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International Conference “Elements of a Greenhouse Gas Neutral Society”

DIVERSIFIED CHALLENGES FOR THE ENERGY TRANSITION IN THE TRANSPORT SECTOR

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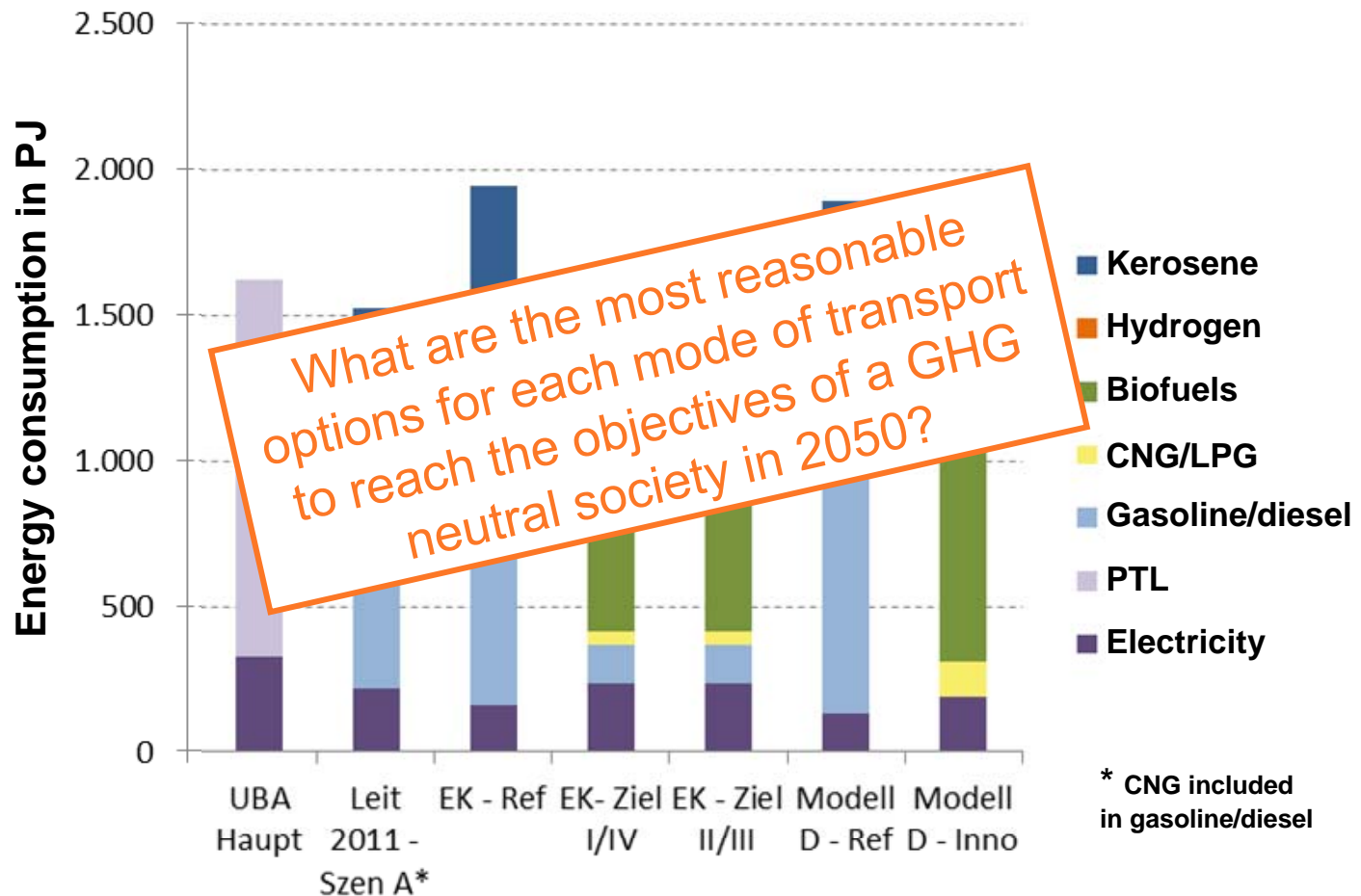
Content

1. **Starting point of discussion**
2. **Pre-selection of possible energy supply options**
3. **Assessment of pre-selected options**
4. **Conclusions and next steps**



Starting point of discussion

Öko-Institut: Energy consumption of the transport sector in Germany 2050 within different scenarios



The project at a glance

UBA project “Ecological requirements for the energy transition in the transport sector ”

- Systematic and comprehensive overview of energy supply options for the transport sector beyond fossil fuels (using only renewable energy sources)
- Considering all transport modes (passenger cars, trucks, trains, airplanes, and ships) as well as national, European and worldwide level
- Assessment of the different energy supply options including ecological, economical, technological, infrastructural and systemic aspects ⇒ identification of the most advantageous option for each transport mode
- Time horizon of the study is the year 2050
- The analyses are based on recently published studies, reports and analyses combined with own investigations
- Project will be finished at the end of November 2013



The project at a glance

Ecological requirements on the transformation of the traffic-related energy supply: Approach

Step 1:

Pre-
selection

- Pre-selection of the most reasonable renewable energy supply options for the transport sector
- Considering of options beyond fossil fuels
- Identification of “must” criteria

Step 2:

Asses-
ment

- Assessment of energy supply options based on ecological, economical, technological, infrastructural and systemic aspects
- Firstly: focusing on GHG reduction and costs
- Secondly: considering the other aspects

Step 3:

Recom-
mendation

- Identification of the most advantageous energy supply option(s) for each of the transport modes considered
- Final recommendations

