COMSYN project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 727476

Advances in the techno-economic assessment to identify the ideal plant configuration of a new biomass-to-liquid process

29th European Biomass Conference & Exhibition

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[1] German Aerospace Center (DLR)
[2] VTT Technical Research Centre of Finland
[3] INERATEC GmbH

27th of April 2021

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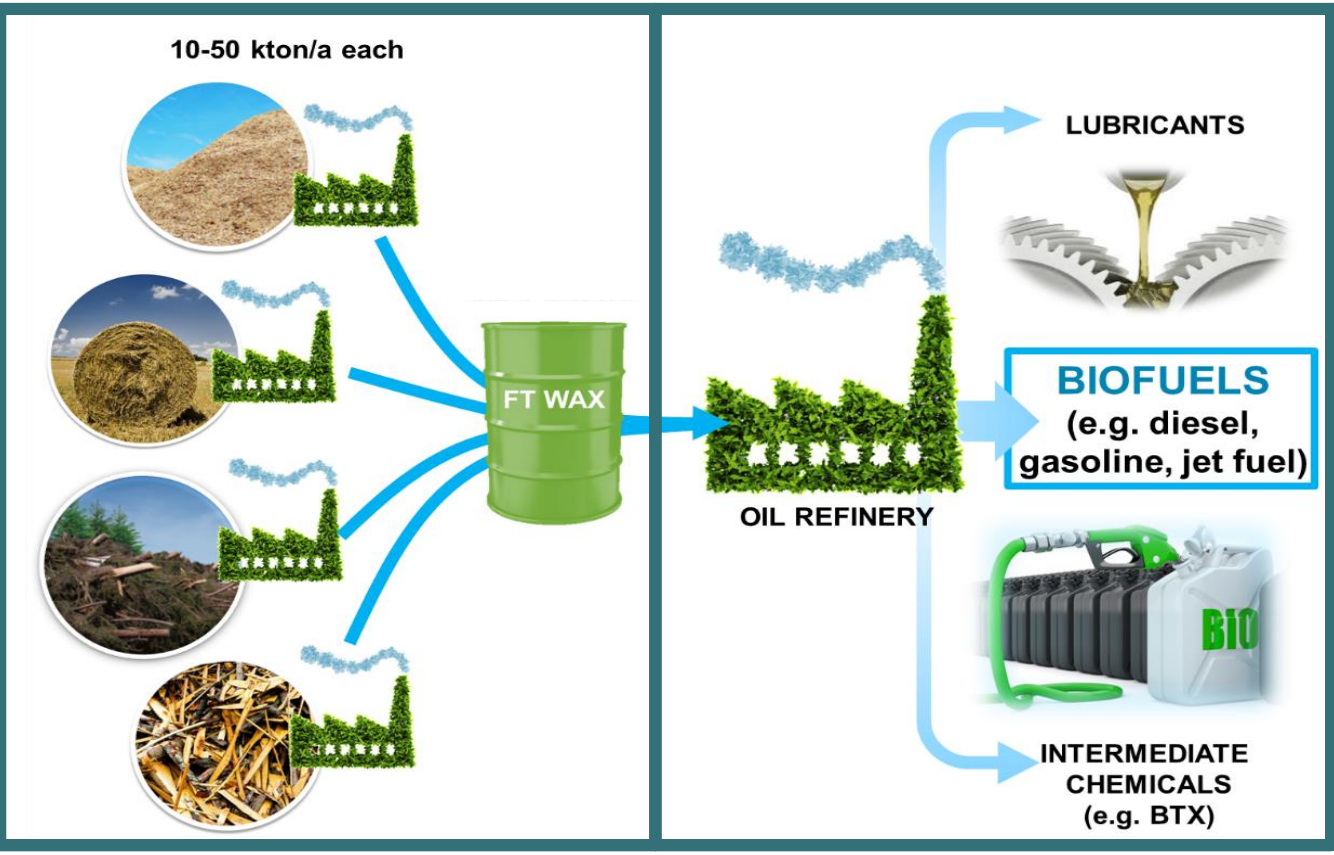
COMSYN – Compact Gasification and Synthesis process for Transport Fuels

www.comsynproject.eu – EU No. 727476

New BtL production concept with biofuel production **cost reduction** up to 35 % compared to alternative routes (Project goal: < 1.05 €/kg production cost for diesel)

PRIMARY CONVERSION

Decentralized FT wax production at **small-to-medium scale** units located close to biomass resources ($50\text{-}150\ MW_{th}$ input) + locally utilized excess heat for 80+ % overall efficiency



PRODUCT UPGRADING

Centralized FT product refining to high quality drop-in liquid fuels* at existing oil refineries

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Techno-economic and ecological evaluation at DLR

