Berlin, 10th of October 2013

International Conference “Elements of a Greenhouse Gas Neutral Society”

DIVERSIFIED CHALLENGES FOR THE ENERGY TRANSITION IN THE TRANSPORT SECTOR

Martin Schmied, INFRAS (Switzerland)

Head of transport and environment division

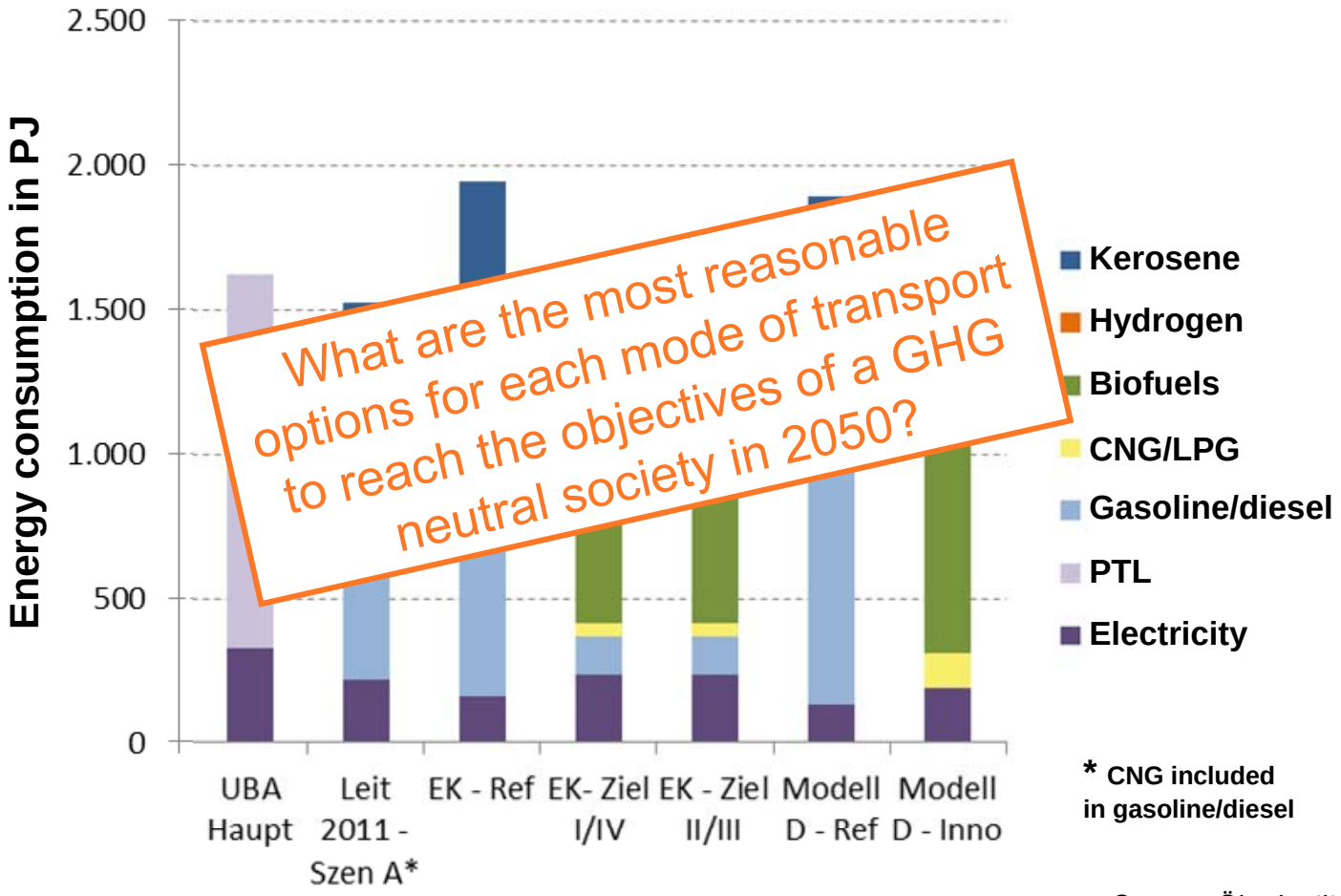
On behalf of:

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

On behalf of:
Umwelt Bundes Amt
For our Environment

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



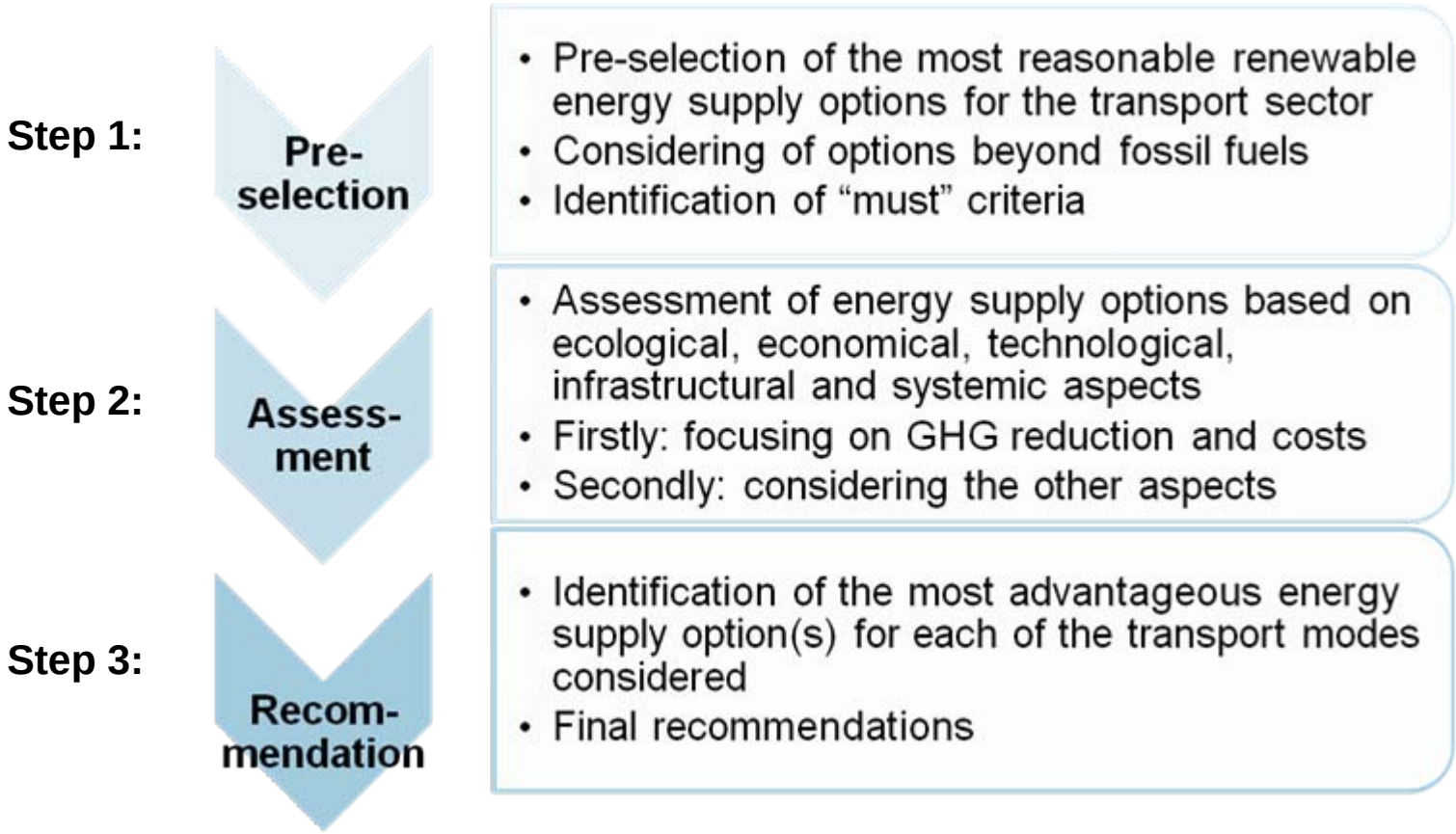
* CNG included in gasoline/diesel

Source: Öko-Institut 2013 (without ships, unpublished)

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

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



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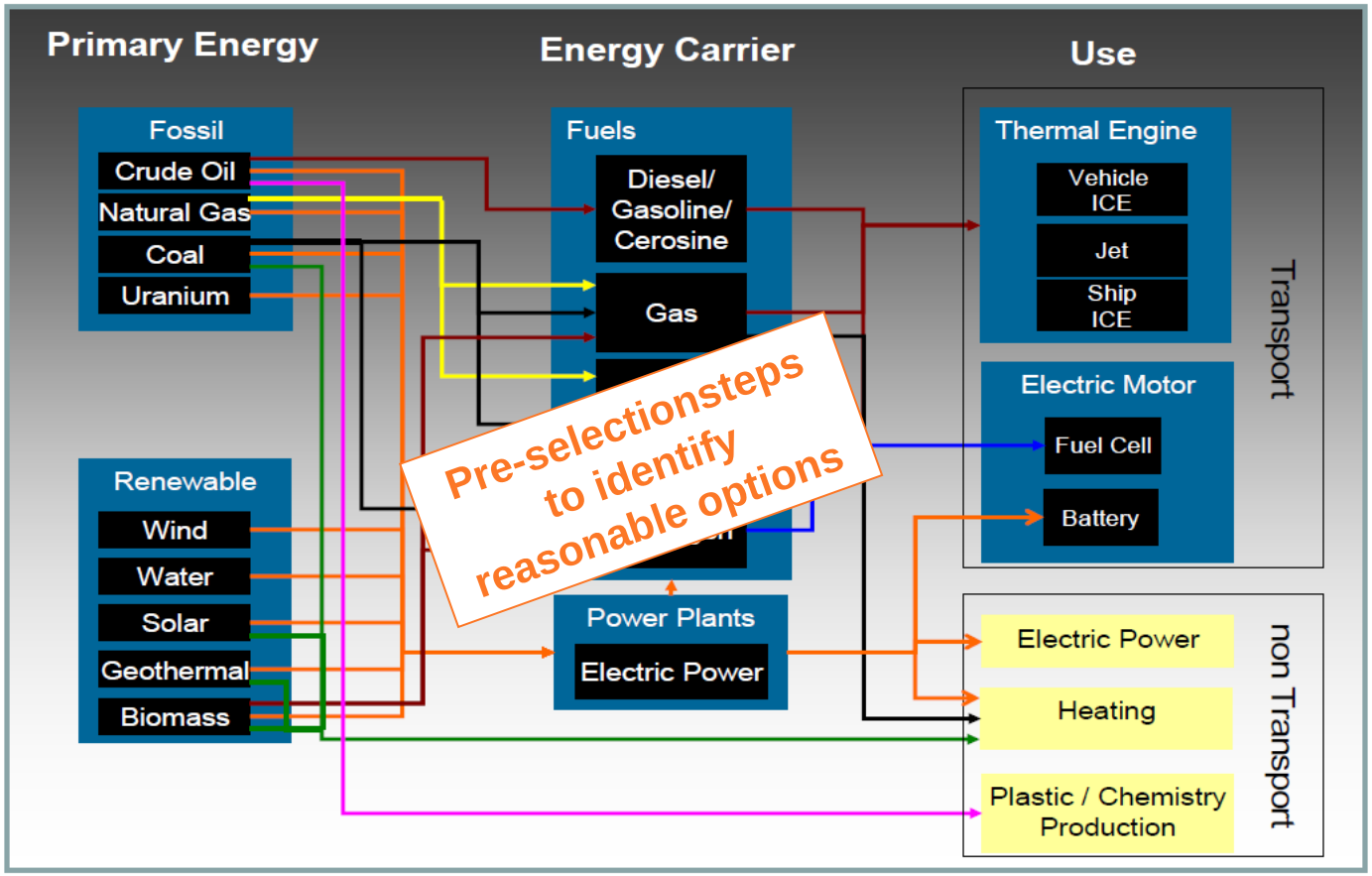
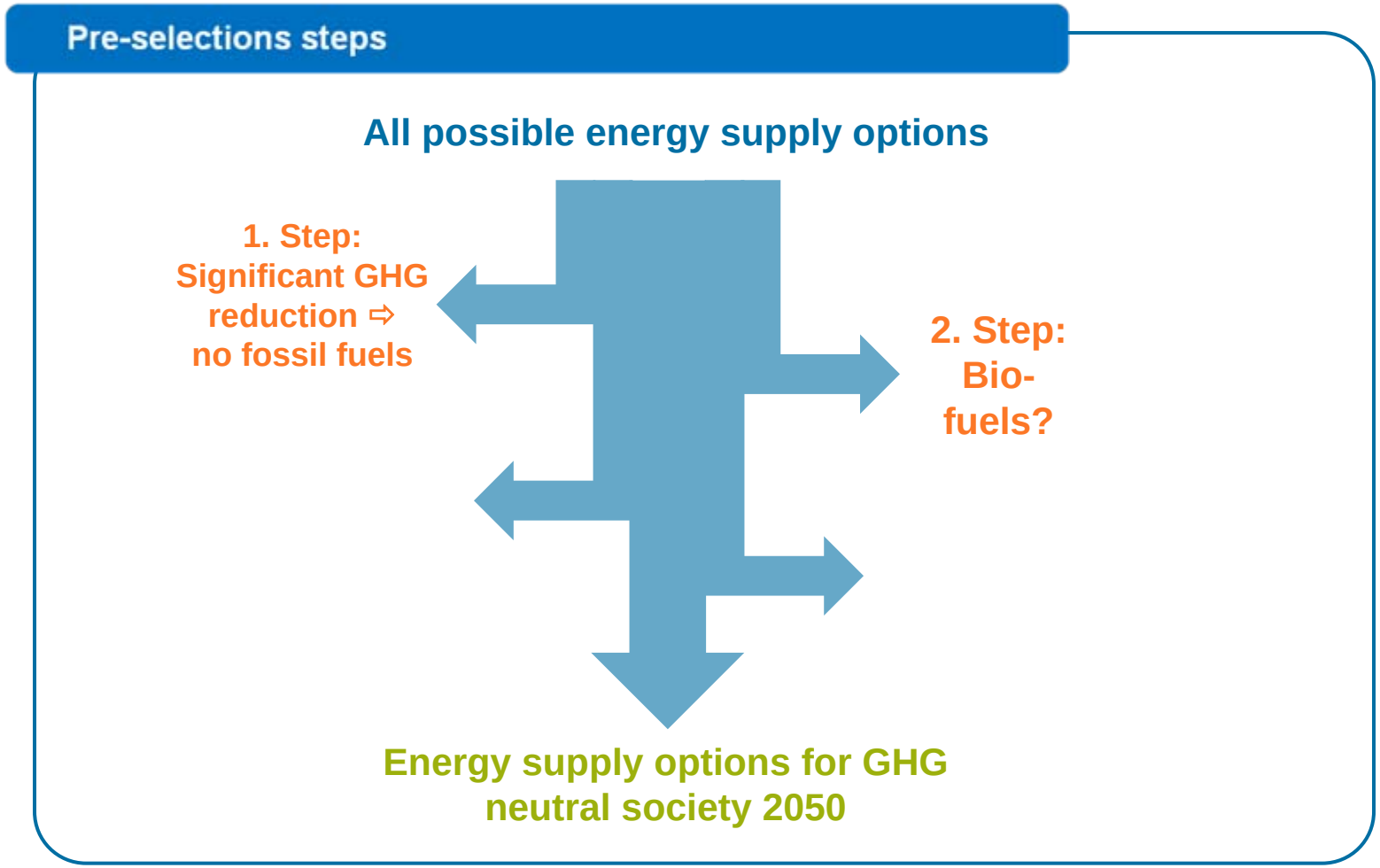
A wide range of possible alternative ways to supply the transport sector with energy



