

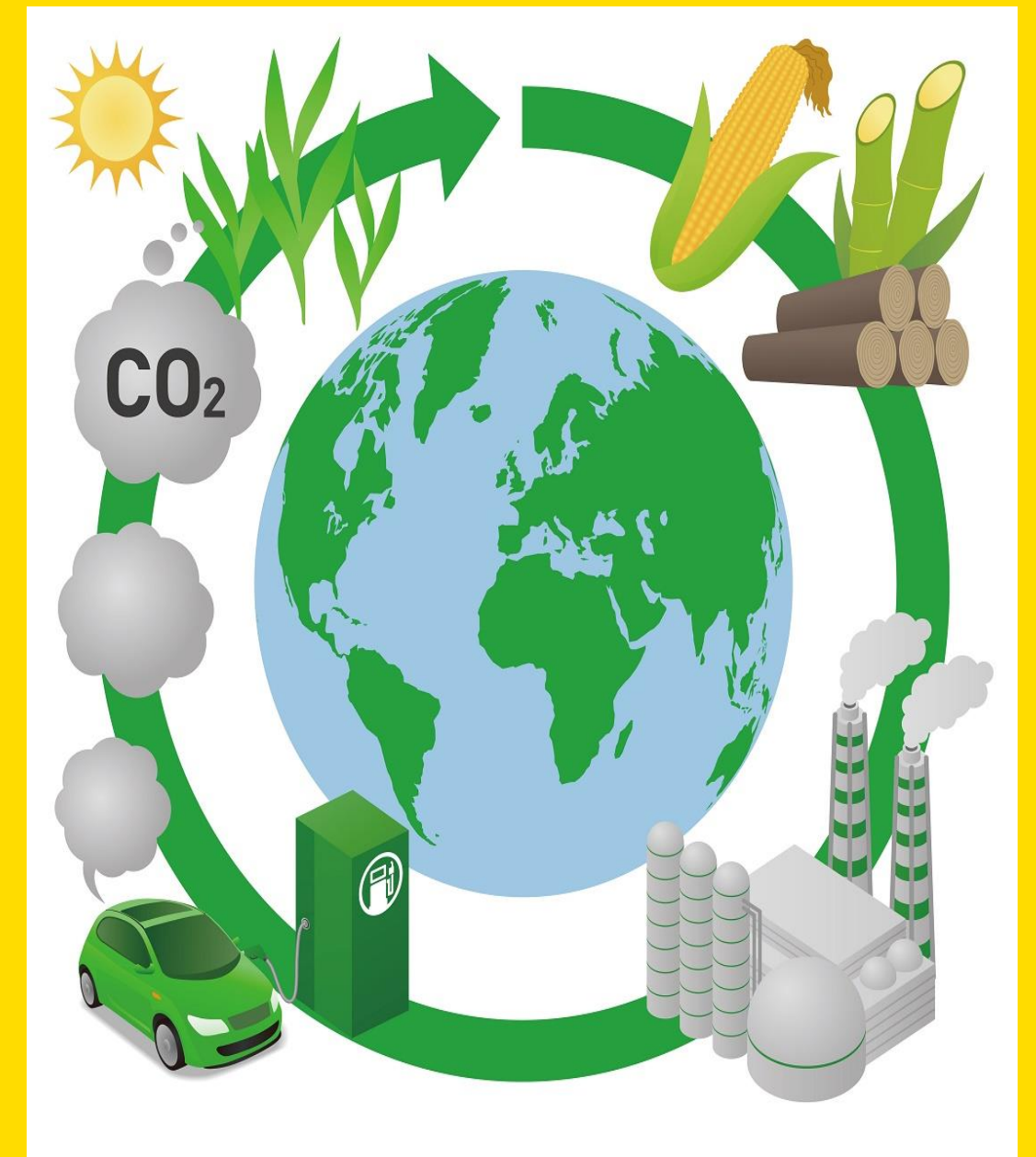
The Future Role of Biofuels in Transport

- A sweet dream turned sour?

