

# Potential role of Power-to-X technologies

## 13<sup>th</sup> Concawe Symposium

Antwerpen, 18th of March 2019



# Contents

---

1.	Short Introduction to Frontier	3
2.	A few thoughts on the future role of Power-to-X	7

**Dr Christoph Gatzen**

 +49 221 33713110

 [Christoph.Gatzen@frontier-economics.com](mailto:Christoph.Gatzen@frontier-economics.com)

---

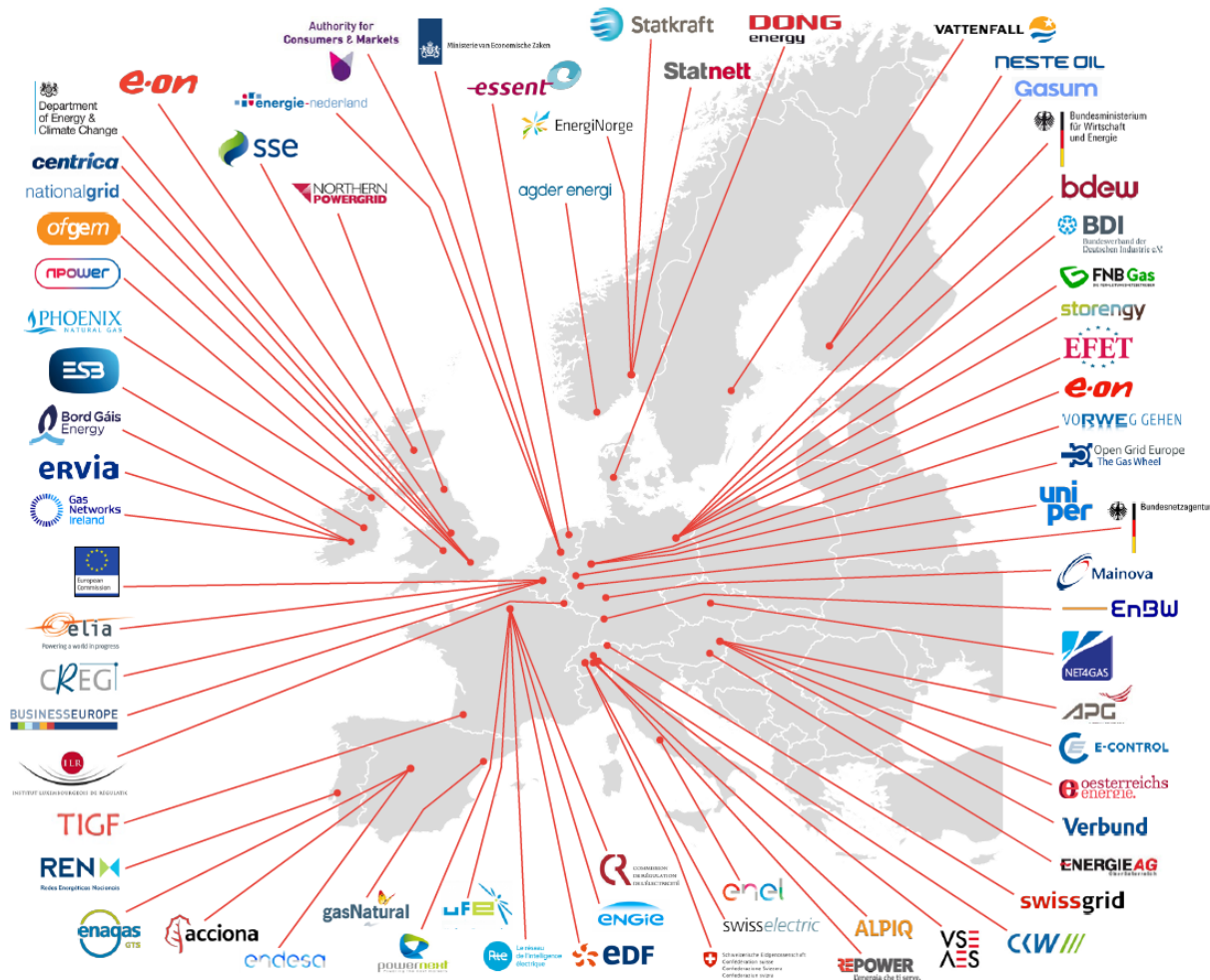
1.	Short Introduction to Frontier	3
2.	A few thoughts on the future role of Power-to-X	7

# Frontier is an economic consultancy working across a range of sectors...



...but energy is major capability

# In the energy sector we have advised...



...many different stakeholders across Europe –  
obtaining a 360° view of the market

# Our focus is Europe but we also work worldwide...

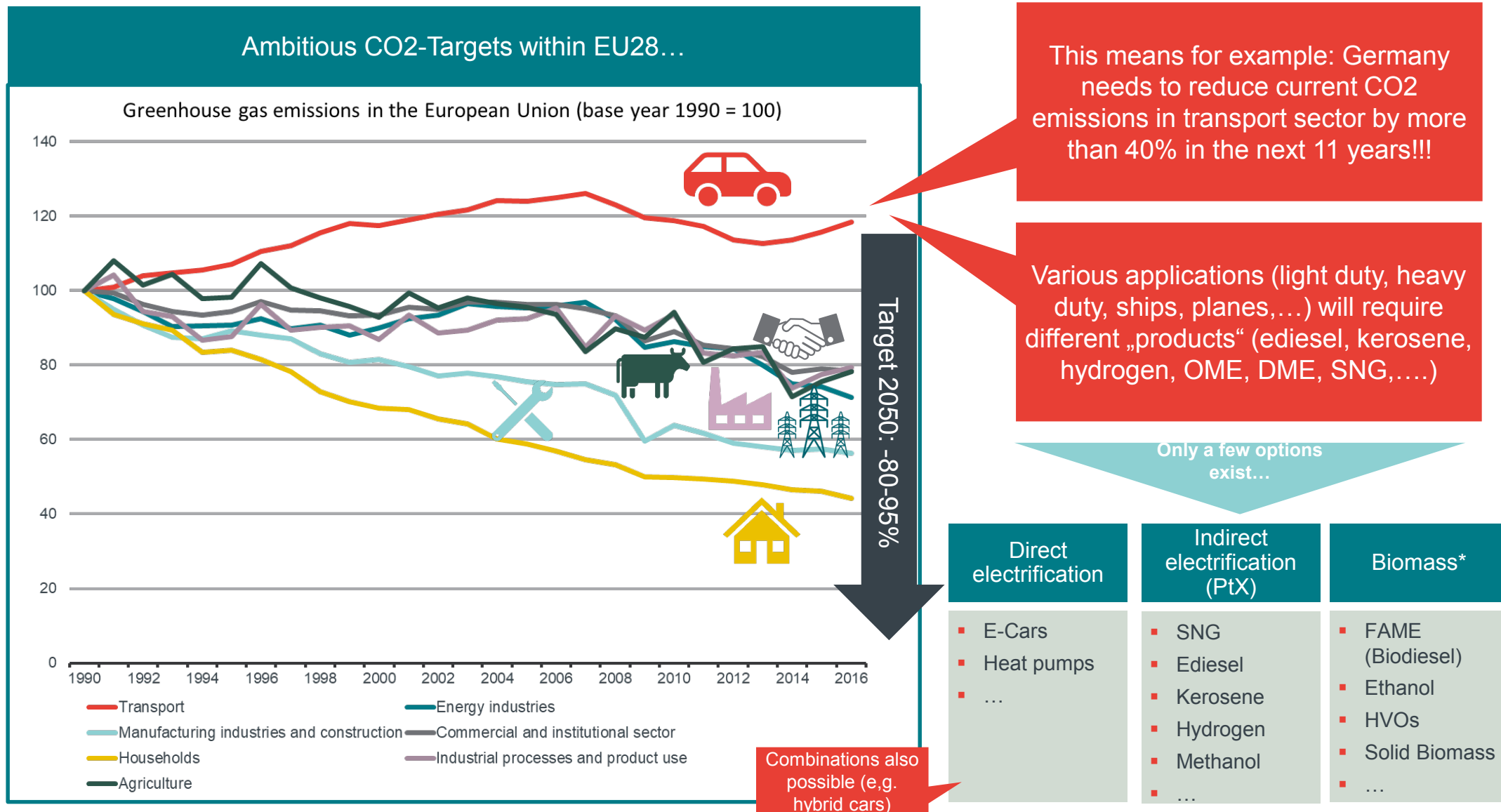


Frontier Economics Limited in Europe (client work with red connectors) and Frontier Economics Limited Pty in Australia (client work with blue connectors) are members of the Frontier Economics network. The companies are independently owned.

