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Carbon Capture and Storage Program

Identification of best options for CO_2 utilisation for biorefineries

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Comment: Mari Tuomaala, Gasum Oy

Subtask 2.6.4 Publications and reports

- Arpiainen, V. & Turpeinen, E, CO_2 to chemicals and market study, project report, 30.10.2015, 28 p.

- Hannula, I., Doubling of synthetic biofuel production with hydrogen from renewable energy, Presentation in tcbiomass2015 Conference, Chicago, USA, 2-5th November 2015

- Hannula, I., Hydrogen enhancement potential of synthetic biofuels in the Europeaan context: A techno-economic assessment. Article in Energy paper, In progress

Key drivers for new type biorefineries

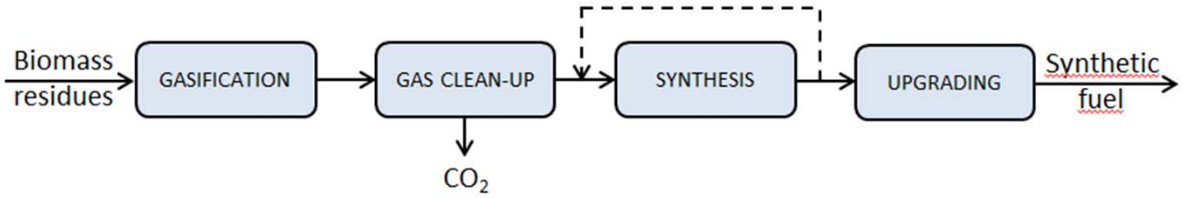
- Consumption of transportation fuels is increasing in European Union (Kyoto protocol 1990-2012, rise about 15 percent during the period)[1)]

- Only 16 percent of road transport fuels (1 million oil equivalent bbl/day) in 2030 could be displaced with all biobased raw materials (223 Mt/a) in Europe [2)]

- It is known that hydrogen could increase the efficiency of biomass use in biorefineries

1) EEA, greenhouse gas – data viewer (Accessed Oct 22nd 2015). http://www.eea.europa.eu/data-and-maps/data/data-viewers/greenhouse-gases-viewer
2) S. Searle, C. Malins, Availability of cellulosic residues and wastes in the EU, White paper, The International Council on Clean Transportation (2013)

Conventional biorefinery without external hydrogen use



Synthetic biofuels production (methanol, dimethyl ether; Fischer-Tropsch wax and Mobile gasoline) allows:

- 50 – 60 % synfuel efficiency
- up to 80 % overall efficiency when synfuel and district heat is produced

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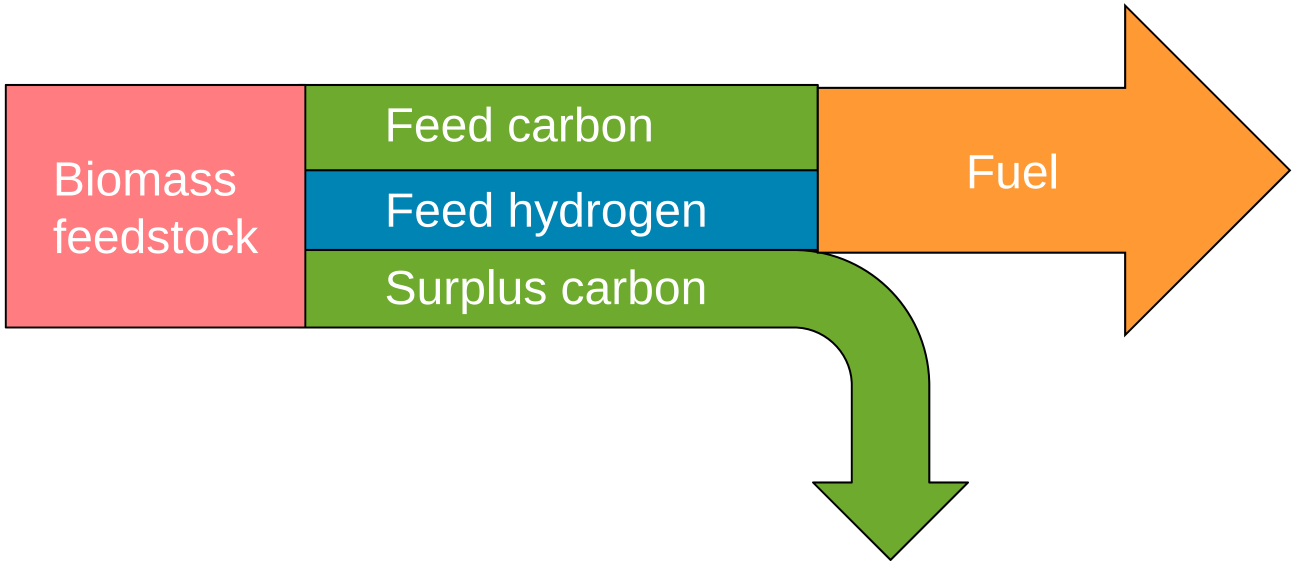
Conventionally more than half of feedstock carbon is rejected from the process. This is because there is not enough hydrogen to convert it into fuels.



