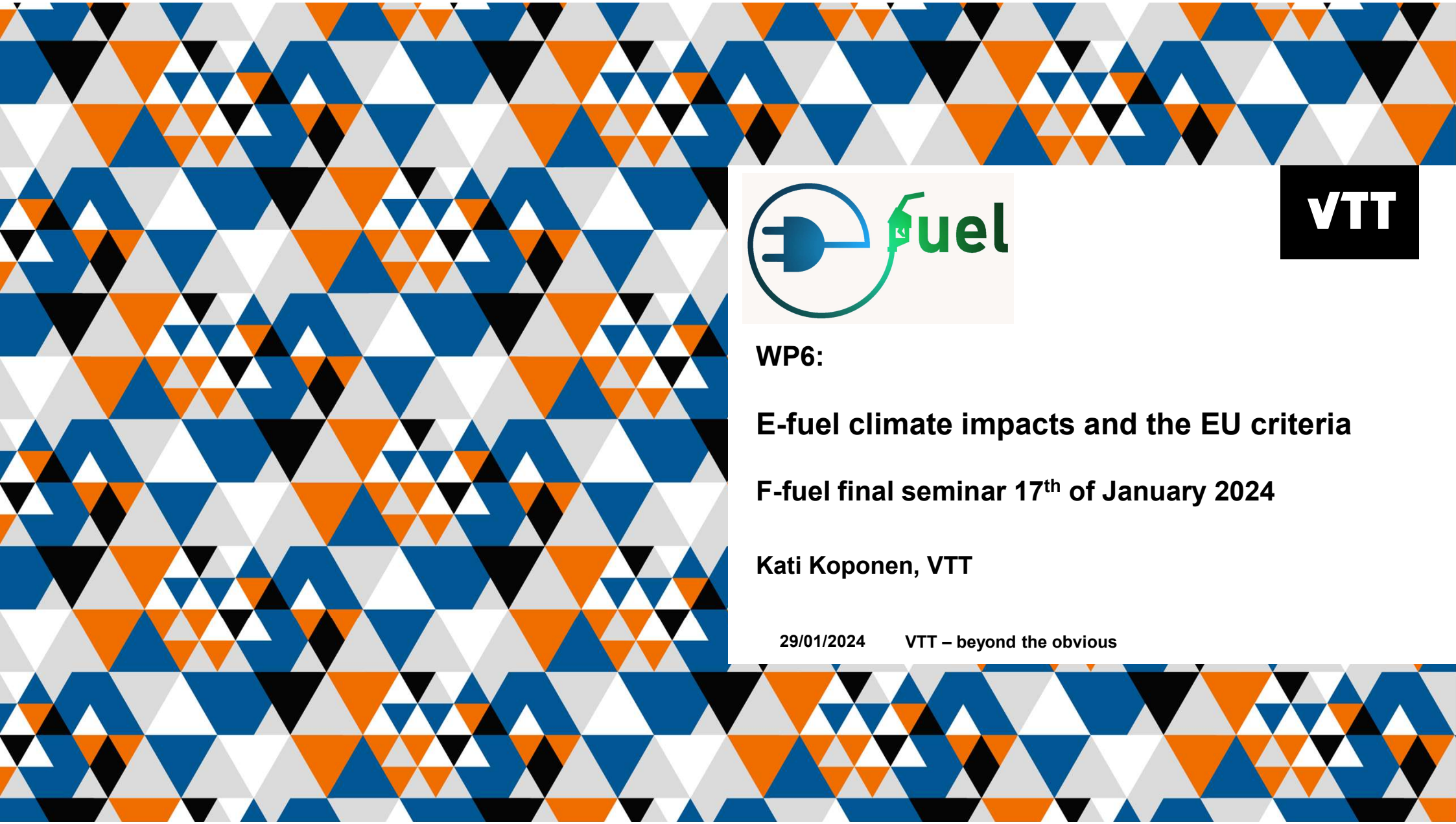


WP6:

E-fuel climate impacts and the EU criteria

F-fuel final seminar 17th of January 2024

Kati Koponen, VTT

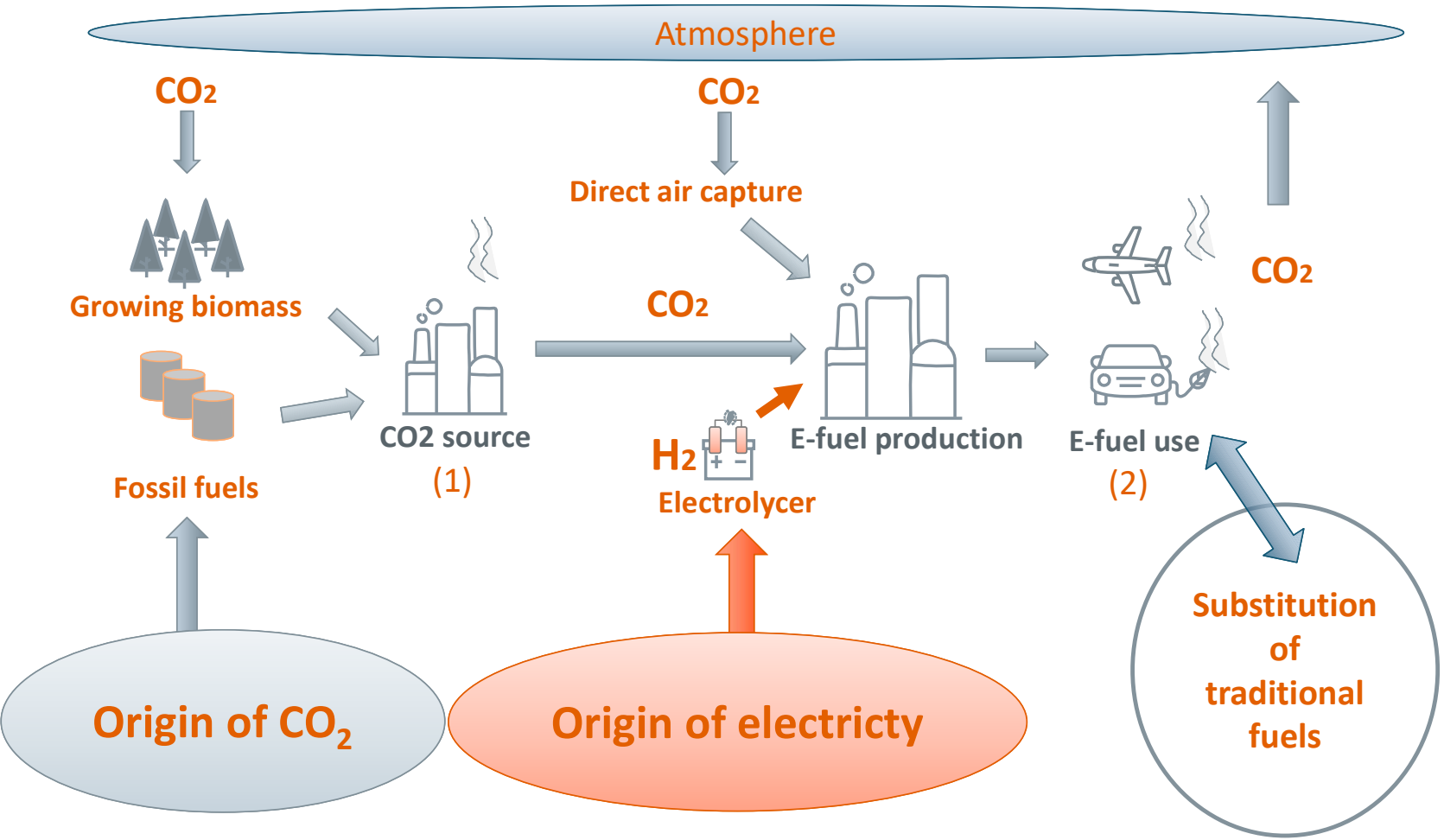
Content

1. EU regulation: definitions, targets & criteria
2. Key issues in GHG accounting for e-fuels & EU calculation rules
3. GHG balances for the e-SAF concepts studied in the project
4. E-fuel market model

Several EU regulations regarding e-fuels were accepted during the project

- **RED3**
  - Definition of RNFBO = “renewable fuels of non-biological origin”
  - Targets & double counting rules: Share of RNFBOs at least 1 % by 2030 / Share of RFNBOs in maritime transport sector is at least 1.2 %
  - Double counting allowed for RNFBOs, 1.5 x counting for aviation & maritime fuels
- **Refuel EU aviation** (”synthetic low-carbon aviation fuels”)
  - Targets for aviation:
    - 2030-2031: 6% SAF of which 0.7%/year e-fuels
    - 2035: 20% SAF of which 5% e-fuels
    - 2050: 70% SAF of which 35% e-fuels
- **Delegated acts** (2023/1184, 2023/1185):
  - Definition of the 70% emission saving reduction & GHG calculation rules for e-fuels
  - Definition of fully renewable electricity

Key issues in GHG accounting for e-fuels:



In case of e-fuels, the CO_2 emission to atmosphere is delayed, not cancelled:

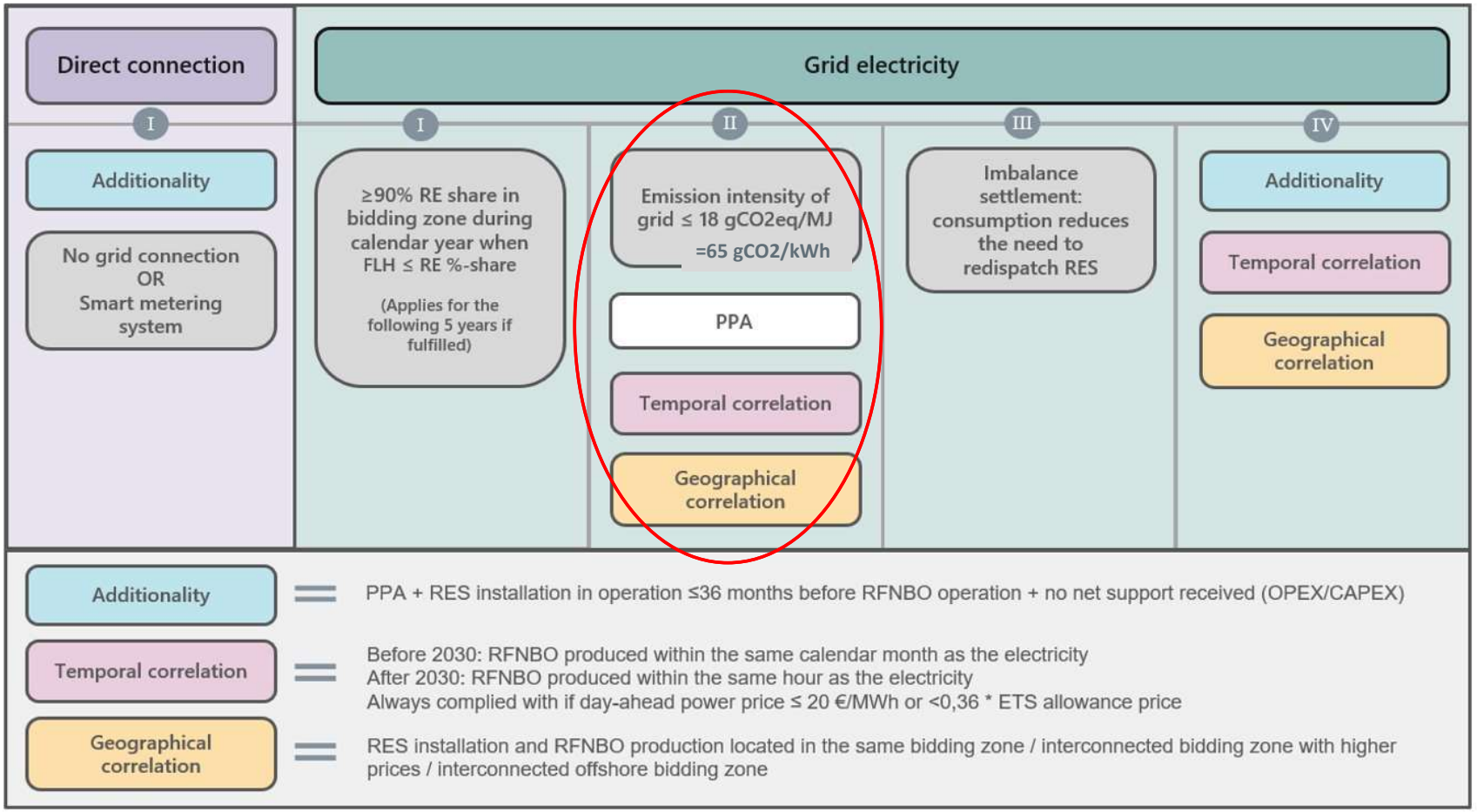
- For fossil CO_2 the emission needs to be fully accounted for either at point (1) or (2).
- For biogenic CO2 and CO_2 captured by DAC, the cycle is carbon neutral.
- Emission reductions if e-fuels replace traditional fuels with higher life cycle emissions.
- However, this **does not make the concept "carbon negative".**

EU criteria for the origin of the CO_2 (EU 2023/1185)

- **CO_2 from e-fuel combustion is fully accounted despite the origin of the CO_2.**
- **However, captured CO_2** incorporated in the chemical composition of the e-fuel can be considered as **"avoided emission"** when the origin of the CO_2 is one of the following:
  - **Until 2035: Fossil** CO_2 which has been captured from **electricity production** under ETS
  - **Until 2040: Fossil** CO_2 which has been captured from **other source** under ETS
  - CO_2 captured from the **air**
  - CO_2 from production of bioenergy complying with the EU **sustainability and GHG criteria**
  - CO_2 captured from the **combustion of RNFBOs** complying with the EU **GHG criteria**

→ Emissions from the capture process need to be included.

