



**VTT**

# Techno-economic feasibility of producing polycarbonate polyols from CO<sub>2</sub>

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BECCU Final Workshop

26/08/2022 VTT – beyond the obvious





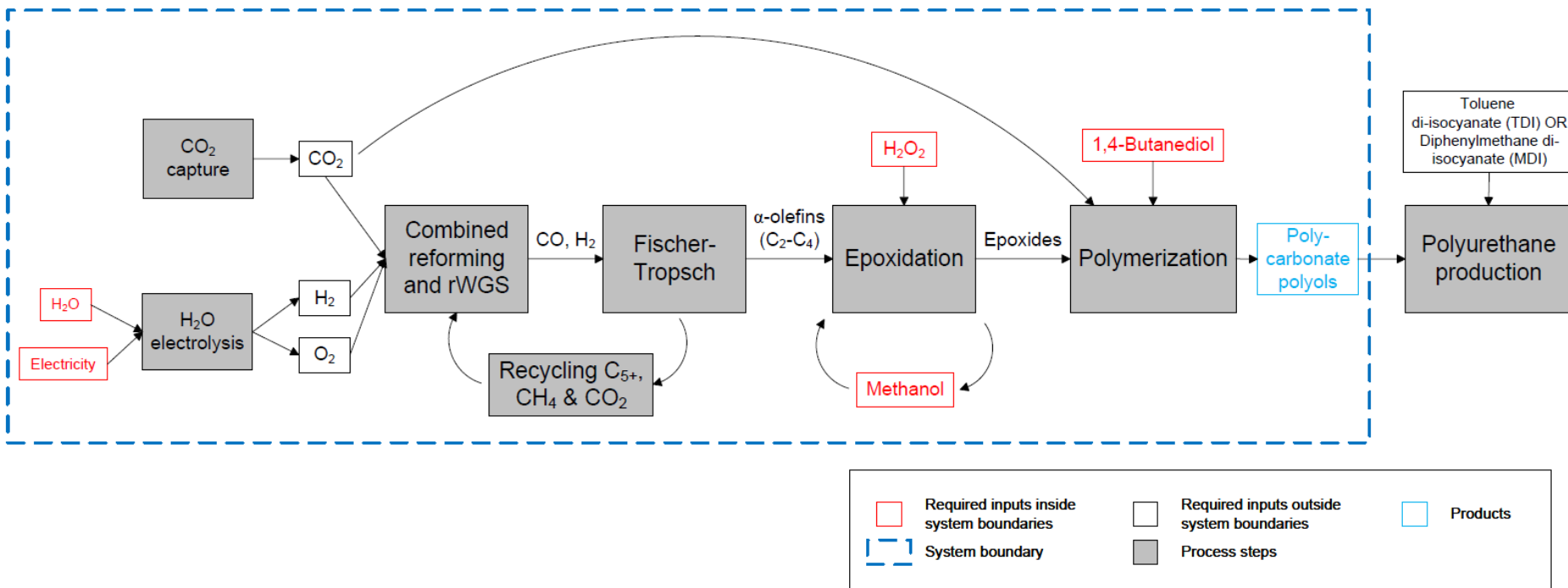
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# BECCU process & background