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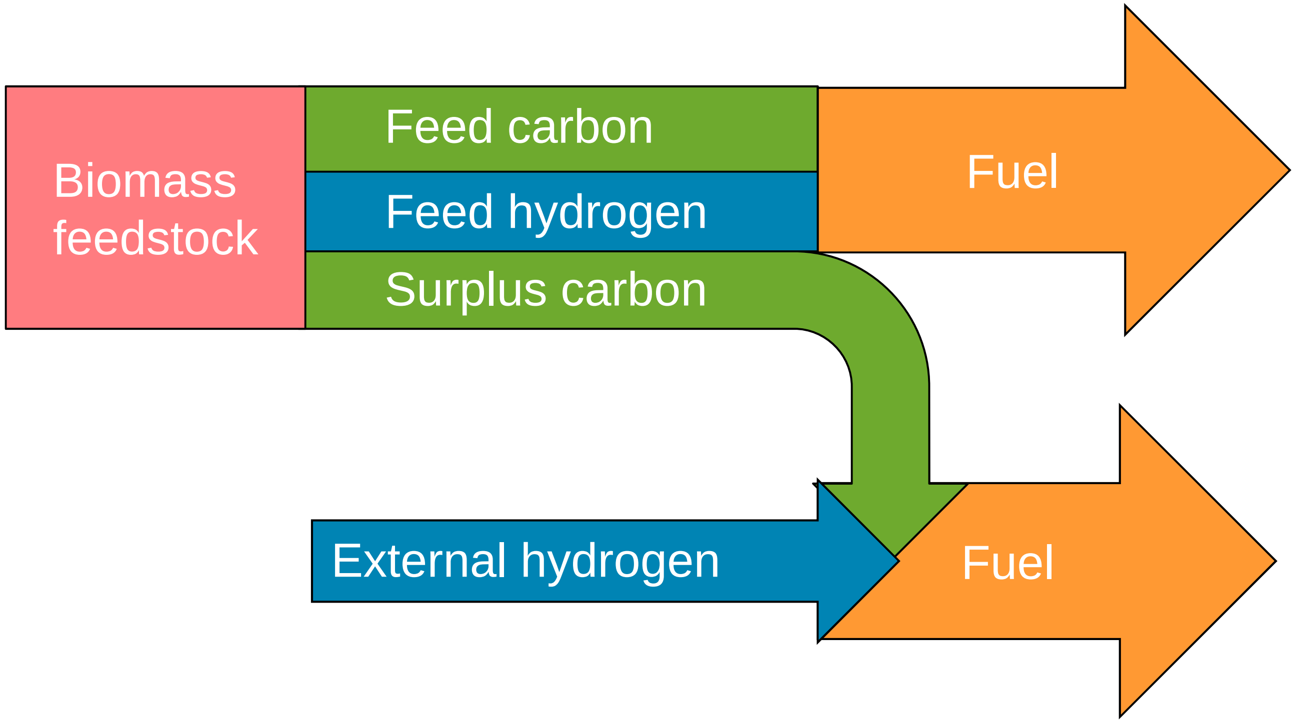
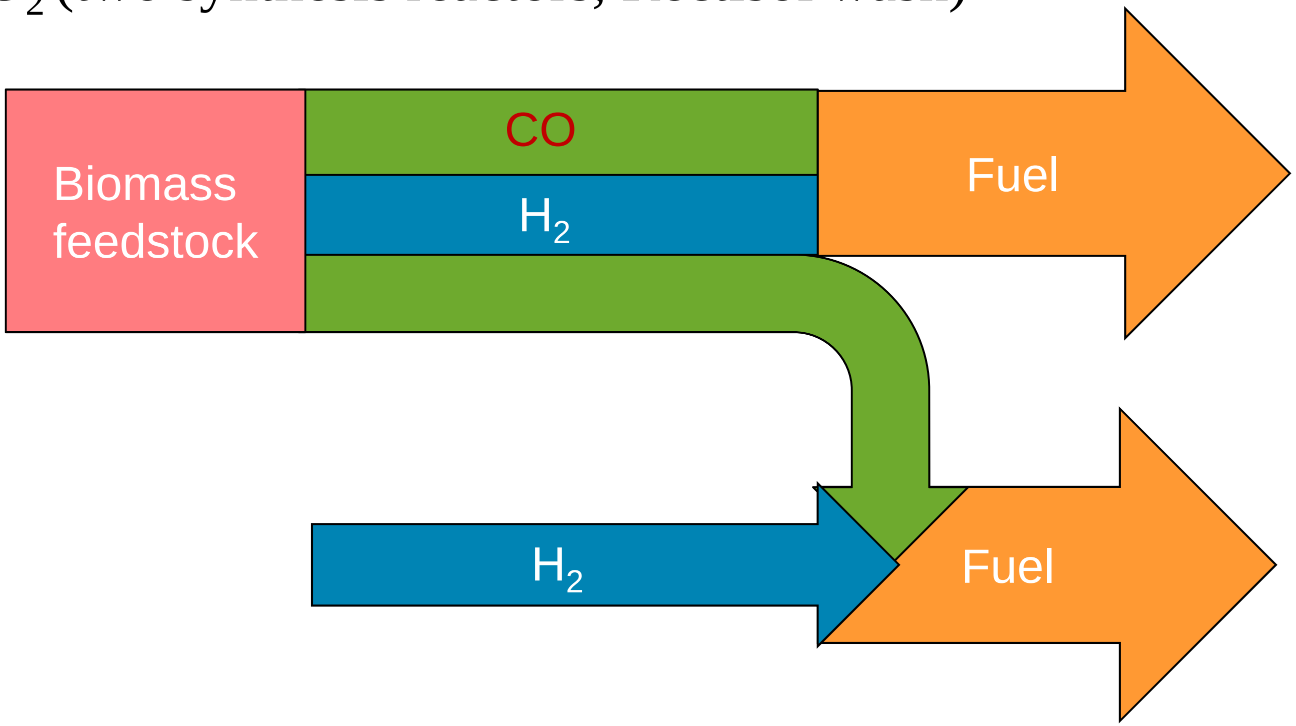
