Biofuels

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Decarbonization – the convernment conundrum

- Politicaly driven transition toward low carbon economy/energy systems.
- Governments over-ruling the business – industry and the customers demand. See the examples of renewables, EV cars, energy efficiency solutions, etc.
- But – what if the chosen solution is wrong?

- https://www.youtube.com/watch?v=WWiX2edcBoA

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Decarbonization of transportation

- EV cars could be a solution, but what about freight, marine and air transport?

- Energ density – measure of energy we can harness from 1kg of energy source.
- Kerosene – 43 MJ/kg vs. Li-ion batteries – 1 MJ/kg.

= in aeroplanes, to fly a lift needs to equal the weight of the plane. The more weight the more lift is needed.

= Biofuels could be an option, however, presence of biofuels in esp. marine and air transport almost non-existent. (Biofuels stations available on 6 airport only).

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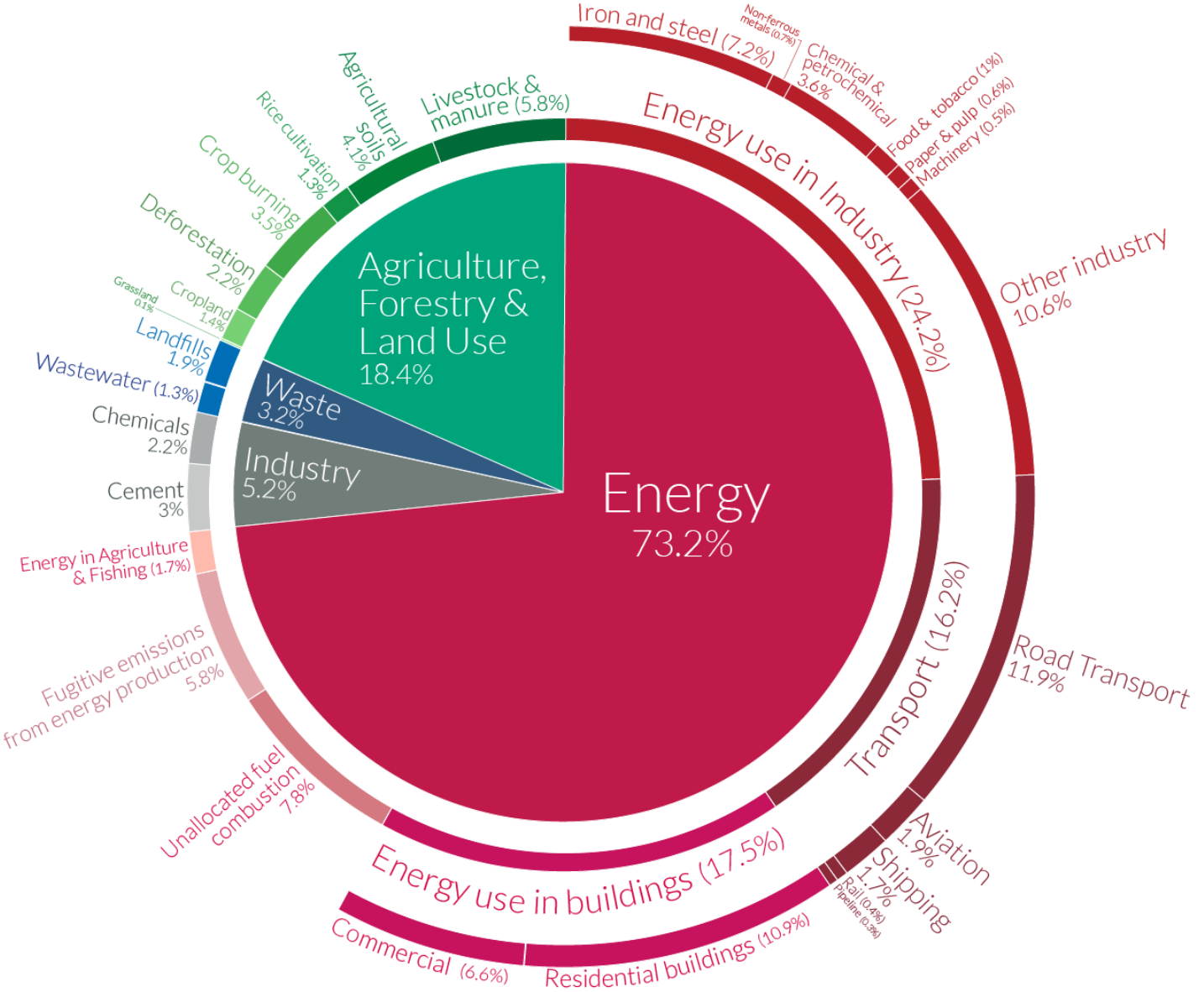
Global greenhouse gas emissions by sector

