E-Fuel, H_2, and Energy Justice within the Energy Transition

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- Our emissions have never been as high as they will be in 2024, CO_2 concentration is accelerating, as carbon sinks are weakening: decarbonization is not an option.

- “Net 0” and carbon offsetting should be reserved for governments, not industries.

- Climate, energy and the economy are intimately linked: this calls for trade-offs.

- Decarbonizing energy: the main difficulty is not the technology, but inputs & scalability.

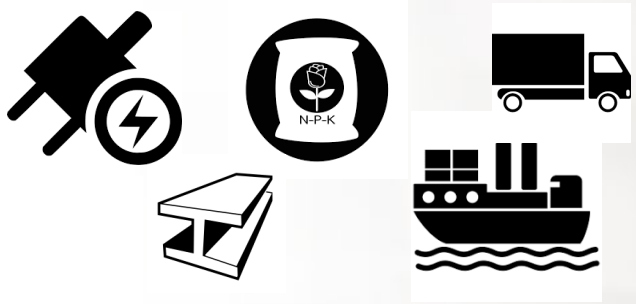
- Energy is at the heart of our mobility, and the choice of energy carrier should be adapted to each type of mobility, according to its efficiency.

SUSTAINABILITY

What type of feedstock is environmentally & socio-politically sustainable

- 1G crop based feedstock at risk
- Limited 2G feedstock
- Life Cycle Analysis shall take into account LUC / ILUC and all externalities (such as water for H_2)
- Several technologies shall be added (biofuels, efuels, hybrid)

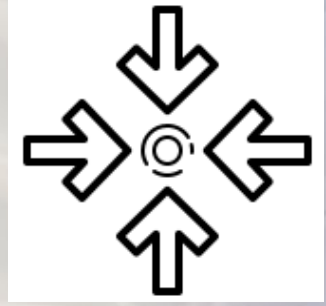
OPTIONALITY



Which applications are today's and future users of feedstock

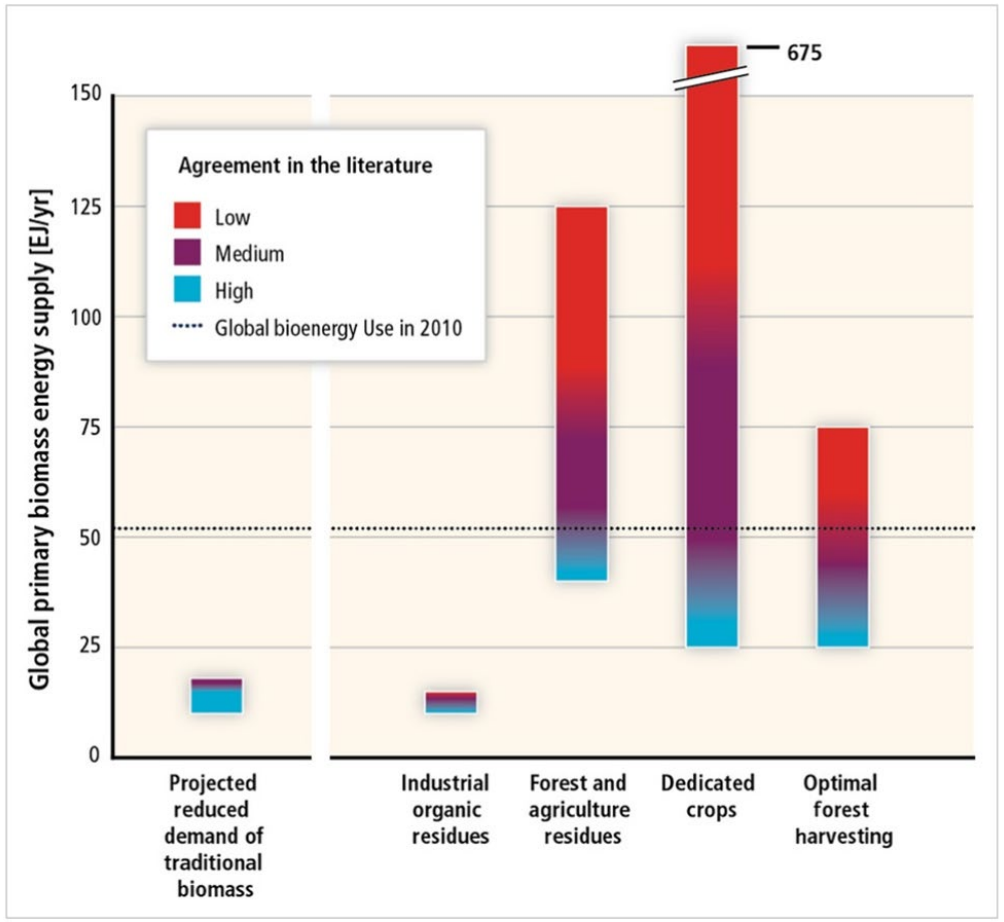
- Multiple competitors (present & future) such as heat, electricity generation, marine and road transport, food, steel manufacturing, fertilizers…