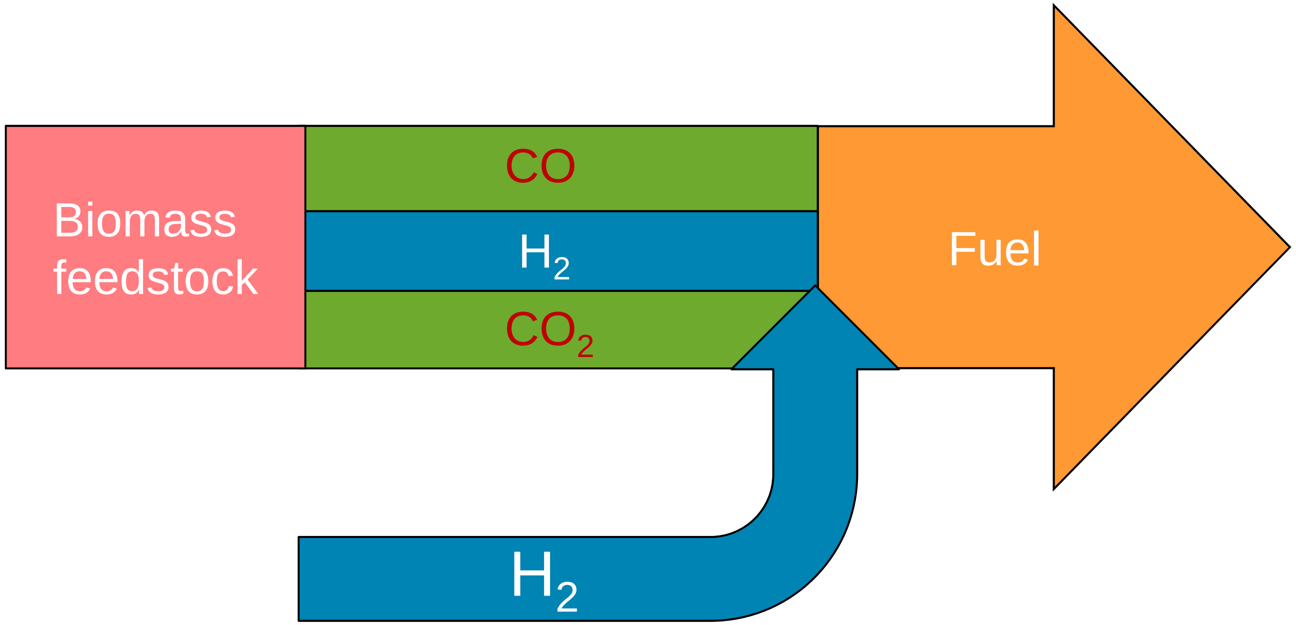
By adding hydrogen from external source, the surplus carbon could be hydrogenated to fuel as well.