Electricity: Fully renewable electricity (EU 2023/1184)

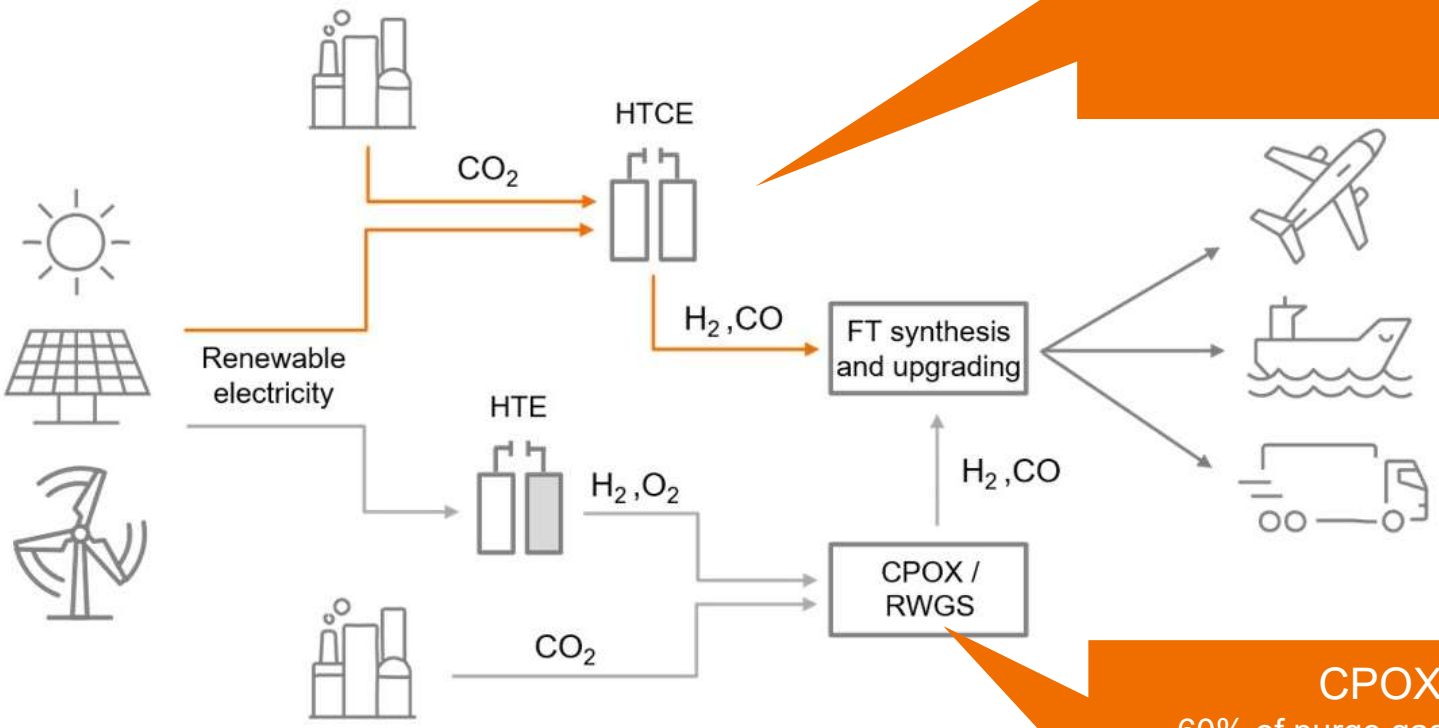


Summary by Aleksandra Saarikoski VTT

Electricity not defined as fully renewable (EU 2023/1185)

- Three methods to define emissions for electricity which does not qualify as fully renewable
  1) Method given in Delegated act (2023/1185) Annex part C to define country / bidding zone emission intensity (Table A emission for Finland 82 gCO_2/kWh).
  2) Full load hours of RNFBO production ≤ hours in which the marginal price of electricity is set by renewable / nuclear installations.
  3) The GHG emission value of the marginal unit generating electricity at the time of the production of the RNFBO in the bidding zone.
     - (Information for 2&3 is not publicly available by Fingrid / Nordpool)

E-fuel concepts studied



Co-SOEL
60% of purge gas recycled

Products:
- Jet fuel (C9-C16)
- Gasoline (C5-C8)
- Purge gas

CPOX
60% of purge gas recycled
(90% of purge gas recycled)

eRWGS
60% of purge gas recycled
(90% of purge gas recycled)