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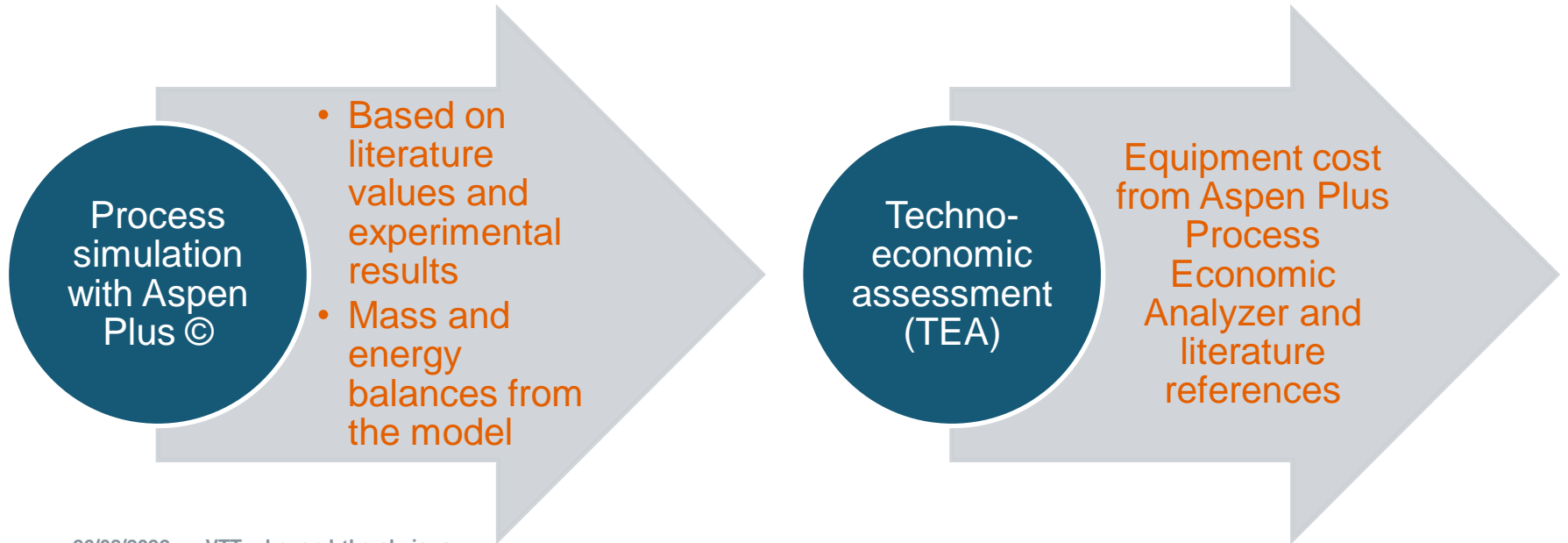