---

1.	Short Introduction to Frontier	3
2.	A few thoughts on the future role of Power-to-X	7

# Europe's challenge...defossilisation of the European economy – all sectors!



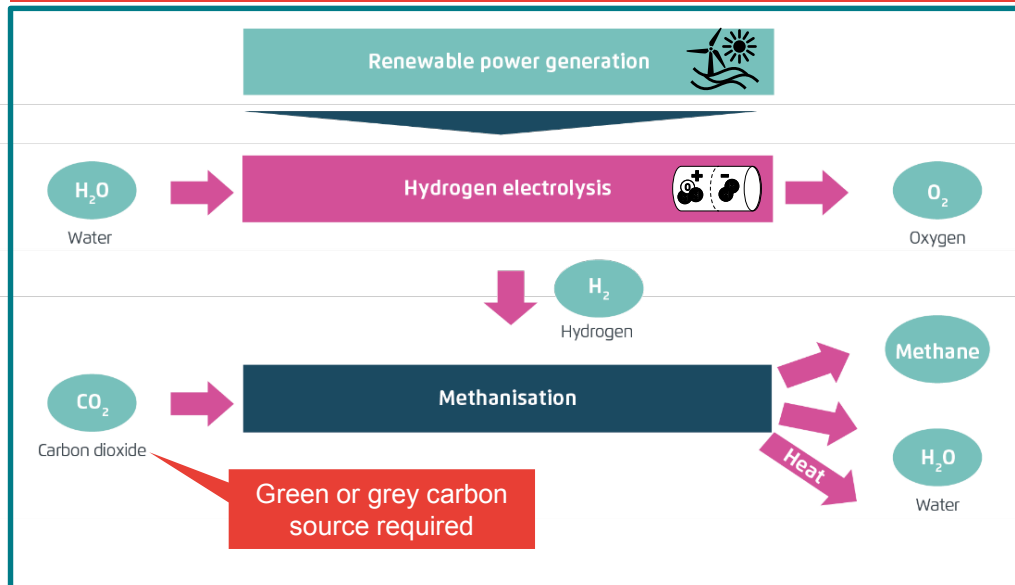


# What do we mean with Power-to-X (PtX)?

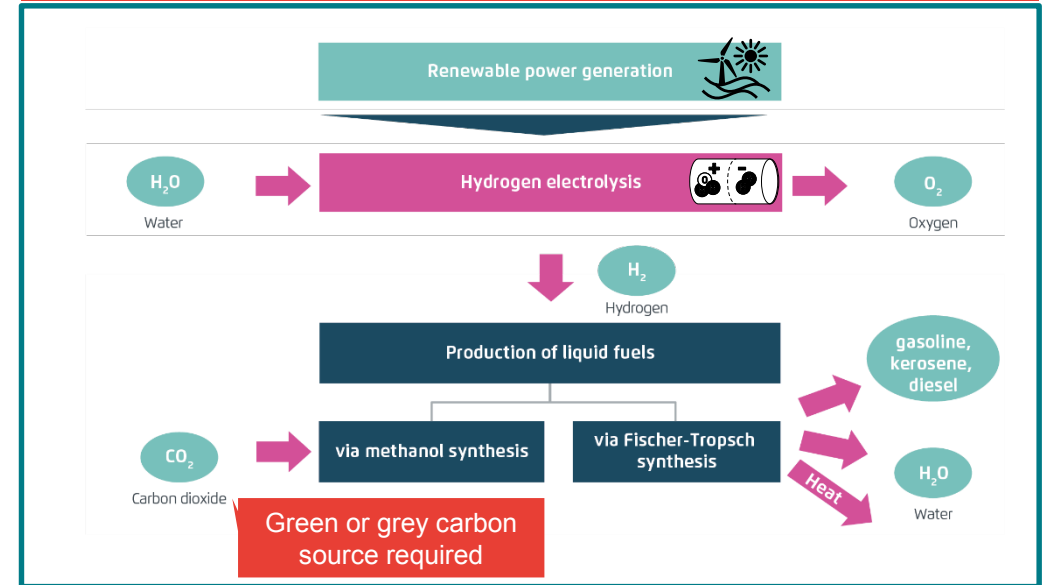
## Power-to-X

- PtX means input of **electricity** to produce
  - Liquids (PtL – e.g. ediesel, kerosene, methanol)
  - Gases (PtG) – (e.g. hydrogen, SNG)
  - Chemicals (PtC – e.g. chlorine)
  - Heat (PtH – e.g. high or low temperature heat)

## Power-to-Gas



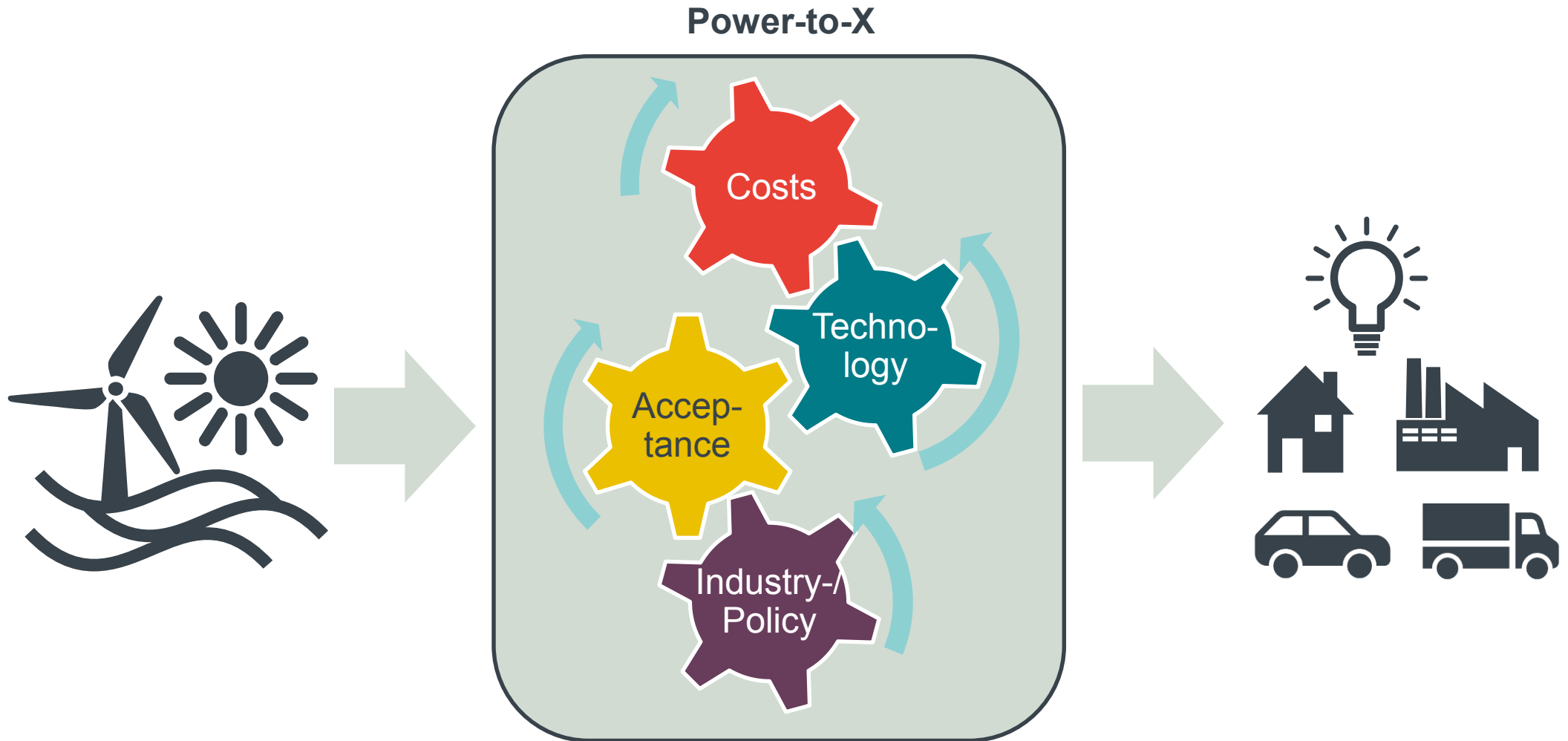
## Power-to-Liquids



## Power-to-X requires...

- ... a power source (e.g. wind, PV, hydro, network procurement)
- ... a water source
- ... a carbon source („green“ – e.g. air capture or biomass) or point source (industry)
- ... an electrolyser
- ... a methanisation plant (if we go beyond hydrogen production)
- ... a storage or off-take infrastructure of the product