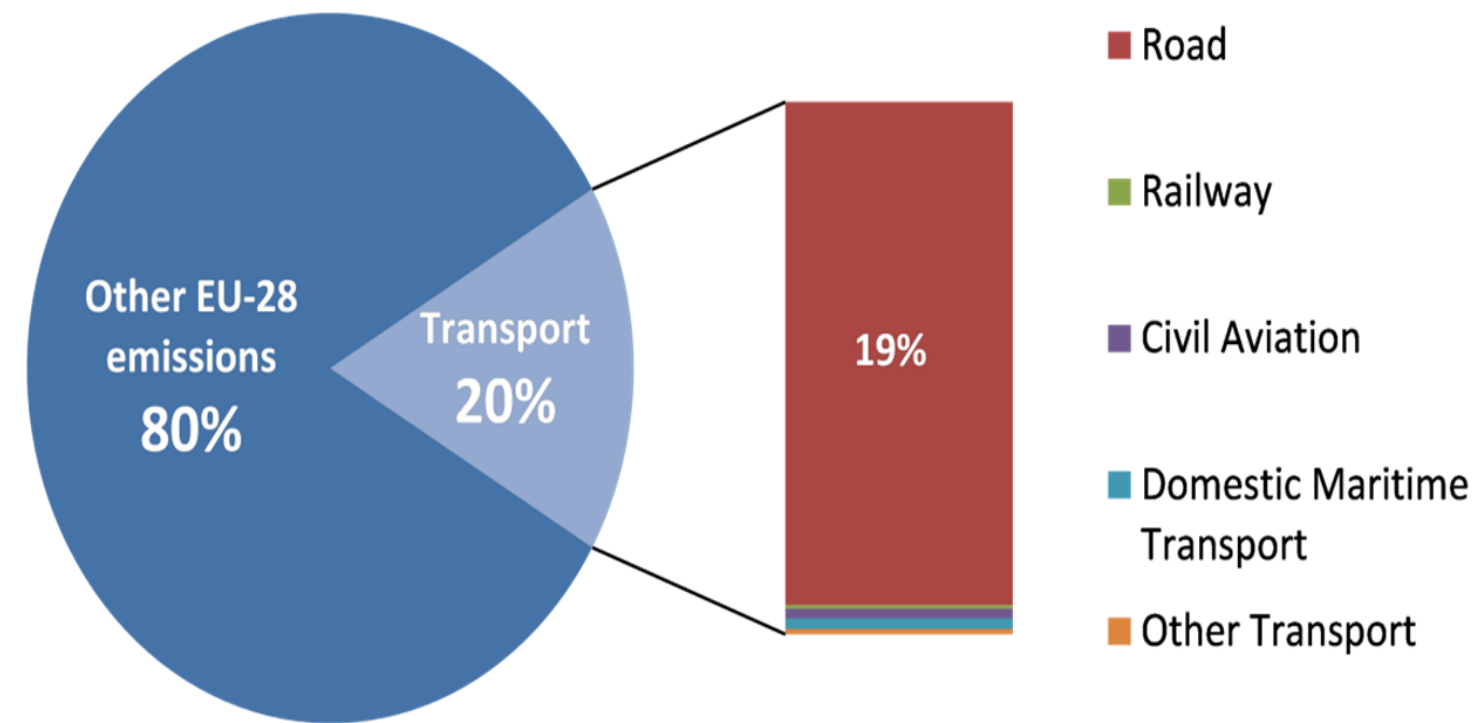
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Why biofuels in transport?