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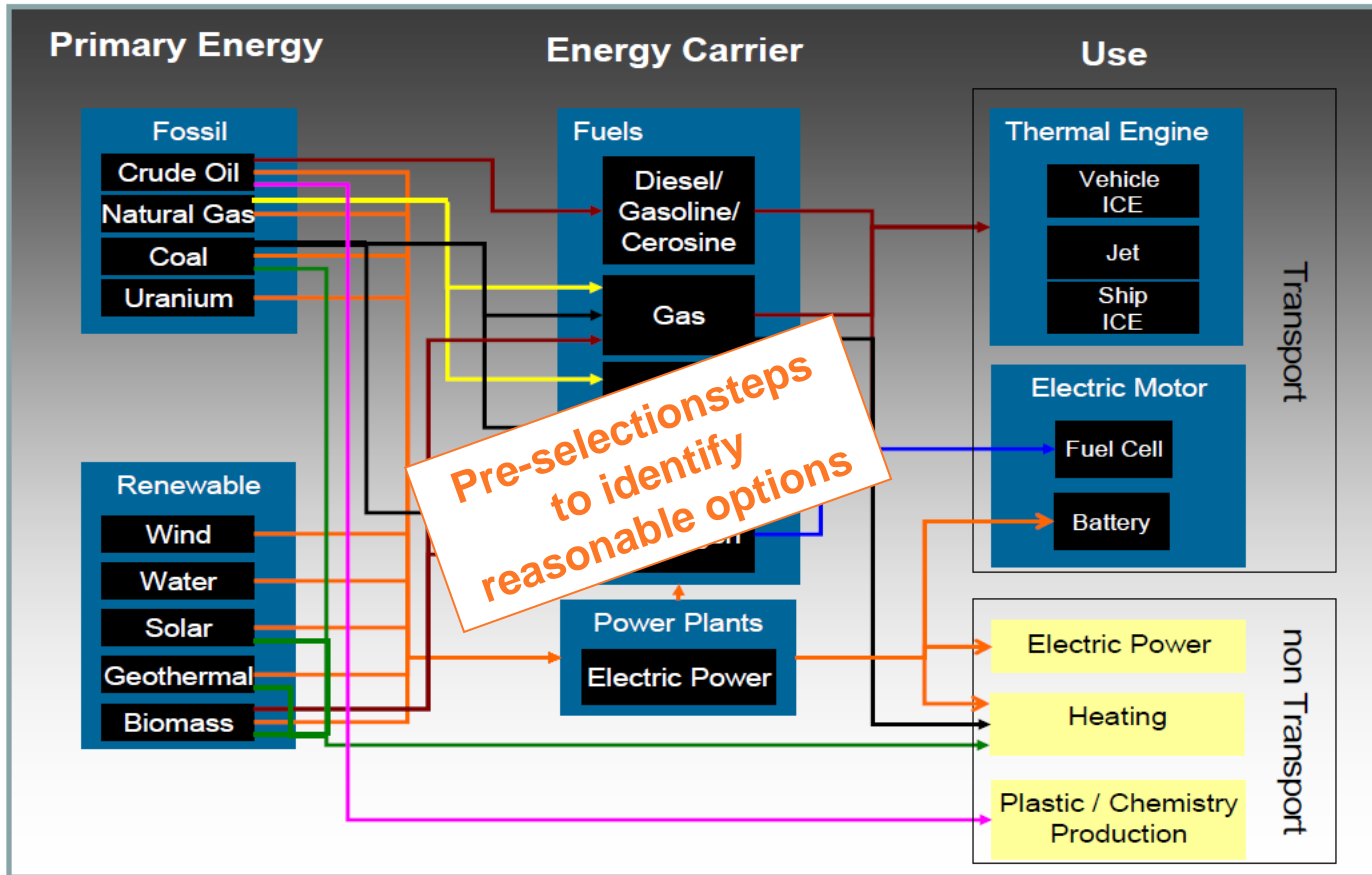
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Pre-selection of possible energy supply options

A wide range of possible alternative ways to supply the transport sector with energy



Source: ERTRAC, cited in the report of the European Expert Group on Future Transport Fuels 2011.

Pre-selection of possible energy supply options

Pre-selection steps of the most reasonable renewable energy supply options for transport (1)

Pre-selections steps

All possible energy supply options

1. Step:
Significant GHG
reduction ⇔
no fossil fuels

2. Step:
Bio-
fuels?

Energy supply options for GHG
neutral society 2050

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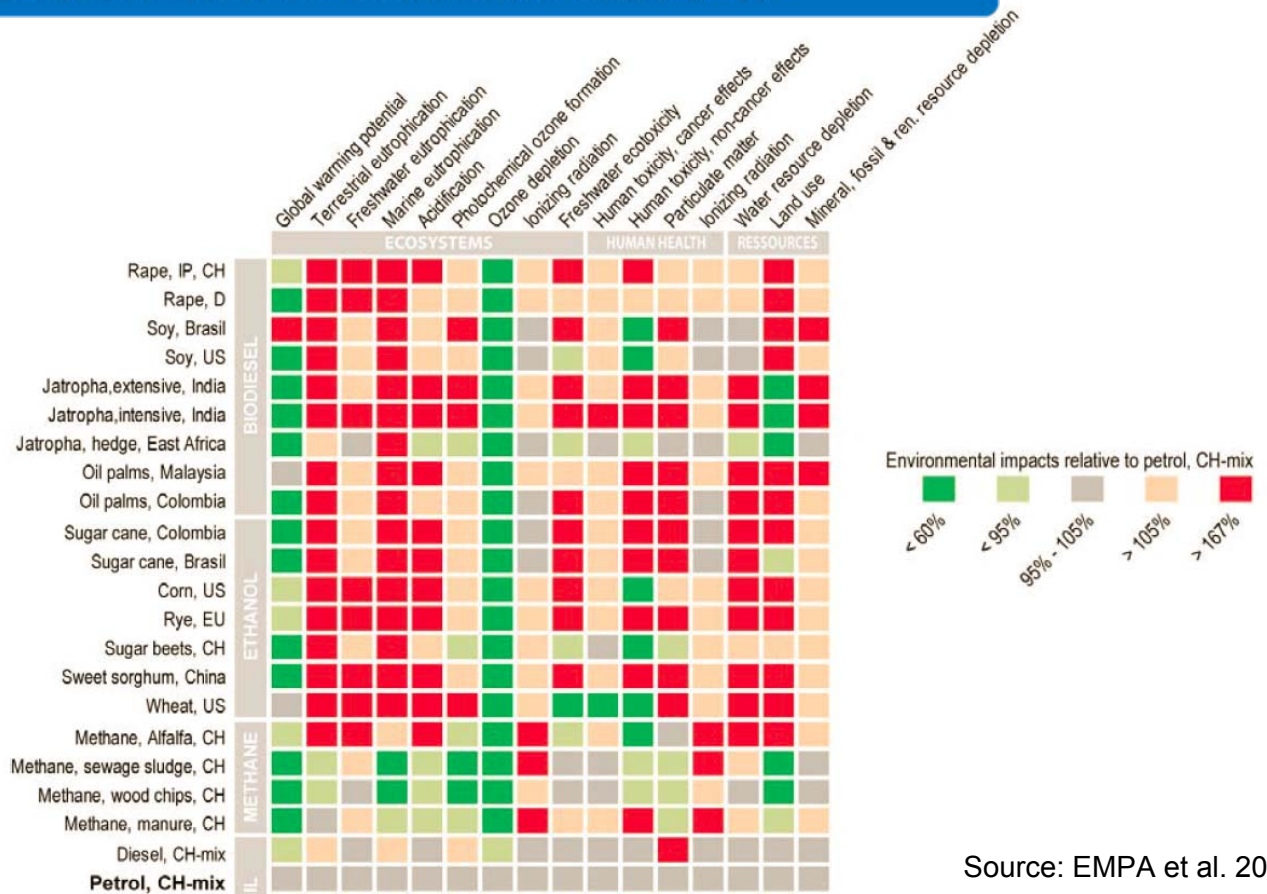
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Pre-selection of possible energy supply options