This is shown for the year 2016 – global greenhouse gas emissions were 49.4 billion tonnes CO_2eq.

Our World in Data



Source: Climate Watch, the World Resources Institute (2020).

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The history of biofuels in transportation

- The very first patented ICE engine ran on a blend of ethanol and turpentine (1886, Karl Benz). Both Henry Ford and Rudolf Diesel used biofuels in their prototypes.
- Some spikes in interest and usage of biofuels during WWI, WWII (used by Brazil, Argentina, China, India, Japan…), oil crises in 1970s....

Biofuels in transportation

- Replacement of imported oil with domestic biofuels – benefits in energy security and balance of payment.
- Carbon neutral.
- Support of domestic agriculture, revitalization of rural economy.

Biofuels in transportation

Biodiesel

- Vegetable (less often animal fat-based) oil, produced by transesterification. Used in diesel engines (also for heating).
- Rapeseed, soybean, palm oil, sunflower, peanut; waste vegetable oil; animal fats (about 328 million pigs, sheep, beef, goats and dairy cattle and 6 billion chickens, turkeys and other poultry are slaughtered every year in Europe).

Bioethanol

- Ethanol produced by fermentation.
- Sugar and starch based feedstock (corn-maize, sugarcane, cassava).

Biofuels in transportation

- Global production of conventional biofuels at 152 bn. litres in 2018 – around 3.5% of energy used in transportation.
- About 3% y/y increase is expected in the next five years.
- Above-average increase expected esp. in India, China, ASEAN, continuous ramping up of a production in Brazil, U.S.
- Around 9% of biofuels in 2018 advanced (mostly waste fats, oil and grease).
- Slow increase in share due to the overal increase in energy demands of transportation.

Biofuels in transportation - demand

- Demand driven primarily by mandates stipulating blending at low levels (Renewable Fuel Stadard in U.S., EU´s requirement for 10% of biofuels in transportation by 2020)
- Exemptions from, or reduced rates of, excise duty on fuel (changing the economics of fuels).
- Agricultural support.

Country	Ethanol	Biodiesel	Carbon intensity policy	Recent updates
United States	82 billion L of renewable fuels in 2018 and 136 billion L by 2022		LCFS in California and Oregon	-
Canada	5%	2%	LCFS in British Columbia; federal clean fuel standard in development	10% ethanol mandate in Ontario from 2020; clean fuel standard for liquid fuels in 2022
European Union	10%* renewable energy in transport by 2020 (T) with 7% cap for conventional biofuels		GHG intensity of fuels to fall 6% by 2020	Provisional agreement for 14%* renewable energy in transport in 2030
France	7.5%*	7.7%*	-	Conversion kits to allow cars to use E85 approved
Germany	-	-	Climate Protection Quota (CPQ) 6% reduction in 2020	Upstream fossil fuel emissions reductions eligible for CPQ target
Italy	7%* biofuels		-	-
Denmark	5.75%* biofuels		-	-
Finland	30%* biofuel supply obligation by 2030		-	-
Sweden	-		Emissions reduction obligation system introduced	-
United Kingdom	12.4% renewables share by 2032 in RTFO		-	RTFO target extended to 2032; cap on conventional biofuels of 4% in 2020, 2% in 2032
China	10%	-	-	10% ethanol mandate to extend nationwide in 2020
India	5%	-	-	Biofuels policy expands approved feedstocks for ethanol production
Indonesia	20%	2%	-	Mandated consumption extended to new sectors, including rail and mining
Malaysia	-	7%	-	-
Thailand	32% by 2036 (T)	Currently 7%, and 25% by 2036 (T)	-	-
Argentina	12%	10%	-	-
Brazil	27%	10%	RenovaBio signed into law, 10% GHG reduction by 2028 (T)	-