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

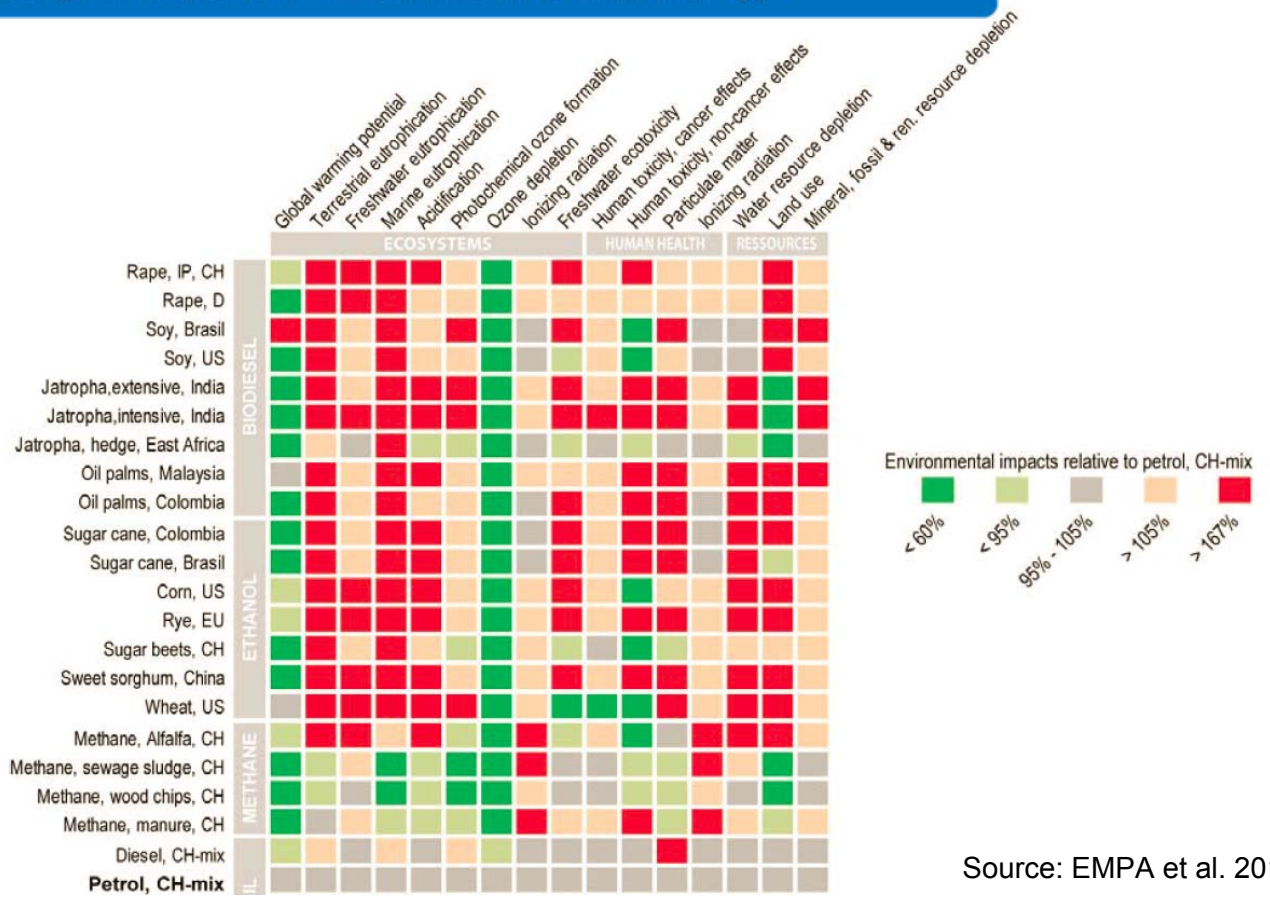
Pre-selection steps of the most reasonable renewable energy supply options for transport (1)



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.