Environmental and climate impact of biofuels based on detailed life cycle assessment (1)

EMPA study for the Swiss Federal Office for Energy



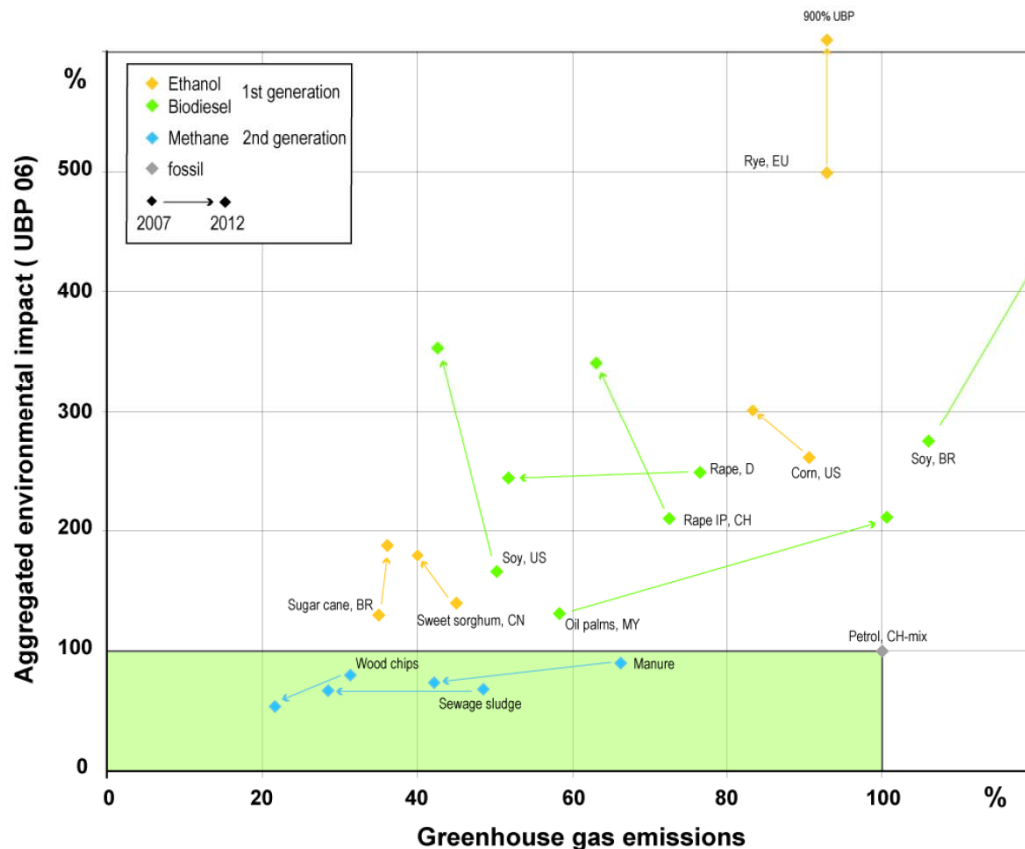
Source: EMPA et al. 2012.



Pre-selection of possible energy supply options

Environmental and climate impact of biofuels based on detailed life cycle assessment (2)