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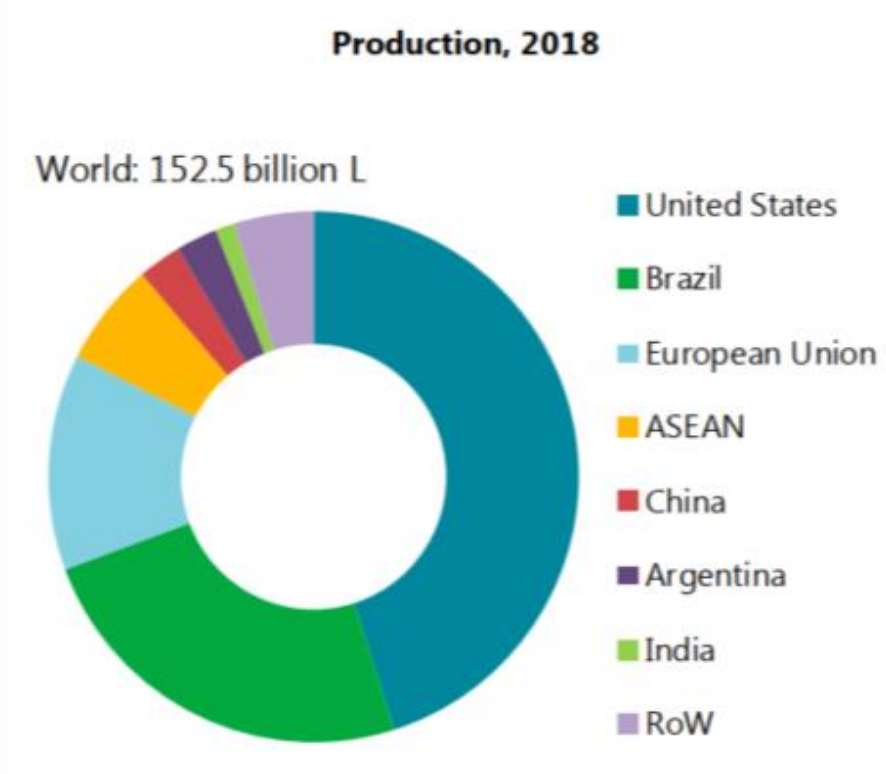
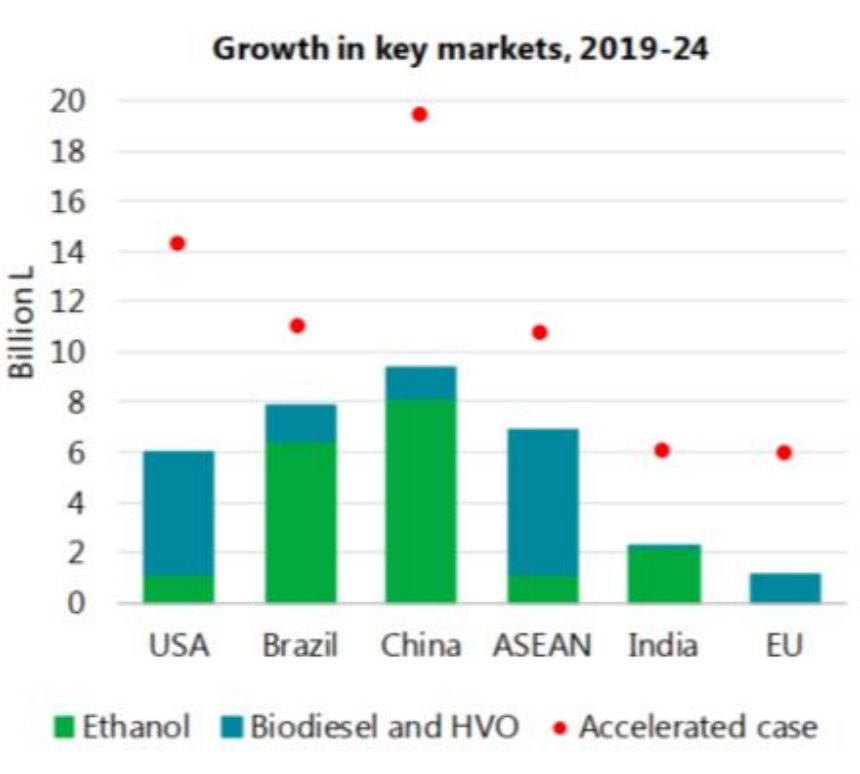
Biofuel forecast overview