Reference concepts: H_2 production by AEL

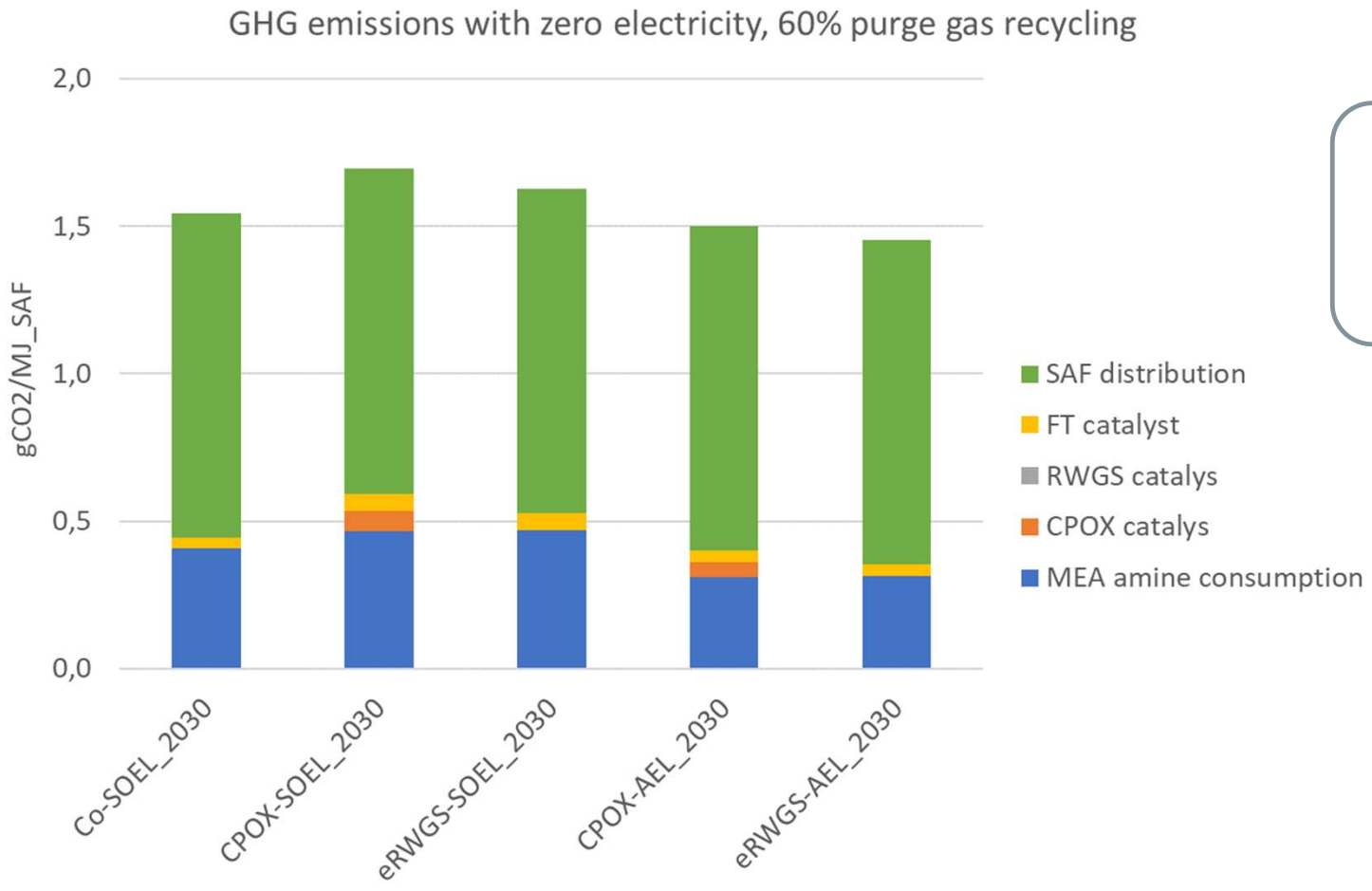
Abbreviations:

Co-SOEL	Co-solid oxide electrolyser
CPOX	Catalytic partial oxidation
eRWGS	electrically heated reverse water gas shift reactor
AEL	Alkaline electrolyser
FT	Fischer-Tropsch