EMPA study for the Swiss Federal Office for Energy

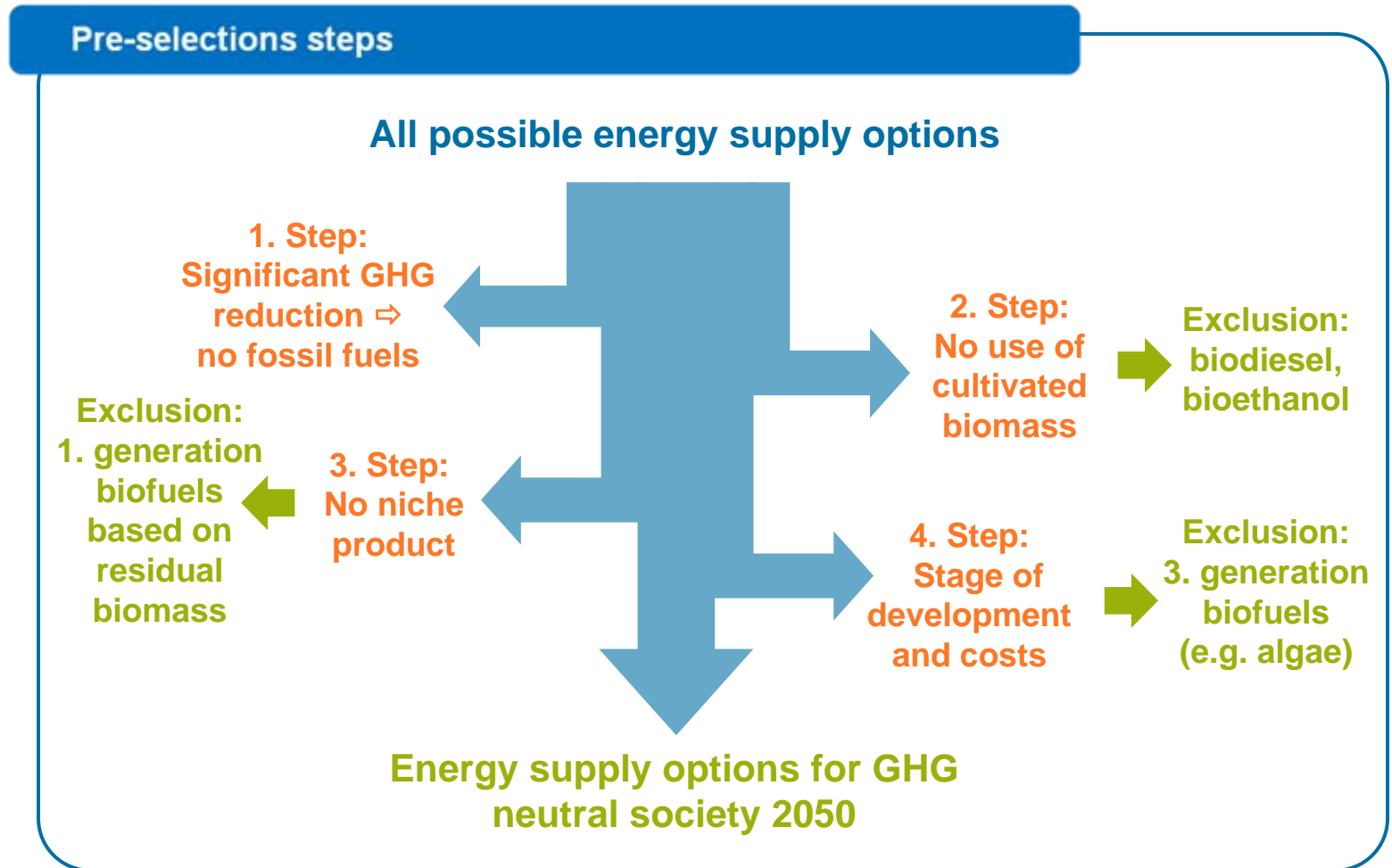


1st generation biofuels based on cultivated biomass have higher impacts on the environment than conventional fuels

Source: EMPA et al. 2012.



Pre-selection steps of the most reasonable renewable energy supply options for transport (2)



Pre-selection of possible energy supply options

Pre-selected energy supply options for each transport mode in 2050 used for detailed assessment

	Renewable electricity					2nd generation biofuels	
	Battery electric vehicle/ Plug-in hybrid electric Vehicle	Overhead catenary wire	Hydrogen: compressed/ liquid (renewable)	Power-to-Gas (renewable)	Power-to-Liquid (renewable)	Biomass-to-Liquid/ Ethanol: wood/straw	SNG: wood/straw
Passenger car	x		x	x	x	(x)	(x)
Trucks - collection and distribution	x		x	x	x	(x)	(x)
Trucks - long haul		x	x	x	x	(x)	(x)
Air traffic - short haul			x		x	(x)	
Air traffic - medium and long haul					x	(x)	
Sea transport			x	x	x	(x)	(x)
Rail traffic		x			x	(x)	
Urban buses	x	x	x	x	x	(x)	(x)

⇒ 2050: without fossil fuels and 1st/3rd generation biofuels

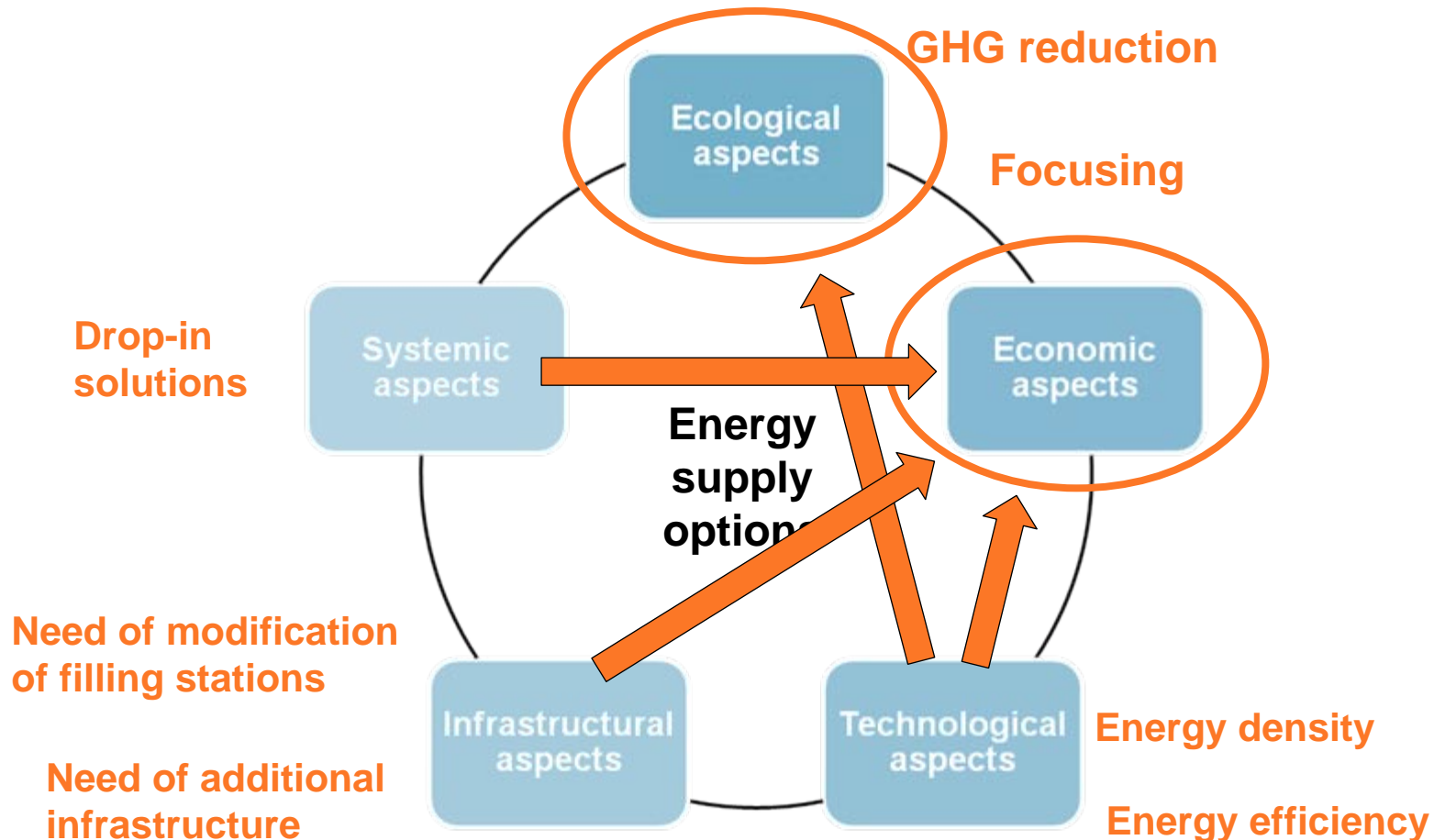
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Ecological requirements on the transformation of the traffic-related energy supply: First assessment