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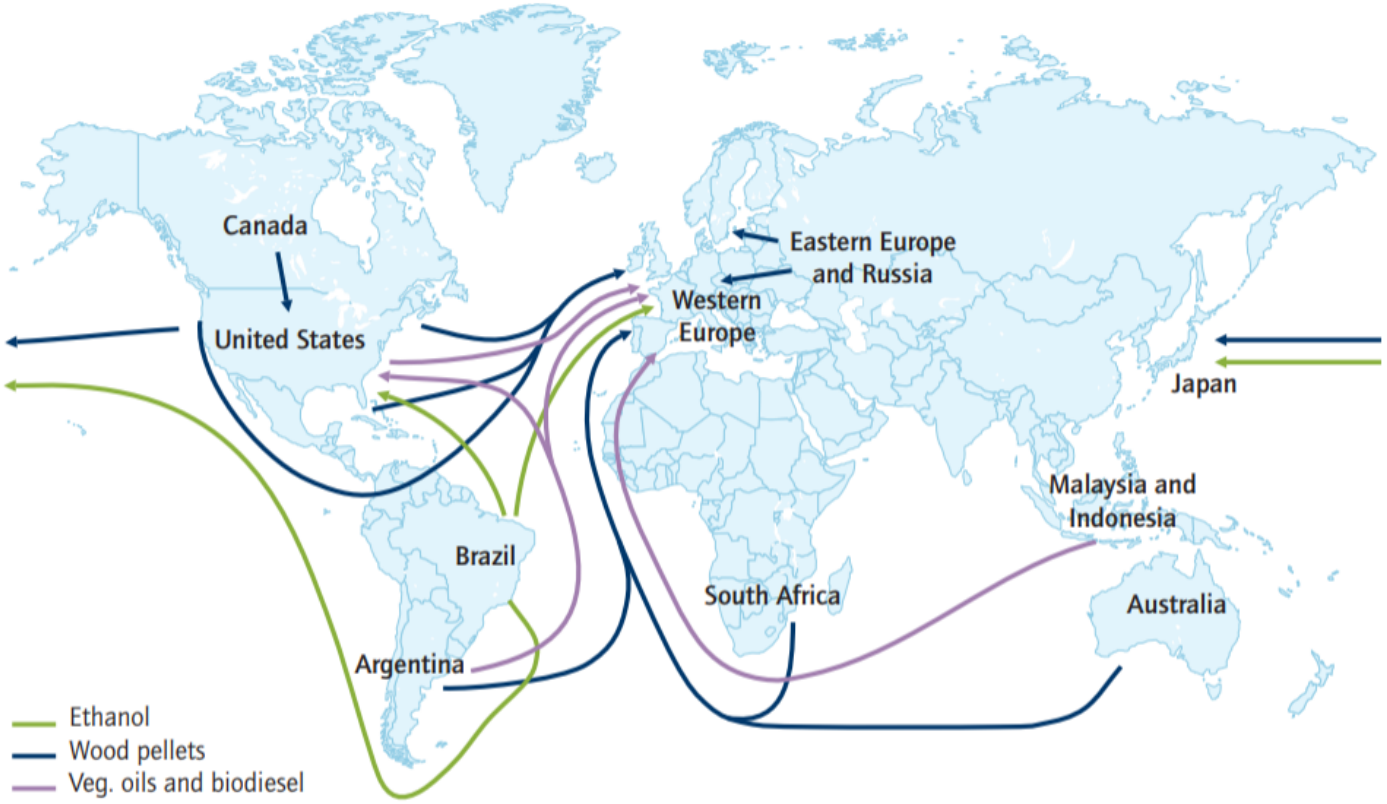
World biomass shipping



Source: Based on Bradley *et al.*, 2009.