Calculation principles used

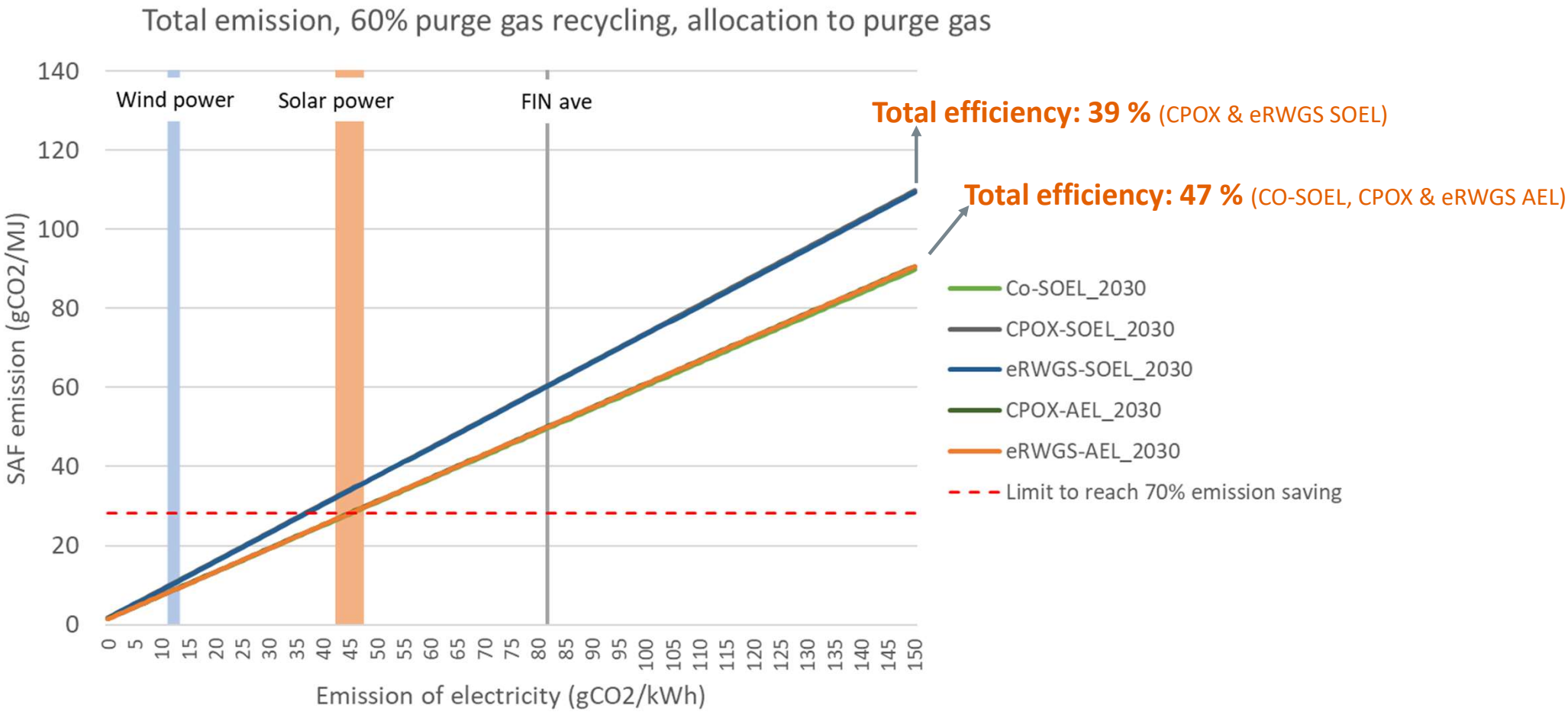
- The CO_2 input for the process is considered as “avoided emission” according to the EU criteria → balances the emission of e-fuel combustion.
  - Also the CO_2 emission from purge gas combustion in the process is considered as avoided emission.
- Emission of electricity production for electrolyser is varied from 0-150 gCO_2/kWh to show the impact on the e-fuel emissions.
  - According to the EU criteria, emission of electricity is zero, if defined as fully renewable.
- Process data represents 2030 case and 60% recycling of purge gas in the process.
- Hydrogen & energy needs for the refining phase of SAF are covered by the process.
- Emissions by catalyst application and fuel distribution are included.
- Emissions are allocated between main product (SAF) and co-products (gasoline and purge gas). Energy allocation (LHV) is applied according to the EU criteria.