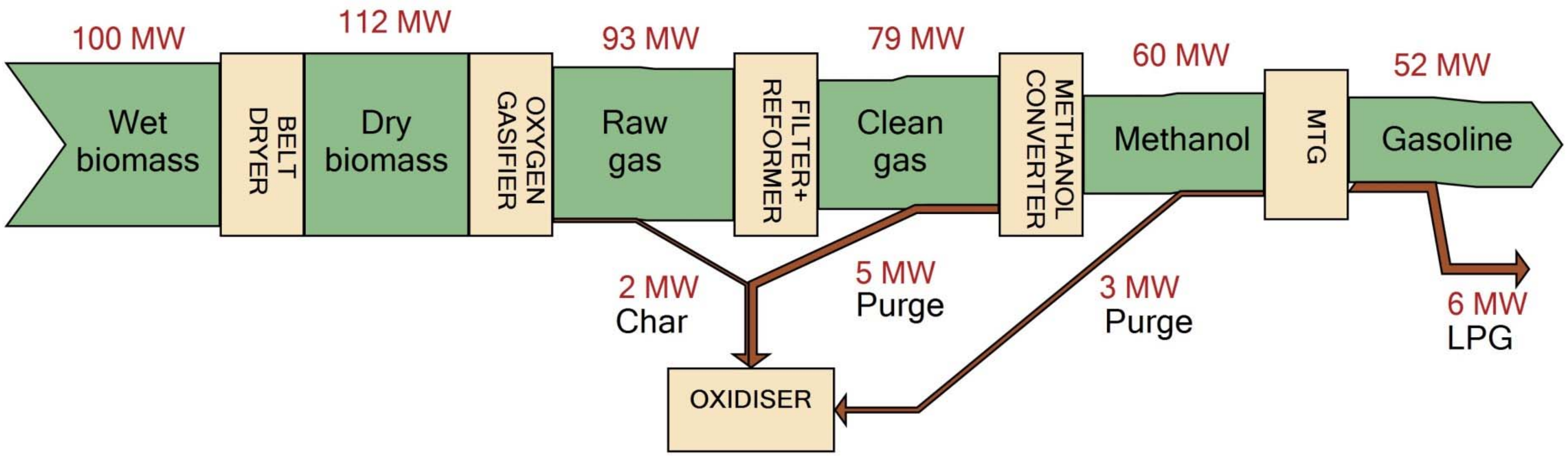
Surplus carbon is in the form of CO_2 instead of CO
Hydrogen reacts conventionally with CO
Commercial fuel production not technically available via hydrogen and CO_2 (two synthesis reactors, Rectisol wash)