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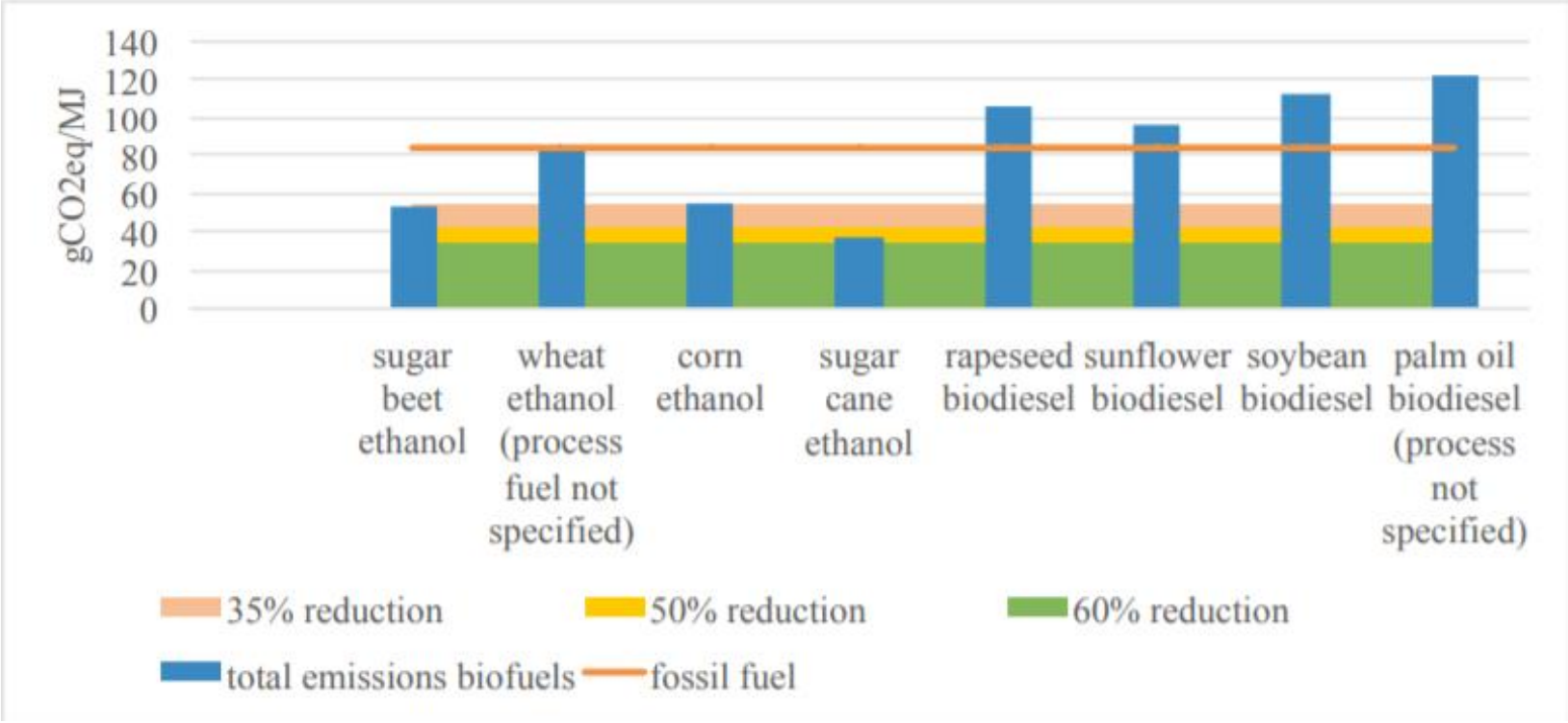
Asia and security of supply

- In China (69% → 76%), India (80% → 83%), and Indonesia (52% → 68%), import dependency is set to increase rapidly between 2018 and 2024.
- Security concerns are driving biofuel production.
- China – ethanol from corn and cassava, India molasses from sugar industry, Indonesia palm oil.
- China 10% of gasoline demand by domestic biofuels, India 5% of ethanol, 20% by 2030, Indonesia 20% biodiesel.