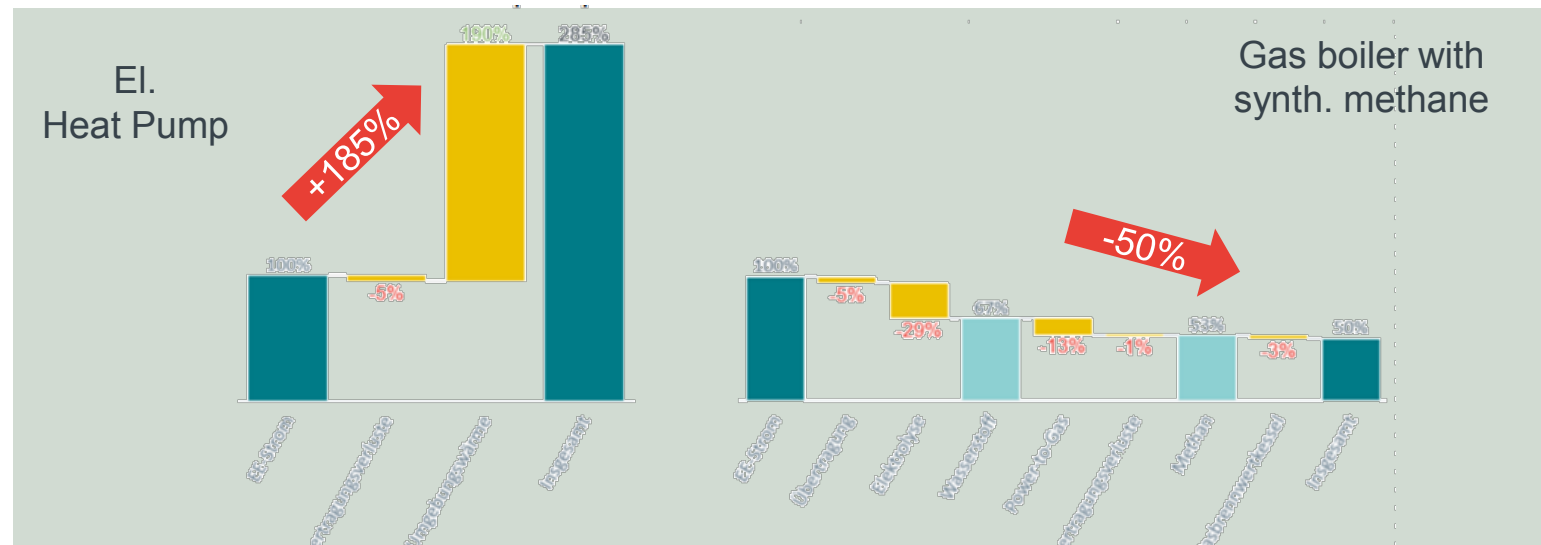
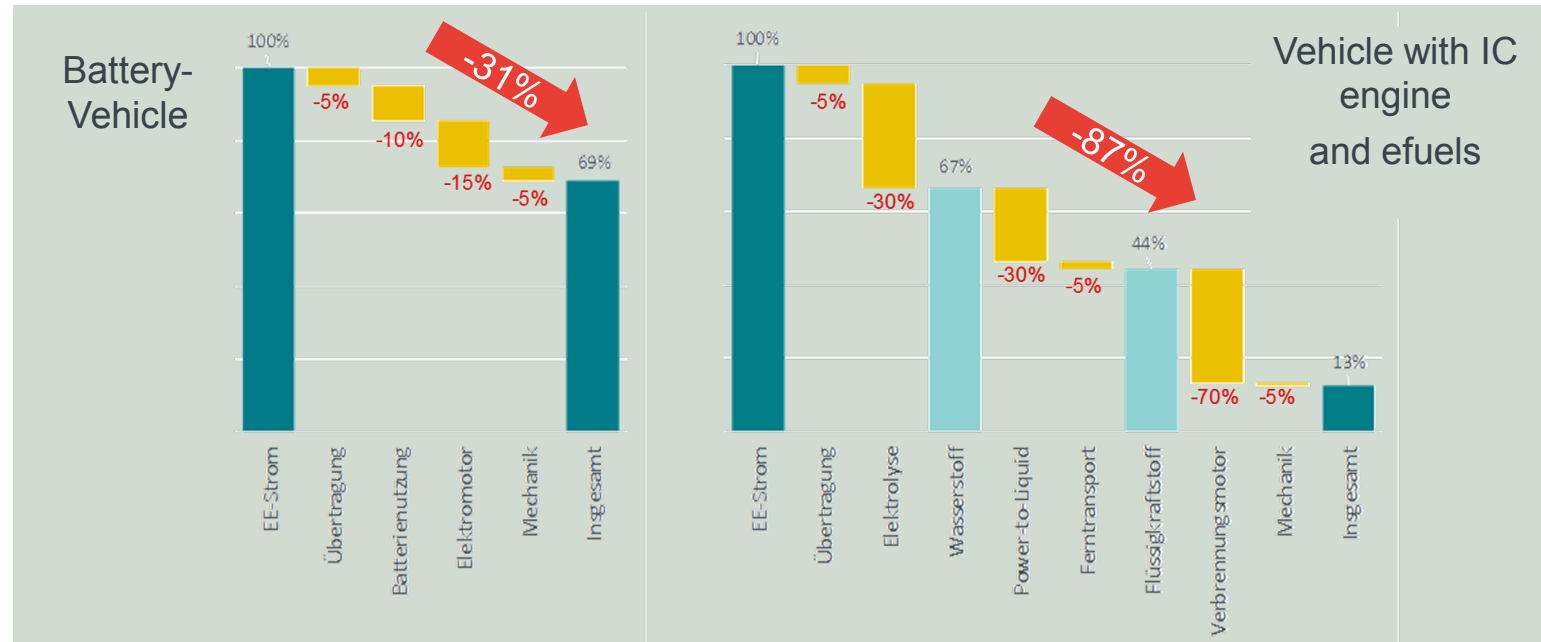
# PtX will play a crucial role for the decarbonisation of society...