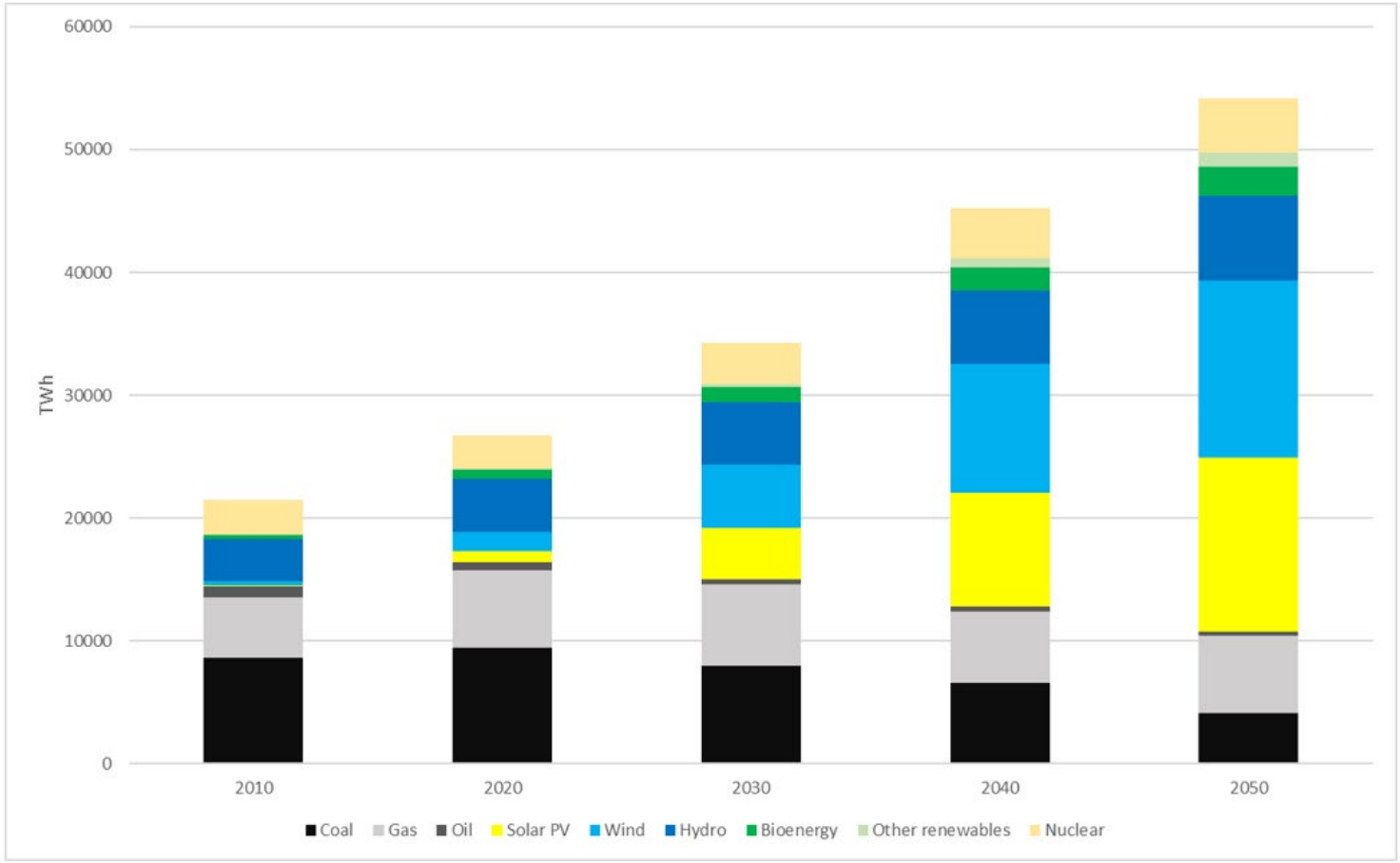
COLLECTABILITY

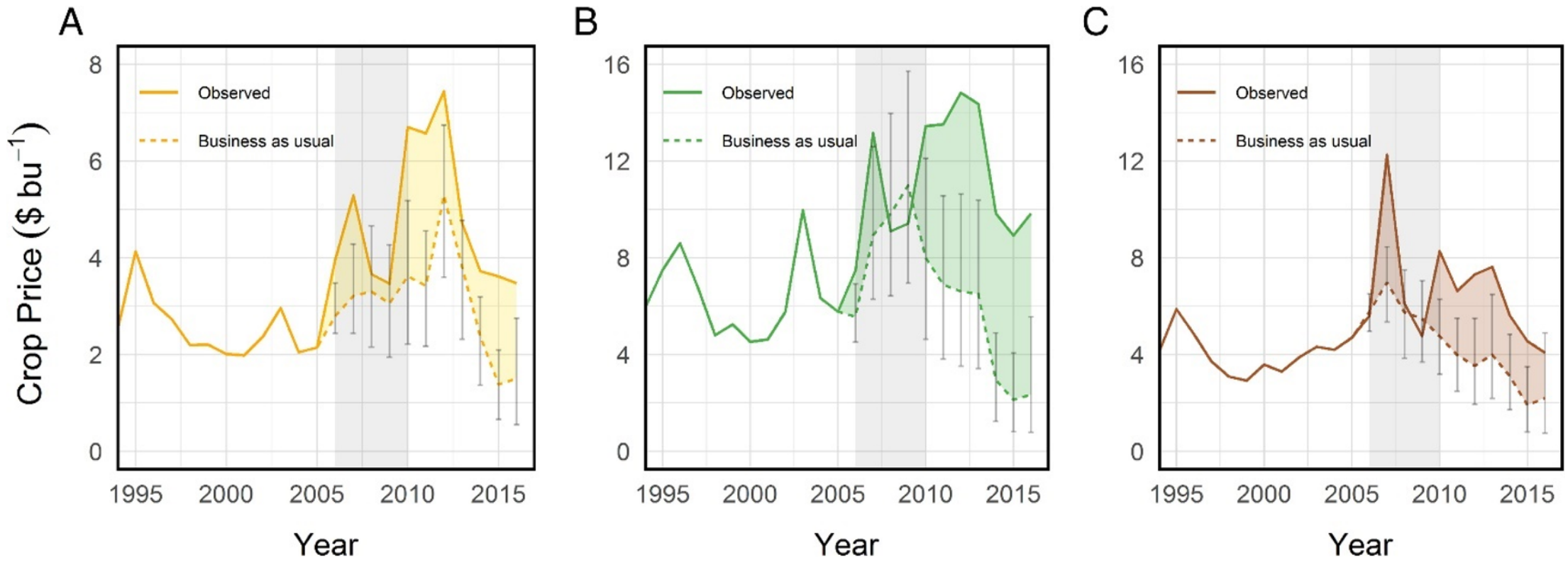


What is the volume of feedstock economically reasonable to collect & transport