Controversy No. 1 – impact on the environment

- A real contribution to global climate mitigation and cleaning up the atmosphere highly debatable, depending on local conditions.
- Encourage monoculture of energy crops and reduction of biodiversity.
- Transport of biofuels around the world (supported by subsidies).
- So far only Brazil´s and Thailand´s sugarcane-to-ethanol; ethanol as a by-product of cellulose output in Sweden or Switzerland, and manufacture of biodiesel from animal fats and used cooking oil, are delivering significant climate benefits.
- The other conventional biofuels deliver savings under 40% compared to fossil fuel alternative (plus land use - soil acidification, fertilizer use, biodiversity loss, toxicity of agricultural pesticides).

Biofuel estimated emissions versus fossil fuel emissions



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Controversy No. 2 - Impact on food production

- Food price crisis in 2005-2008. Corn prices almost tripled, wheat increased by 130%, rice 170%. Traditional biofuels compete with food for the same arable land.
- Price impact calculated by the U.S. administration as low as 3% but by World Bank as high as 70% rise of a basket of food commodities in the period of 2002-2008 (later corrected for significantly smaller figures).
- Peak probably combination of high prices of oil, poor harvests, speculations, and biofuels.

- (EU put a cap on food crop-based biofuels of 3.8% by 2030, overal 10% aim cancelled, overall support for the 1st generation decreasing).

Energy density of biofuels

- Brasil´s sugarcane (energy density 0,45W/m^2) = 600 million ha to replace existing consuption of oil in transport. Equivalent of 40% of all agricultural land worldwide or of all tropical areas combined.
- In U.S., all corn (0,35W/m^2) production (280 million tons) processed to ethanol (0,4l/kg) would provide 13% of fuel consumption in transportation. 120% of all U.S. arable land would be needed to cover the whole U.S. transport demand for fuels.

