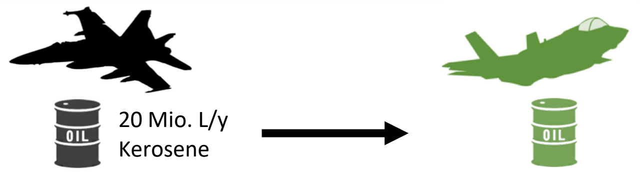
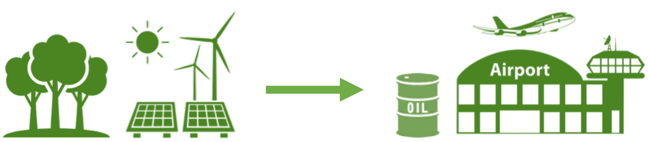
SAF for SAF

Sustainable Aviation Fuel for Swiss Air Forces



Goal: Local CO_2 neutral aviation fuel production



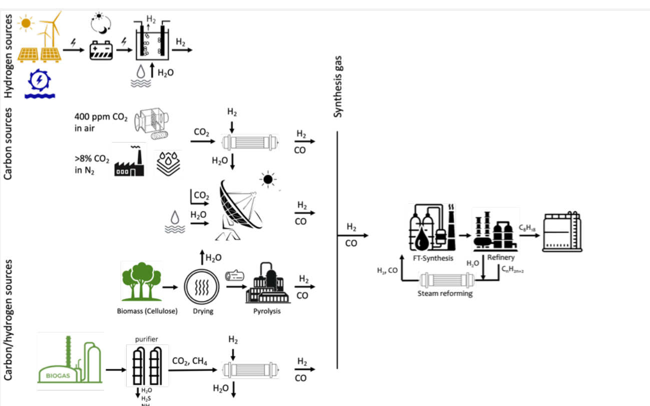
The synthesis of hydrocarbons requires carbon and hydrogen. The source of carbon is CO_2 and for hydrogen electrolysis of H_2O. Biomass contains carbon and 50% of the hydrogen. The sustainable availability of the sources, the energy efficiency of the process and the cost of the final product are the parameters to determine the process for the synthetic aviation fuels. Additionally the environmental impact and the energy security have to be considered for the installation of a SAF plant.

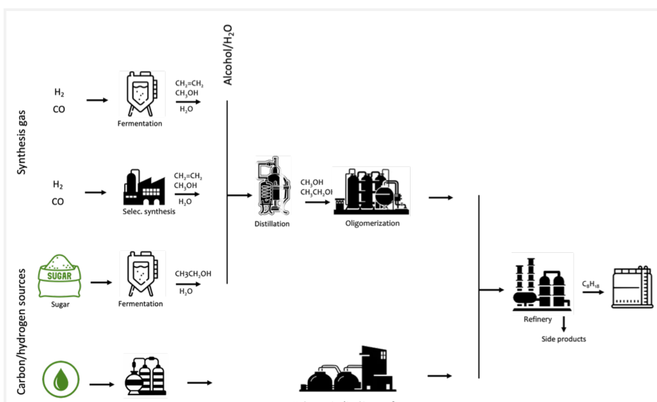
In the summer of 2022, the LMER research group at EPFL was commissioned by armasuisse to carry out a feasibility study for the production of synthetic fuel together with partners Ott & Partner Architektur, groupe-e and swiss aeropole SA. The goal is to cover the fuel consumption the coming F35 fleet, from renewable energy, i.e. CO_2-neutral. The possible technical production paths are analyzed and compared in terms of energy consumption, raw materials, efficiency and costs.

Electricity Storage with PV

Converter	Efficiency [%]	W [kWh/kWh]	Cost/W [CHF/kWh]	Investment [CHF/kW]	W [kWh]	W [kWh]	Wel. [kWh]	Cost cum [CHF]	Cost/Wcum [CHF/kWh]	Size unit	Size [kW or kWh]	CAPEX [CHF]	Cost factor
PV	100.00%	0	0.071	1607	271	318.4	47.8	22.56	0.07	W [kWh·y-1] =	318.43	465	0.0708
Converter AC/DC	95.00%	0	0.022	845	257	302.5	45.4	29.09	0.10	Pp [kW] =	0.11	92	0.0253
Battery	89.00%	0	0.133	239	229	269.2	40.4	65.00	0.24	C [kWh] =	1.31	312	0.1453
Inverter DC/AC	95.00%	0	0.022	845	217	255.8	38.4	70.52	0.28	Pp [kW] =	0.09	78	0.0343
Electrolyzer	60.00%	0.02	0.054	2227	130	130.4	0.0	77.55	0.59	Pp [kW] =	0.07	99	0.3190
Compressor	95.00%	0.15	0.021	1223	124	123.9	0.0	80.19	0.65	Pp [kW] =	0.04	55	0.0525
Hydrogen Tank	100.00%	0	0.020	61	124	123.9	0.0	82.71	0.67	C [kWh] =	0.51	31	0.0204
CO2 Capture 400 ppı	100.00%	0.054	0.347	17750	124	123.9	0.0	125.76	1.02	Pp [kW] =	0.04	753	0.3474
CO2 Storage	100.00%	0.05	0.000	40	124	123.9	0.0	125.78	1.02	C [kWh] =	0.51	20	0.0002
FT-Synthesis	70.00%	0.05	0.028	3467	87	86.7	0.0	128.21	1.48	Pp [kW] =	0.04	147	0.4631
Fuel Taransport	99.00%	0	0.000	0	86	85.9	0.0	128.21	1.49	Pp [kW] =	0.03	0	0.0149
Fuel Tank	99.00%	0	0.000	0	85	85.0	0.0	128.21	1.51	C [kWh] =	85.00	16	0.0151
	26.7%	38.4	Auxillary power						1.51			2069	
Efficiency =	**26.7%**							**Fuel [CHF/L] =**	**15.08**		**CAPEX [CHF] =**	**2069**	

The production of hydrogen from renewable energy, the source of carbon, and the reduction and refining process determine the cost and the energy efficiency of the synthesis for the SAF.





The low efficiency of the electrolysers of only 60% and the cost and energy demand for the direct air capture of CO_2 have a great potential for improvement. The F-T synthesis is already working close to the thermodynamic limit and realized in large scale. The processes based on biomass lead to a significantly lower cost of the SAF. The potential of sustainable biomass in Switzerland is 27 $TWh\cdot y^{-1}$, enough to produce all aviation fuel in Switzerland.

Andreas ZÜTTEL, Prof. Dr.

Laboratory of Materials for Renewable Energy (LMER)
Institute of Chemical Sciences and Engineering (ISIC)
Basic Science Faculty (SB)
École polytechnique fédérale de Lausanne (EPFL) Valais/Wallis

Rue de l'Industrie 17, CP 440
CH-1951 Sion, Switzerland

e: andreas.zuettel@epfl.ch
m: +41 79 484 2553
T: +41 21 695 8304 (Secretary)
U: http://lmer.epfl.ch