Pre-selected energy supply options for collection and distribution trucks (<12 t GVW)

	Renewable electricity					2nd generation biofuels	
	Battery electric vehicle/ Plug-in hybrid electric Vehicle	Overhead catenary wire	Hydrogen: compressed/ liquid (renewable)	Power-to-Gas (renewable)	Power-to-Liquid (renewable)	Biomass-to-Liquid/ Ethanol: wood/straw	SNG: wood/straw
Passenger car	x		x	x	x	(x)	(x)
Trucks - collection and distribution	x		x	x	x	(x)	(x)
Trucks - long haul		x	x	x	x	(x)	(x)
Air traffic - short haul			x		x	(x)	
Air traffic - medium and long haul					x	(x)	
Sea transport			x	x	x	(x)	(x)
Rail traffic		x			x	(x)	
Urban buses	x	x	x	x	x	(x)	(x)

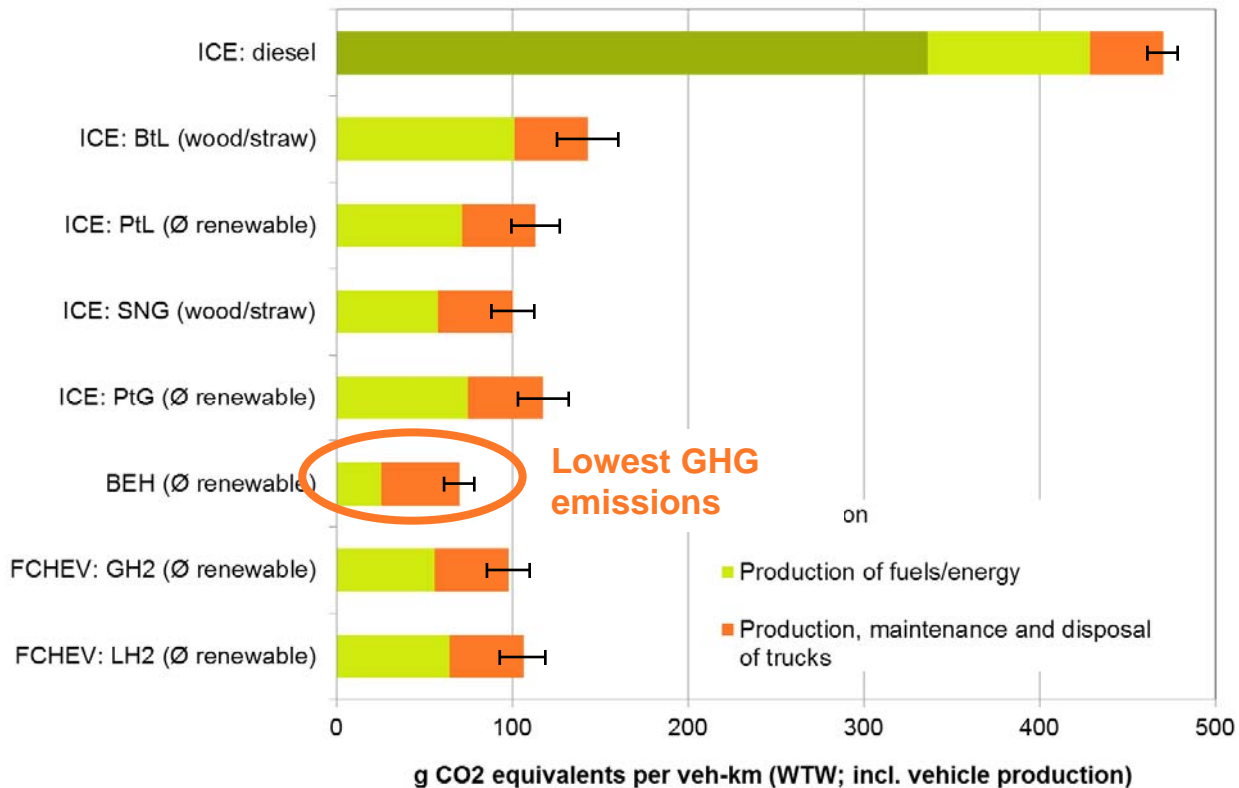


Assessment of pre-selected options

10 t truck: WTW GHG emissions per vehicle kilometre in 2050 for different fuel types

