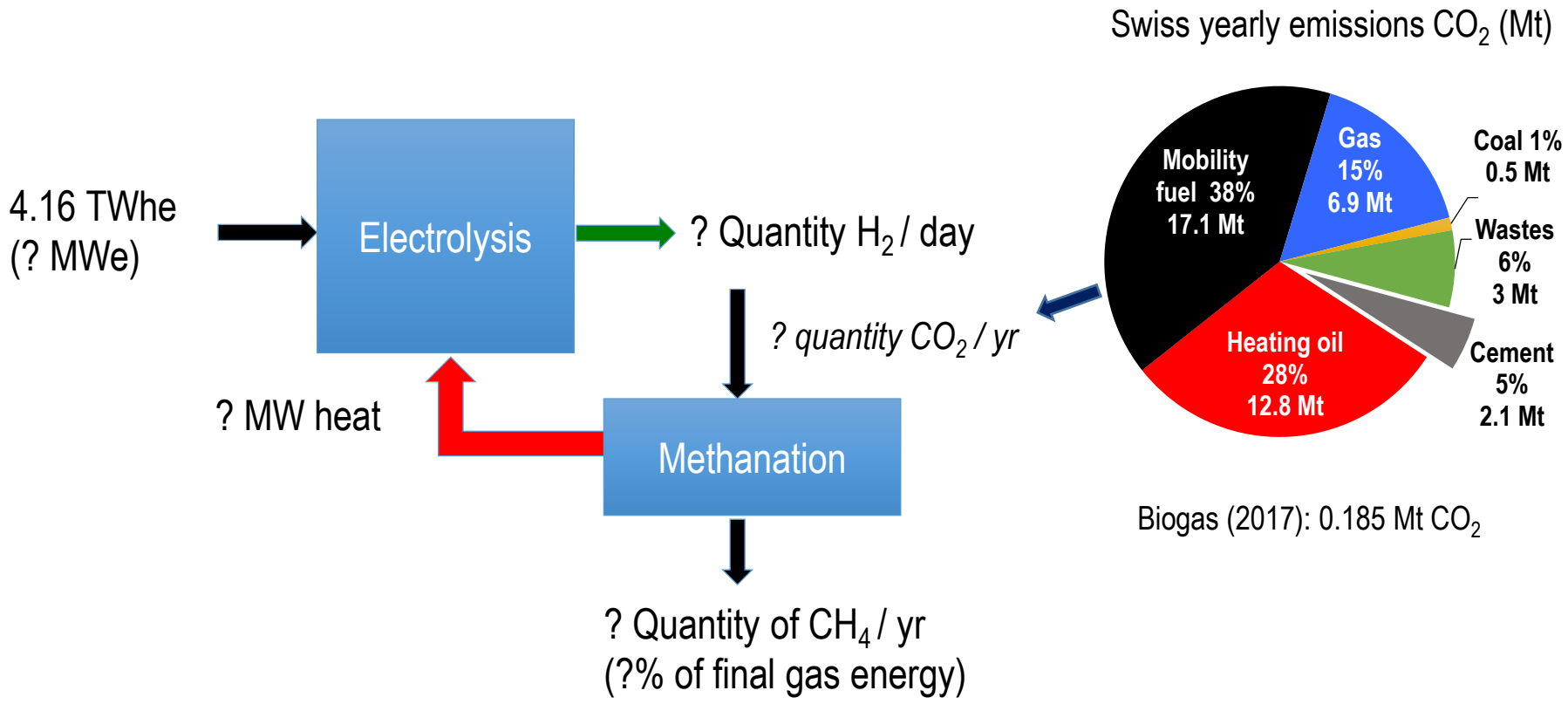
2. Exemple: P2G instead of hydro-pumping (CH - 2017)

Electrolyser efficiency = 90% LHV

Methanation conversion rate = 95%

Energy of formation at 200 C = 177524 J/mol CO2

Assuming the H2 and CO2 enter and leave the reactor at 200C, solve for each missing values.