1. Step
Literature survey

Exchange with project partners

Simulation & Process evaluation

2. Step
Detailed process simulation

Variation of process parameters

Aspen-TEPET-Brightway2-Link

3. Step
Techno-economic and ecological evaluation

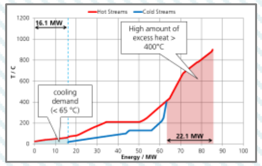
aspentech
Aspen Plus®

- Upscaling
- Technical optimization

Material and energy balance data

TEPET [1]

Brightway2 [2]



- Economic calculation
- Sensitivity analysis
- Cases studies
- Heat integration
- Exergy analysis
- LCA

4. Step
Identifying crucial process parameters

[1] Albrecht et al. (2016) - A standardized methodology for the techno-economic evaluation of alternative fuels – A case study, Fuel, 194: 511-526
[2] Mutel (2017) - Brightway: An open source framework for Life Cycle Assessment, Journal of Open Source Software, 2(12): 236

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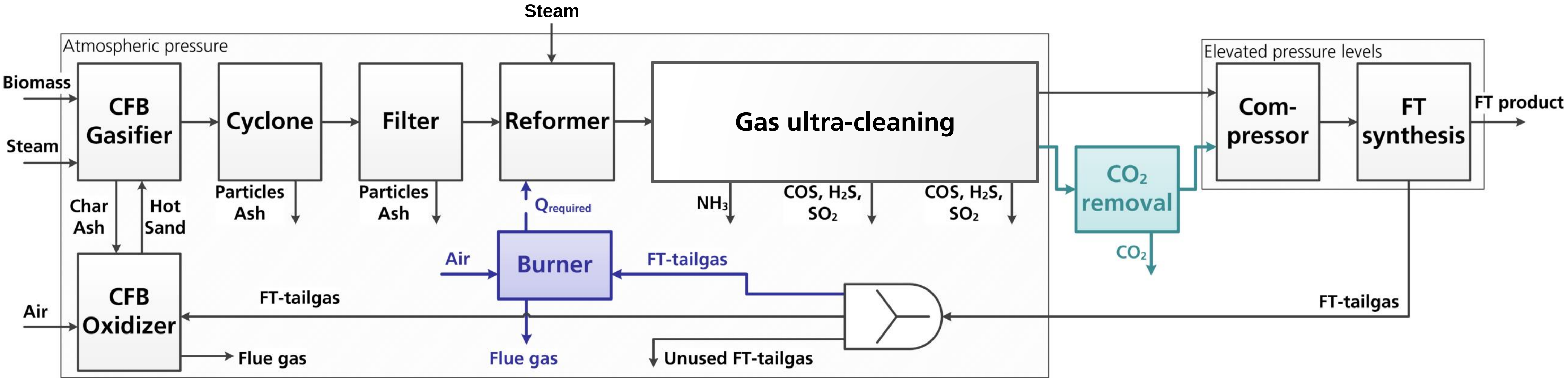
COMSYN – Compact Gasification and Synthesis process for Transport Fuels

Process concepts



Case 1	Case 2	Case 3
• Base case • Autothermal reforming with air	• Autothermal reforming with air • **CO_2 removal** after guard bed ➢ Operating at 6 bar ➢ 80 % CO_2 is removed	• **Allothermal** steam reforming ➢ Required heat is provided by an additional burner ➢ Steam is led into the reformer