# BECCU-polyols from biogenic CO<sub>2</sub> & green H<sub>2</sub>

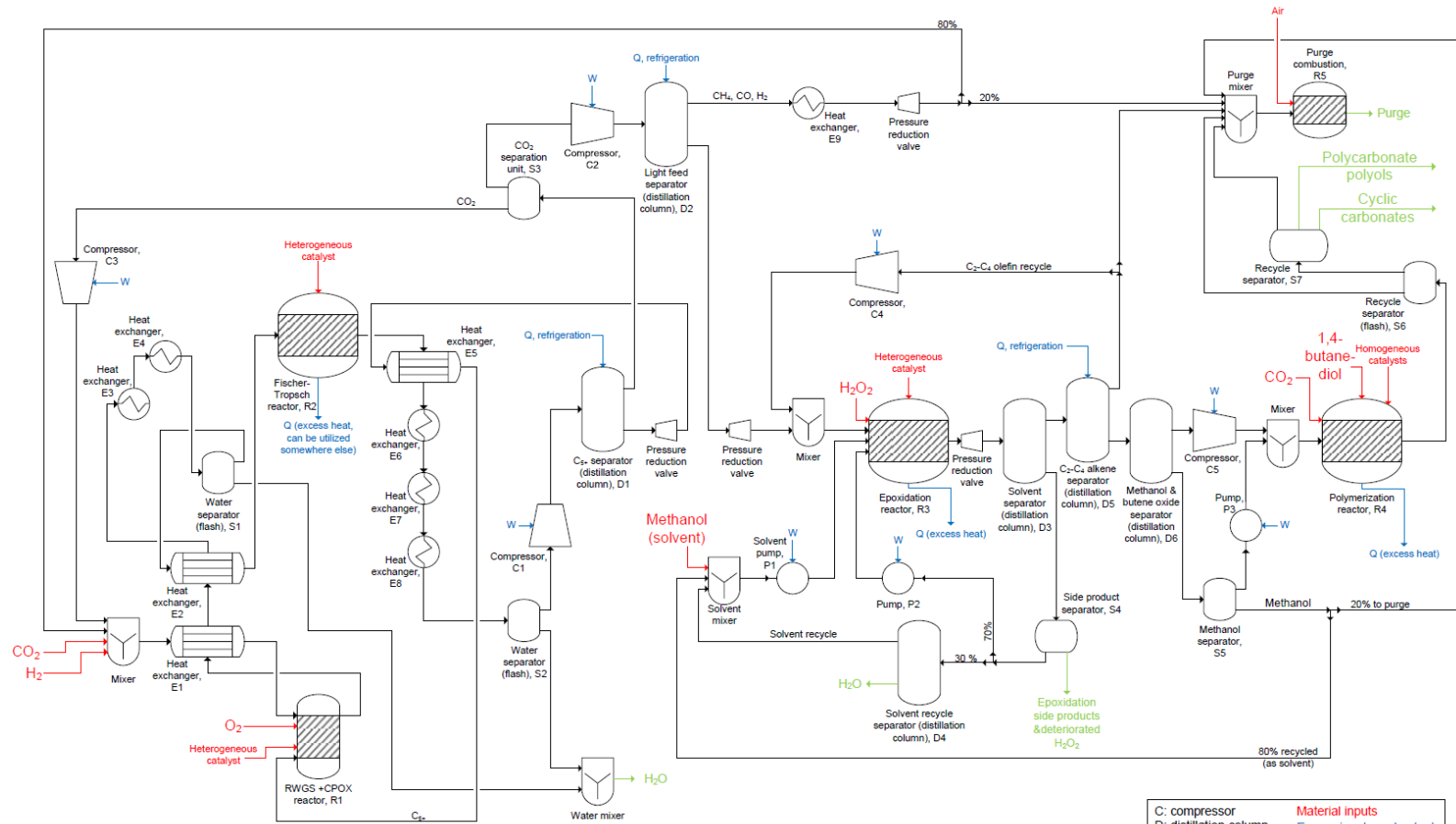


# Methods

- Aim of this techno-economic assessment (TEA) is to evaluate whether the concept would be economically viable



# Process flowsheet – simulated with Aspen Plus ©



C: compressor	Material inputs
D: distillation column	Energy inputs and outputs
E: heat exchanger	Products and by-products
P: pump	
R: reactor	
S: flash/separator	



# Assumptions & results

Inputs	Price	Outputs	Price
Electricity (total)	45 €/MWh	Cyclic carbonates	947 €/t
Hydrogen peroxide	550 €/t	By-product heat	15 €/MWh
		By-product oxygen	40 €/t

Other parameters	
Electrolyser electricity input	100 MW <sub>e</sub>
Annual plant operation time	8 000 h
Plant lifetime	20 years
WACC for annuity	8 %

IN	
CO <sub>2</sub> need	121 kt/a
H <sub>2</sub> need	16 kt/a



OUT	
Polycarbonate polyols	34 kt/a
Cyclic carbonates	4 kt/a
Excess oxygen	109 kt/a