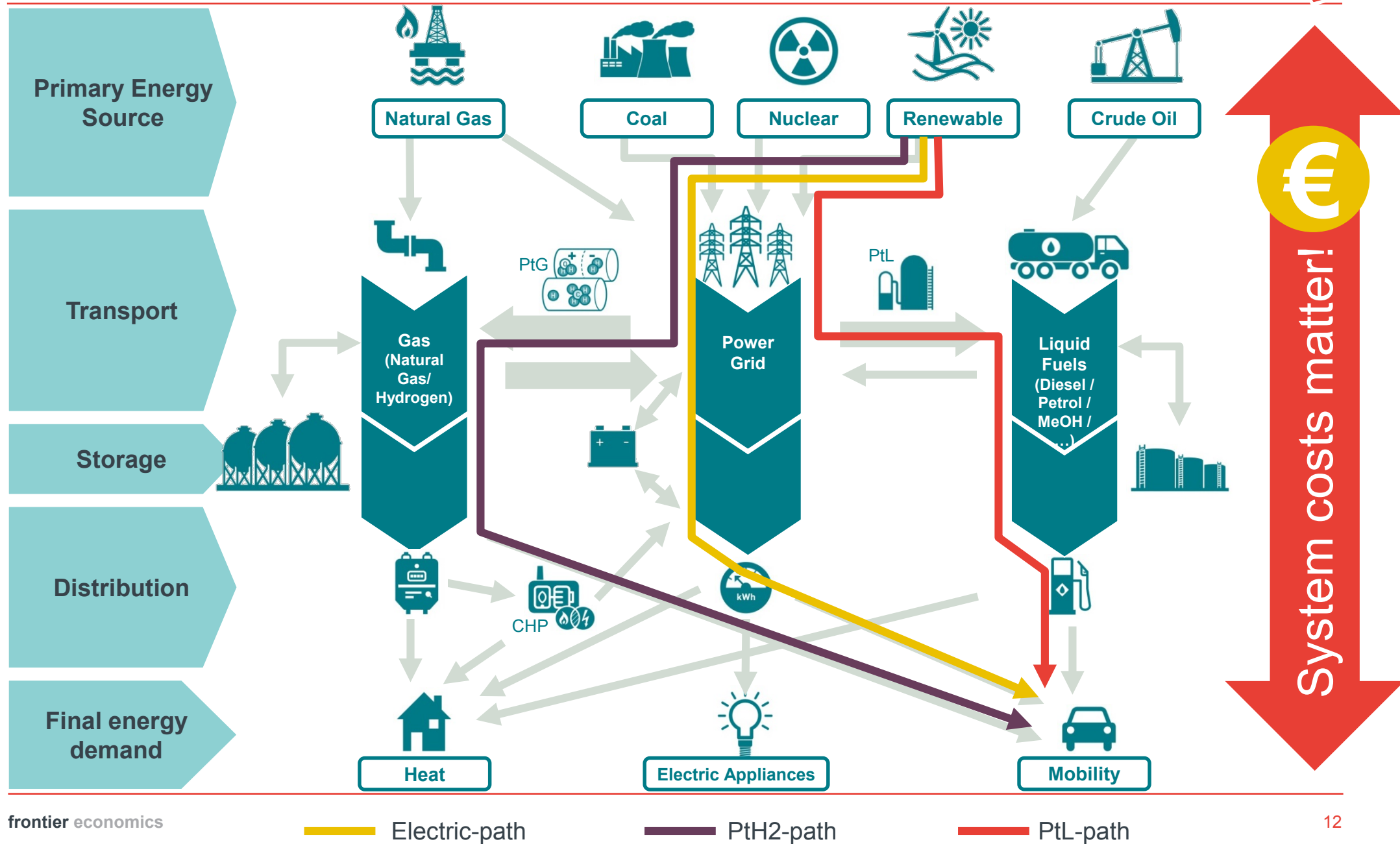
... as it addresses multiple issues (e.g. seasonal storage, transport, existing infrastructure)!

Some people made an „too early call“ against PtX based on tank-to-wheel efficiency only...

Costs



... but **overall system costs** and **practical considerations** matter as well!

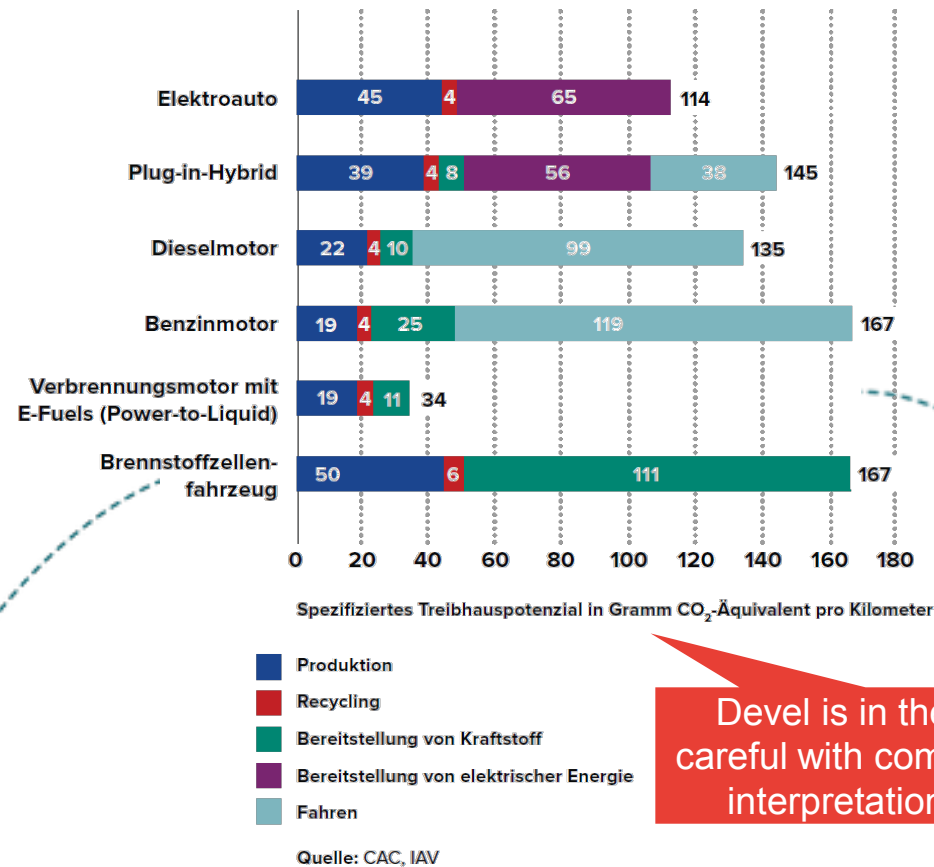


... “Cradle to Grave” analysis is important, e.g. in context of life cycle analysis on environmental impacts

Frontier is currently involved in two studies...