CE-Delft/DLR: «Zero emission trucks»; own calculations

Preliminary results

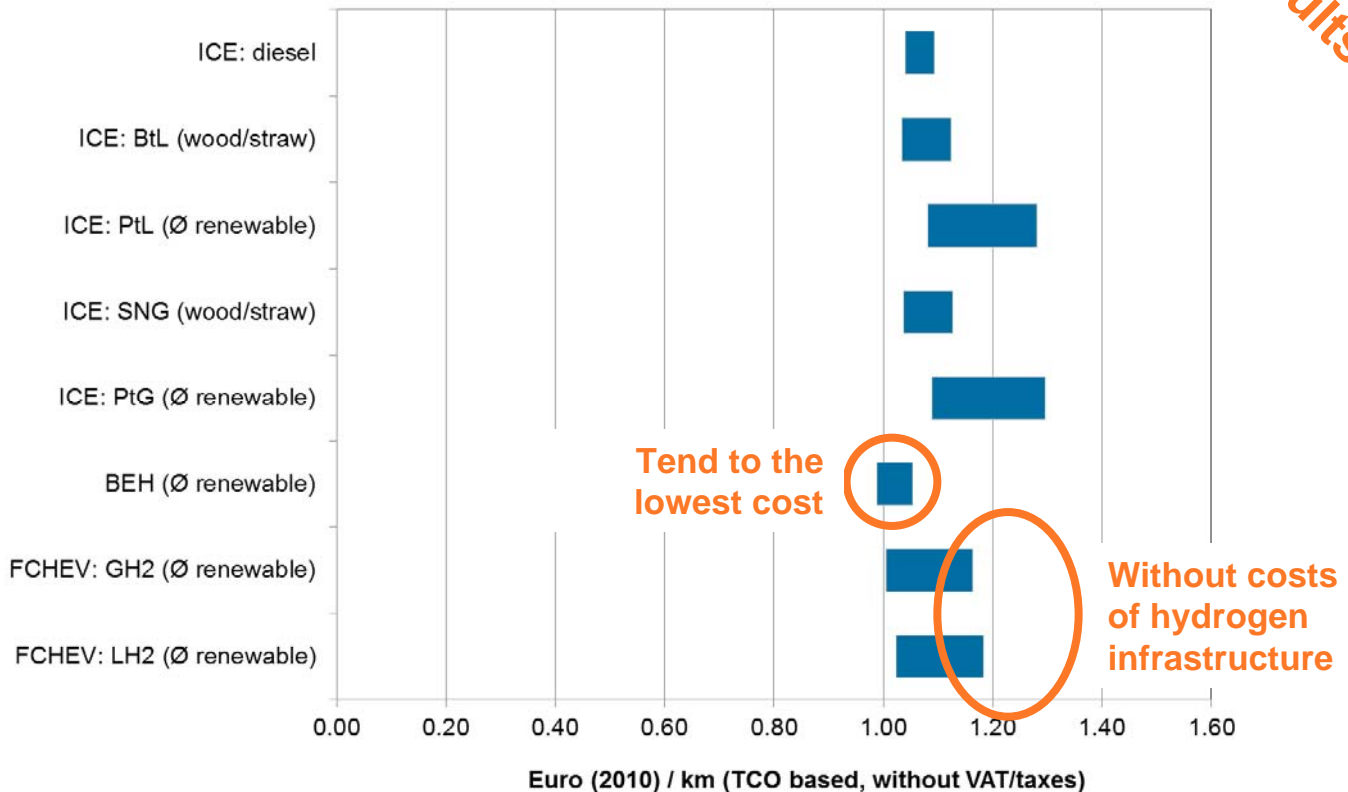


Assessment of pre-selected options

10 t truck: Total costs of ownership (TCO) per vehicle kilometre in 2050 for different fuel types

CE-Delft/DLR: «Zero emission trucks»; own calculations

Preliminary results



Pre-selected energy supply options for the air traffic without fossil fuels / 1st generation biofuels

	Renewable electricity					2nd generation biofuels	
	Battery electric vehicle/ Plug-in hybrid electric Vehicle	Overhead catenary wire	Hydrogen: compressed/ liquid (renewable)	Power-to-Gas (renewable)	Power-to-Liquid (renewable)	Biomass-to-Liquid/ Ethanol: wood/straw	SNG: wood/straw
Passenger car	x		x	x	x	(x)	(x)
Trucks - collection and distribution	x		x	x	x	(x)	(x)
Trucks - long haul		x	x	x	x	(x)	(x)
Air traffic - short haul			x		x	(x)	
Air traffic - medium and long haul					x	(x)	
Sea transport			x	x	x	(x)	(x)
Rail traffic		x			x	(x)	
Urban buses	x	x	x	x	x	(x)	(x)