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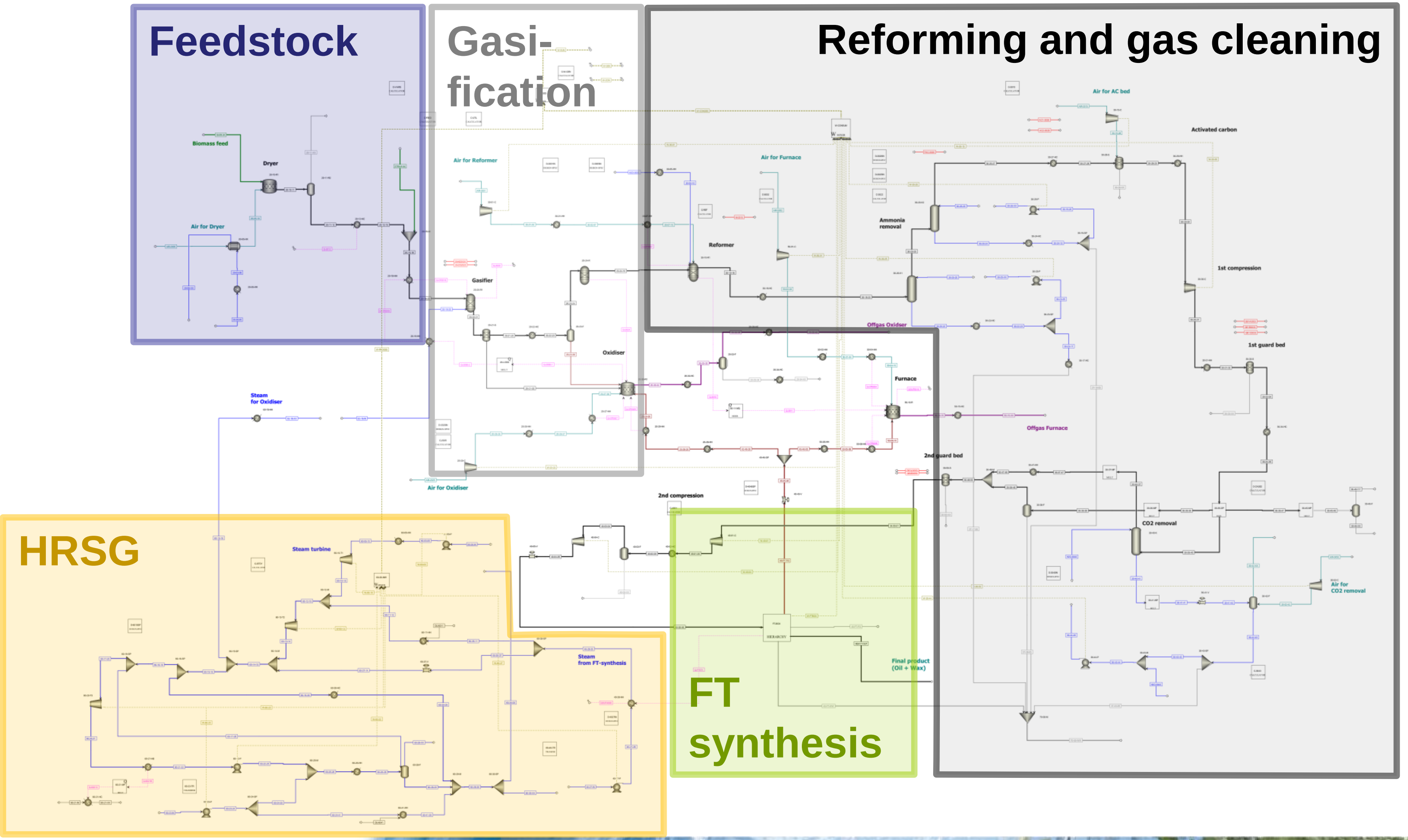
Process flowsheet model



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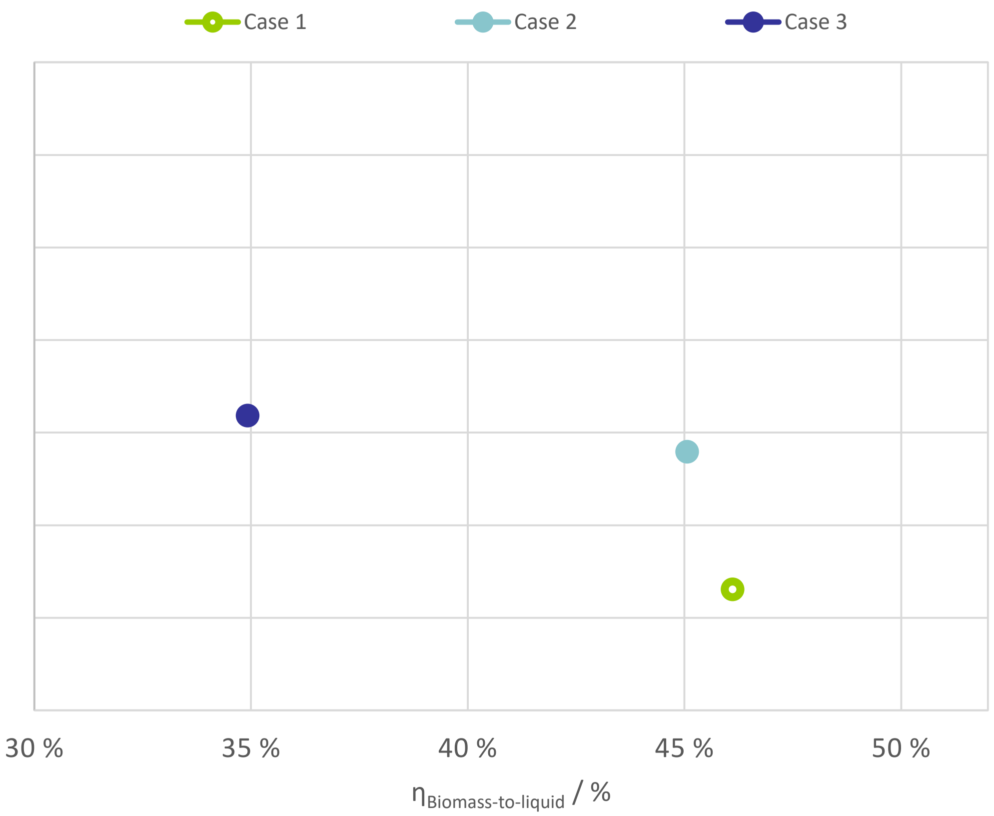
TEPET Results

