Global gasification developments focussing on RNG and advanced fuel

TC Biomass, 2024

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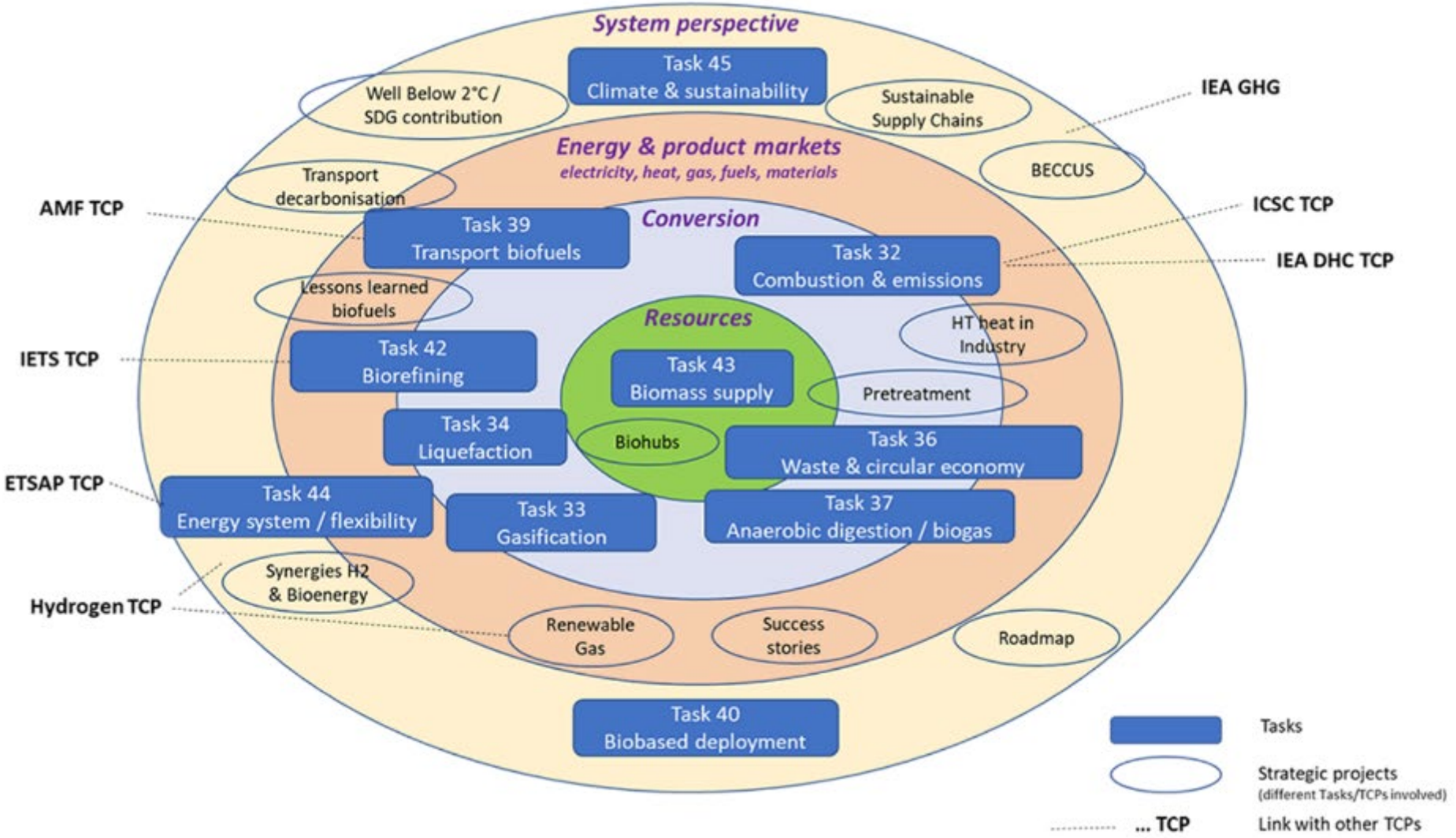
Outline

- What is IEA Bioenergy / Task 33
- Gasification examples to Green Gas and Fuels
- Observations
- Conclusions
- Recommendations

IEA Bioenergy at a glance



Who to contact

If you have information that you want to share and to support the deployment of gasification, contact your national contact point.