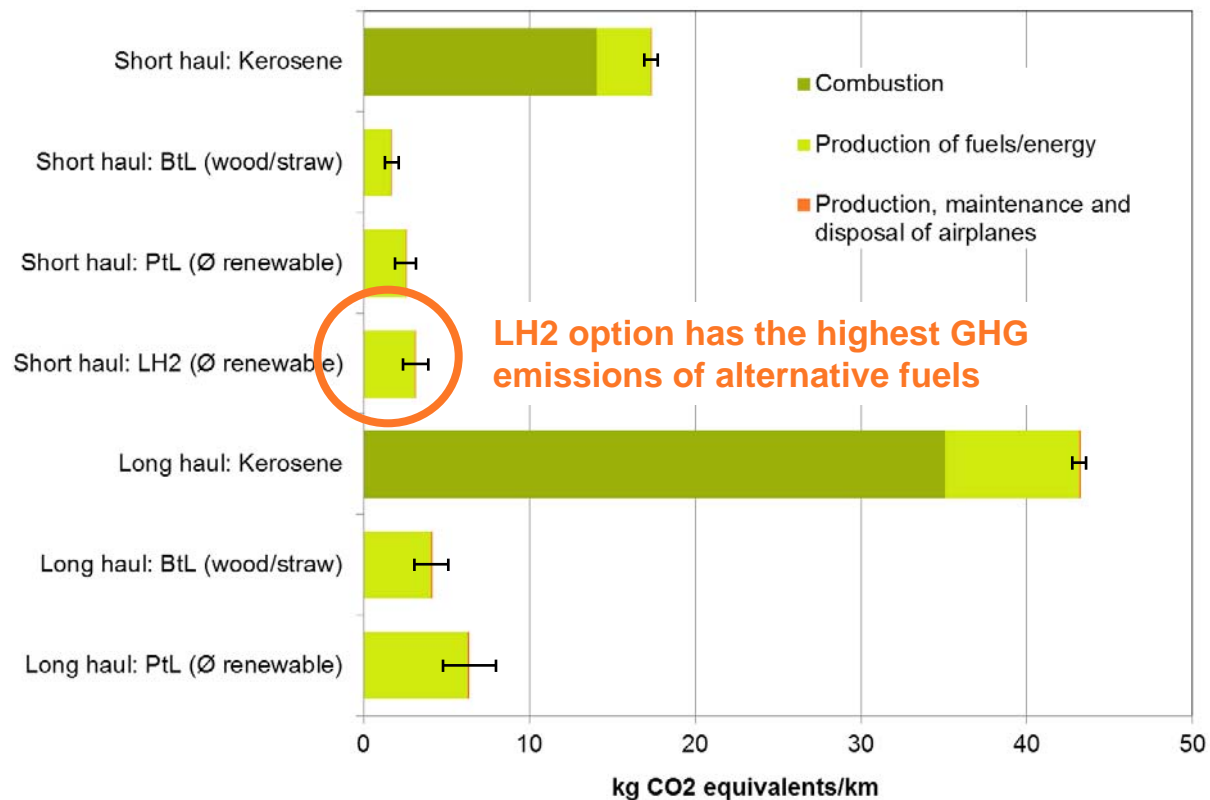


Assessment of pre-selected options

WTW GHG emissions of short and long haul passenger airplane 2050 by different fuel types

Own calculations

Preliminary results



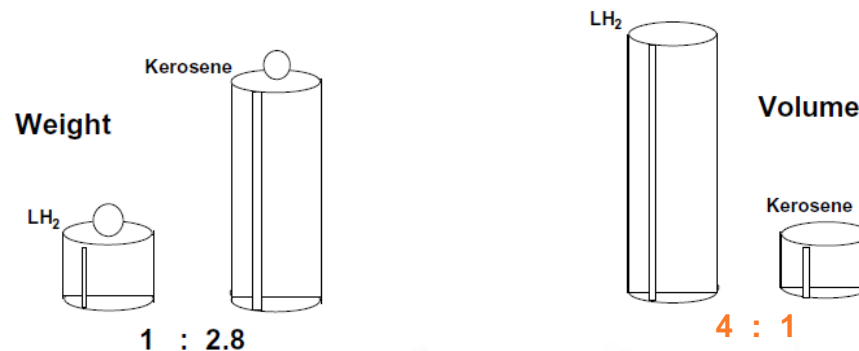
LH2 option has the highest GHG emissions of alternative fuels



For similar energy content the volume of liquid hydrogen is four times higher than for kerosene

Volumetric and gravimetric energy density

Comparison of LH2 and kerosene – similar energy content:



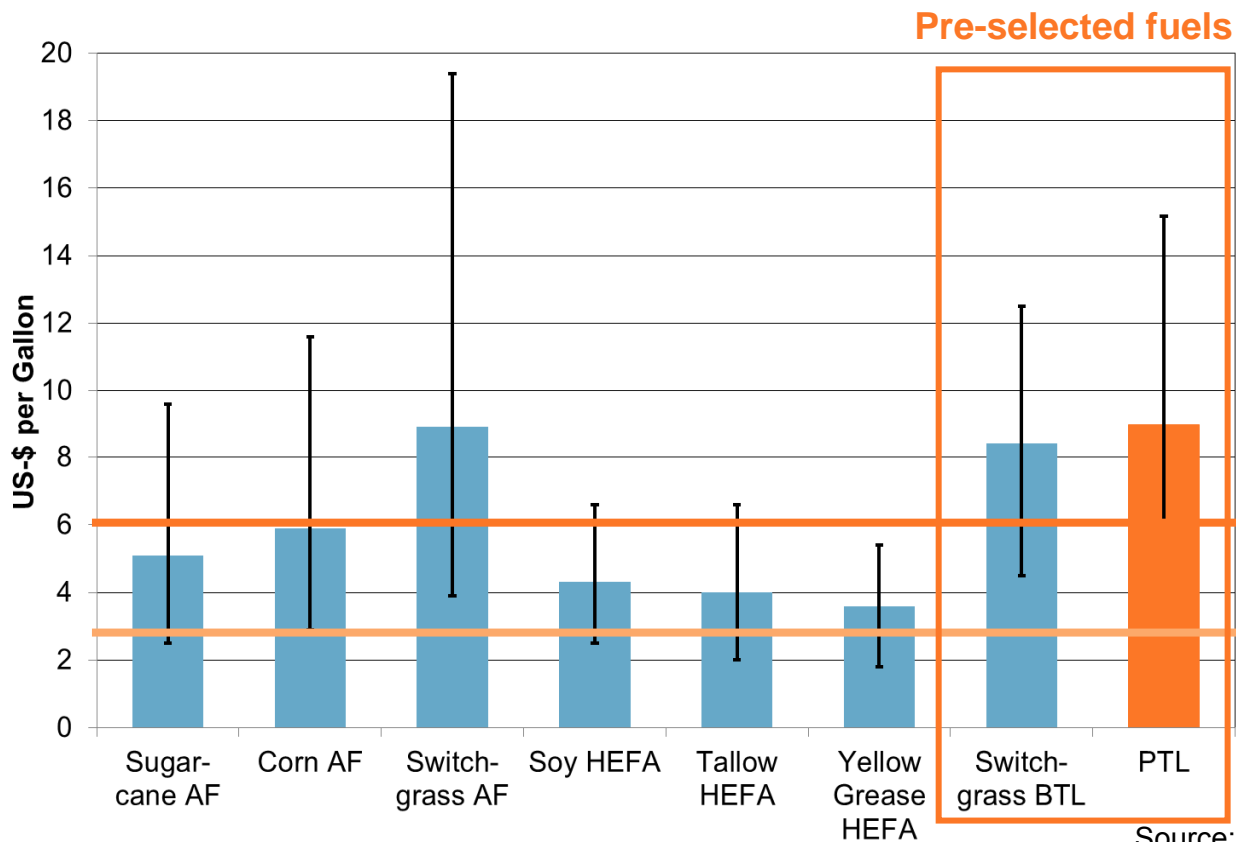
- ⇒ New design of airplanes
- ⇒ No realistic option for 2050