Techno-economic assessment of process concepts

100 MW biomass input		Case 1	Case 2	Case 3
Electricity demand	MW	11.4	12.3	9.1
Steam + Distr. heating	MW	39.7	38.7	47.7
Product output	MW	**51.4**	**50.6**	**38.1**
BtL efficiency	%	46.1	45.1	35.0
Energetic efficiency	%	81.7	79.3	78.7

Boundary conditions		
Base year		2019
Full load hours	h/a	8260
Interest rate	%	10
Electricity costs	€/MWh	60
Biomass costs	€/GJ	11.3
District heating revenue	€/MWh	30
Process steam revenue	€/MWh	36.2
Labor costs	€/h	28.94



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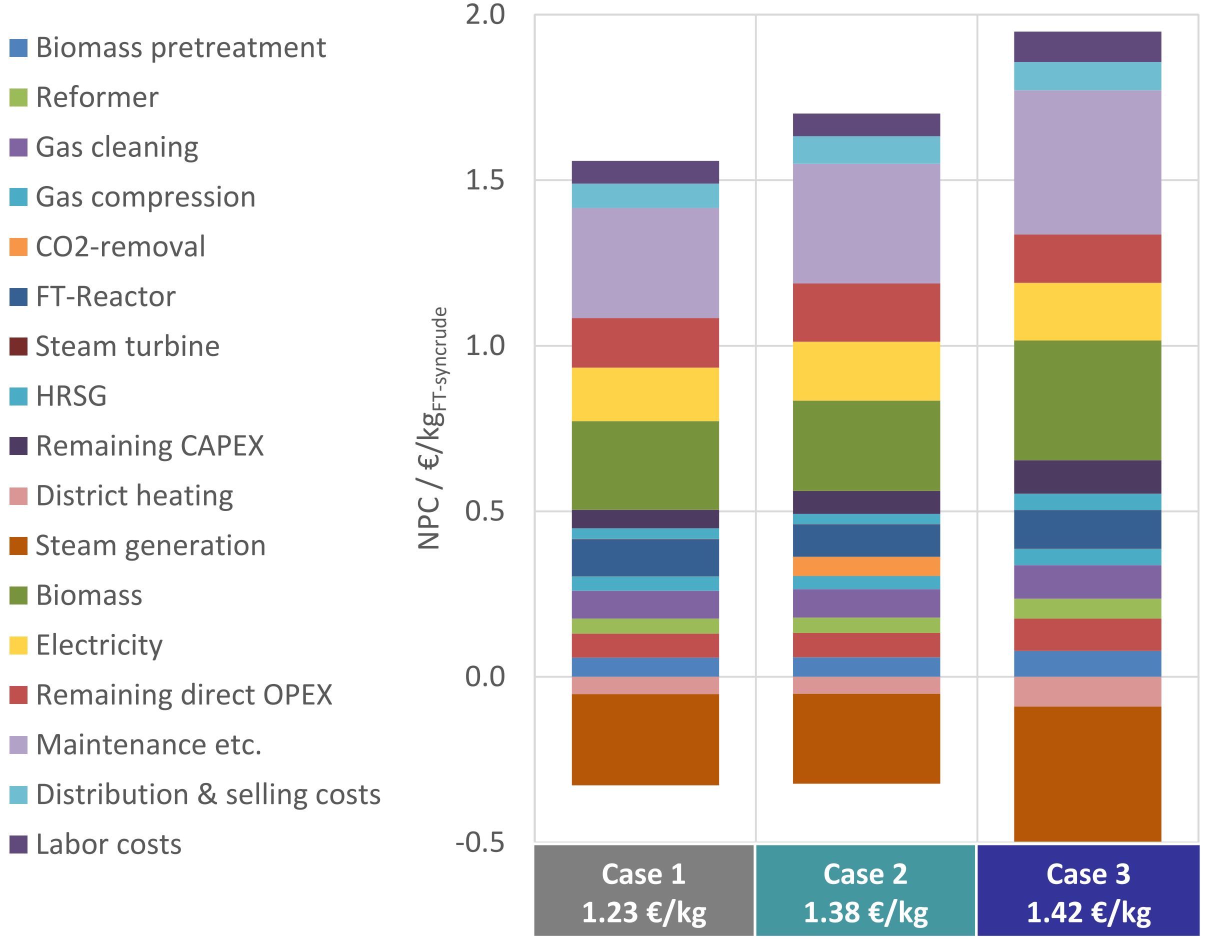

