

# The mathematics of climate protection and the importance of hydrogen for future mobility

**Prof. Dr.-Ing. Thomas Willner**

Verfahrenstechnik / Chemical Engineering

HAW Hamburg / Hamburg University of Applied Sciences

Mail: [thomas.willner@haw-hamburg.de](mailto:thomas.willner@haw-hamburg.de)

Twitter: @thomas\_willner

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**ENERGY 4 Mobility ExpertTalk: Hydrogen – Game Changer for Future Mobility**



Climate change is a phenomenon of natural physics.

Francis Bacon: "Nature, to be commanded, must be obeyed".

Those who want to control climate change must consider **physical laws**.

**Physical laws are not politically negotiable!**

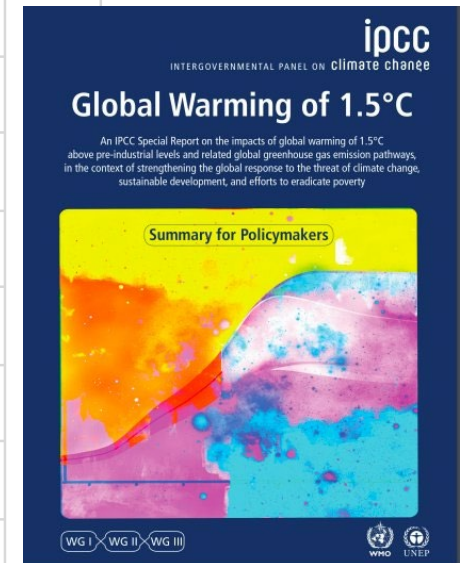
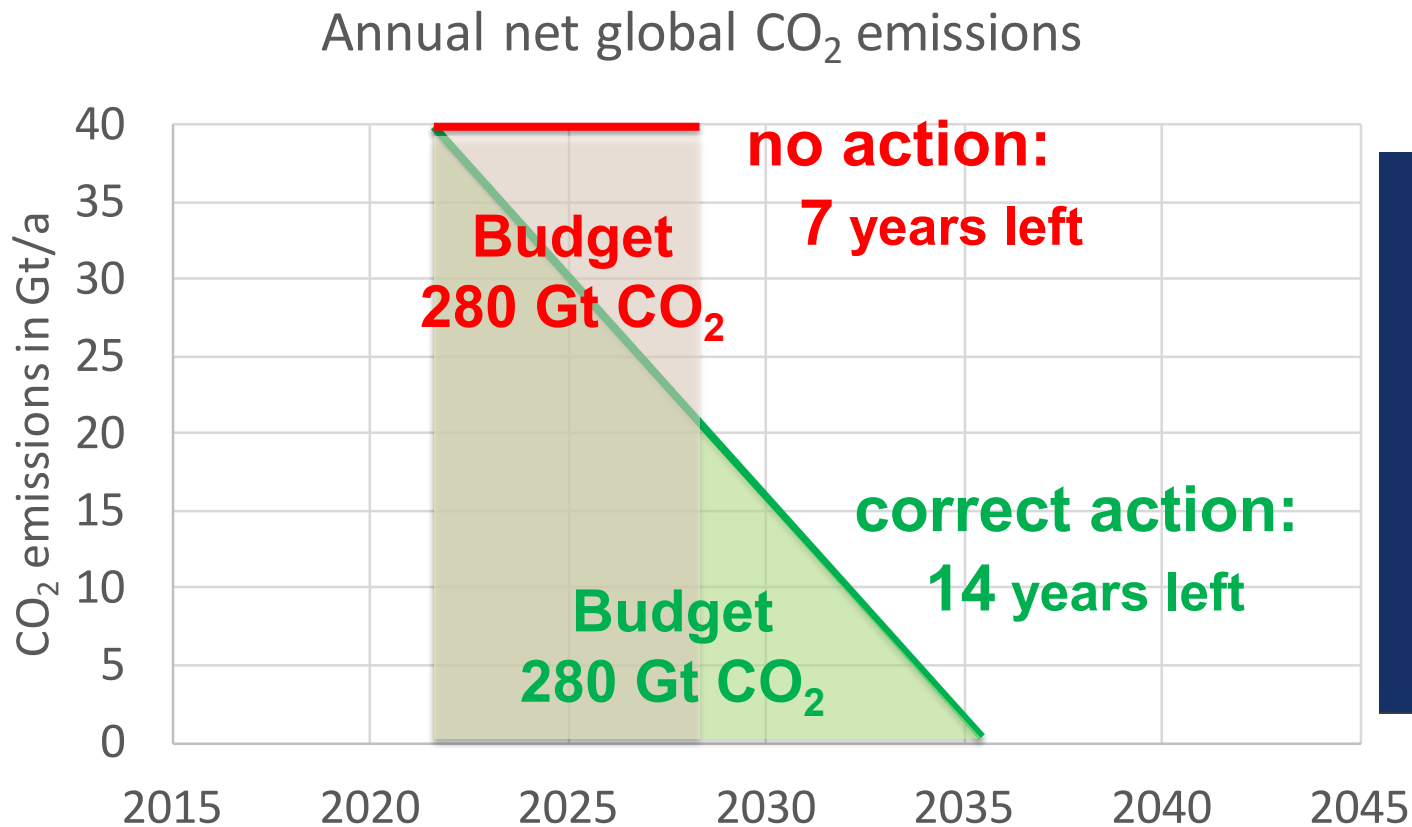
The mathematics of climate protection, derived from its physics, is presented on the next slide.