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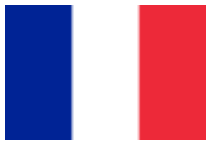
	USA (Robert Baldwin) Robert.Baldwin@nrel.gov		France (Chourouk Nait Saidi) c.naitsaidi@atee.fr
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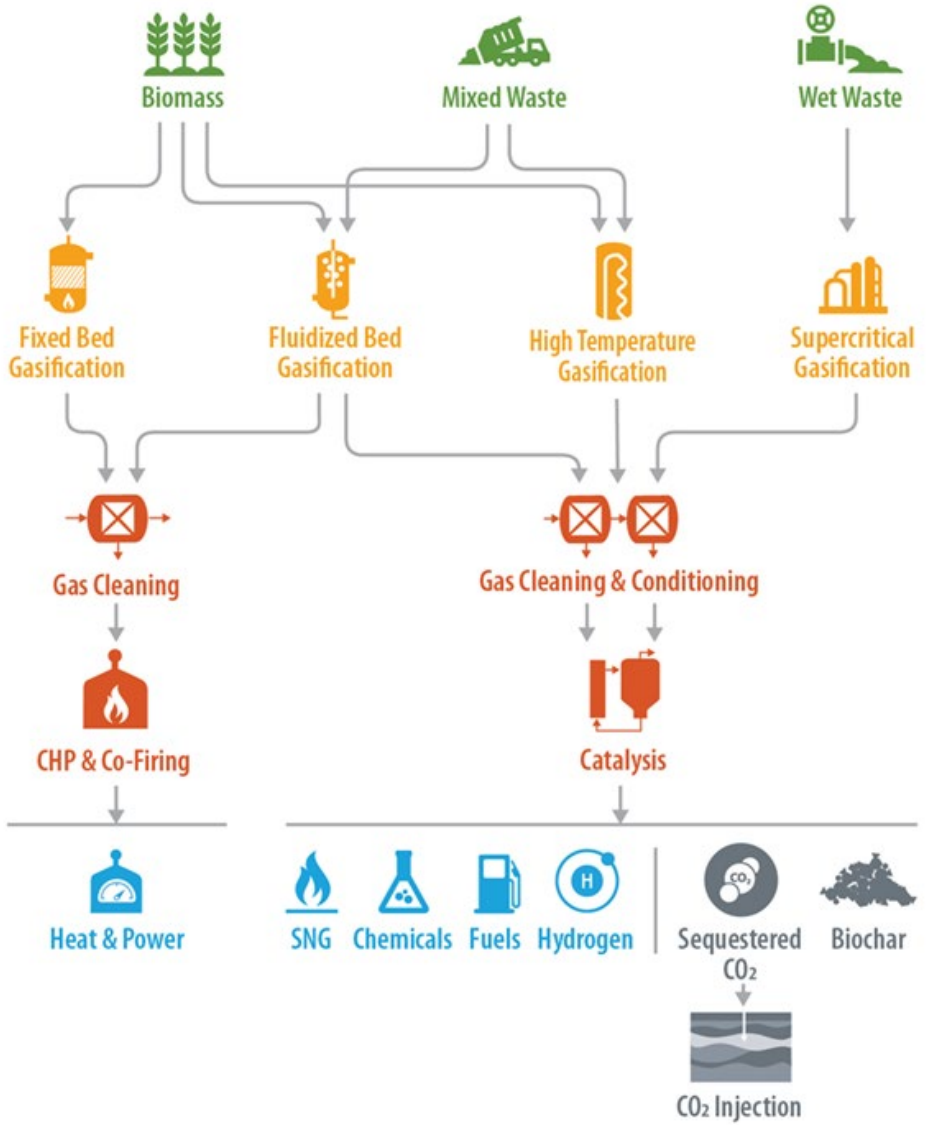
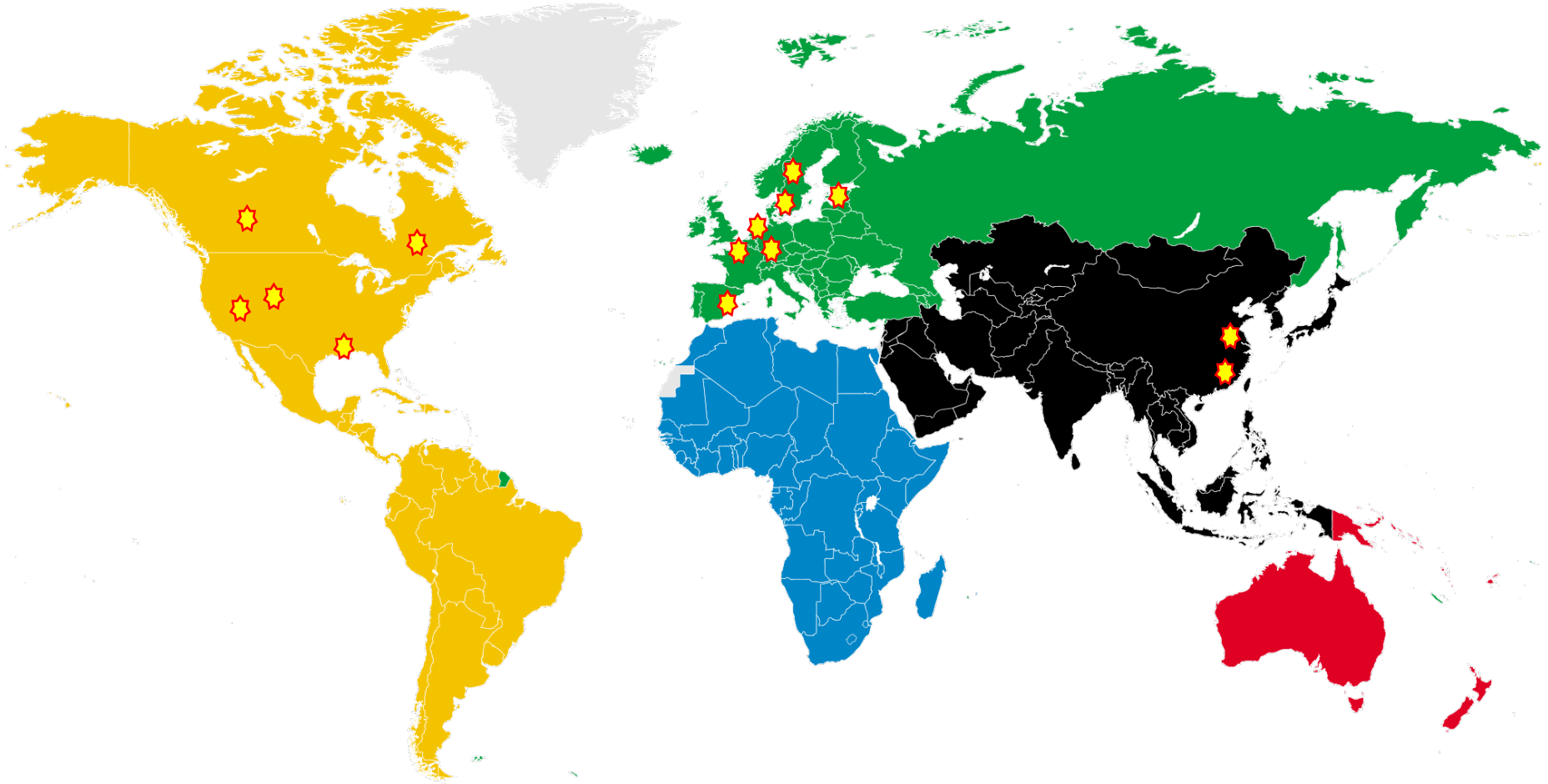
Gasification pathways