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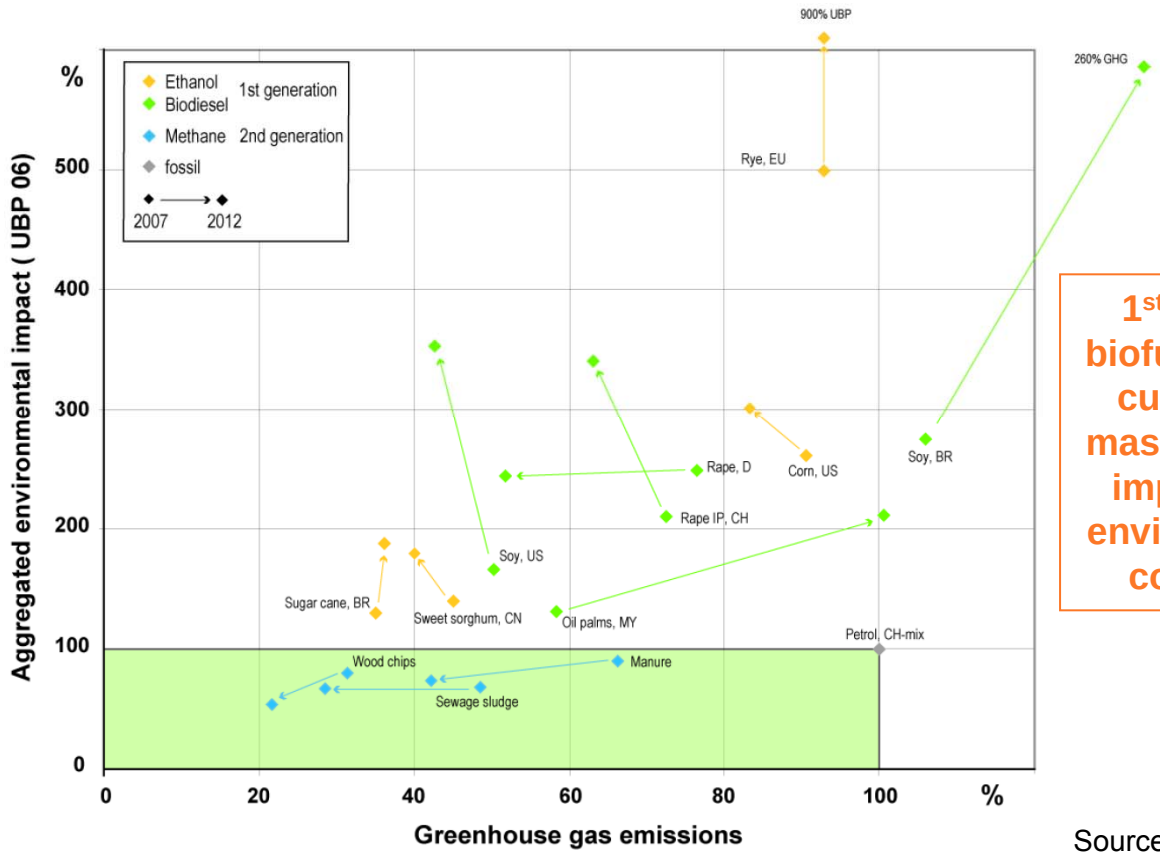
Environmental and climate impact of biofuels based on detailed life cycle assessment (2)

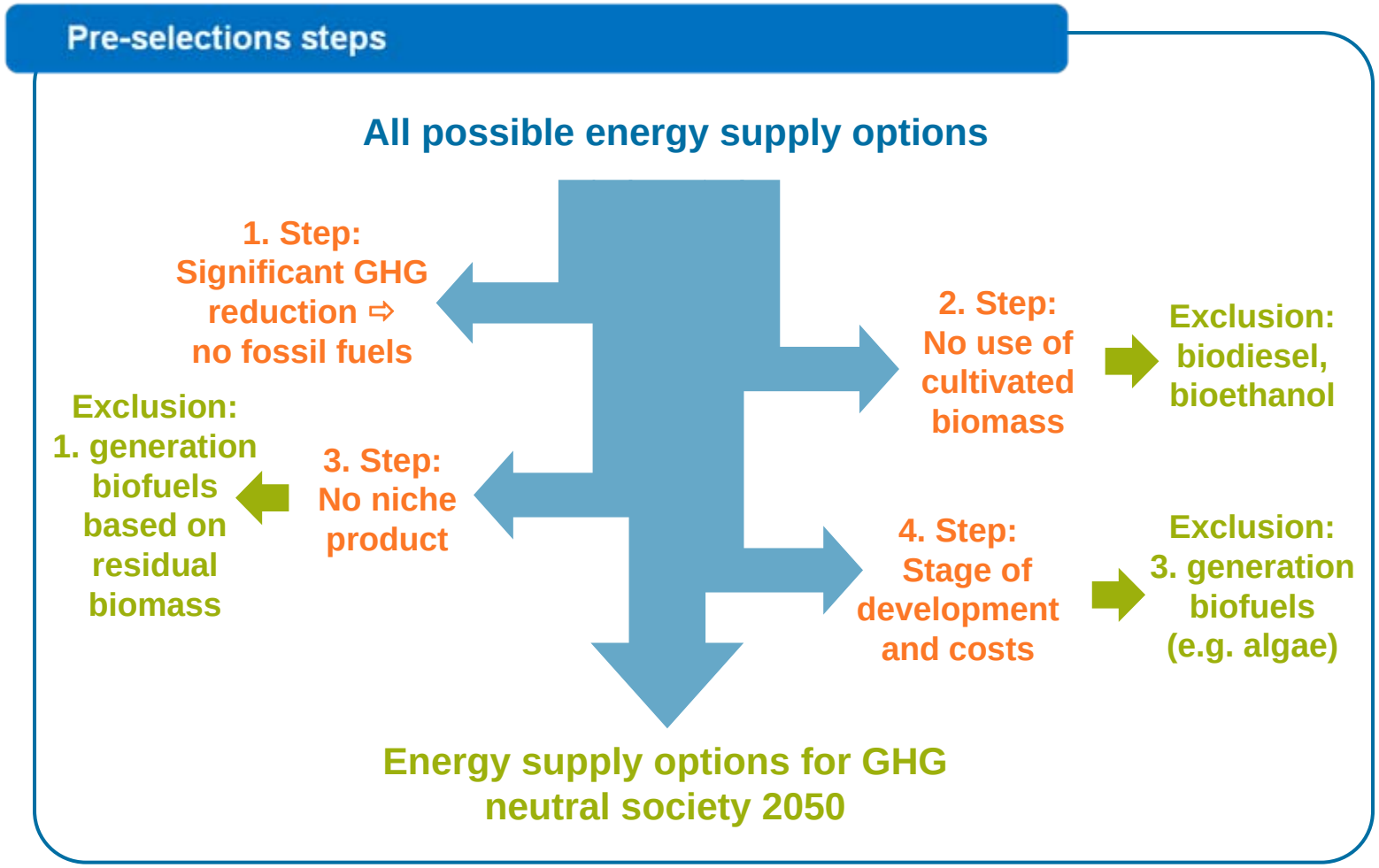
EMPA study for the Swiss Federal Office for Energy