# Mathematics of climate protection

Global CO<sub>2</sub> emission budget (1.5-degree target) from July 2021: **280 Gt CO<sub>2</sub>**

Current global level of CO<sub>2</sub> emissions:

**40 Gt CO<sub>2</sub> per year**



Source: IPCC (2018) Special Report on Global Warming of 1.5° C, October 2018

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# Derived criteria for climate protection measures

## 3 criteria that climate protection measures must generally fulfil

### No delay

- Immediate effect of GHG reduction measures when implemented. (see “correct-action” scenario)

### No GHG export

- Entire value chain: No upstream or downstream GHG emissions in other countries or sectors.

### Fast roll-out (of successful technologies)

- Climate protection is a global task (Germany only accounts for 2 % of global GHG emissions) and can only succeed in international cooperation.

GHG = Greenhouse gas

Source: Willner (2020)

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# Significance of the 3 criteria for road transport

## No delay

- **Alternative fuels: Immediate effect in the large existing vehicle fleet (1.4 billion cars).**
- **E-mobility: 5 to 15 years delay and no effect in the existing fleet (Exchange takes too long).**

## No GHG export

- **Alternative fuels: Great performance (Germany: 83% GHG reduction<sup>1</sup>).**
  - **E-mobility: Huge GHG export to other countries or sectors.**  
(e.g. for battery production and recycling, for new infrastructure, for power production)

## Fast roll-out (of successful technologies)

- **International cooperation is key for climate protection!**
- **Export of RE technology to countries with surplus of RE + production of green fuels (e-fuels).**
- **Import of e-fuels for Germany, Europe, USA... (high PED import: Germany 70 %<sup>2</sup>, EU28 58 %<sup>3</sup>).**

E-mobility = electric mobility; RE = renewable energy, e-fuels = fuels based on electric power, PED = primary energy demand

Sources: <sup>1</sup>BLE (2020), <sup>2</sup>BMWi (2020), <sup>3</sup>Eurostat (2021)

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# Conclusion

Scientific analysis (see below for relevant literature) clearly shows:

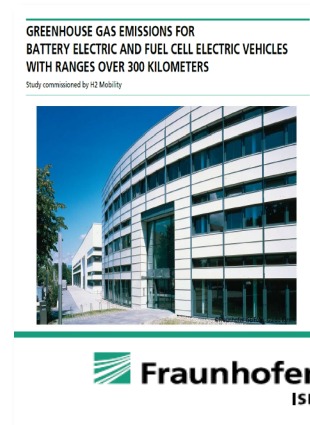
- **Sustainable alternative fuels fulfil all 3 criteria** for effective climate protection. Therefore, they must be promoted as a matter of priority.
- **Electric mobility does not fulfil any of the 3 criteria** for effective climate protection and is therefore ruled out as a medium-term climate protection measure.
- **The exaggerated one-sided promotion of electric mobility at national and European level must be corrected immediately.**



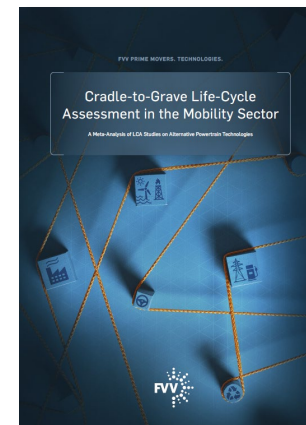
DECHEMA /  
ProcessNet 2018



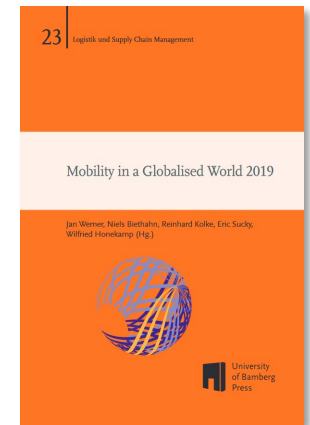
Joanneum  
Research 2019



Fraunhofer ISE  
2019



Frontier  
Economics 2020



Willner 2020

## Electric mobility: **Note: Mistake in official calculations!**

- Electric cars are energy **consumers**, not energy suppliers.
- They bring almost **no new renewable energy** into the system. Instead, they **tie up renewable potentials** of the power sector in the transport sector.
- These potentials are then **missing elsewhere**, e.g. in industry.

