

# THE REMOVAL OF CO<sub>2</sub> FROM FLUE GAS VIA ADSORPTION COMBINED WITH MEMBRANE SEPARATION – COST ESTIMATION

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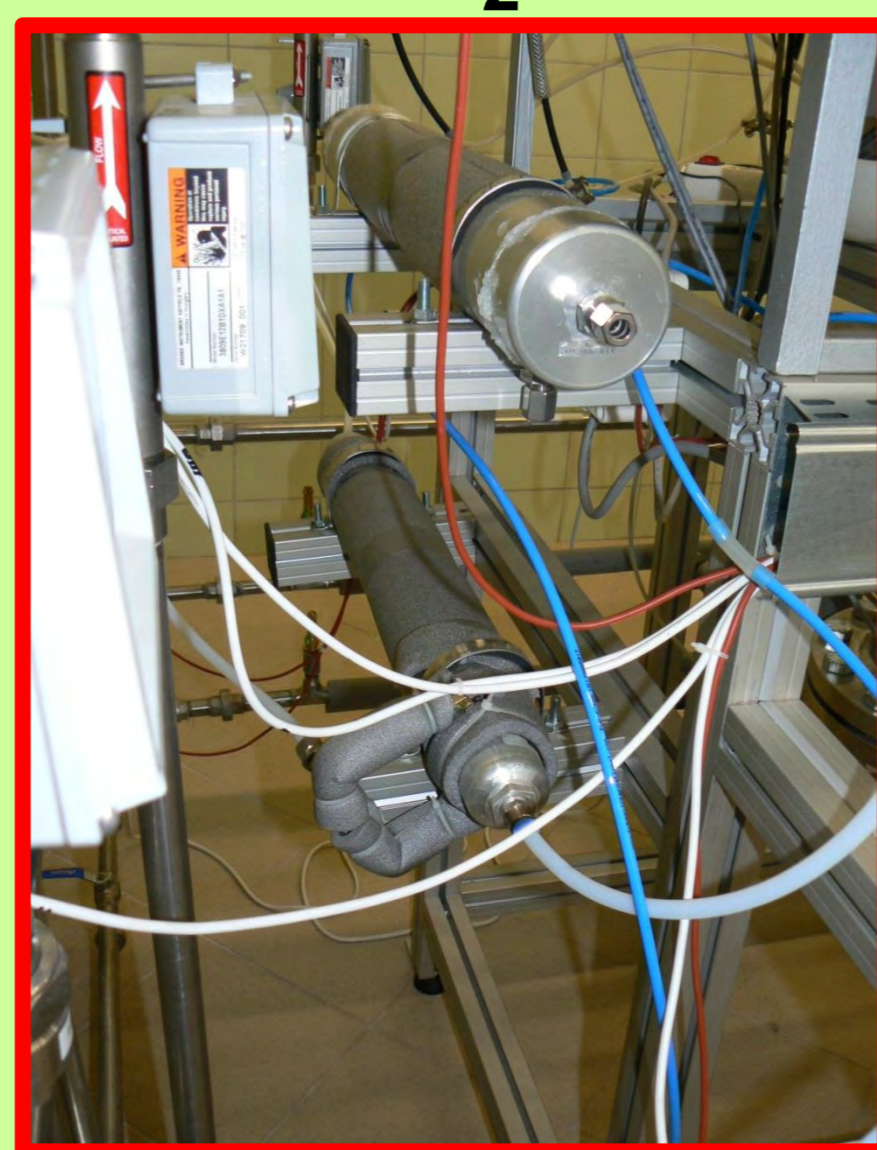
Based on extensive modelling and experimental studies a novel process for the separation of CO<sub>2</sub> from flue gas has been developed

Demonstration hybrid installation for CO<sub>2</sub> capture from flue gas

Flue gas flowrate: 7.5 m<sup>3</sup>(STP)/h  
Energy consumption: 741 kWh/t<sub>CO<sub>2</sub></sub>



