

10 Jahre synthetisches Methan

~~20 Jahre synthetisches Methan~~

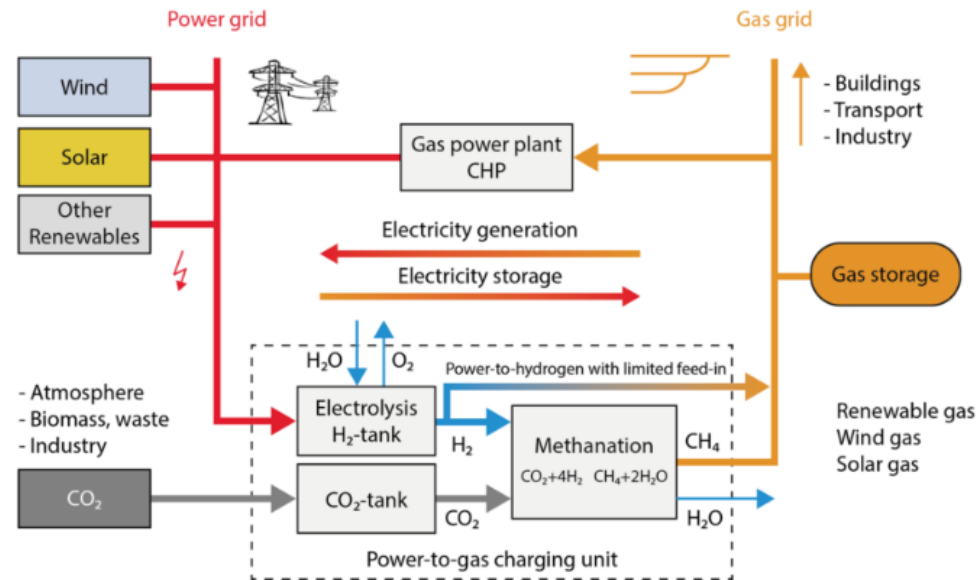
14 years of synthetic methane (eRNG)

Agenda

- 1 History 2010-2024 for renewable synthetic methane (eRNG)**
- 2 What do we need eRNG for?**
- 3 Economics and legislative boundary conditions**
- 4 Summary**

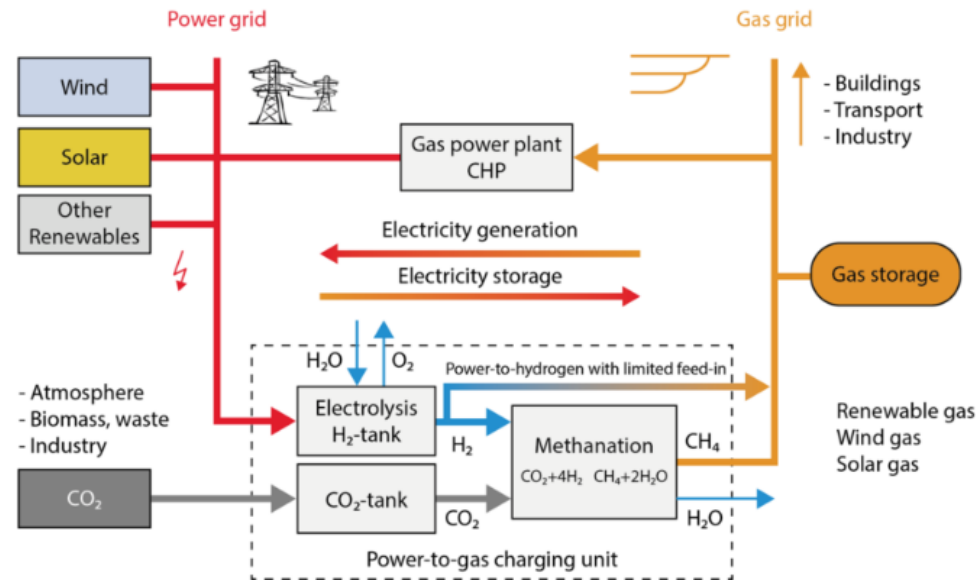
Once upon a time there was an idea...

- Dr. Michael Specht, Researcher at ZSW Stuttgart
- Dr. Michael Sterner, IWES Kassel, Dissertation 2009