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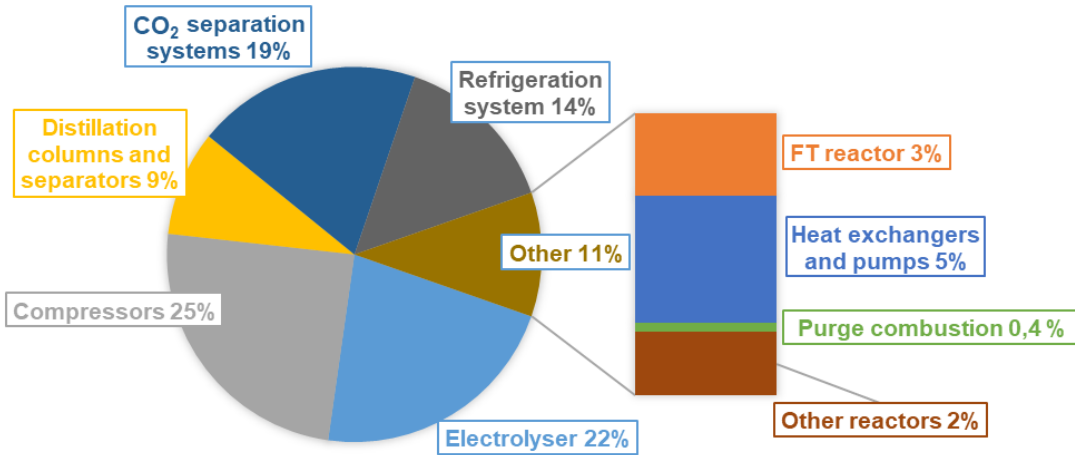
# Results of the techno-economic assessment for BECCU polyols

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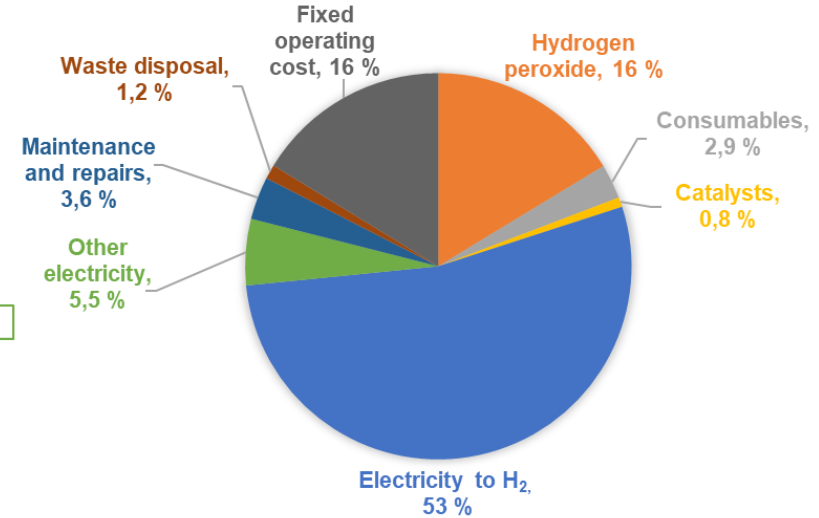
# Equipment & operational cost structures