Costs

coming soon



Devel is in the details – careful with comparison and interpretation of LCAs

# Chemical energy carriers (e.g. PtX) are a “must have” to cover need for **seasonal storage**...

Technology



Storage of oil-products within Germany  
**>400 TWh**

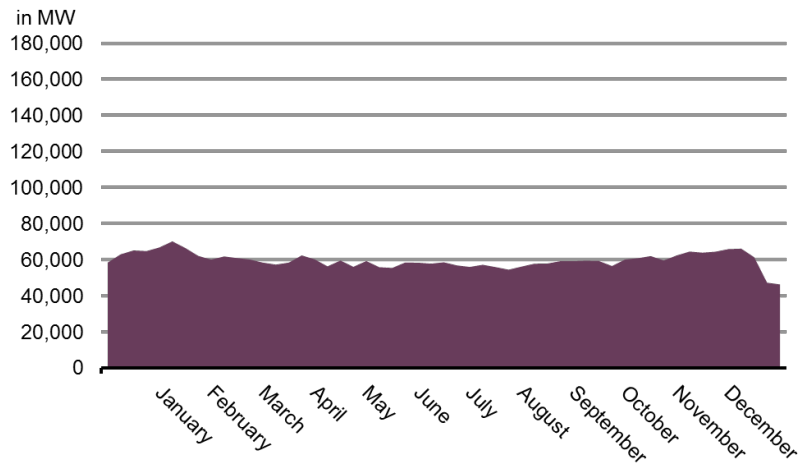
Gas-Storage in Germany  
**>260 TWh**

Power storage  
0.04TWh<sub>el</sub>

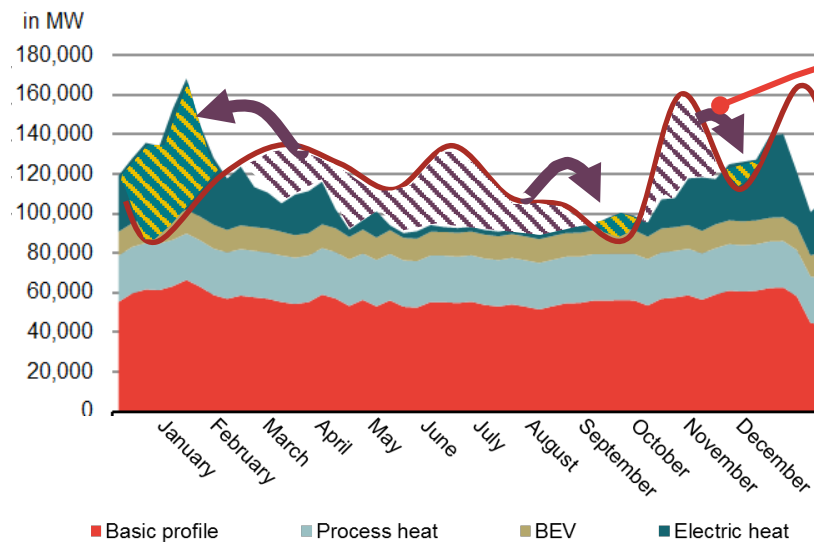


=1.3m x

Electricity load profile today\*



Electricity load profile 2050 in the “Electricity only“-scenario (modelled)\*



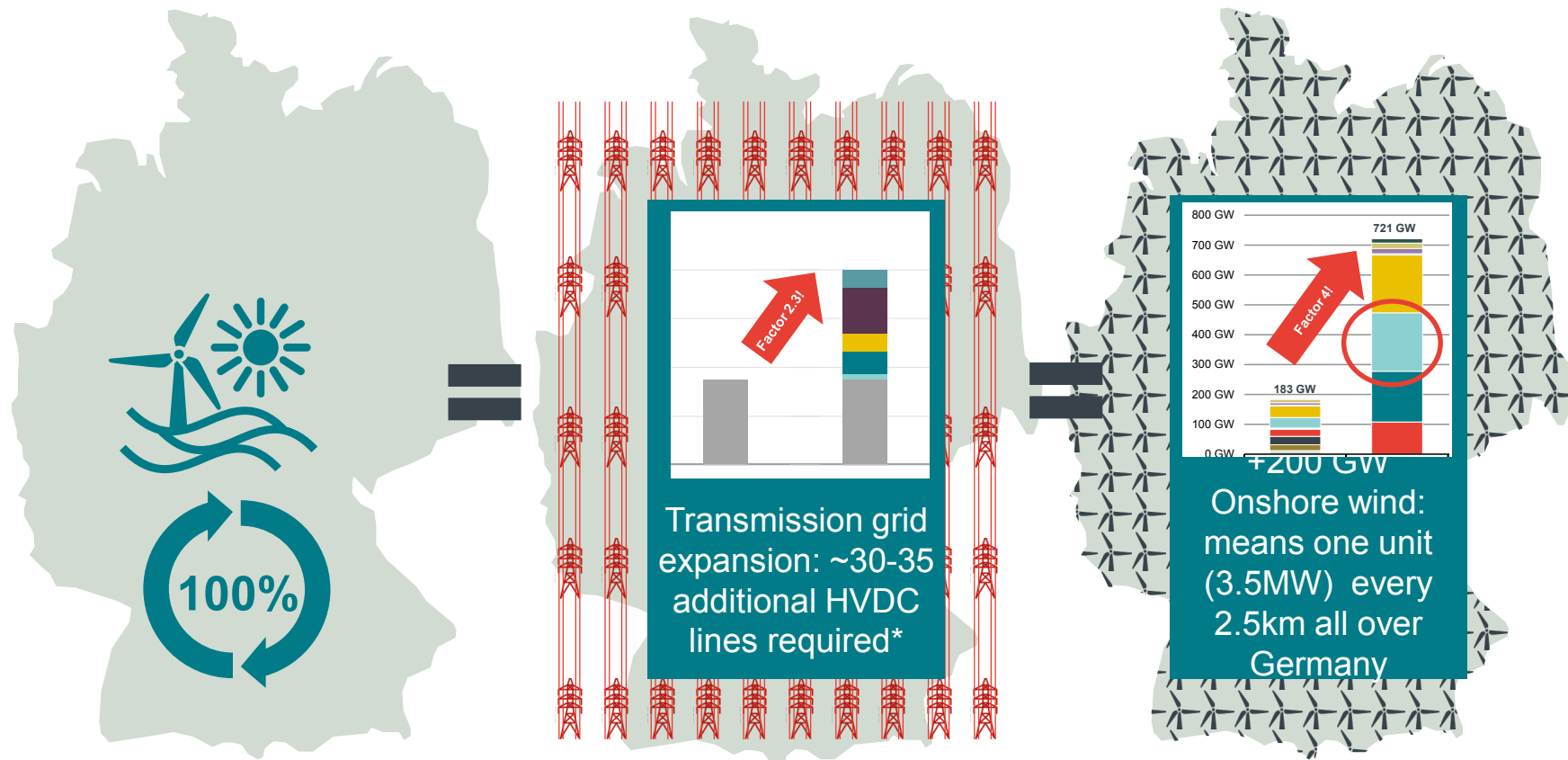
- Seasonal storage required
- Back up for “1 in 20” winter heat demand and for low RES-E year

Generation  
RES-E 2017  
(Monthly Average)

# Public acceptance – will be key for a successful energy turnaround ... but in practice new infrastructure is difficult to establish...

Acceptance

Macro  
economic  
view...