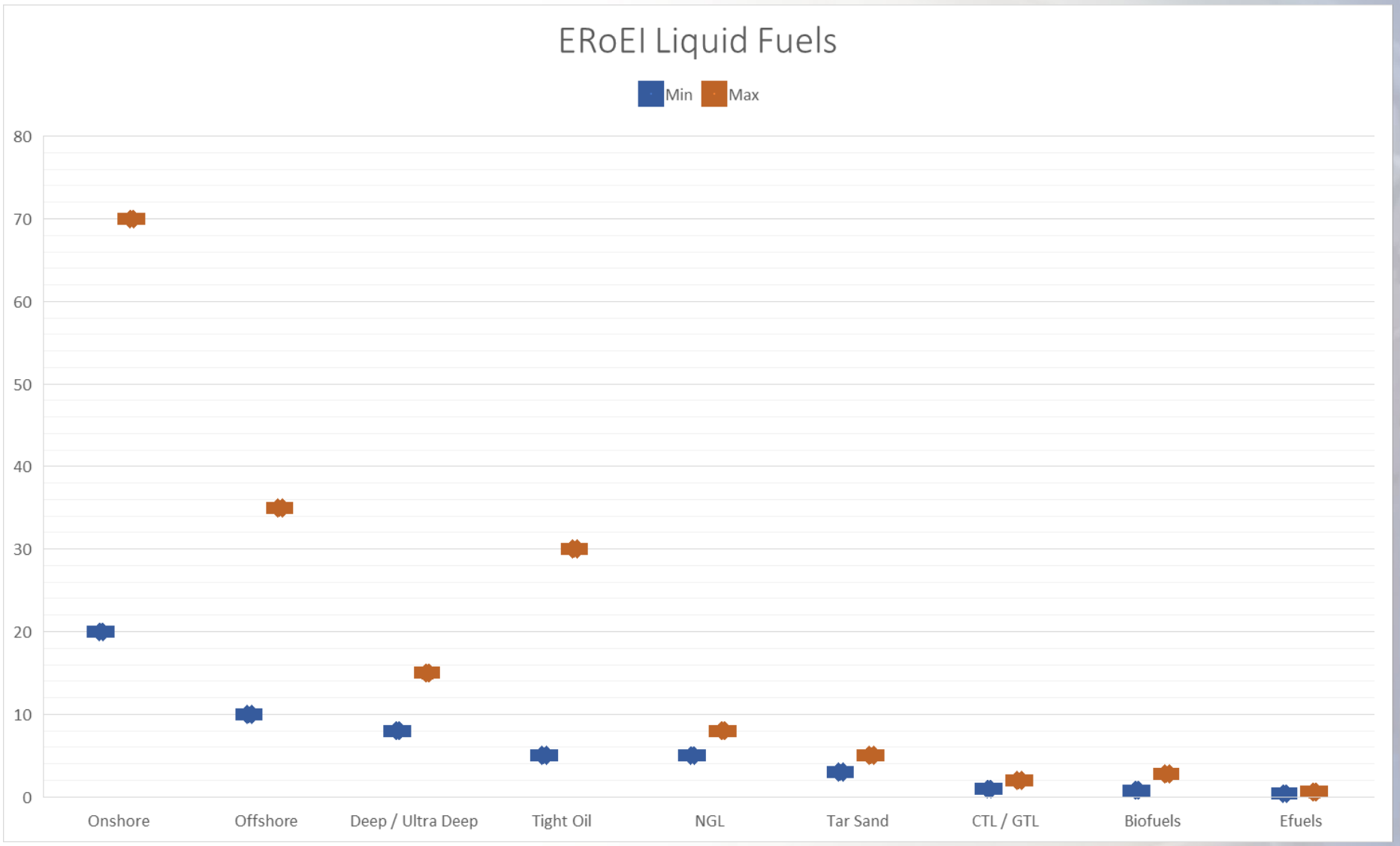
- Must consider feedstock local production, existing or required infrastructures, climate change impacts, cost of transport and associated emissions…