GHG results when zero emission used for electricity



Fossil comparator emission $94gCO_2/MJ$

GHG results when emission of electricity is varied



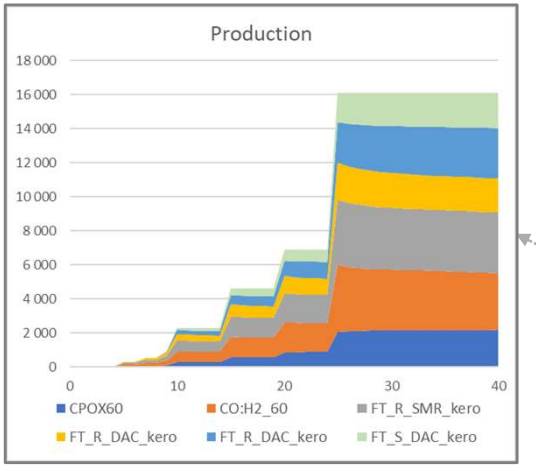
Conclusions from the GHG calculation

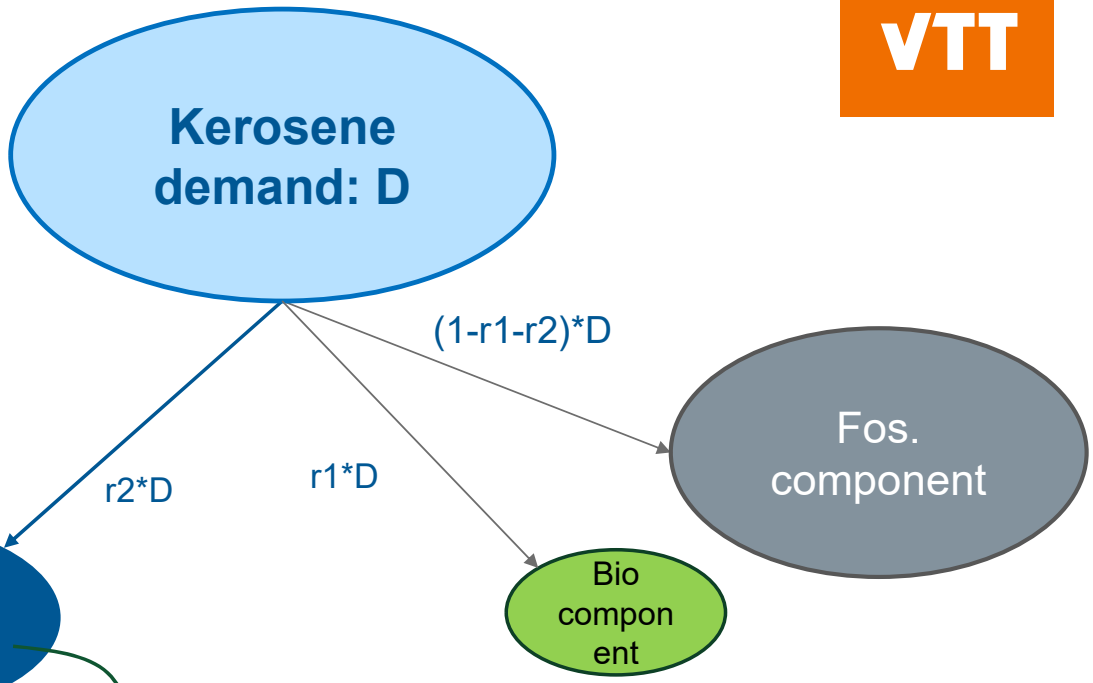
- When zero emission for electricity is used and CO_2 input considered as “avoided emissions”, emission saving for the studied concepts is 98%.
- Grid electricity emission should be under 34-44 gCO_2/kWh to for the concepts to reach emission savings over 70%. (However, not all grid electricity is renewable.)
- The origin of the CO_2 is important in future and needs to be under Emission Trading Sector (or equivalent pricing mechanism) already now.

Task 2: E-fuel market model

Juha Forsström VTT

Technologies compete for market shares





Production volume

Unit cost

Production process 1

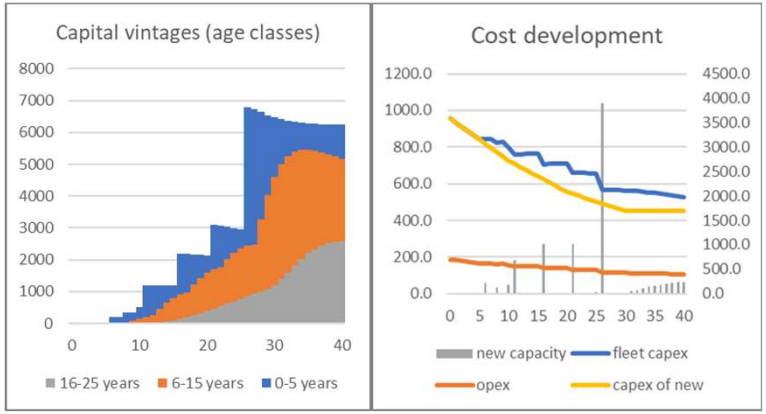
Capacity_1

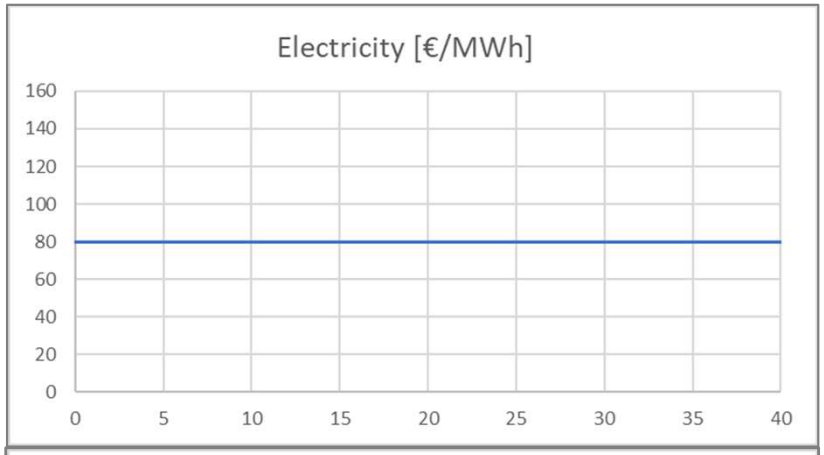
. . .