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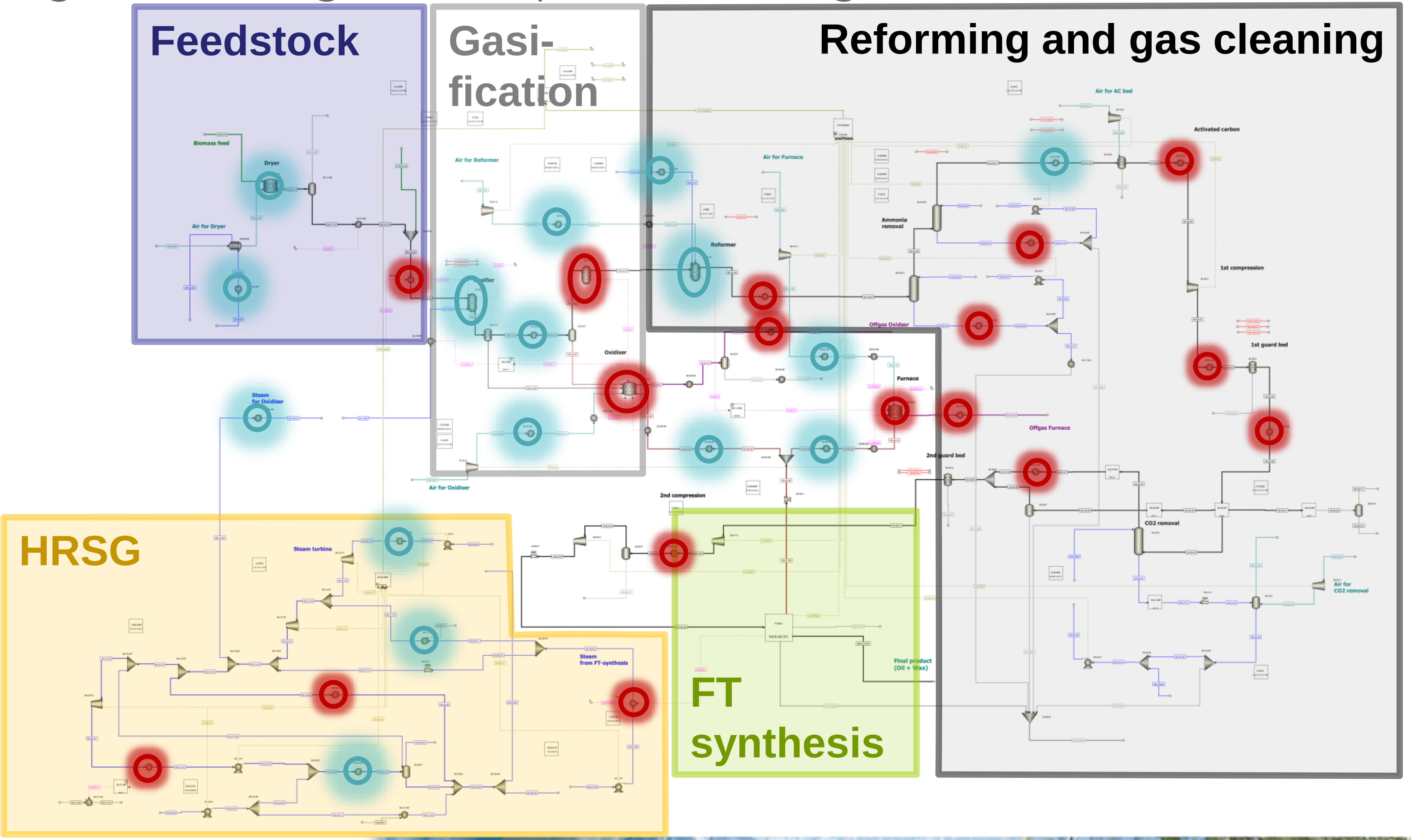
Process flowsheet model