PSA unit



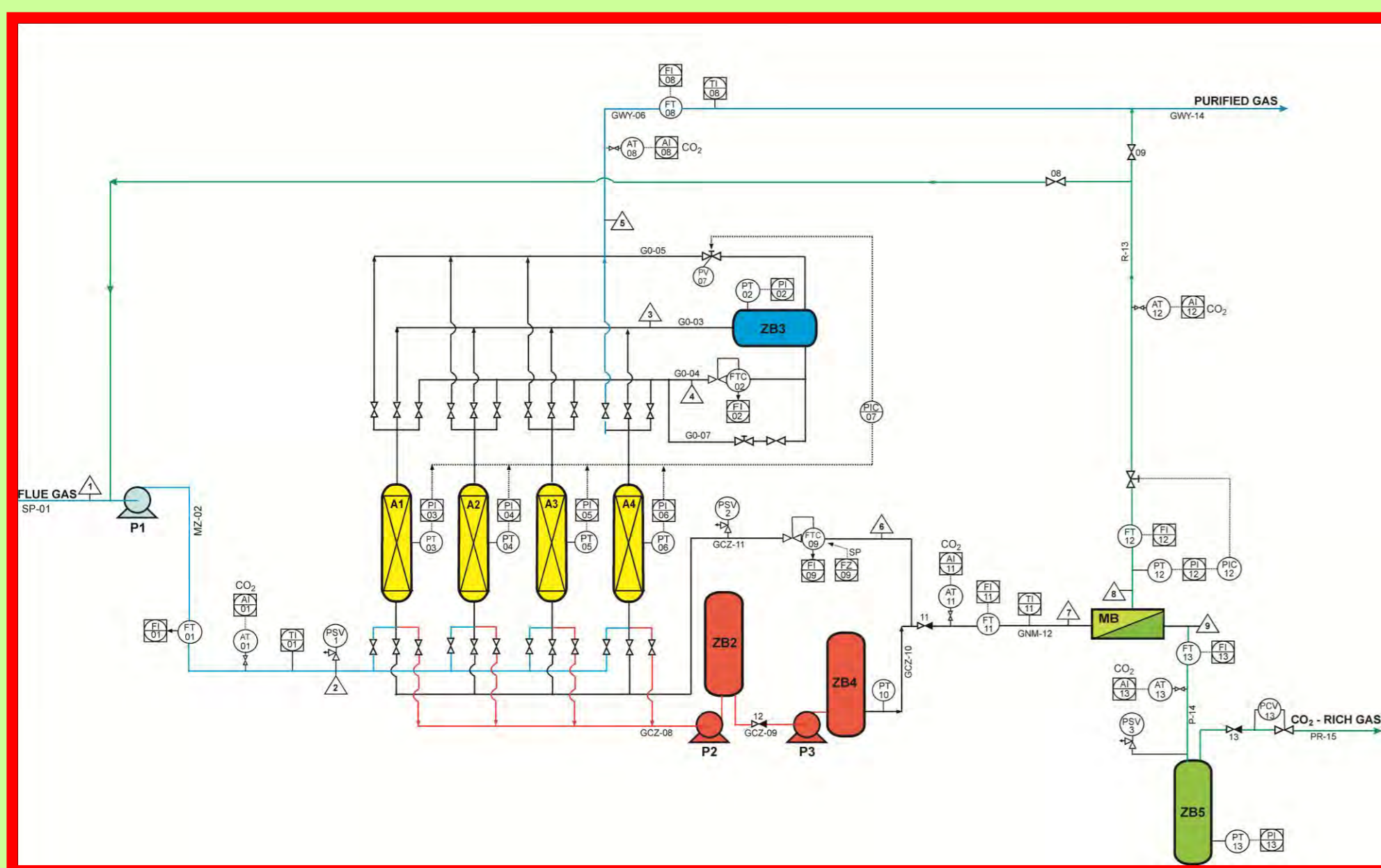
Membrane unit

SCALE-UP

Basic parameters of the scaled-up hybrid process

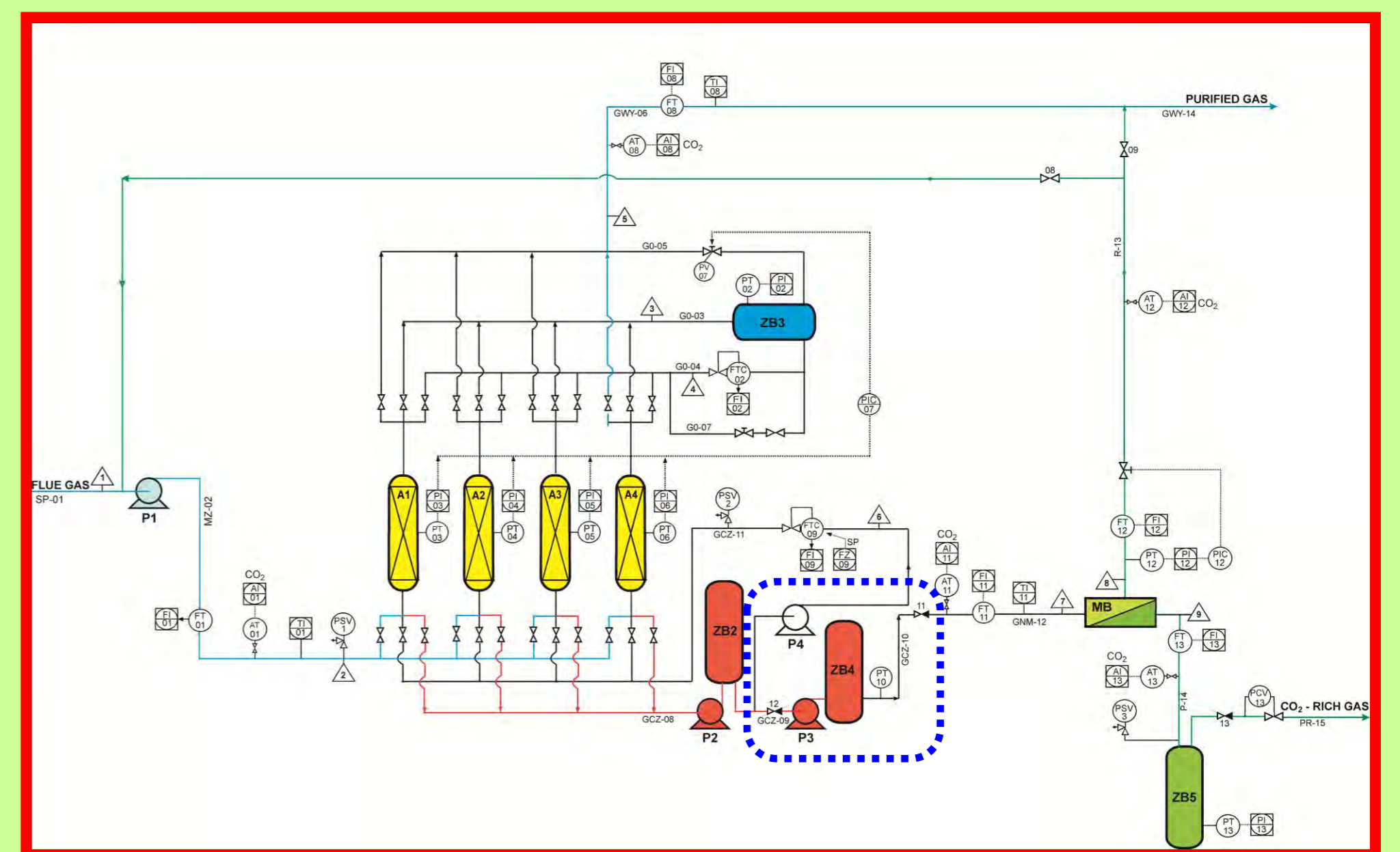
- flue gas flowrate: 1,000 m<sup>3</sup>(STP)/h
- gas composition:
  - CO<sub>2</sub> = 13.3 vol.%
  - N<sub>2</sub> = 80.7 vol.%
  - O<sub>2</sub> = 6.0 vol.%
  - H<sub>2</sub>O ≤ 150 mg/kg dry gas
- purity of the product (CO<sub>2</sub>): above vol. 95%
- recovery: 100%
- adsorbent – zeolite molecular sieve 13X: 1.0 – 2.4 mm
- cycle time: 8 × 240 s
- hollow fibre PRISM membrane modules

Hybrid installation before modification (1)