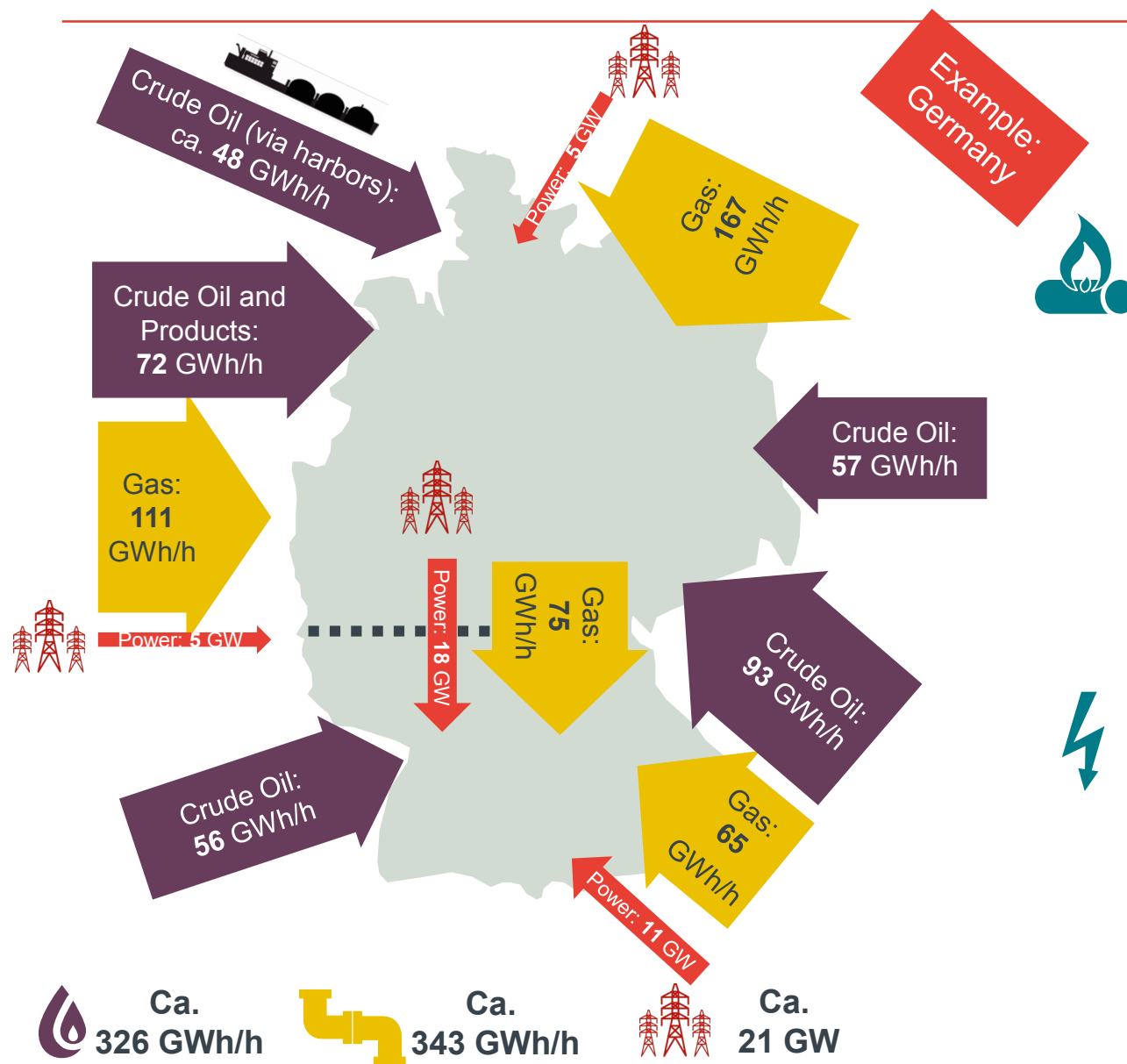
... individual  
perception





# PtX allows us using existing infrastructure...also for imports of fuels!

Acceptance

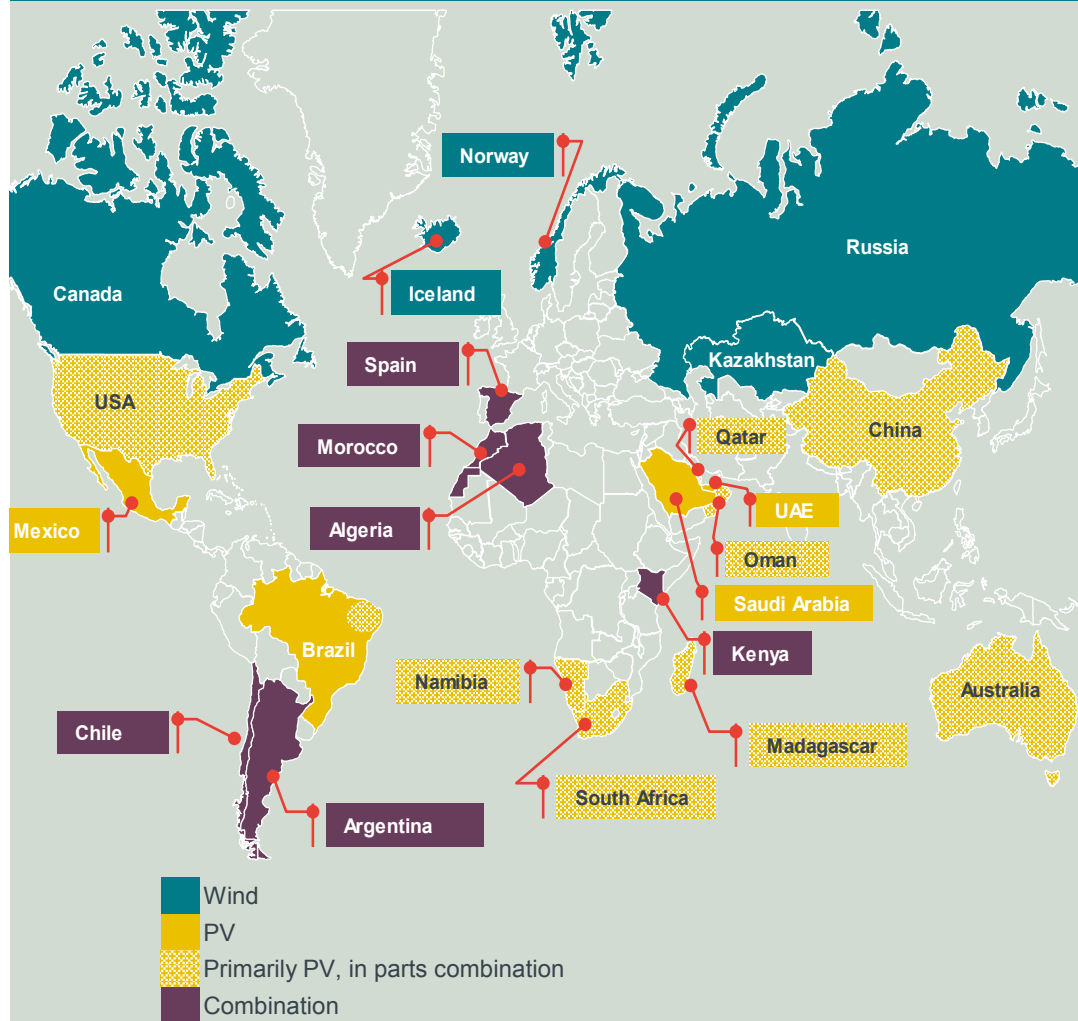
















Still, a lot of PtX production will be imported to Europe due to cost advantages outside and limited (accepted) potentials within Europe...