675
150
125
100
75
50
25
0
Global primary biomass energy supply [EJ/yr]
Agreement in the literature
Low
Medium
High
Global bioenergy Use in 2010
Projected reduced demand of traditional biomass
Industrial organic residues
Forest and agriculture residues
Dedicated crops
Optimal forest harvesting


60000
50000
40000
30000
20000
10000
0
TWh
2010
2020
2030
2040
2050
Coal
Gas
Oil
Solar PV
Wind
Hydro
Bioenergy
Other renewables
Nuclear



Observed vs Business as Usual crop prices for Corn (A), Soybeans (B) and Wheat (C) in the USA. Source Lark et al, originally Figure 1 in Environmental outcomes of the US Renewable Fuel Standard. It is found that the development of biofuels policies for transportation increased corn prices of 31%, wheat and soybeans of 20 and 19% respectively


EROEI Liquid Fuels
Min
Max
80
70
60
50
40
30
20
10
0
Onshore
Offshore
Deep / Ultra Deep
Tight Oil
NGL
Tar Sand
CTL / GTL
Biofuels
Efuels

Mean Scenario
4 Mt SAF / Year
=
6 Mt biomass
+
100 TWh

E-CHO / NAQ
0.1 to 0.2 MT SAF / Year
=
300 kt biomass
(approx. 15% NAQ)
+
4 TWh
(approx. 8% NAQ)