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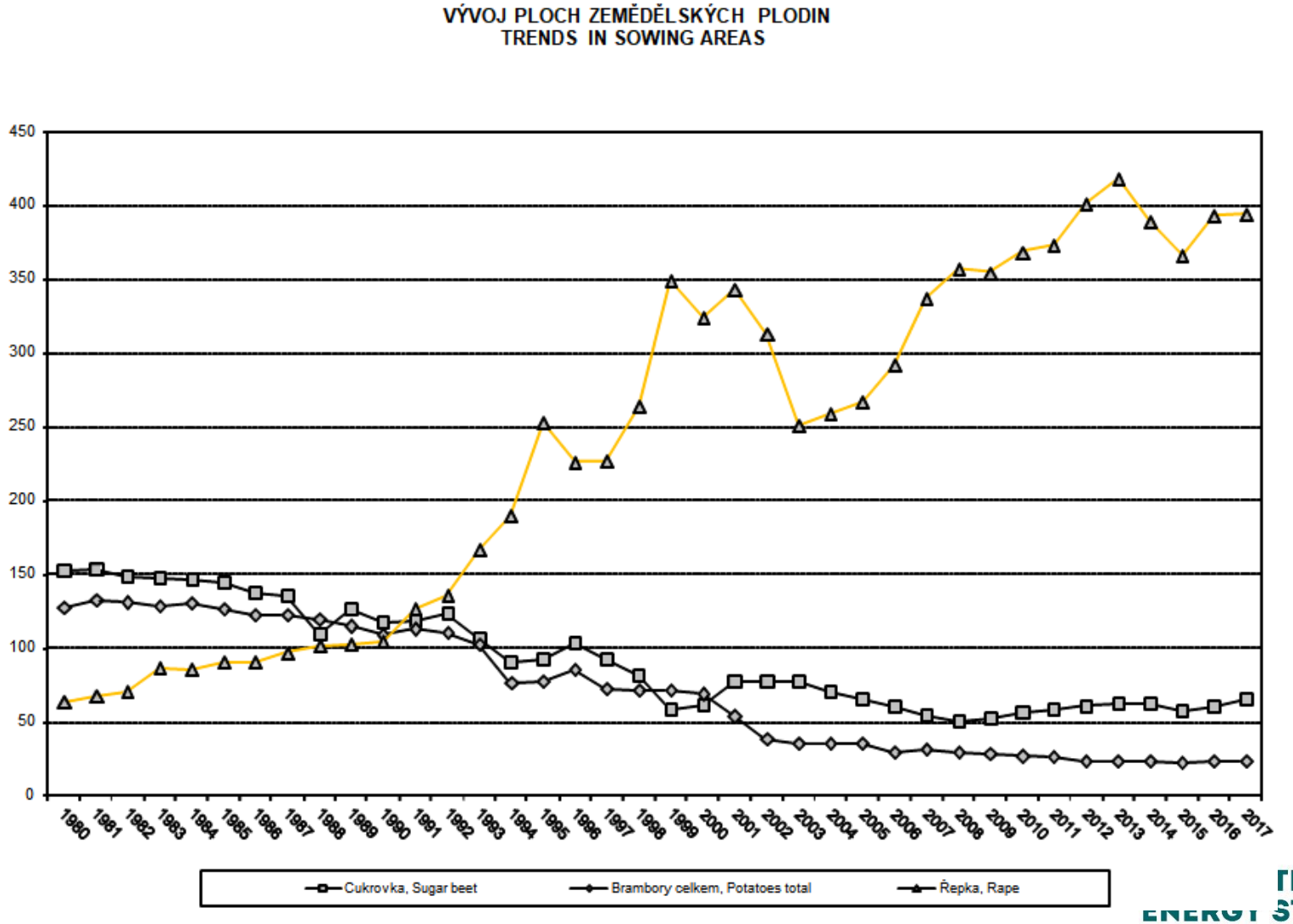
Future of liquid biofuels

- An importance for freight transportation, shipping and aviation (12% of total global energy-related CO2 emissions).
- Five-fold increase in production is needed by 2025 (to 650bn litres/y) to fulfil Paris goals – vs. decrease in investment from USD 27bn in 2007 to USD 2bn in 2017 (regulation).
- Advanced liquid biofuels, e.g. biofuels from lignocelluloies feedstock, municipal waste, waste oils, fats, algae, etc., delayed by lacking (supportive) regulation.

Conventional ethanol	Conventional biodiesel and HVO	Advanced biodiesel and HVO	Novel advanced biofuels
71%	20%	8%	1%

Fuel	Definition	Technological example
Advanced biofuels	Sustainable fuels produced from non-food crop feedstocks, capable of significantly reducing lifecycle GHG emissions compared with fossil fuel alternatives, and which do not directly compete with food and feed crops for agricultural land or adversely affect sustainability	Biodiesel, HVO and biomethane, when waste/residue feedstocks are used.
Novel advanced biofuels	Advanced biofuels made using technologies that are not yet fully commercialised.	Cellulosic ethanol and other biofuels made through thermochemical processes. HVO when 100% waste/residue feedstocks are used.

Biofuels in the Czech Republic



Biofuels in the Czech Republic

- Driven by the EU obligations.
- Supported via a) mandatory blending, b) exemption from excise (tax).
-
- Law 180/2007 – mandated 3,5% (later raised to 4,1%) of biofuels blending in gasoline and 4,5% (later raised to 6%) in biodiesel vs. 2% in both cases directed by the EU legislation.
- Over the course of time, EU regulation softened (limit on 1st generation introduced) and focused more on 2nd generation biofuels. Also 0,5% of waste biofuels suggested. No adjustment in the Czech Republic.

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Sources

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