## Equipment cost structure



Total TCI (M€): 274

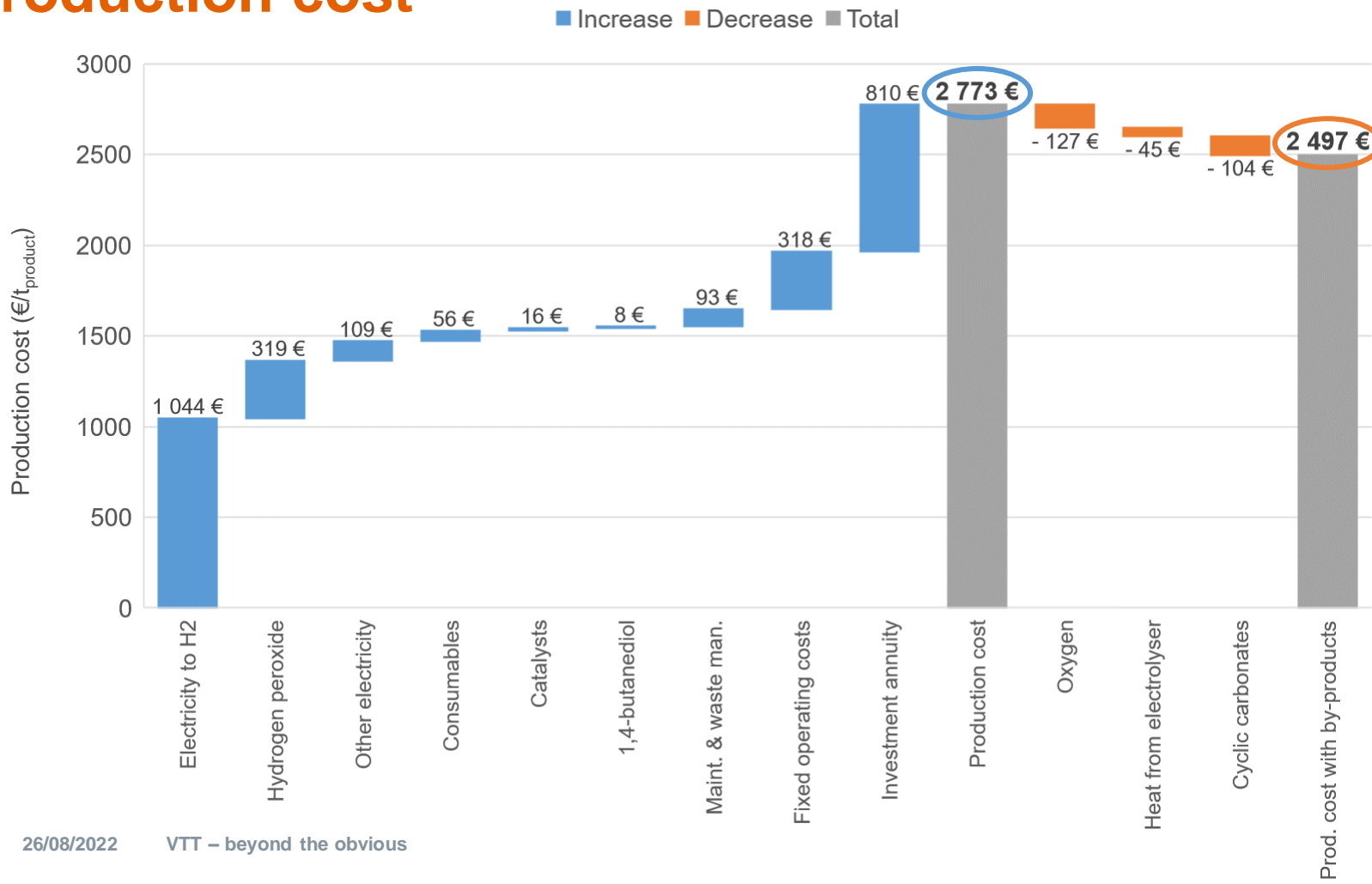
## Operational cost structure



Total OPEX (M€): 67,7



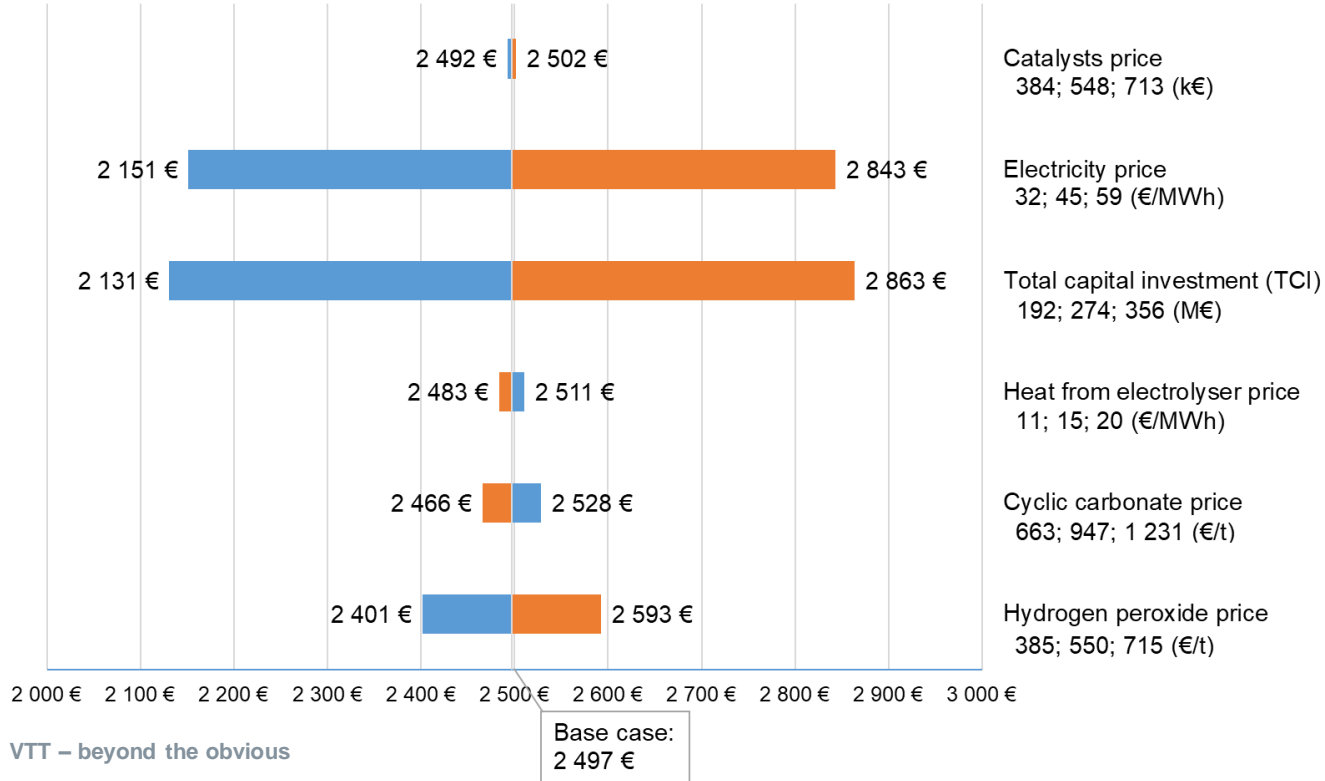