1st generation biofuels based on cultivated bio-mass 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-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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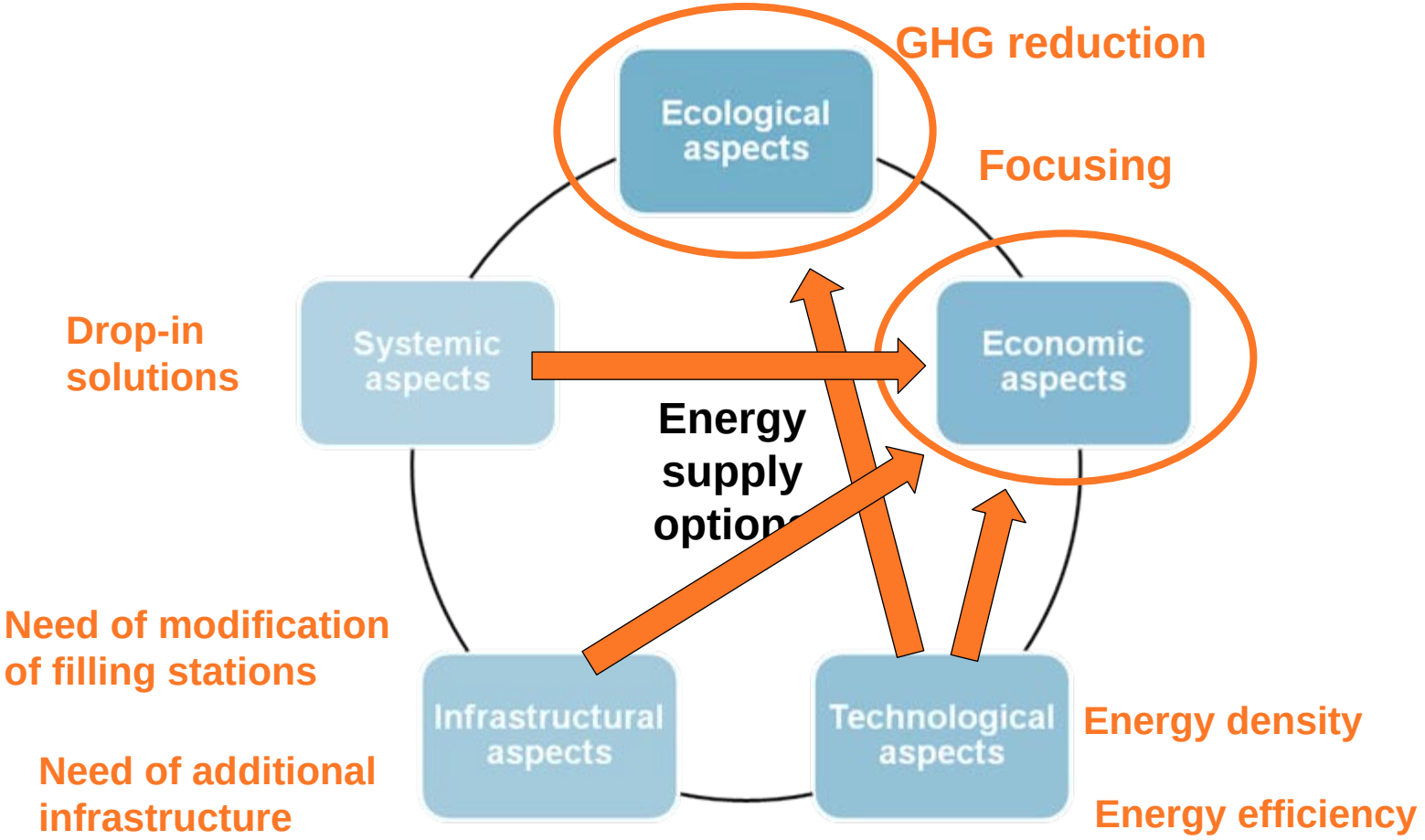
Ecological requirements on the transformation of the traffic-related energy supply: First assessment



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)