**We urgently need new renewable energy in the system  
in the form of alternative fuels.**

Alternative fuels (**liquids and gases**) are manifold including green hydrogen **H<sub>2</sub>**, green methane **CH<sub>4</sub>** etc.

**We need not only biodiversity, but also technology diversity**

1. 1G biofuels as a by-product of animal feed production (biodiesel and bioethanol)
2. 2G biofuels from waste and residues from agriculture, forestry, wood processing, the food industry, etc.
3. Fuels from household waste, industry waste, plastic waste, etc.
4. Renewable electricity-based fuels (PtX fuels, e-fuels) **H<sub>2</sub>**  
from countries with a surplus of RE
5. Combinations (hybrids) (e.g. biomass or waste based PtX fuels) **H<sub>2</sub>**

1G = 1<sup>st</sup> generation, 2G = 2<sup>nd</sup> generation, RE = renewable energy, PtX = Power to X

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# Hydrogen H<sub>2</sub>

## Green H<sub>2</sub> (including biogenic H<sub>2</sub>!!!)

is a key molecule for future mobility

- Direct use in fuel cell cars
- PtX fuels, e-fuels:  $\text{H}_2 + \text{CO}_2 \rightarrow \text{CH}_2$  or  $\text{CH}_3\text{OH}$  or  $\text{NH}_3$  or ... +  $\text{H}_2\text{O}$   
from countries with a surplus of RE
- PtX hybrids:  $\text{H}_2 + \text{waste} \rightarrow \text{CH}_2$  or  $\text{CH}_3\text{OH}$  or ... +  $\text{H}_2\text{O}$  + ...  
from any countries

PtX = Power to X

$\text{CH}_2$  = liquid hydrocarbon fuel (e.g. from Fischer-Tropsch or Hydrotreating)

$\text{CH}_3\text{OH}$  = methanol,  $\text{NH}_3$  = ammonia,  $\text{CO}_2$  = carbon dioxide,  $\text{H}_2\text{O}$  = water,  $\text{H}_2$  = hydrogen

- **RED II Article 27 (2c) should be revised:** “The share of renewable electricity shall be considered according to its energy content ...” instead of the existing wording “The share of renewable electricity shall be considered **to be four times its energy content...**”
- **Fleet regulation system for CO<sub>2</sub> emissions:** **Battery electric vehicles count with zero emission, but renewable fuels do not count at all.** These regulation needs urgent correction considering at least well-to-wheel (WtW) emissions.
- **Energy taxation regulation:** **Renewable fuels are taxed like fossil fuels.** These regulation needs urgent correction to relieve renewable fuels.

# Open letters in 2021 to the EU Commission

**27/05/2021: 223 companies, organisations and scientists (thereof 135 scientists)**

**Open letter from the e-fuel community on the fleet regulation system for CO<sub>2</sub> emissions:**

**Letter:** [https://www.efuel-alliance.eu/fileadmin/Downloads/2021-05-](https://www.efuel-alliance.eu/fileadmin/Downloads/2021-05-26_Joint_Letter_Call_to_include_a_voluntary_crediting_system_for_sustainable_renewable_fuels_into_the_vehicle_CO2_regulations.pdf)

[26\\_Joint\\_Letter\\_Call\\_to\\_include\\_a\\_voluntary\\_crediting\\_system\\_for\\_sustainable\\_renewable\\_fuels\\_into\\_the\\_vehicle\\_CO2\\_regulations.pdf](https://www.efuel-alliance.eu/fileadmin/Downloads/2021-05-26_Joint_Letter_Call_to_include_a_voluntary_crediting_system_for_sustainable_renewable_fuels_into_the_vehicle_CO2_regulations.pdf)

**Press release:** [https://www.efuel-alliance.eu/fileadmin/Downloads/PM\\_Anrechnungssysteme\\_2705.pdf](https://www.efuel-alliance.eu/fileadmin/Downloads/PM_Anrechnungssysteme_2705.pdf)

**17/06/2021: 170 scientists**

**Open letter on REDII/III, taxation regulation and fleet regulation system for CO<sub>2</sub> emissions:**

**Letter:** <https://www.dropbox.com/s/tbdd5d5ovutddm2>

**Press release:** <https://www.dropbox.com/s/35fksvzylco3bzbv>

**20/06/2021: WKM/IASTEC: 171 scientists**

**Open letter on calculation error in the climate impact of electric cars:**

**Letter:** <https://iastec.org/wp-content/uploads/2021/06/20210615-IASTEC-Letter.pdf>

# Thank you



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