# Production cost



# Production cost most sensitive to TCI and electricity price

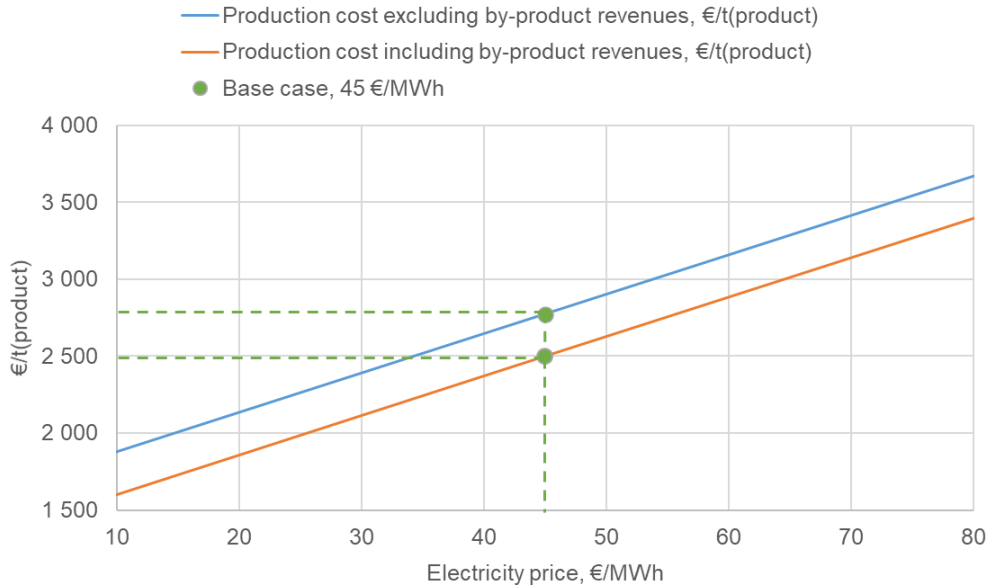
Effect of  $\pm 30\%$  change in each variable to production cost