Comparison of costs for different types of fuels for air traffic

Malina 2013 «Economics of alternative fuels»; own calculation

Preliminary results



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Diversified challenges for the energy transition in the transport sector: Conclusions (1)

- ❑ Fossil fuels and first generation biofuels don't fulfill the ecological requirements of a GHG neutral mobility in 2050
- ❑ Therefore only electricity, electricity-based fuels (e.g. PtG: H2 and Methane, PtL) and second generation biofuels (but with very limited potential) are available for the energy supply of the transport sector in 2050
- ❑ Considering costs and GHG emission reduction potentials the direct use of electricity is the most advantageous option
⇒ if possible battery-electric vehicles and plug-in-hybrid vehicles should be preferred
- ❑ If electricity can't be used directly (e.g. airplanes, ships, 40 t trucks) electricity-based fuels are the first choice due to limited potential of second generation biofuels

Diversified challenges for the energy transition in the transport sector: Conclusions (2)

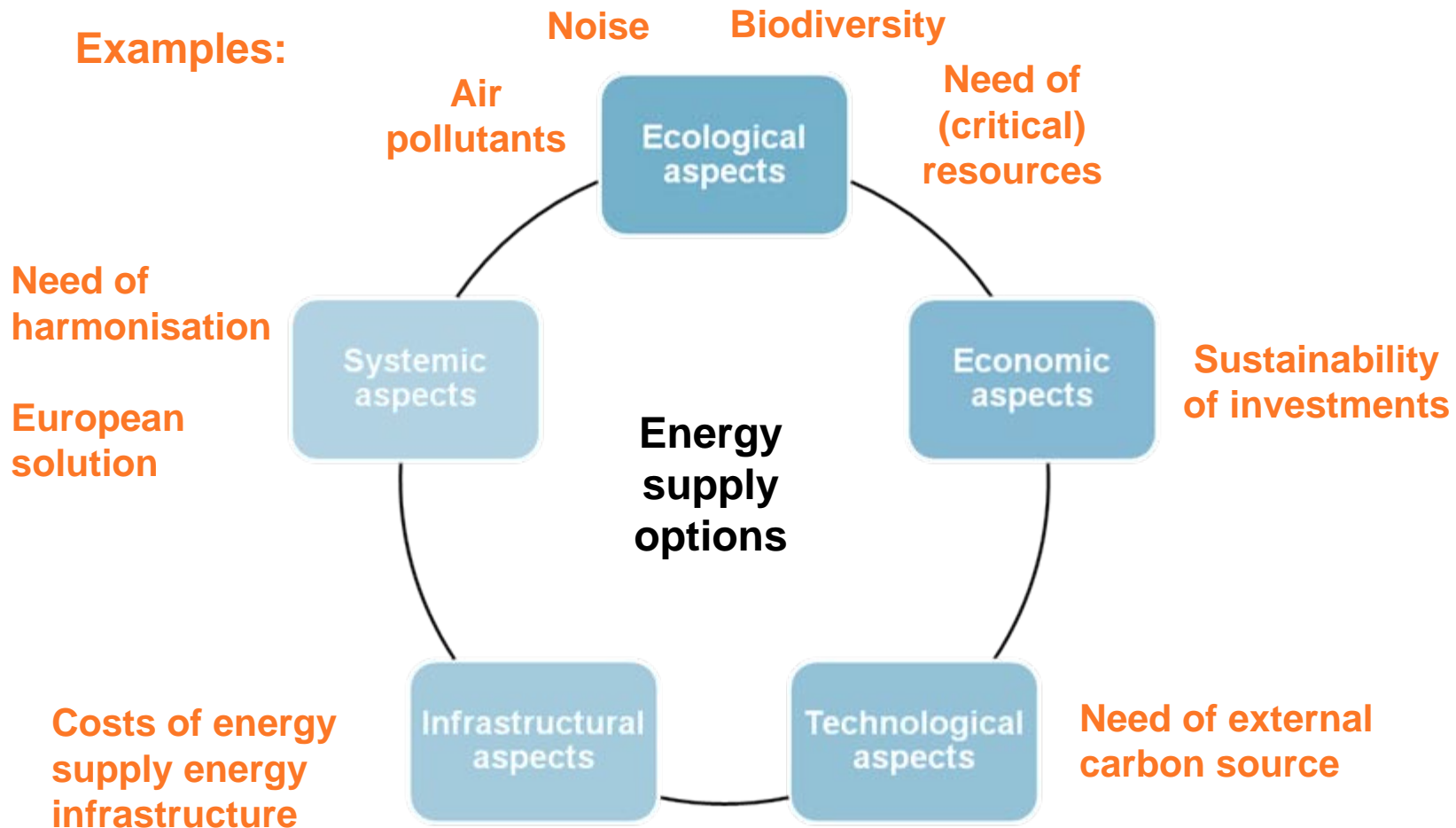
- Which electricity-based fuel is preferable depends on the transport mode and vehicle size considered
 - Airplanes ⇒ PTL
 - Sea ship ⇒ PTG
 - 40 t trucks ⇒ different options (*catenary*, H2, PTL) which has to be investigated in more details
- *But:* A challenge is that electricity-based fuels won't be available with appreciable potentials before 2040 ⇒ it has to be avoided installing of infrastructures for fuels which aren't purposeful for a GHG neutral future
- Independent of the energy supply option chosen the reduction of the traffic-related energy demand by avoiding, shifting and improving is needed ⇒ a energy transition in the transport sector requires a transition of the transport sector



Next steps

Diversified challenges for the energy transition in the transport sector: Next steps

Examples:



Thank you for your attention

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The logo for INFRAS, featuring the word "iNFRAS" in white lowercase letters on a black rectangular background, which is partially overlaid by a yellow square.The logo for INFRAS, featuring the word "iNFRAS" in white lowercase letters on a black rectangular background, which is partially overlaid by a yellow square.The logo for Quantis, featuring a stylized blue and green arrow pointing right, followed by the word "Quantis" in a blue sans-serif font.

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On behalf of:

The logo for Umwelt Bundes Amt, featuring the text "Umwelt Bundes Amt" in green, with a small circular icon to the right, and the tagline "For our Environment" below it.