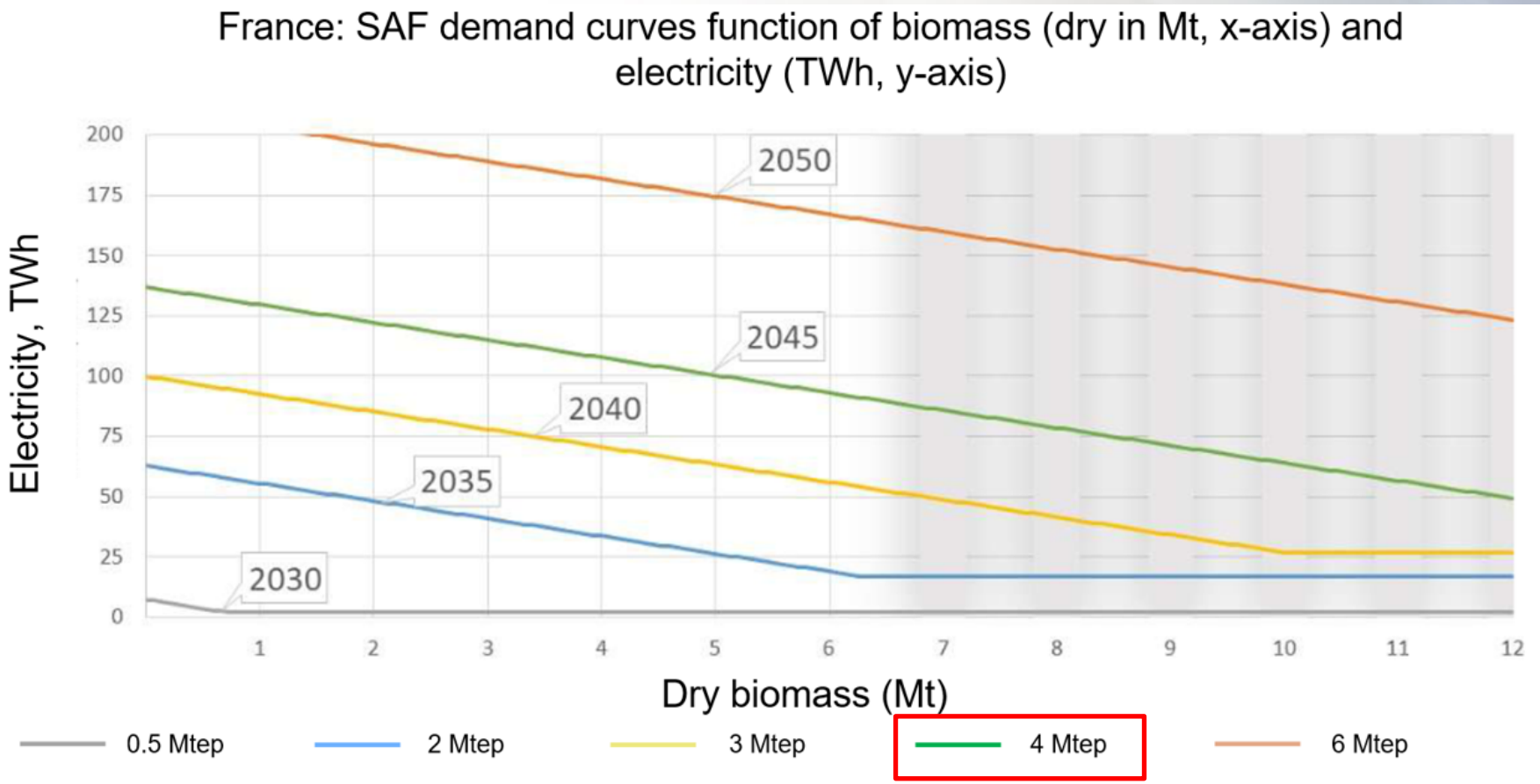