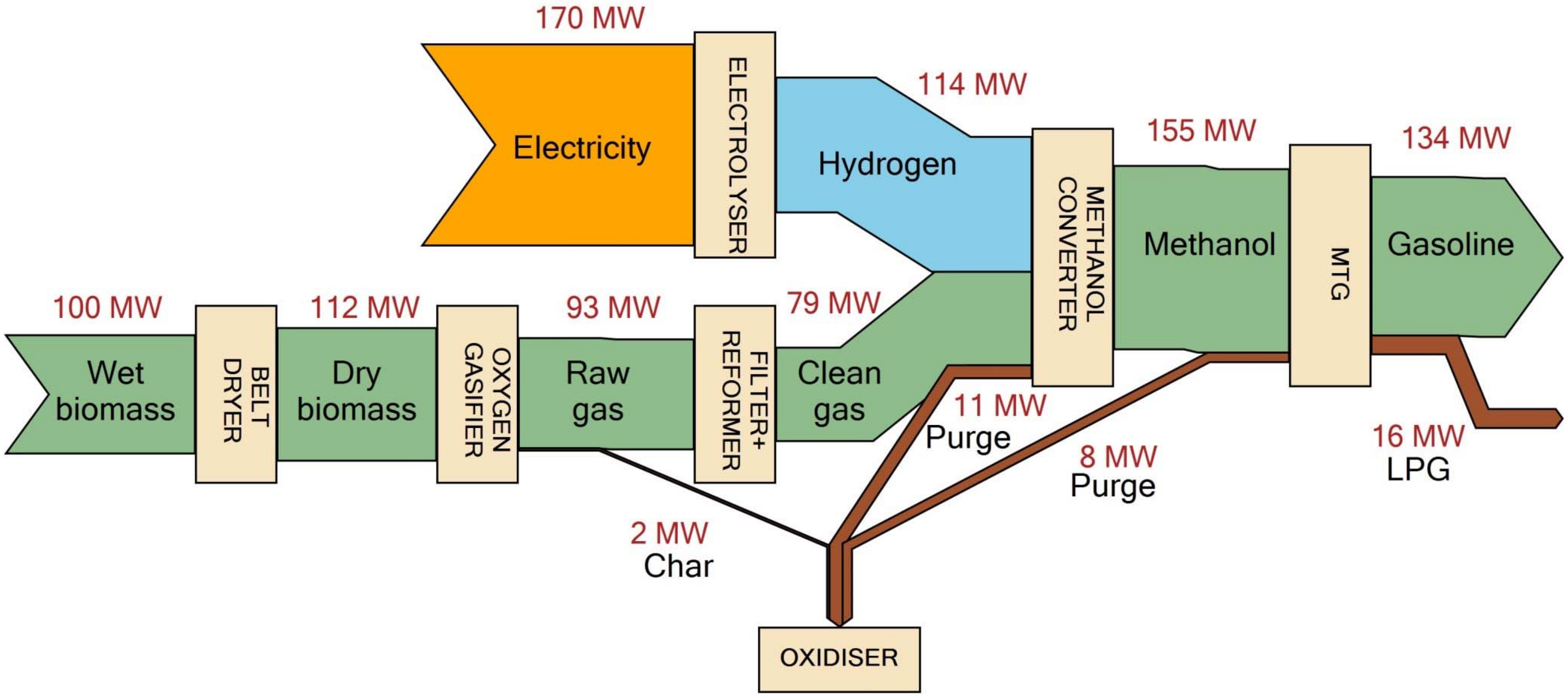
It is more economic solution to develop new synthesis without CO_2 separation (one synthesis reactor, H_2S selective Rectisol wash) Commercial fuel production not technically available via this route. However the potential increase in fuel output would be significant