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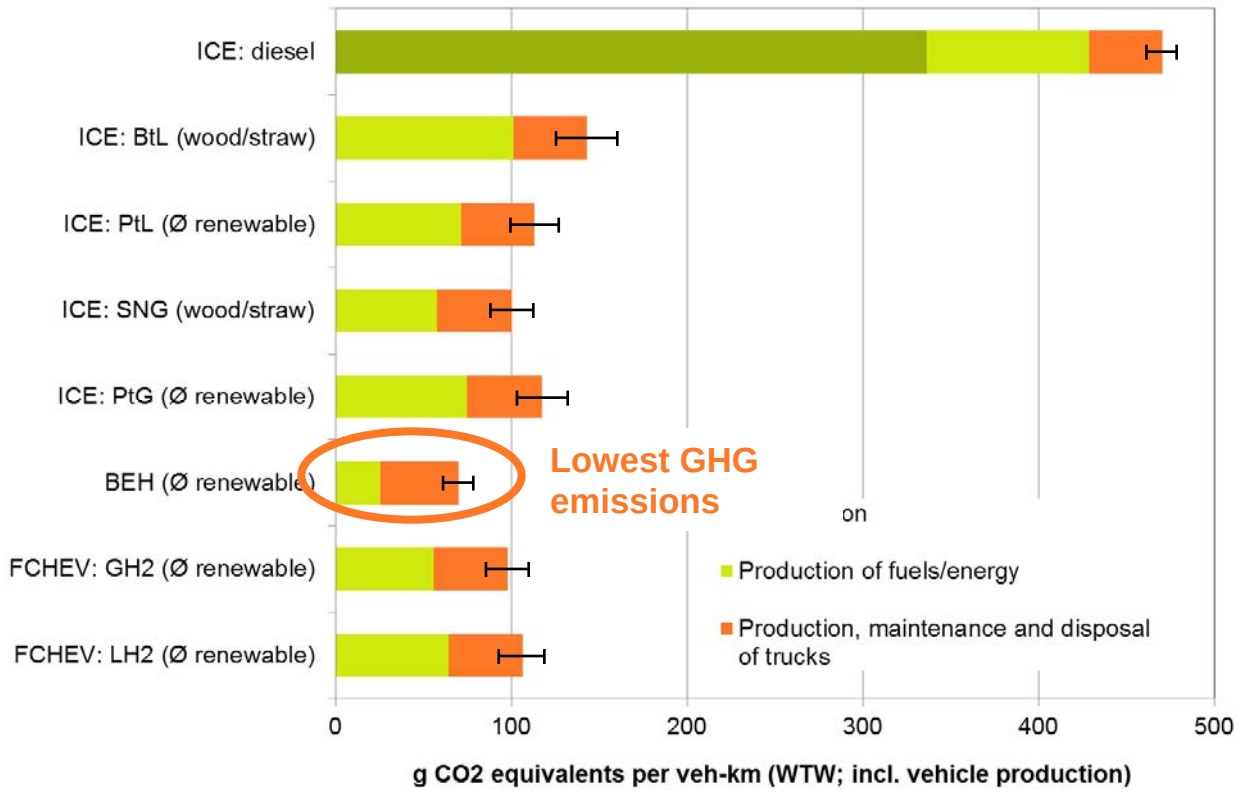
10 t truck: WTW GHG emissions per vehicle kilometre in 2050 for different fuel types

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

Preliminary results



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Quantis

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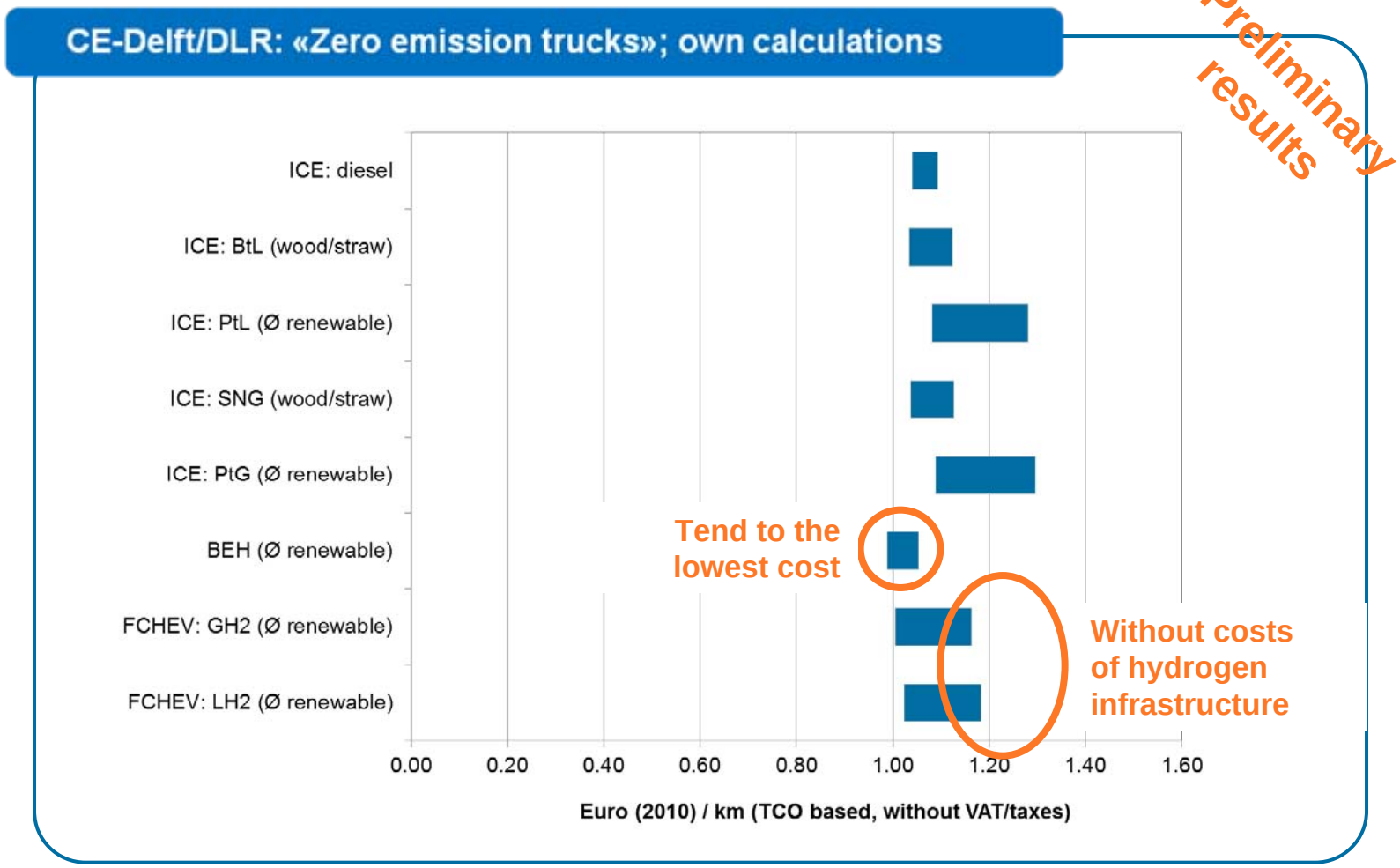
10 t truck: Total costs of ownership (TCO) per vehicle kilometre in 2050 for different fuel types