Globally many drivers exist for Methane and Fuel production

- ReFUEL EU Aviation
- Fuel EU Maritime
- SAF Grand Challenge 35 billion gallon by 2050 in USA
- Biofuel Act Law India
- Methanol Fuel Vehicle push in China
- Green Gas target of 35 bcm by 2040
- 2 bcm Green Gas blending mandate in the Netherlands
- Etc. etc….

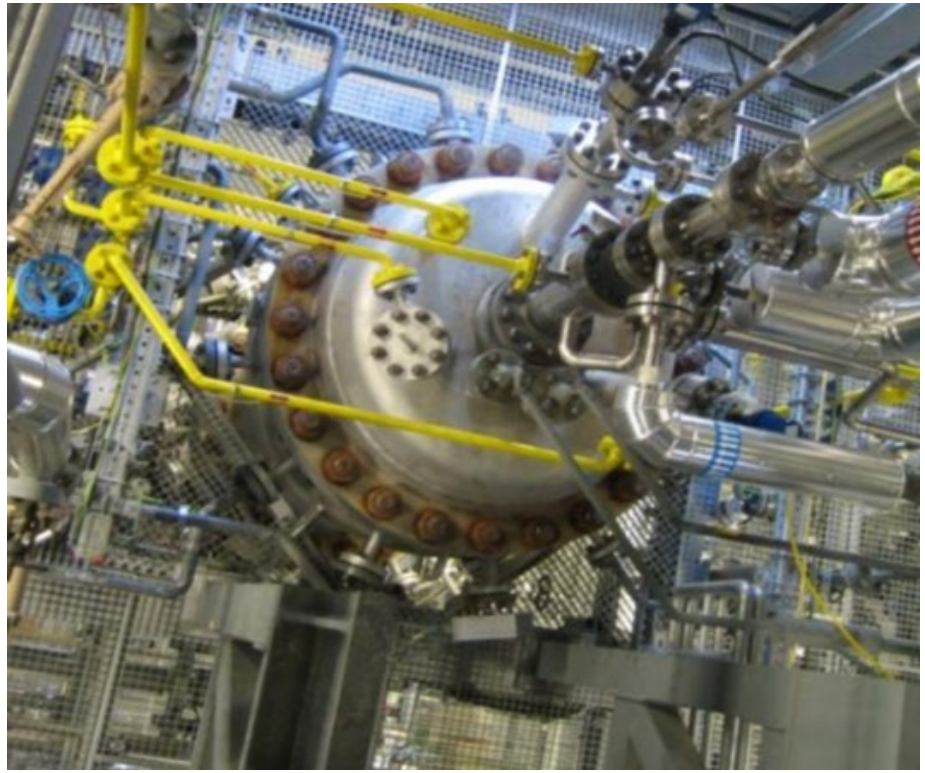


Gasification examples world wide



Bioliq® High-pressure entrained flow gasifier

Top view of the Bioliq® syngas platform



- High pressure entrained flow gasifier
- Pressure 40 / 80 bar (abs)
- Capacity 5 MW_{th}
- Gasoline type fuels from biogenic pyrolysis oil slurries
- Operational
- Syngas composition:
  - H2: 24.3 – 33.4 vol%
  - CO: 28.6 – 37.8 vol%
  - CO2: 15 – 29.1 vol%
  - H2/CO: 0.78 – 0.91
- Production of 2 t gasoline for fleet tests within ReFuels project

GoBiGas Indirect gasifier for SNG production

Gobigas

- Indirect fluidized bed gasifier, provided by Repotec/Valmet
- 32 MW_{th} ~ 50 ktpa dry feedstock
- Green Gas 20 MW_{SNG}
- Build and operated 2014/2015
- Successful demonstration, however next phase cancelled

! Do not optimize to the extreme on a first plant. Complicates start-up and operation

Engie - Salamandre project

- Indirect gasification of waste streams followed by fluidized methanation
- Based on the Gaya platform (picture)
- 20 MW Green Gas
- Status – Under development

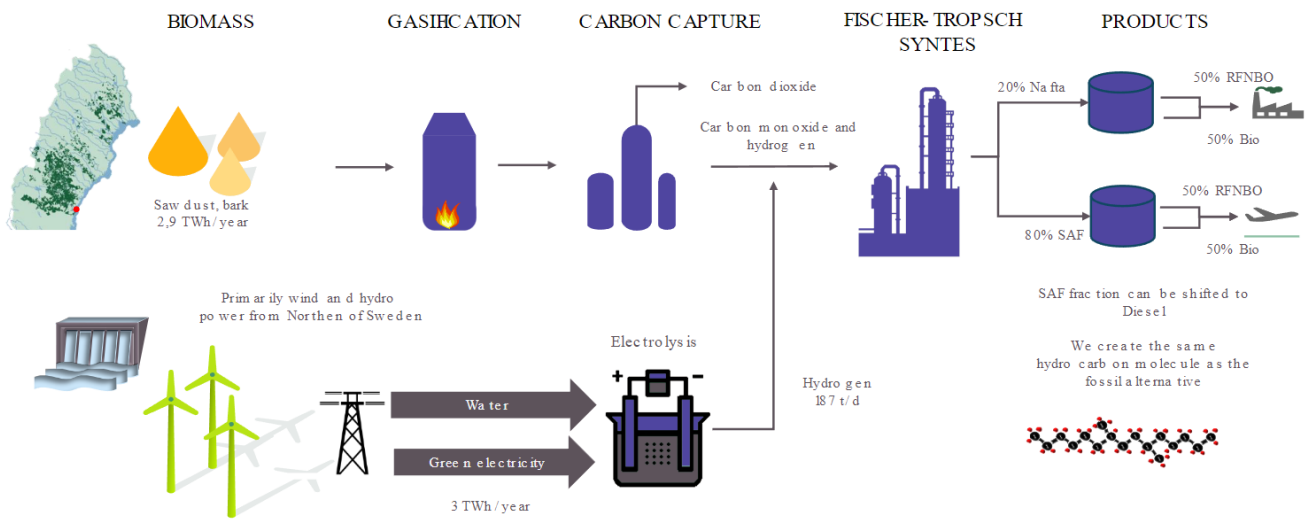
! Supported by strong team of engineers/scientist with a running demonstration platform