Example: Conventional synthetic gasoline route via oxygen gasification



Example: Synthetic gasoline route via oxygen gasification when external hydrogen is added to methanol synthesis



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Summary: Synthetic gasoline output from 100 MW biomass input

Biomass only" (conventional) pathway:

- 52 MW of gasoline
- 31 % utilisation of carbon in biomass

Bioenergy with hydrogen supplement:

- 134 MW of gasoline
- 79 % utilisation of carbon in biomass

-------> 134 / 52 = 2.6 fold increase in output!

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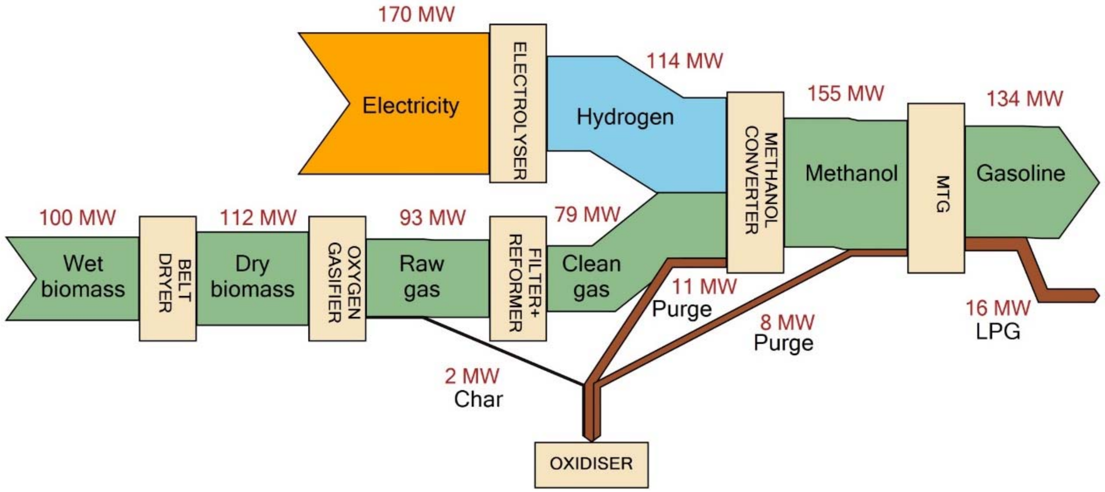
Take-home messages

- Renewable and sustainable carbon is a scarce resource globally
- Currently more than half of biomass carbon not utilised at all in conventional synfuel production
- Biomass residues can be converted conventionally to biofuels and heat at ~80 % overall thermal efficiency
- Combining the vast resources of wind and solar with bioenergy can effectively more than double biomass ”availability”

Thank you for your attention!

http://www.cleen.fi/en/ccsp

Comment: Mari Tuomaala, Gasum Oy



The presented approach combines two important megatrends:

- Bio-energy use - and its efficient utilization!
- Renewable electricity – and it’s seasonal conversion?

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