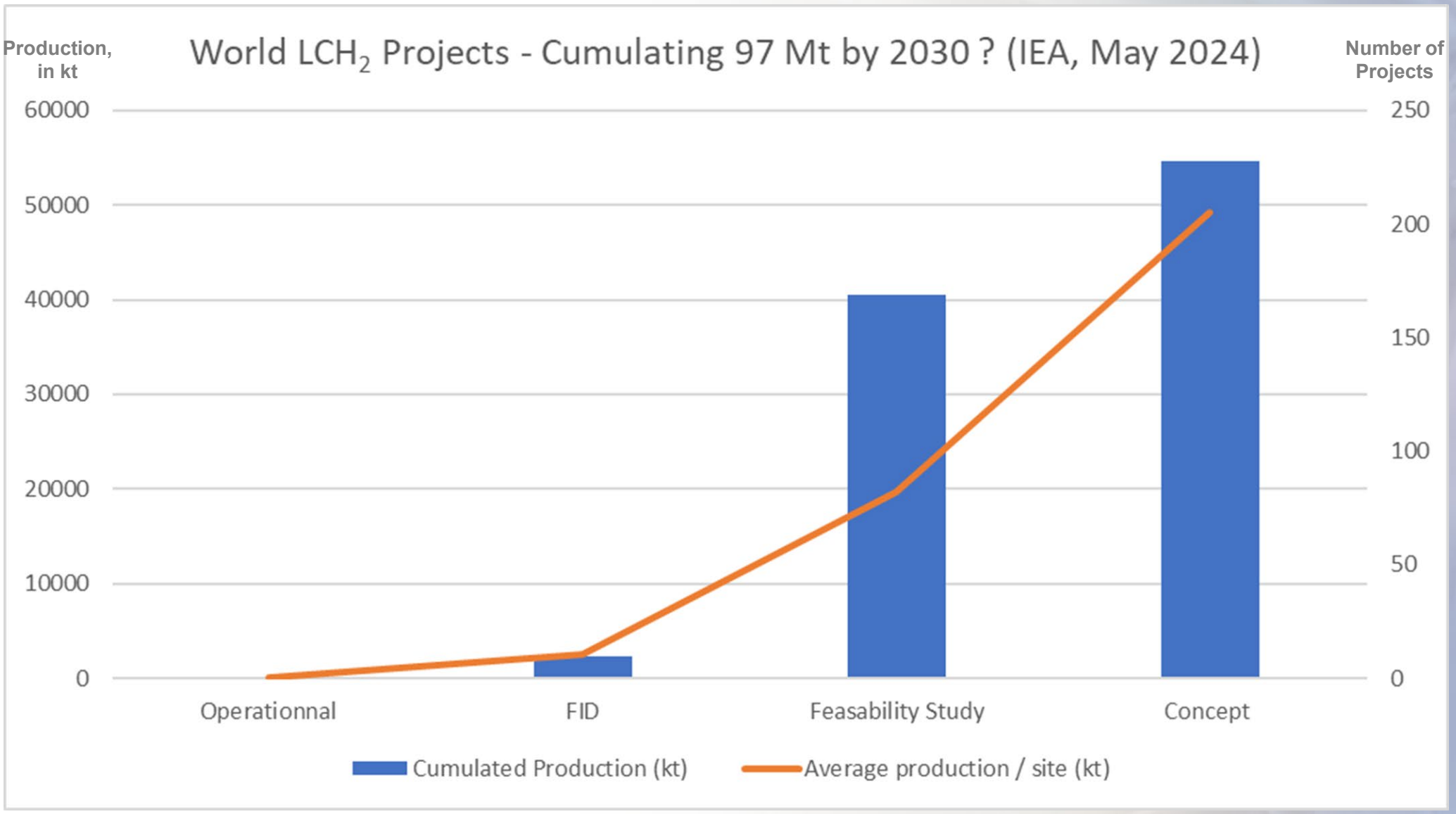