Industry-/  
Geopolitics

## Screening possible exporting countries (Costs/Potential/Regulation/local specifics)

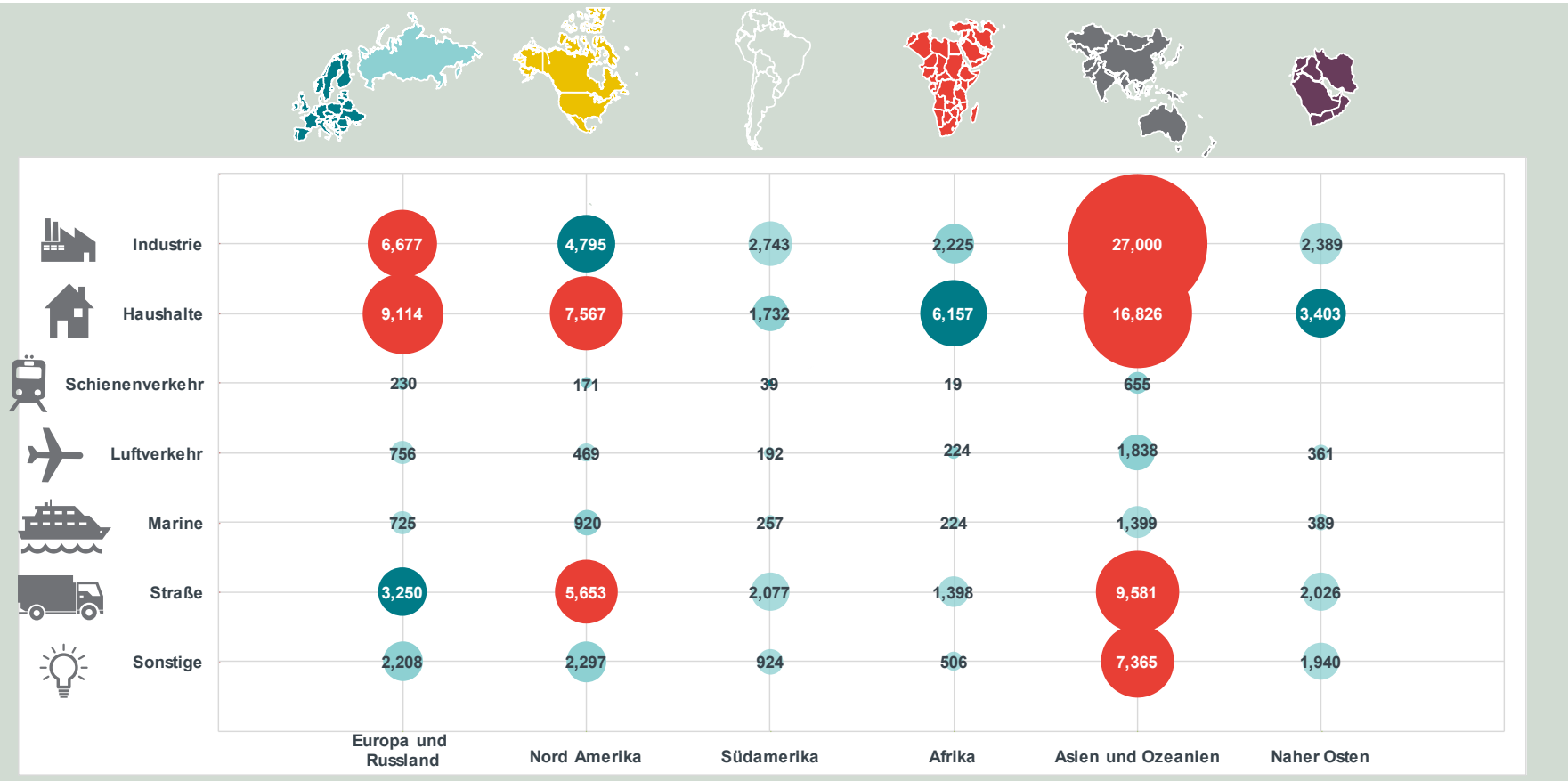


## A few examples....

Type	PtX Motivation and Readiness	Examples
 <b>Front-runners</b>	➤ Especially favourable in early stages of market penetration	 <b>Norway</b>
 <b>Hidden Champions</b>	➤ PtX could readily become a serious topic if facilitated appropriately	 <b>Chile</b>
 <b>Giants</b>	➤ Provide order of PtX magnitudes demanded in mature market	 <b>Australia</b>
 <b>Hyped Potentials</b>	➤ Potential to lead technology development; may depend on solid political facilitation	 <b>Morocco</b>
 <b>Converters</b>	➤ Strong motivation for PtX export technology; may require political facilitation	 <b>Saudi Arabia</b>
 <b>Uncertain Candidates</b>	➤ May drive PtX technology development, export uncertain	 <b>China</b>

... and even with conservative estimates the global demand for PtX will be enormous!

**Final energy  
consumption  
by region and  
sector –  
Forecast  
2040  
(WEO, IEA)**



**Assumptions on PtX  
Shares**  
(e.g. 10% Road, 70%  
Aviation)

Low Case

**Reference  
Case**

High Case

**PtX  
Market  
potential**

10.000 TWh

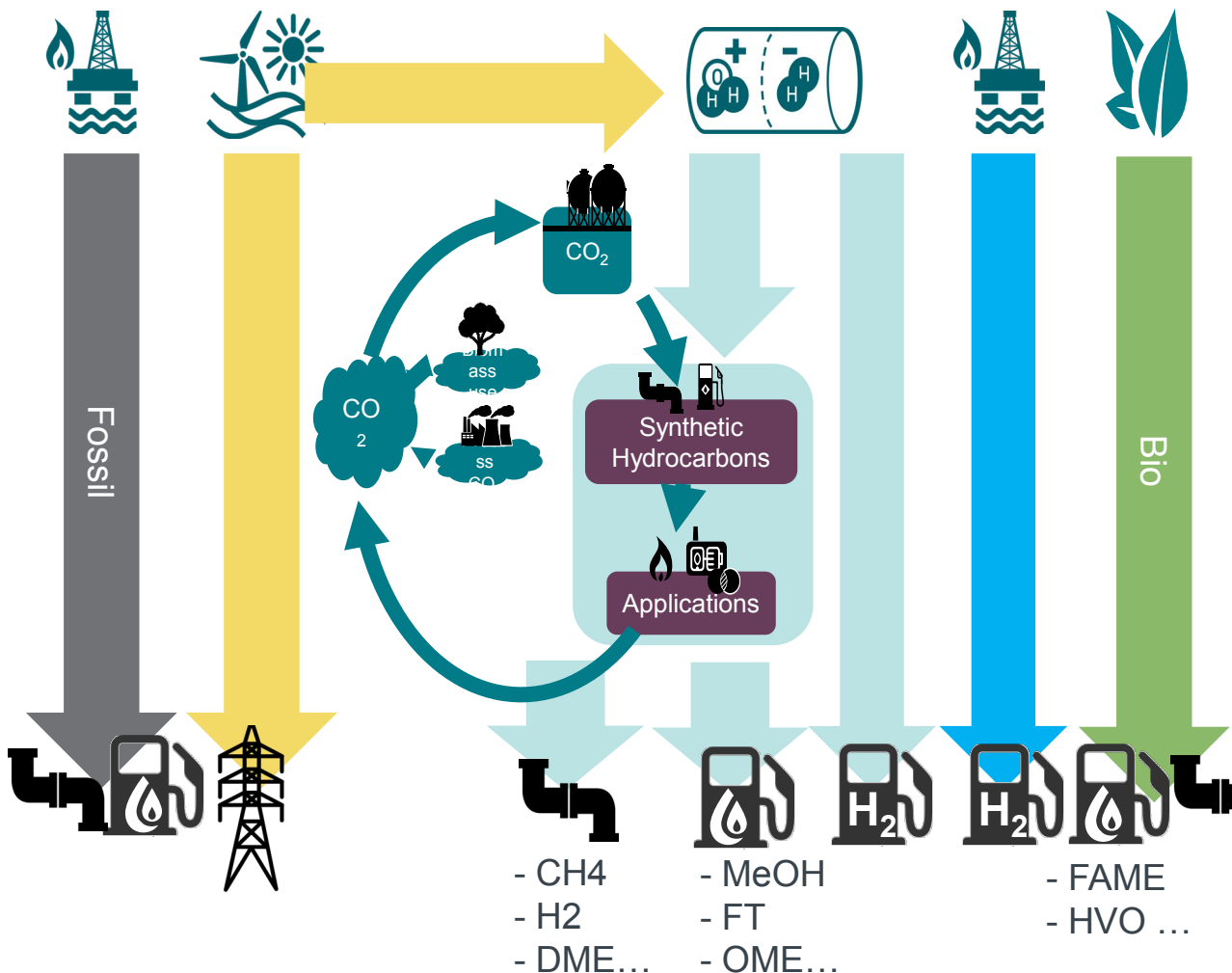
**20.000 TWh**

41.000 TWh

This is 50% of  
today's oil market!

# Starting the PtX market requires balanced regulation and investments – a joint task for industry and policy makers both within EU and outside!

Energy market benefits from new decarbonisation options but becomes more complex through PtX...



... this requires a balanced market regulation within EU and outside!

**For discussion!**

Competition/Unbundling

Standardisation

Technology innovation

Regulation

Internalisation of external costs

Energy transition is a complex and challenging task with strong impacts on society - let's do it in an open minded and cooperative manner!

---

Any further question? Feel free to contact us...