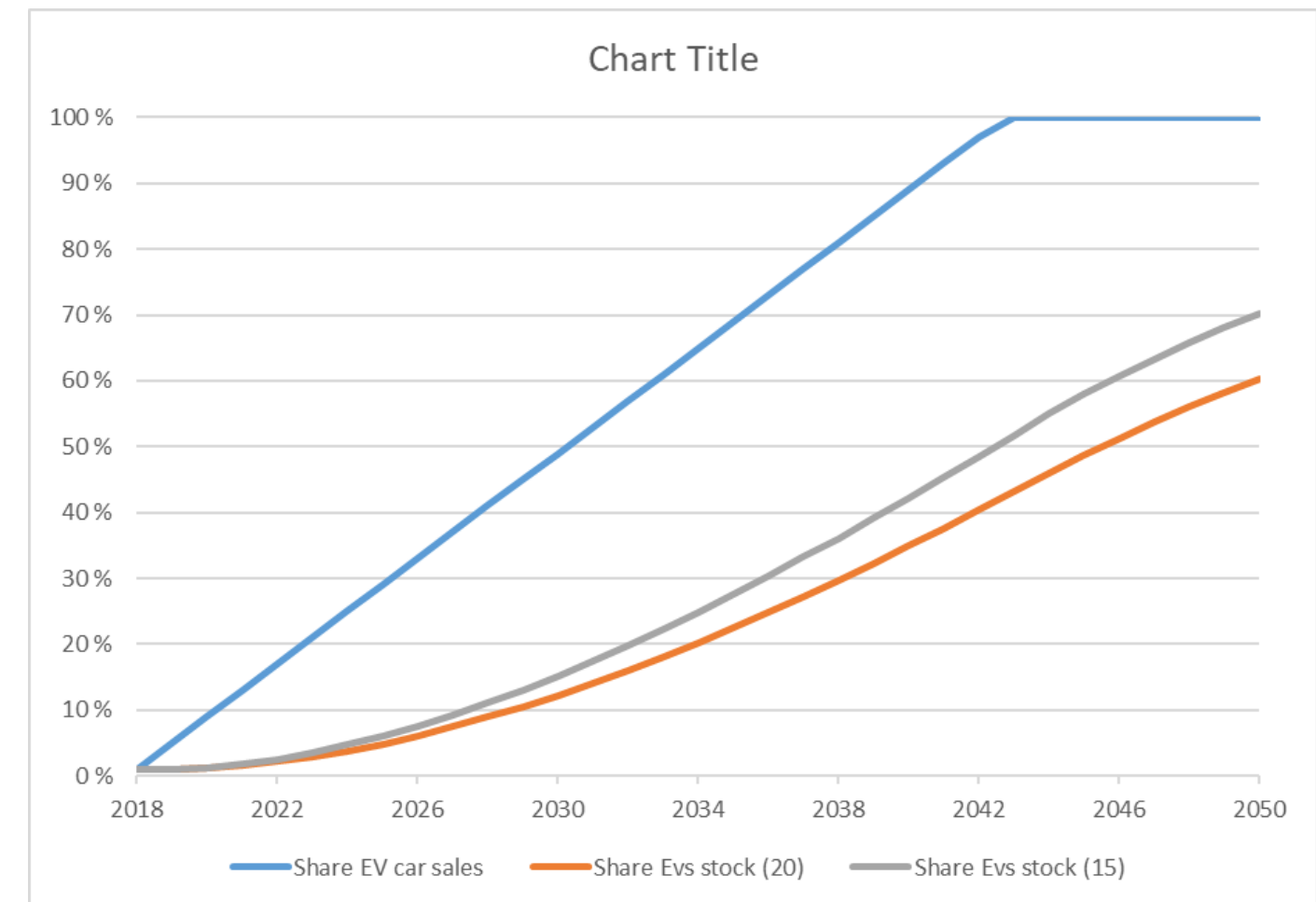


- The EU has set ambitious targets for GHG reductions before 2030
- This especially holds for the Non-ETS sectors for which transport makes up a lions share
- Electrifying transport will take a long time due to the existing stock of gasoline and diesel vehicles of all types
- Biofuels may make an immediate impact for most of the transport modes
- Electrification likely not practical for all modes

(Figure: <https://climatepolicyinfohub.eu/are-transport-emissions-mobilizing-eu-policy-response>)

Confessions from an EV patriot

- The stock of passenger cars is given in the EU
- A car last for 20 (15) years
- The electric vehicle (EV) is a success and increases its market share «rapidly»
- Still hard to get a high share of EVs in 2030



The role of biofuels in 2°C scenarios

- IEA Technology roadmap (2017); Biofuels 10% of energy in transport by 2030, and 27% by 2050
- IPCC (2015) separate chapter in Fifth Assessment report «Mitigation»; Conditional significant contribution all the way to 2100
- Both stresses i) the need to distinguish between different 1st generation biofuels and ii) to speed development of second generation biofuels