FIGURE 156 SAF demand curves for SAF in France function of the biomass availability. When bioenergy is sufficient, the SAF demand is met by ebioSAF processes, mobilizing 10 MWh per ton of SAF. When this is no longer the case, the residual need is met by efuel processes, mobilizing 35 MWh per ton of SAF to reflect a 60% selectivity. Graphic adapted with the courtesy of the original author, Dr Daniel Iracane


World LCH2 Projects - Cumulating 97 Mt by 2030 ? (IEA, May 2024)
Production, in kt
Number of Projects
60000
50000
40000
30000
20000
10000
0
250
200
150
100
50
0
Operationnal
FID
Feasability Study
Concept
Cumulated Production (kt)
Average production / site (kt)

H_2 production key criteria Data: OWID 2019 except when mentionned	**Country Total Electricity Production, in TWh**	**2030 LCH_2 total production expected in MT (data from IEA, 05/2024)**	**2030 LCH_2 total production expected in TWhe (data from IEA 2023)**	**2030 Ratio LCH_2 electricity need vs Country Total Electricity Production**	**% of population with access to electricity**	**kWh of electricity per capita**	**T&D losses (data World Bank, 2014)**	**Share of fossil fuels in the 2019 electricity mix**	**Share of fossil fuels in the 2030 electricity mix**
		65	65 TWh_e / Mt for liquid LCH_2	Below 0.15: Green 0.15 to 1: Orange Above 1: Red	Below 100% = Red	Below 4000 kWH: Red 4000 to 6700 kWh: Orange	Below 10% = Green 10 to 15% = Orange Above 15.1% = Red	Below 10% = Green 10 to 30% = Orange Above 30% = Red	Below 8% = Green 8.1 to 11,9% = Orange Above 12% = Red
France	**565,72**	**1,31**	**85,2**	**0,15**	**100%**	**8785**	**6%**	**9,46%**	**5,00%**
Namibia	**1,36**	**0,597**	**38,8**	**28,53**	**55,18%**	**556**	**36%**	**2,94%**	**2,94%**
Chile	**77,39**	**6,63**	**431,0**	**5,57**	**100%**	**4065**	**7%**	**58,35%**	**20,00%**
UAE	**129,65**	**0,275**	**17,9**	**0,14**	**100%**	**14075**	**7%**	**97,07%**	**70,00%**
Morocco	**39,98**	**0,481**	**31,3**	**0,78**	**100%**	**1085**	**15%**	**82,39%**	**48,00%**
Mauritania	**1,82**	**4,871**	**316,6**	**173,96**	**45,83%**	**415**	**16,10%**	**74,73%**	**50,00%**