Objective « 30/30 » of Swiss gas industry: 30% of renewable gas in the grid by 2030

Answers

- 1 yr = 8760 hours ⇒ $475\ MWe$

- With $LHV_{H_2} = 241\ kJ/mol$ ⇒ $170.29\ Mmol/day$
- PV=NRT ⇒ $V = 3.8\ NMm^3 H_2/day$
- $CO_2 + 4H_2 \Rightarrow 2\ H_2O + CH_4$

$$N_{CO_2} = \frac{170.29}{4} = 42.57\ Mmol/day$$

Thus, $m_{CO_2} = N_{CO_2} \times \frac{44}{1000^2} \times 365 = 0.684 Mt\ CO_2/yr$

With conversion = 95 %

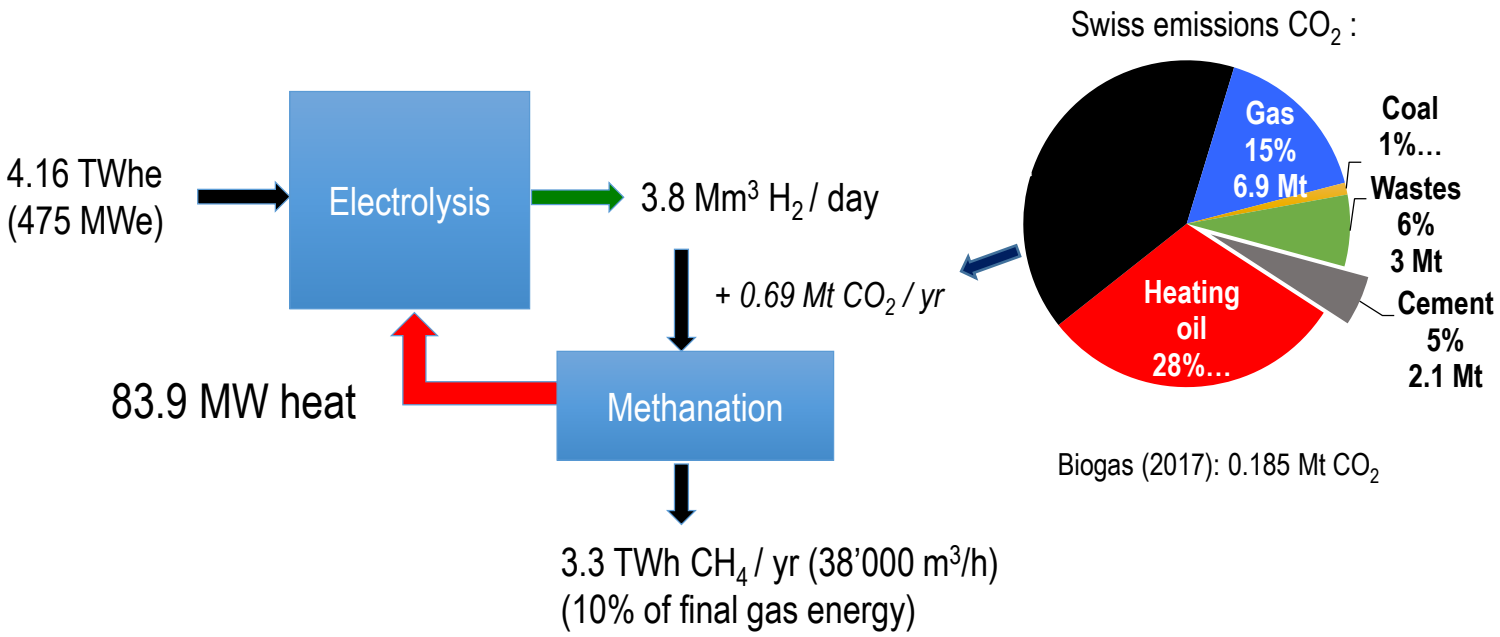
$$Q_{gen} = 0.95 \times 177524 \times 42.57E06 = 83.09\ MW$$

From the methanation reaction equation: 1 mol of CO2 reacted generates 1 mol of CH4

$$N_{CH_4} = 0.95 \times 42.57E06 \times 365 = 14\ 761\ mol\ CH_4/mol$$

- With $LHV_{H_2} = 800.9\ kJ/mol$ ⇒ 3.3 TWh CH_4 / yr

Answers



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