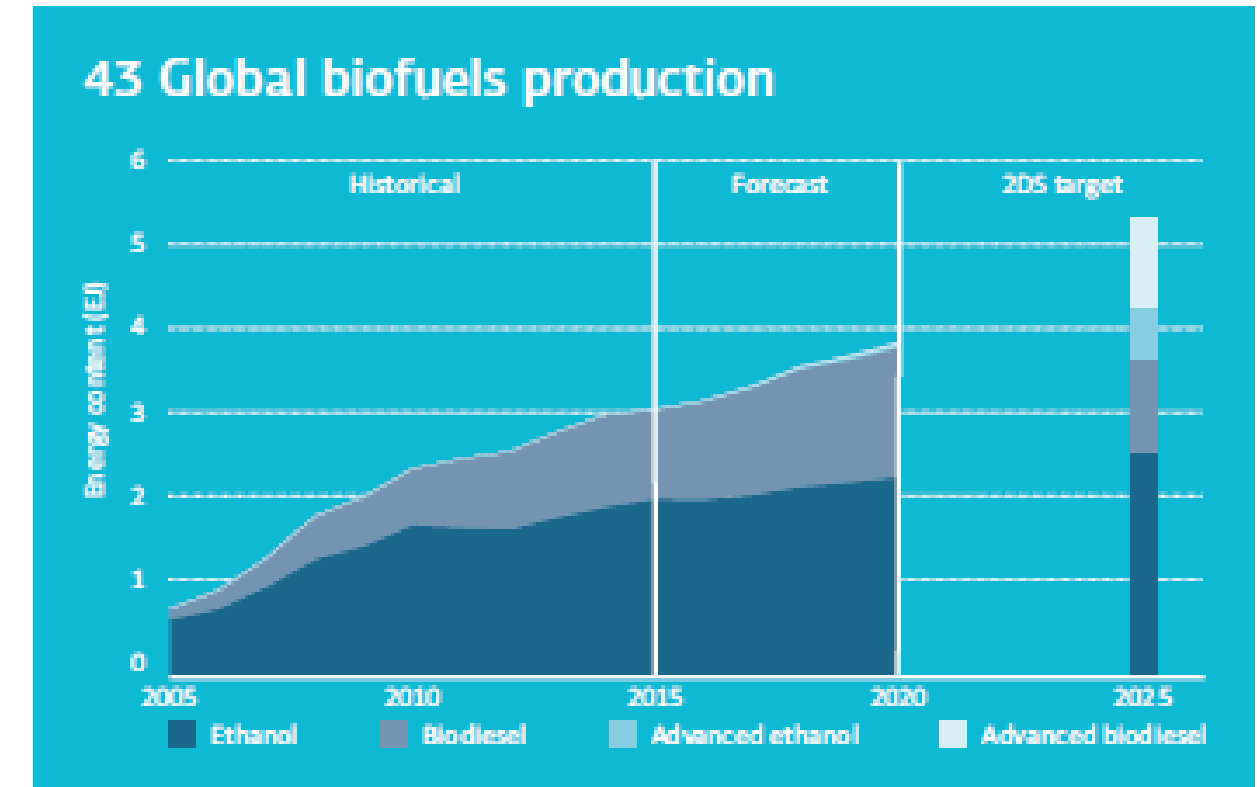
What's wrong with 1'st generation

- Emits high levels of CO₂:
 - Not all types involve high carbon debts
- Competes with food production:
 - But horses used to eat about 15% of agricultural production
 - Food security can also be ensured by i) intensification of land use and ii) changing diets
- A question of costs when there are multiple alternative uses of land



What's happening to advanced biofuels?

- **Different feedstock;** waste, wood residues, corn stover, switch grass, algae
- **Different pathways;** Fischer-Tropsch, Transesterification, Thermochemical gasification process, Biochemical enzymatic process
- IEA; capacity build up is lagging behind
- Costs are still prohibitively high
- Do the market economy choose the path way with the highest cost reduction potential?