Various heating and cooling units require heat integration



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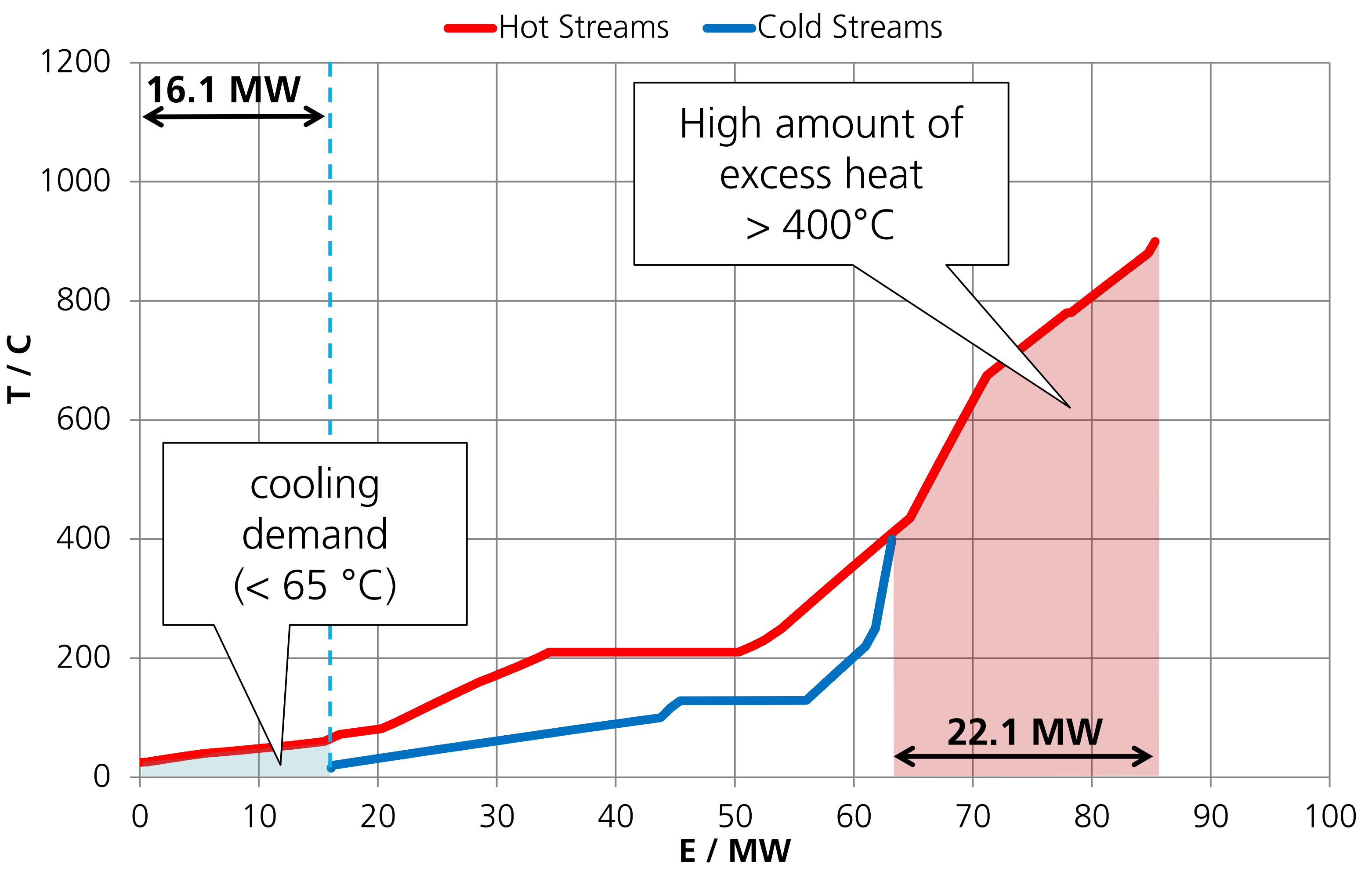
TEPET – Heat integration

The process concept yields in a high amout of excess heat

→ Heat integration options have to be evaluated technically and economically

	Electricity generation	Process steam & District heating
SC0	0.0 MW	42.2 MW_{th}
SC1	2.8 MW	37.8 MW_{th}
SC2	9.7 MW	30.2 MW_{th}
SC3	12.7 MW	0.0 MW_{th}



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TEPET – Results

Techno-economic comparison of different steam cycle modes

Selection of heat utilisation method strongly dependent on revenue for process steam & district heating

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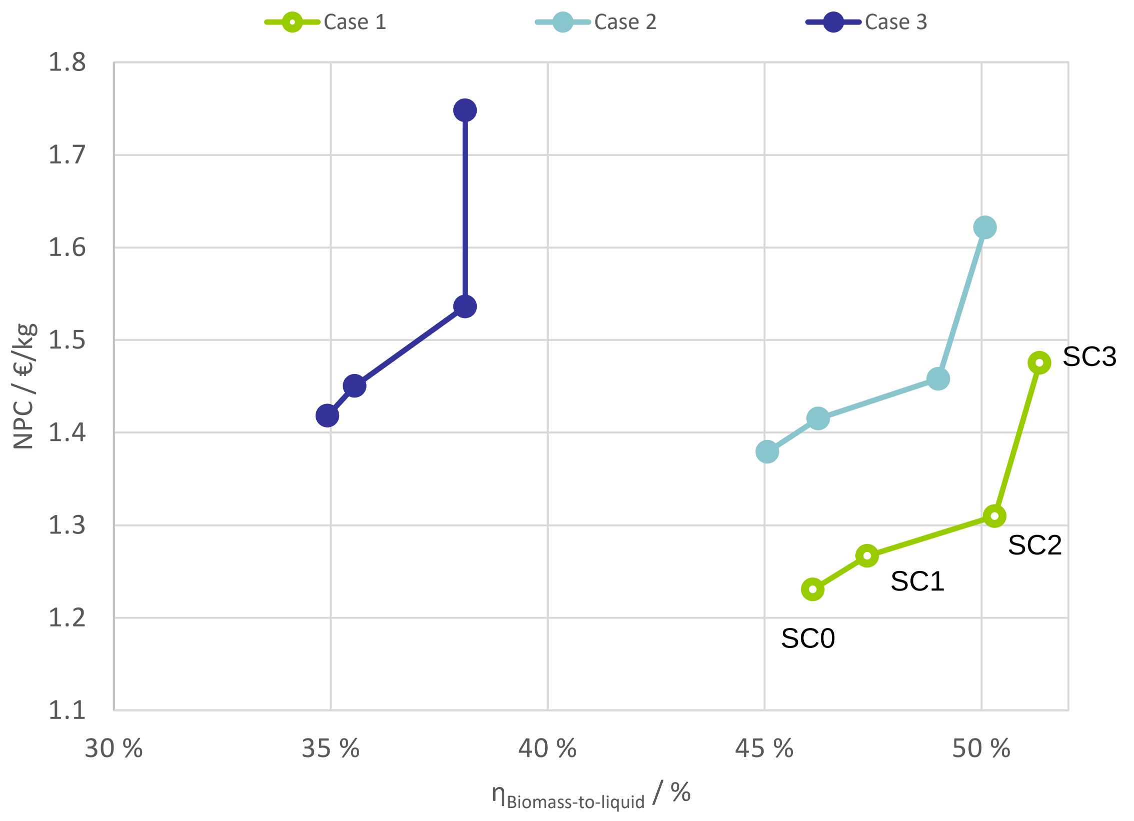