Fulcrum Bioenergy / Sierra Biofuels

- TRI Indirectly heated gasifier (heat pipes)
- BP Cans technology for FTS
- 350 ktpa MSW → 175 ktpa feed
- Status: Plant has been commissioned. Several runs on the BP Cans technology.
- Costs ~ 1 bnUSD

! Issues with fouling and nitric acid (Bloomberg report)

Biorefinery Ostrand – Sweden (SCA and St1)



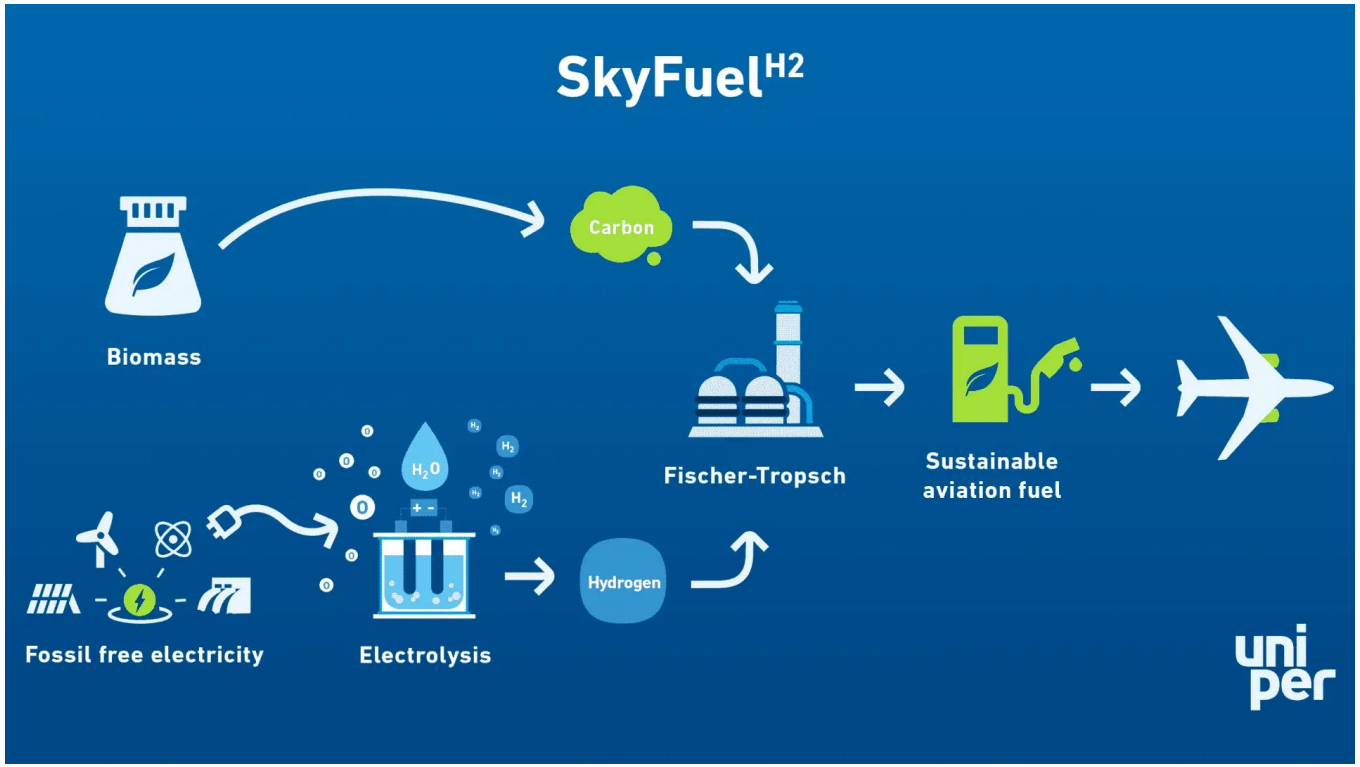
SAF pathway combined with PtX

- Entrained flow gasification combined with torrefaction.
- 2.9 TWh/y ~ 400 MWth input
- PtX = 400 $MW_{electrolyser}$
- Product = SAF + Nafta
- Integration with a pulp mill