**Dr. Christoph Gatzen**

☎ +49 221 337 13 110

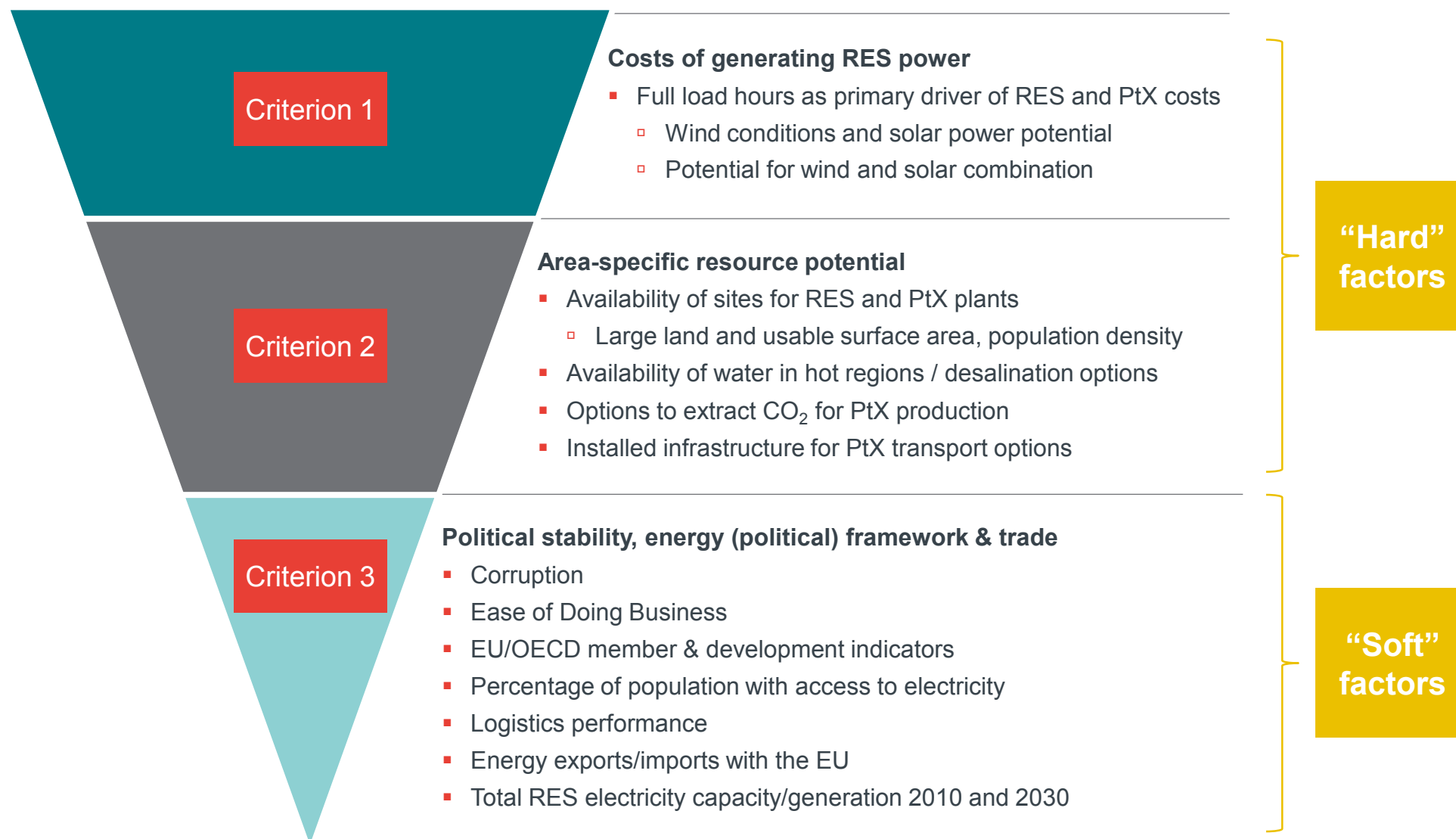
✉ [Christoph.Gatzen@frontier-economics.com](mailto:Christoph.Gatzen@frontier-economics.com)

---

# Annex

# Approach to determine potential exporters of PtX (here PtL)\*

## Overview of “hard” and “soft” factors for identifying potential PtX producer



# Frontier Study on behalf of World Energy Council Germany

**Figure 10 Global PtX demand estimation by sector for 2050, in%**

**1. Energy Forecast**

Energy demand forecast  
(World Energy Outlook)

**2. Plausible PtX final demand shares per sector, in %**

	Low case	Reference	High case
Industry	8 %	10 %	30 %
Commerce, Trade, Services	0 %	10 %	20 %
Households	0 %	10 %	20 %
Rail	0 %	10 %	10 %
Aviation	40 %	70 %	90 %
Marine	40 %	50 %	70 %
Road Freight	10 %	20 %	30 %
Road Passenger	0 %	10 %	30 %

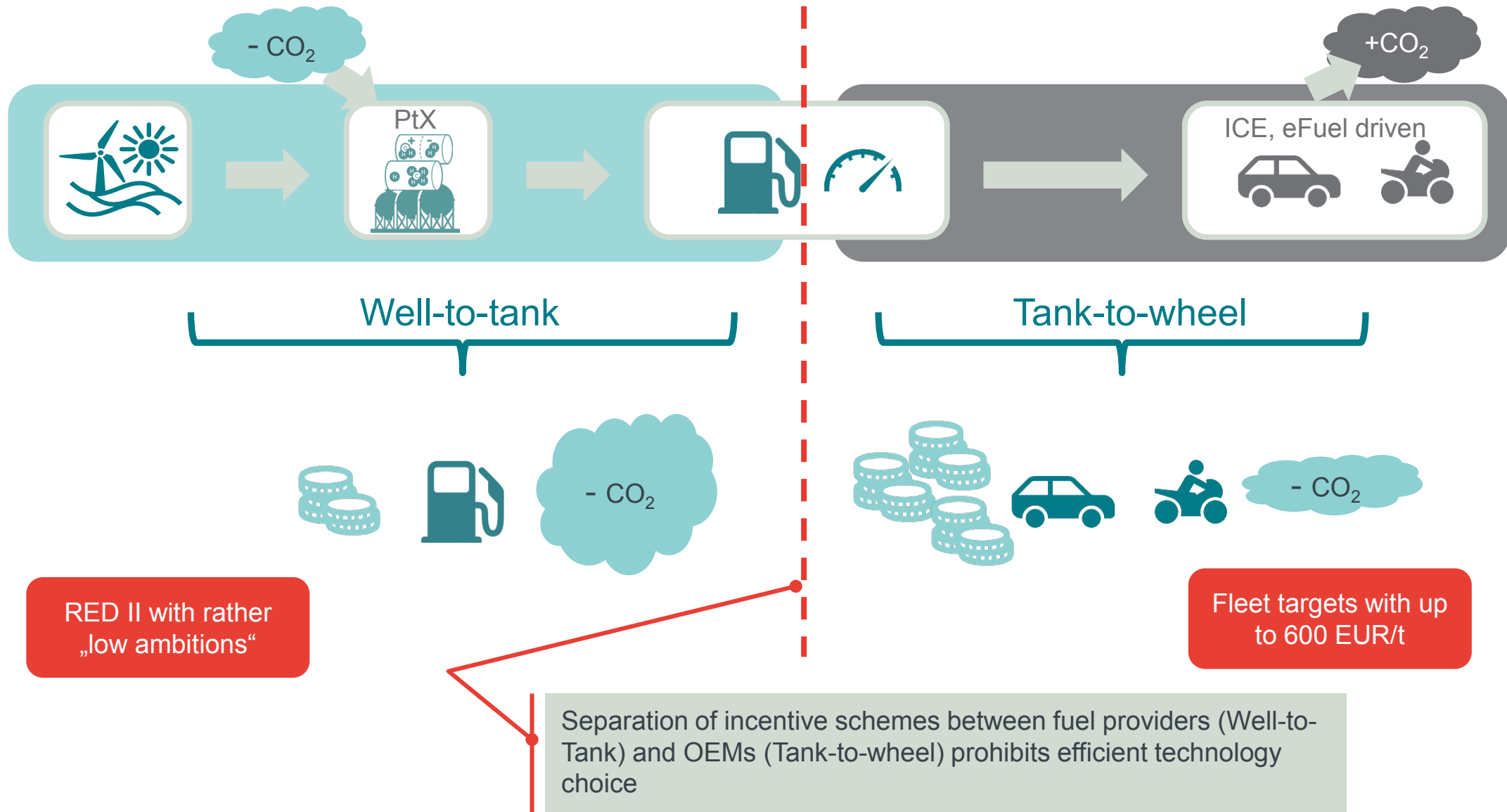
**3. Forecasted PtX demand per region and sector, in TWh, 2040**

	Europe & Russia	North America	South America	Africa	Asia & Oceania	Middle East
Industry	668	480	274	223	2,700	239
Commerce, Trade, Services	250	328	39	32	196	76
Households	662	429	134	583	1,486	265
Rail	23	17	4	2	65	
Aviation	529	329	134	157	1,286	253
Marine	363	460	128	112	699	194
Road Freight	134	243	11	97	1,052	12
Road Passenger	258	444	149	91	432	14

Source: Frontier based on IEA, World Energy Outlook 2016, New Policies scenario

Note: Reference case

# Key regulatory challenge: Fragmentation of responsibilities (and incentives) between OEMs and fuel providers







Frontier Economics Ltd is a member of the Frontier Economics network, which consists of two separate companies based in Europe (Frontier Economics Ltd) and Australia (Frontier Economics Pty Ltd). Both companies are independently owned, and legal commitments entered into by one company do not impose any obligations on the other company in the network. All views expressed in this document are the views of Frontier Economics Ltd.