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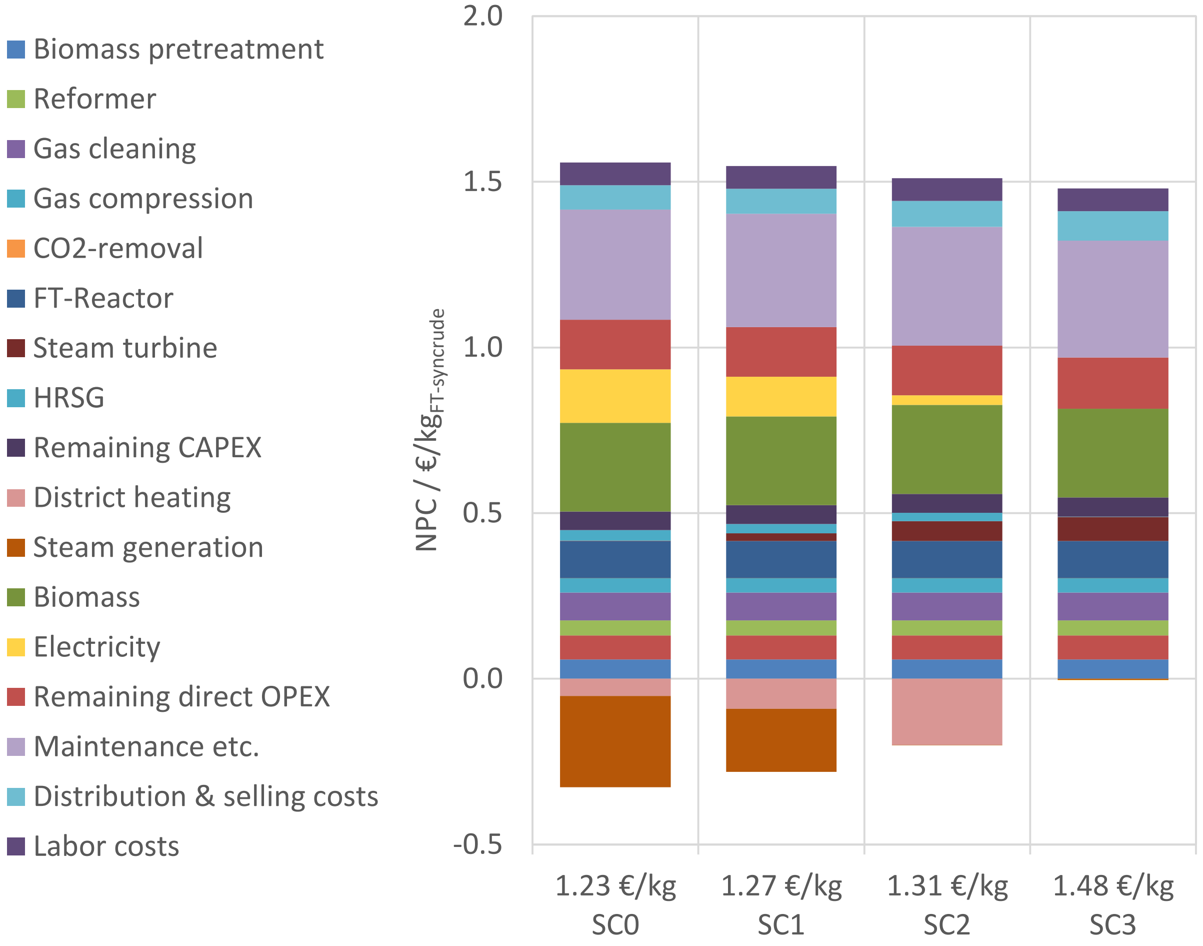