!! Extremely large – feedstock not an issue

!! Sufficient renewable power allows to double the output

SkyFuel^{H2} - Sweden (Uniper)

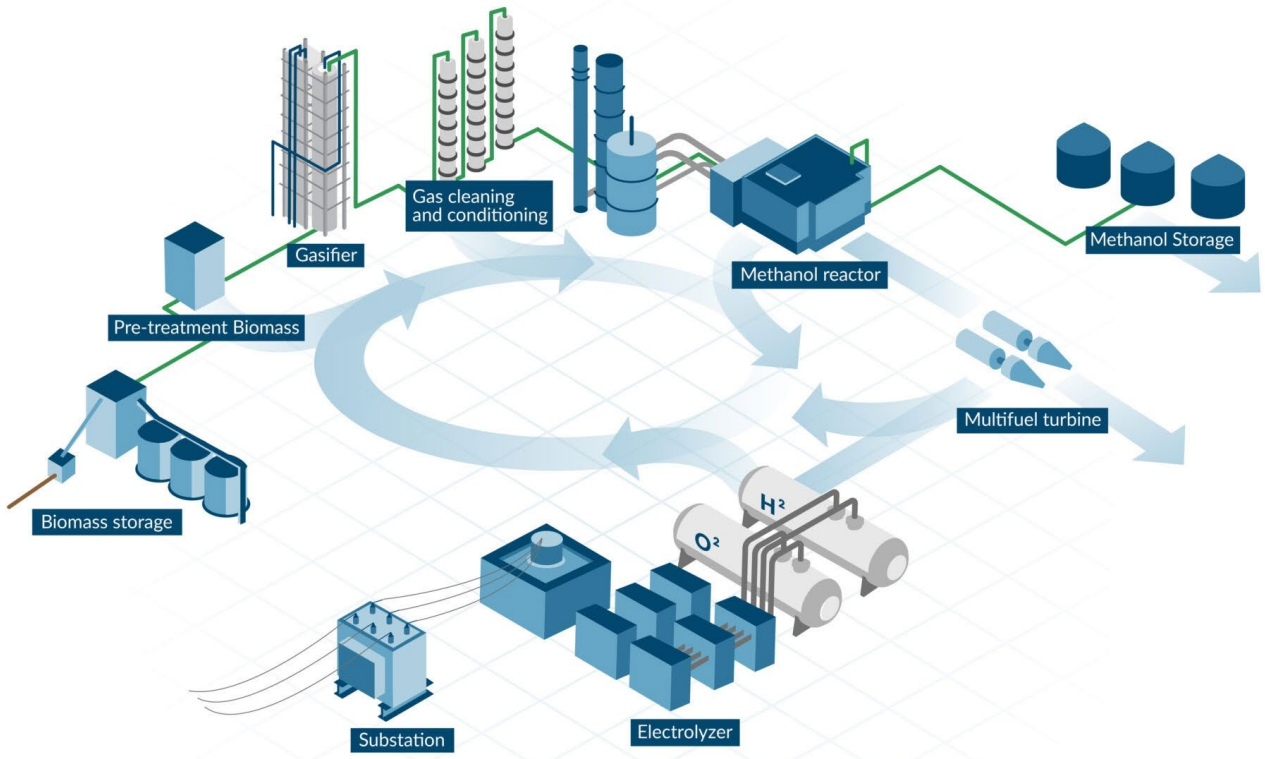


SAF pathway combined with PtX

- Entrained flow gasification combined with torrefaction.
- ~ 100 MWth input of biomass
- PtX = 200 $MW_{electrolyser}$
- Product = SAF + Nafta

!! Sasol (ecoFT) stept out for the FT part. Uniper is reconsidering options. Changing consortia is not uncommon

Power2X – Parnu Estonia



Green MeOH combined with PtX

- Project is under development. Permitting and feasibility phase
- Goal is 500 ktpa MeOH, which could be in the order of 300 MW_{th} + 300 Mw_{el}
- Projected costs 1 bn€

!! Combination of biomass gasification and electrolysis.