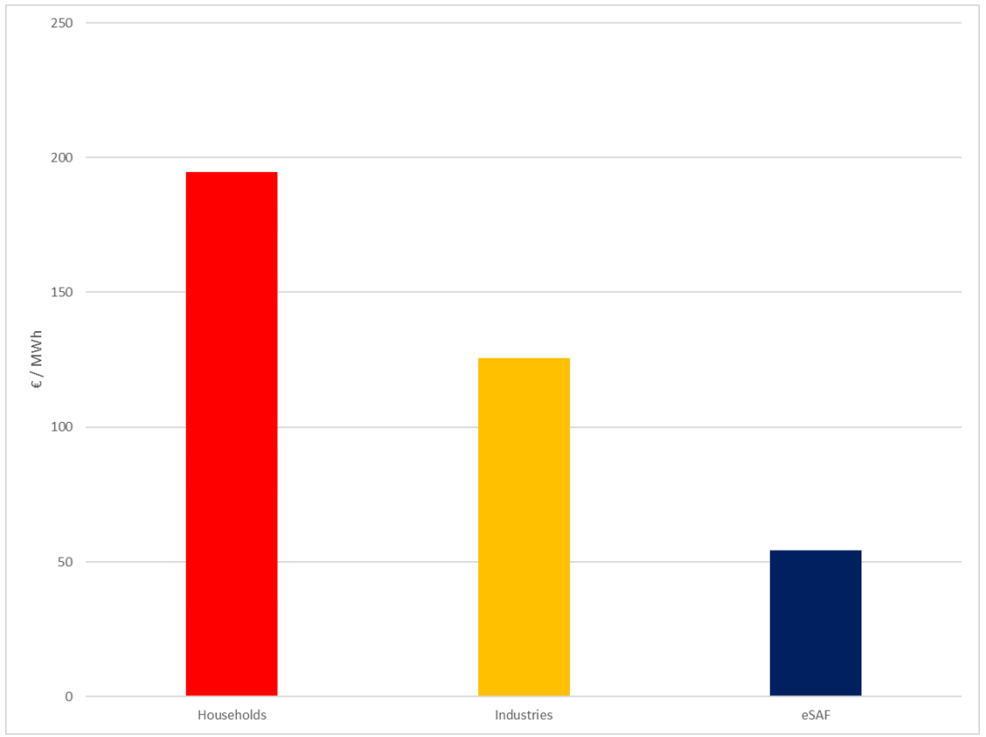


FIGURE 163 Electricity prices in France in S1 2021 for household (red), industries (from 500 to 2000 MWh per year, in orange) and eSAF production (blue), in € / MWh, source Jean-Baptiste Jarin

Comparing electricity prices for primary, secondary and tertiary needs. All prices converted in € / MWh, data from Eurostat, applying French tax code (CIBS)	Production	Transport & Distribution	CTA	Excise Duty	VAT	Final Price in € / MWh
Electricity for Households **Primary Needs**	74 €	55 €	5 €	32 €	28 €	**194 €**
Electricity for Electric Vehicle Local Mobility **Secondary Needs**	74 €	55 €	5 €	32 €	28 €	**194 €**
Electricity for efuel Long distance mobility **Tertiary Needs**	54,3 €	10,5 € (reduced, D.341-9, 81%)	0.5 to 0,7 € (reduced, L.341-4-2, up to 90%)	Exempt (L312-31)	Exempt (L.312-48 & 58)	**65,5 €** (final product exempted of excise duty and VAT)

Figure 3 Electricity prices in France in S1 2021, comparing final prices for primary (green), secondary (blue) and tertiary (orange) needs. Here considering households prices for primary (heating, cooking, appliances) and secondary (electric vehicle for local mobility) needs, and efuel for aviation as tertiary needs (long distance mobility). Prices are in € / MWh. It is found that electricity serving vital needs is 3-fold more expensive than electricity used to produce efuel for aviation, a tertiary need, and that it is mostly due to tax policies (Transport & Distribution, CTA, Excise Duty and VAT).