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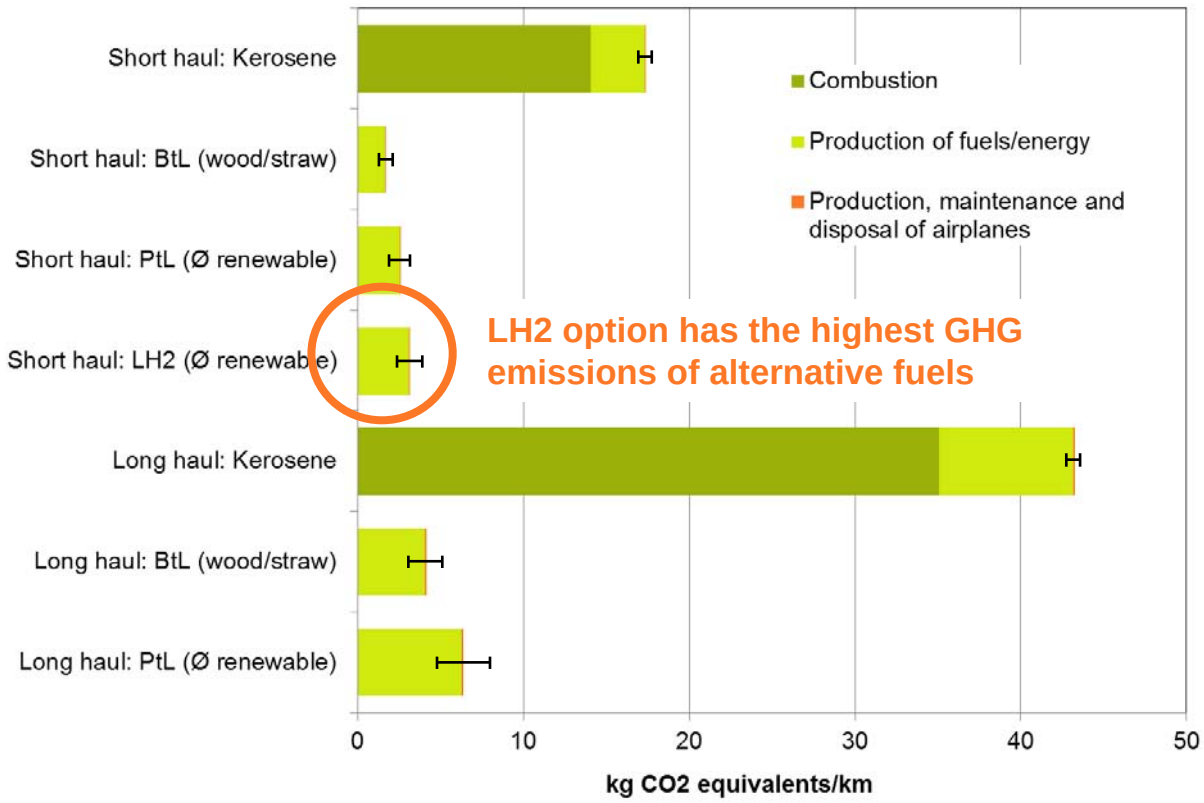
Pre-selected energy supply options for the air traffic without fossil fuels / 1st generation biofuels

	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)

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

Own calculations

Preliminary results



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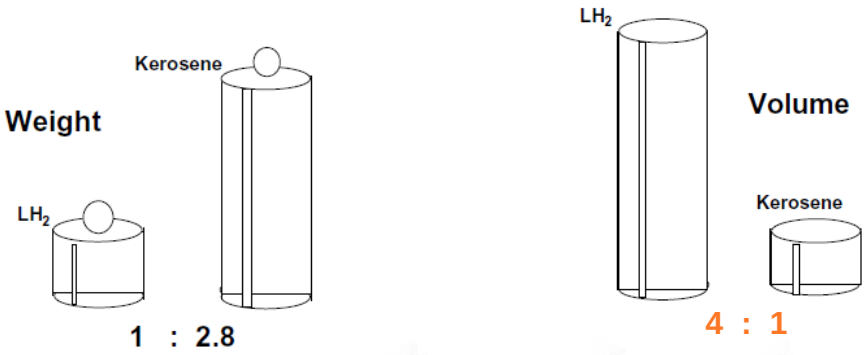
For similar energy content the volume of liquid hydrogen is four times higher than for kerosene