Enerkem - Varennes

Varennes

- Enerkem BFB gasifier coupled to an electrolyzer (90 MW)
- Size 200 ktpa feedstock
- Product biofuels (MeOH)
- Under construction → 2025
- Total costs ~ 600 M$

! Combination of gasification and PtX.

ABSL - Swindon UK

- Fluidized oxy-steam gasifier, connected to a plasma torch for syngas production (RadGas technology)
- Small first demonstration (~6 MWth)
- Product → Green Gas
- Status → First syngas produced in jan-2024

! Other outlets from syngas explored, H_2 etc

RWE – FUREC project

5 tph dense phase flow testing performed

RWE – FUREC project

- Multiple Heart Furnace for torrefaction of waste
- EF gasification of torrefied RDF pellets
- MSW input 700 ktpa
- H_2 produced 54 ktpa
- CO_2 avoided 380 ktpa
- Status: Under development
- Costs: ~600M€

! Managing their own waste
! Extensive testing on foreseen feedstock
! Strong knowledge team at RWE

DG Fuels - Lousiana

Nextchem as technology provider

- Waste to SAF project
- Moving bed technology (O_2 blown)
- BP/JM Cans technology for FTS
- Sugar cane waste (120 M$ cost)
- Start of operation 2028
- 4 bnUSD project

! Joint forces with an EPC with technology inhouse.

New developments – China

Company	Scale and technique route	Location	Status
China National Chemical Engineering Group Corporation Ltd.	1 million ton of methanol per year (0.2 million ton in the first-stage project); Biomass steam gasification	Yancheng, Jiangsu, China	Under construction
Debo bioenergy Ltd.	0.15 million ton of methanol per year. Biomass steam+oxygen gasification	Ruijin, Jiangxi, China	Under construction
Sany Group	0.37 million ton of methanol per year. Biomass gasification integrated with electrolysis of water	Changlin, Jilin, China	Signed a contract

- **32 green methanol** projects are planning or under construction in china, most of which applies biomass gasification.
- It is estimated, by 2025, China shares more than **60%** of global green methanol production, and by 2028, more **than 8.7 million** tons of green methanol will be produced by china.

Observations

- EU seems to have some Green Gas projects in the pipeline. Mainly in France, UK and the Netherlands. A wish for 35 bcm seems out of reach with current progress
- Green gas projects tend to be small
- Fuel projects tend to be big
- USA is investing big in SAF (and failing from time to time)
- MeOH seems a no brainer
- China is ramping up the MeOH production
- Most technologies try to go to syngas asap and often they go big as well.

Preliminary conclusion (1/2)

- Be in charge of your own feedstock pre-treatment (Enerkem, Fulcrum, Torrgas, RWE)
- Gasifiers for fuels/green gas tend to be either fluidized bed or entrained flow. Feedstocks are similar, but in EF case they are torrefied.
- Gasifier to syngas use oxygen and this often translates to very large plants in order to justify CAPEX/OPEX, especially for EF
- Keeping things simple has benefits, specifically for gas cleaning. This is why many platforms go as fast as possible to syngas. (Enerkem, BioTFuel, Fulcrum, Nextchem, Torrgas etc.)
- Clean-up strategies (when diving into them) for syngas platform show many similarities. Well developed and well demonstrated.
- Make sure that the technology has a solid scientific track record and remaining support (Synova, Torrgas, Enerkem)

Preliminary conclusion (2/2)

- Make sure to do a proper risk assessment on fail components and make sure they are in store (Fulcrum)
- Business case needs to be valid today but also 10-15 years into the future
- Flexibility to switch feedstock and/or application, both a strength as well as weakness
- Proper piloting and maintaining that basis is crucial in any technology development.
- Several projects under development that combine PtX with biomass gasification. This holds the potential to double the output. This also holds the potential to drive down the economics for e-biofuels. (Uniper, SCA, Power2X, Enerkem)

Recommendations

1. We need strategies for gasification pathways for advanced gases and fuels to work already at <50 MW_{th} scale, before going to >>100 MW_{th}

2. We need a European / Global Centre of Excellence on Gasification to develop and maintain competence to support developments and avoid mistakes, killing projects

3. The perfect marriage between biofuels and e-biofuels needs stronger focus on all levels, from R&D to deployment.

Thank you for your attention

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