GHG emissions from biofuels

1. Use of inputs when growing energy crops e.g. fertilizer
2. Use of fossil energy for harvesting, transporting and processing
3. Direct land use change; released carbon when virgin land is cleared
4. Indirect land use change; when existing agricultural land is used for biofuels, and new agricultural land is cleared elsewhere



EPA Lifecycle GHG Emissions for selected pathways (2016)

Feedstock	Fuel	Production process	Agri. impacts	LUC	Fossil use	Percent reduction
Petroleum	Gasoline/Diesel	Refining			97.6	0%
Corn starch	Ethanol	Wet mill coal	16.5	27.8	72,7	-19%
Palm oil	Biodiesel	Transesterification	4.8	46.1	29.8	17%
Corn stover	Ethanol	Biochemical enzymatic	11.2	-10.8	-29.3	129%
Switch grass	Ethanol	Biochemical enzymatic	6.3	12.6	-28.9	110%
Switch grass	Biodiesel	Fischer Tropsch	6.5	13.1	9.0	71%

EU Biofuels policy

- 2020: Renewable energy target for transport 10%
- 2030: Still no target for transport?
- All biofuels have to fulfill the sustainability criteria:
 - GHG saving at least 50%
 - Not allowed to convert wetland or forests
 - No feedstock from high biodiversity land
- Do the certification institution work?
- Can you avoid so-called shuffling?
- (Is shuffling a big problem?)



The effect on climate costs of a renewable fuel standard for transport

- Paper in Journal of the Association of Environmental and Resource Economists (2014) with Michael Hoel and Knut Einar Rosendahl
- Research questions:
 - Will a global RFS targeting biofuels reduce climate costs?
 - How much GHG emissions from biofuels can we accept?
 - What are the market and welfare effects of the RFS?
 - What is the extent of carbon leakage if only some countries implement a RFS?

Our model

- Oil is a non-renewable resource, all oil reserves will eventually be extracted, producers choose the optimal extraction path
- Biofuels are more expensive to produce than oil
- Oil and biofuels are perfect substitutes; the consumer price on transport fuel (with a RFS) is weighted average of the price on oil and biofuels
- We do not look at carbon debt, but calculate discounted climate costs like in an IAM
 - Nearly no depreciation of CO₂ in the atmosphere
 - Marginal social cost of carbon increases, but with a lower rate than discount rate
 - Desirable to postpone CO₂ emissions

General results

- A global RFS leads to:
 - Lower price on oil (lower resource rents)
 - Lower extraction initially, but higher later
 - Total use of transport fuel is reduced (initially)
- A regional RFS leads to:
 - Increased use of oil in the rest of the world
 - However, lower total extraction initially
 - Weaker effect than with a global RFS
- A subsidy to biofuels combined with a binding RFS increases climate costs

Numerical simulations

- Based on IEA's prospects for future oil demand and BP's estimate of remaining oil reserves
- Biofuels twice as costly to produce as oil (we assume advanced biofuels)
- Elasticity of transportation fuel demand -0.4
- "Social cost of carbon \$50 – increase with 2% per year
- Discount rate is 4%

How much emissions from biofuels can we accept?

- Assume RFS in the range 10-20%
- Answer; biofuels must at least reduce emissions with 5%
- Thus, even if biofuels have almost as much emissions as oil, climate costs are reduced!
- Why? The RFS leads to less transport oil demand the first 30-40 years, then higher demand.
- It is beneficial to postpone emissions

Optimal policy

- A GHG emission tax on both oil and biofuels
- (No reasons to subsidize biofuels in our model)
- Could the RFS give the same reduction in climate costs as the optimal GHG emission tax?
- With 70% relative emission reduction from biofuels – yes, if RFS = 52%
- RFS amounts to a subsidy to biofuels (and a tax on oil), but biofuels should also be taxed...

Conclusion

- Biofuels can not be written off as a dead end
- RFS should not be combined with production subsidies and or production related tax reliefs
- Any biofuels policy – RFS or partly CO₂ tax exception - requires careful certification of eligible biofuel producers (producer countries)
 - Do the certification schemes work according to plan?
- Cost reducing innovations and learning are needed for advanced biofuels to take off:
 - Are the incentives for developing advanced biofuels adequate?
 - Can the market be expected to choose the right pathway?