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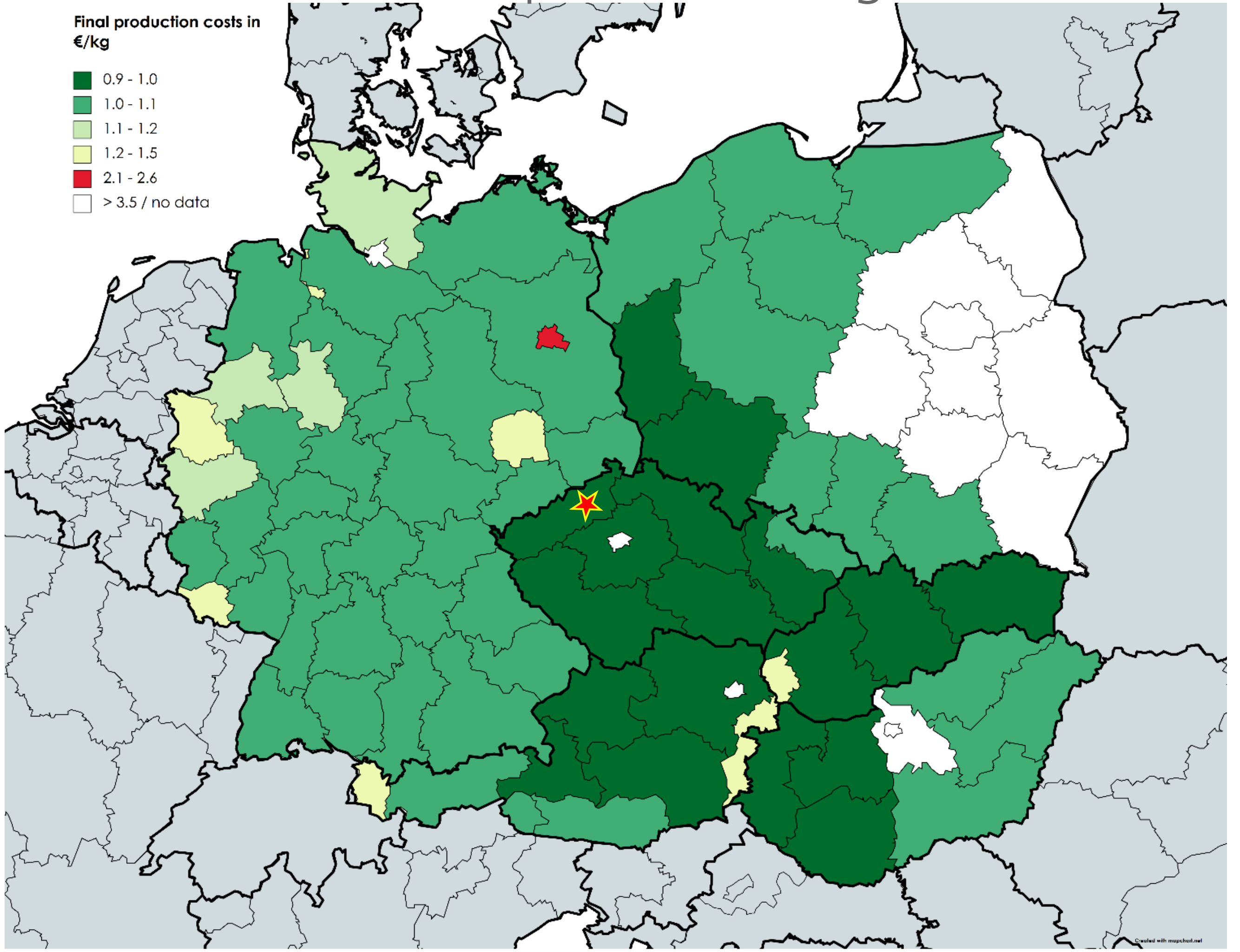
TEPET – Results

Identification of potential sweet spots and their most feasible process configuration

- Assumptions:
  - Bark as biomass feedstock
  - 200 MW max. plant scale (84 t/h)
  - 20 years of plant lifetime
  - 8260 h/a operation
  - 10 persons per shift
  - 10% interest rate
  - Heat market for district heating available
  - Product refining at Litvinov ORLEN UniPetrol refinery (14 wt.% losses)



Data based on: Ruiz (2019), ENSPRESO - an open, EU-28 wide, transparent and coherent database of wind, solar and biomass energy potentials [3]

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Summary & Outlook

- Advances in techno-economic methodology allow …
  - to screen potential regions while including all site-specific boundary conditions
  - Technical parameter variations while tracking economic impacts

- Apply methodology for any other process conept on biomass feedstock
- Ecologcial assessment has to be taken into account (**4CO.14** – Julia Weyand, DLR)

Data based on: Camia (2018), Biomass production, supply, uses and flows in the European Union

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References

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Thank you!

German Aerospace Center (DLR)
Institute of Engineering Thermodynamics

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Project partners

VTT
INERATEC
wood.
GKN SINTER METALS
ORLEN Unipetrol