■ 30 % ■ -30 %

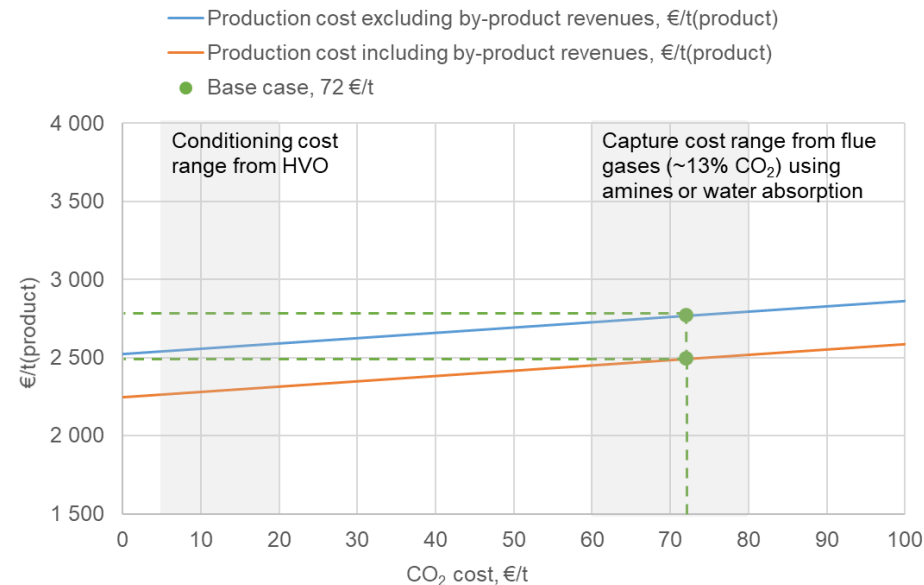


# The effect of electricity & CO<sub>2</sub> cost

## Sensitivity to electricity price



## Sensitivity to CO<sub>2</sub> cost



# Polyether -, polyethercarbonate - & polycarbonate polyols

Calculated  
production cost:  
~2500 €/t

Image: Sonnenschein (2015)

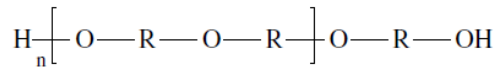


Image: Bian et al. (2016)

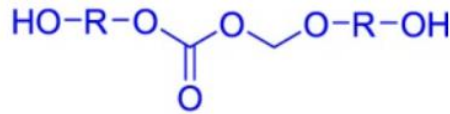
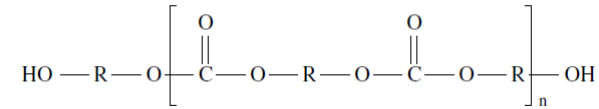


Image: Sonnenschein (2015)



## Polyether polyols

- Conventional polyols
- Global production: 9,4 Mt in 2016 <sup>1)</sup>
- Lower viscosity and faster diffusion compared to polyethercarbonate polyols
- Market price around 1 700 €/t <sup>2)</sup>

## Polyethercarbonate polyols

- New products
- Larger market potential, as they can replace traditional polyether polyols
- Market price closer to polyether polyols? Probably some premium for improved properties and sustainability.

## Polycarbonate polyols

- Specialty products - smaller markets and production volumes, around 30 kt/a <sup>3)</sup>
- Higher market price, can be even 6 000 €/t <sup>3)</sup>

Have carbonate groups in the polymer backbone & can be produced from CO<sub>2</sub>

# Conclusions for BECCU-polyols

- Production cost is very much lower than the expected selling price of polycarbonate polyols
  - The market size is however very limited
  - Selling price depends on the end product properties
- Results indicate that the process is most sensitive to changes in the investment cost and electricity price
  - Hydrogen peroxide price also has significant effect
- The price of petroleum-based polyether polyols is lower than the production cost of BECCU-polyols
  - The profitability of replacing these with BECCU-polyols depends on whether the customers are willing to pay for better and greener products



# bey<sup>0</sup>nd

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