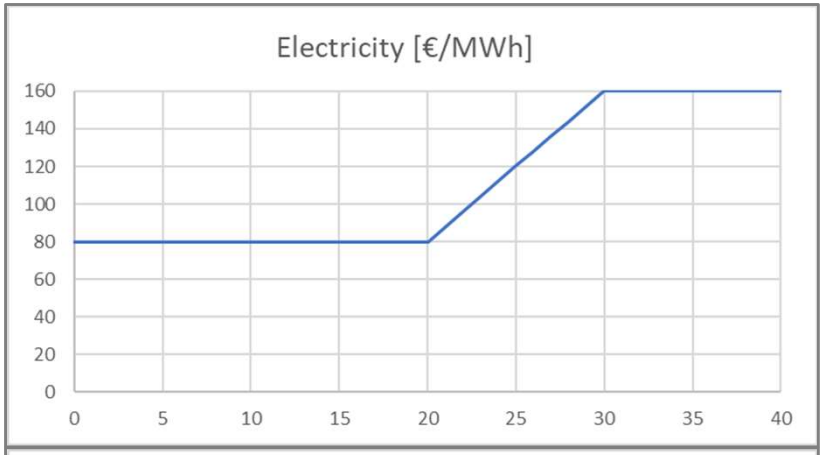
Production process L

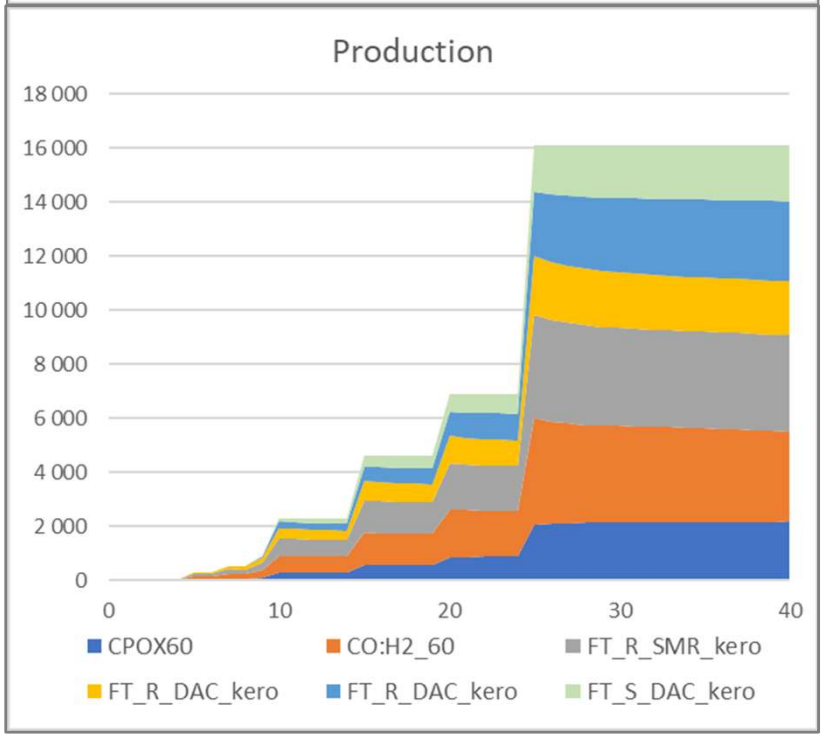
Capacity_L

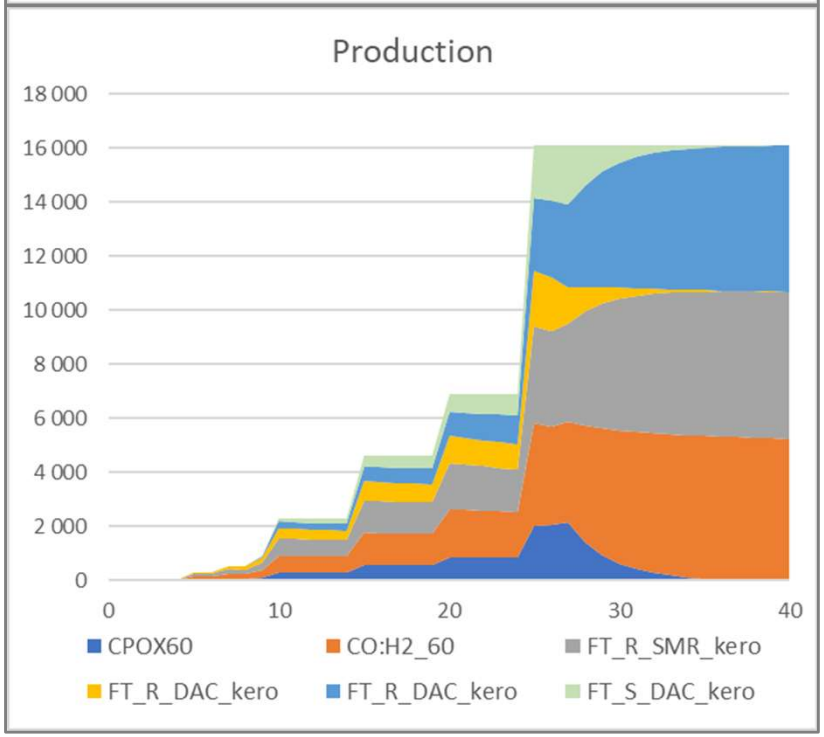
Perfect substitutes











Production inputs for a production plant

- CAPEX(t)
- OPEX(t)
- Efficiency(t)
- Prices of feedstocks

Thank you!

Contact:
Kati.koponen@vtt.fi