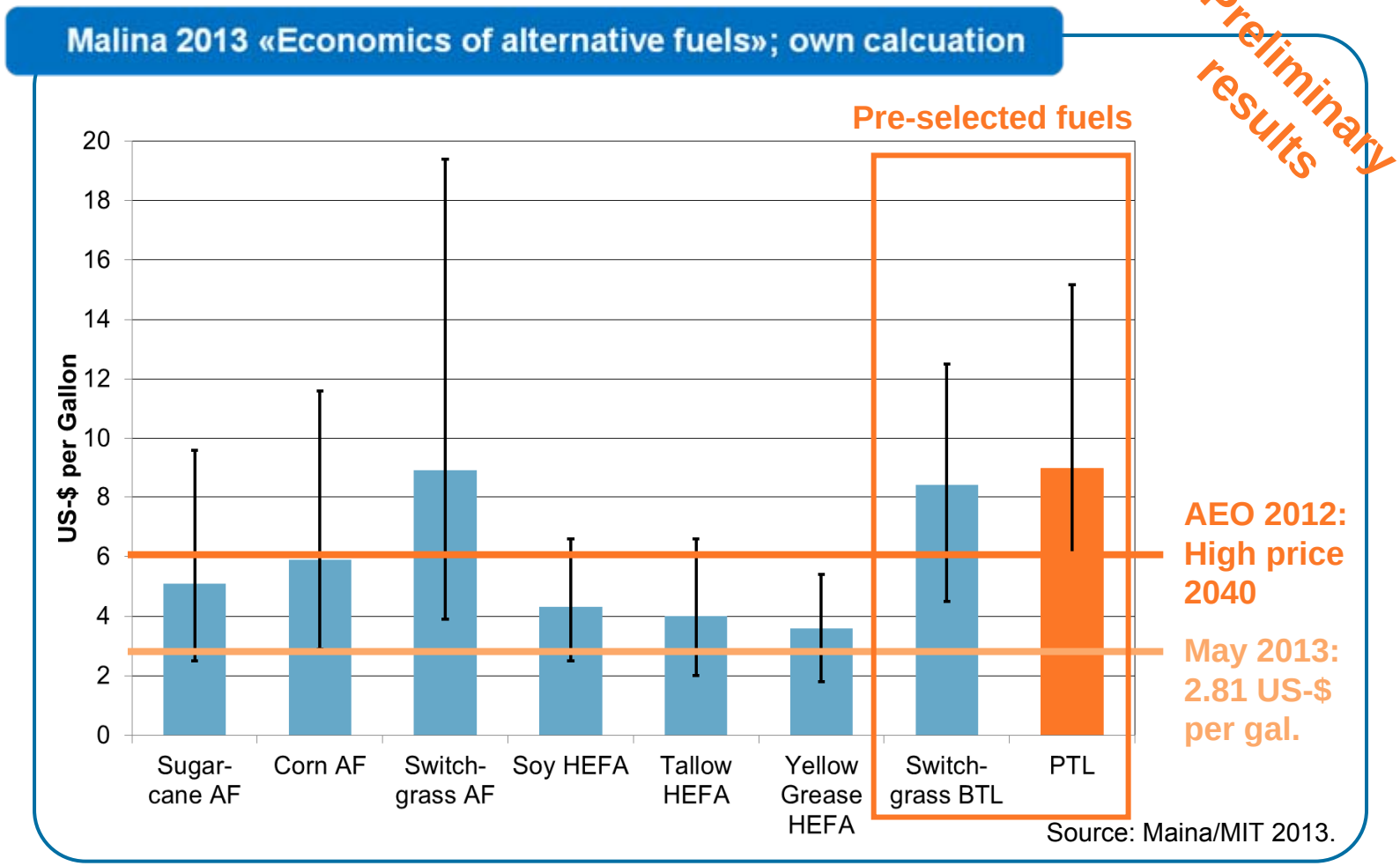
Volumetric and gravimetric energy density

Compariosn of LH2 and kersone – similar energy content:



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

Comparison of costs for different types of fuels for air traffic



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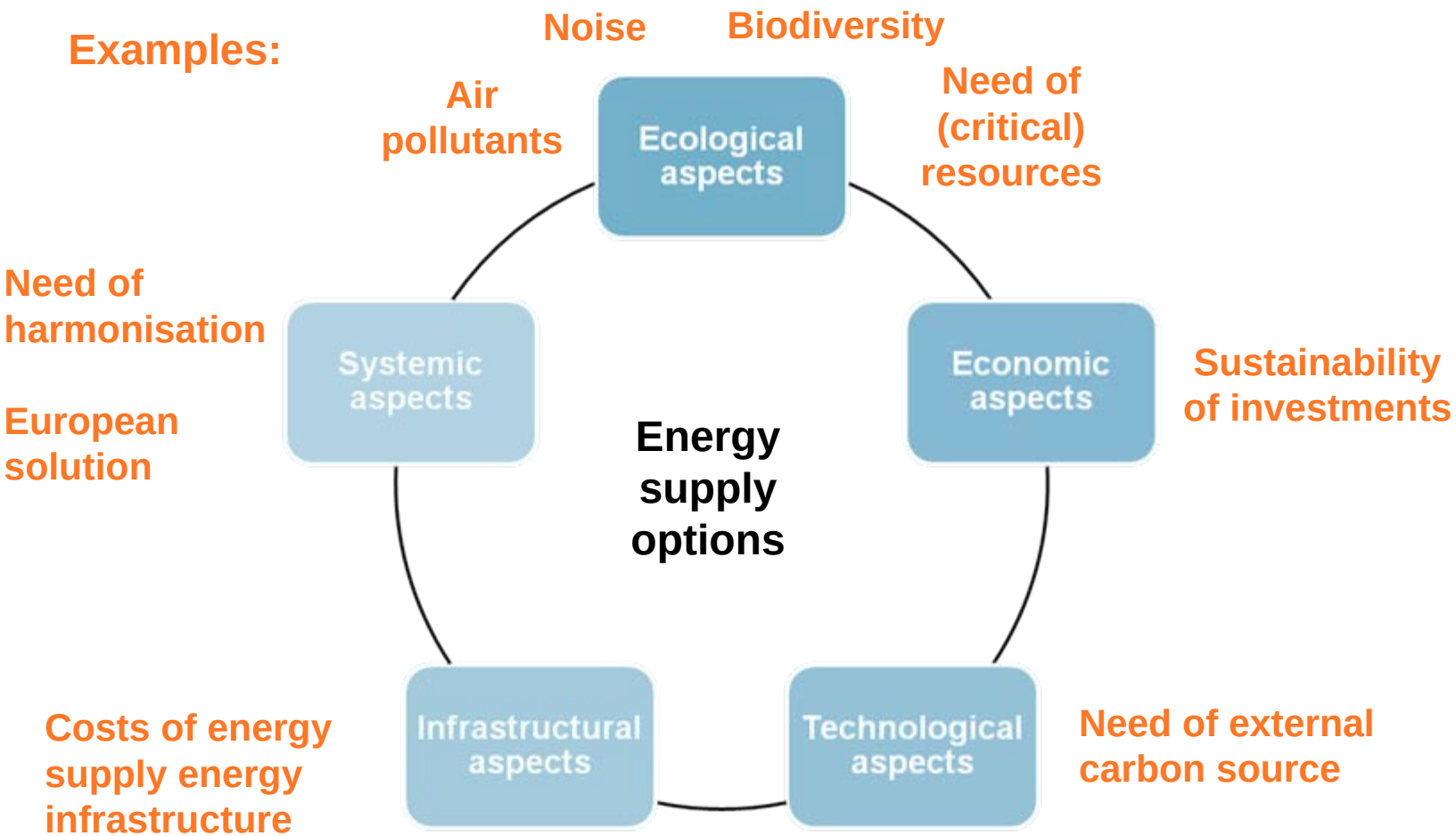
Diversified challenges for the energy transition in the transport sector: Conclusions (1)

- 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

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



Thank you for your attention

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