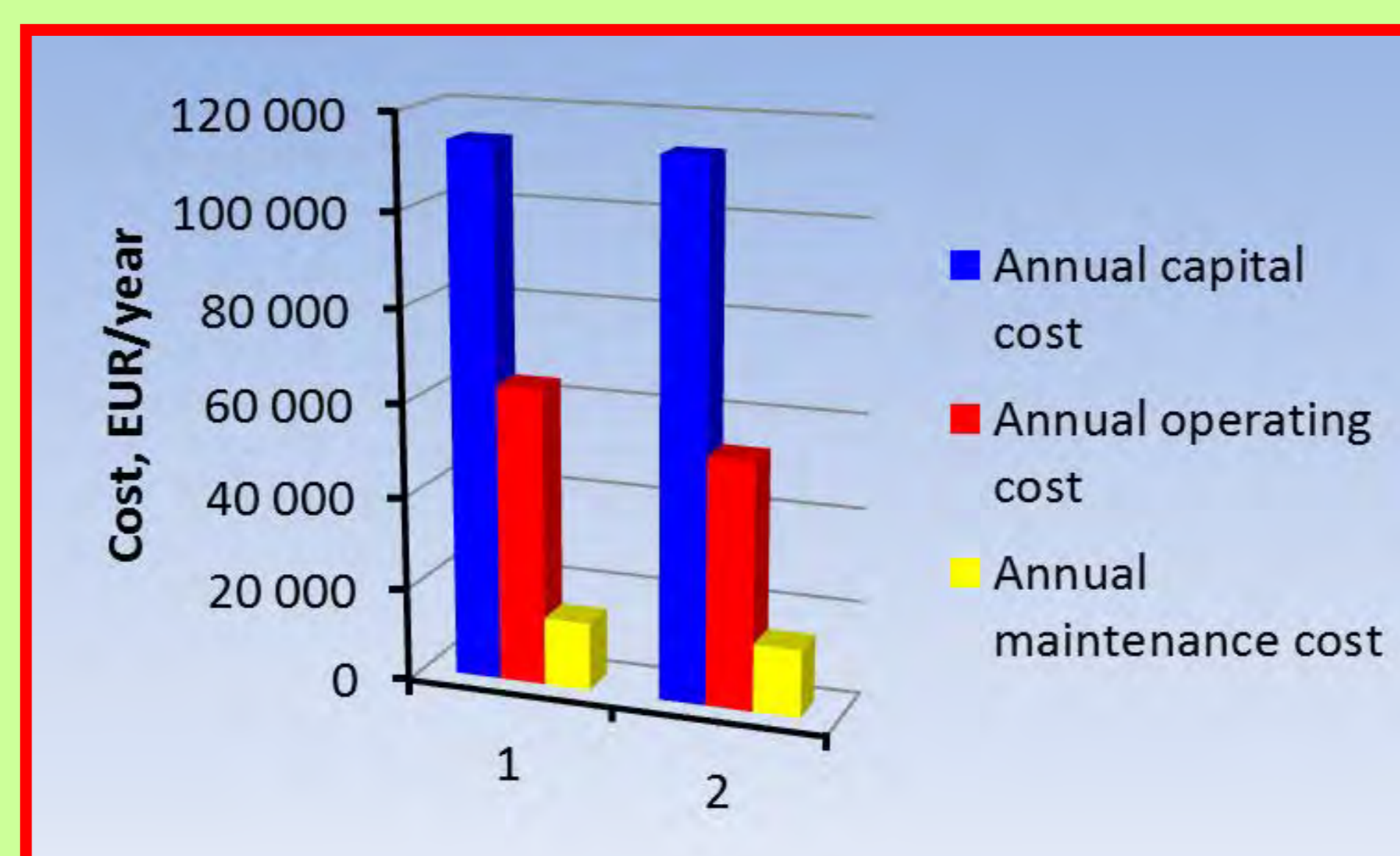
Energy consumption: 555 kWh/t<sub>CO<sub>2</sub></sub>

Hybrid installation after modification (2)



Energy consumption: 461 kWh/t<sub>CO<sub>2</sub></sub>

P<sub>1</sub> = 14.3 kW  
P<sub>2</sub> = 89.0 kW  
P<sub>3</sub> = 43.1 kW



P<sub>1</sub> = 14.3 kW  
P<sub>2</sub> = 89.0 kW  
P<sub>3</sub> = 14.5 kW  
P<sub>4</sub> = 4.0 kW

Costs of the hybrid installation before and after modification

It has to be stressed that small systems are, obviously, less cost-efficient than full-scale installations. Additionally, the technique proposed has not yet been fully optimized and may benefit greatly from further scale-up and practical experience