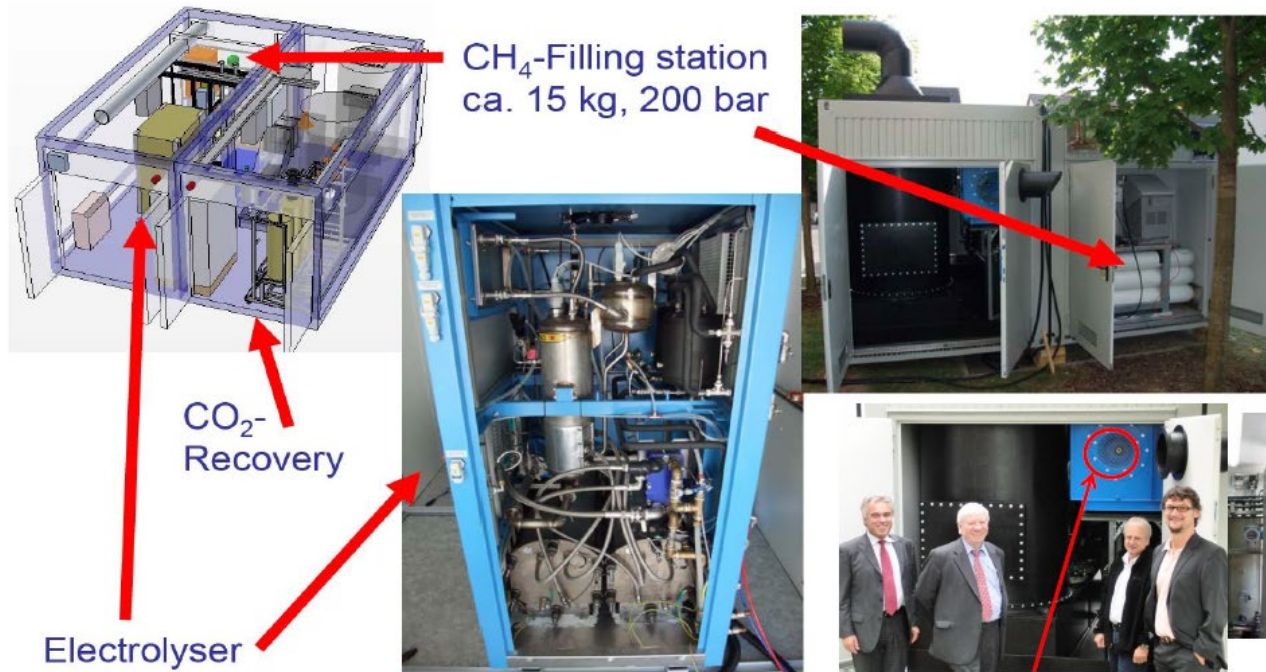


...store electricity in chemical form in the gas grid...

- **Dr. Michael Specht**,
Researcher at ZSW Stuttgart
- **Dr. Michael Sterner**,
IWES Kassel, Dissertation
2009



...the idea was financed and a prototype built...



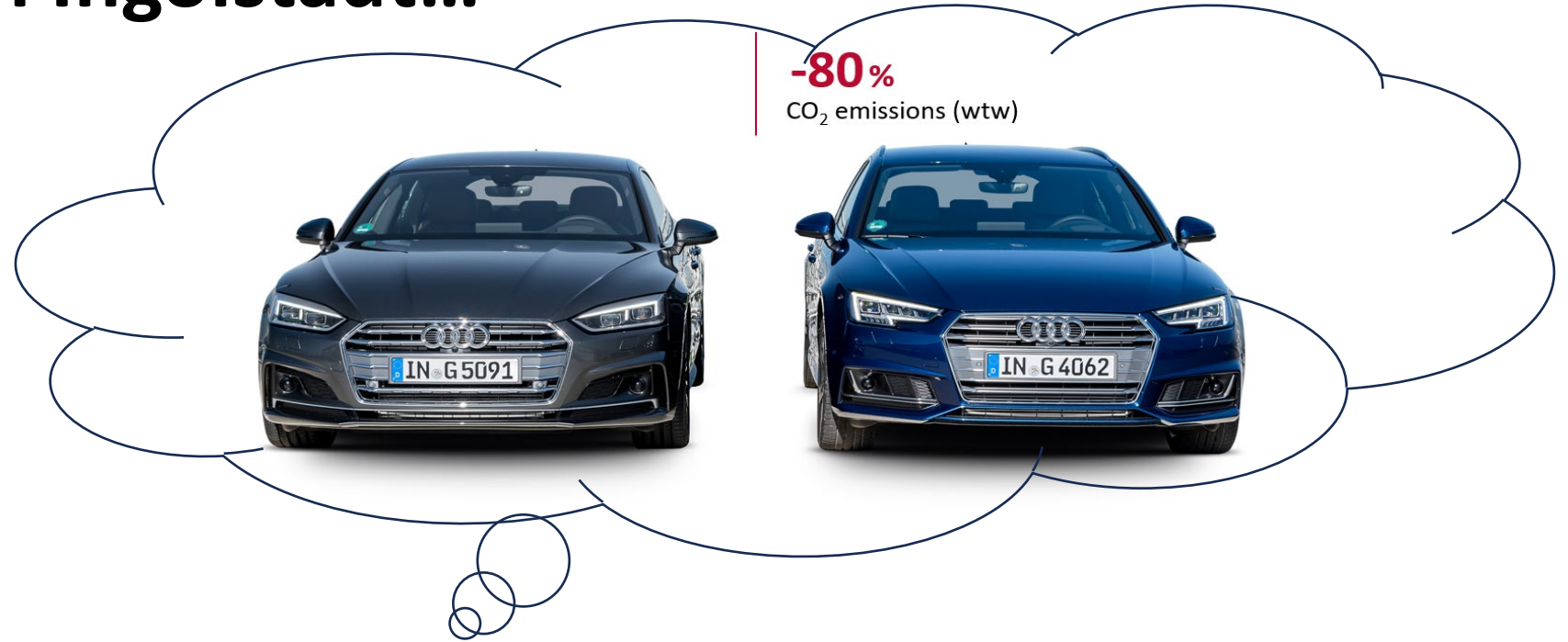
Quelle: Specht et al., 2009

CO₂Absorption = 1,5 hectares corn / a



- 2010 – Solarfuel GmbH
- Founder: Gregor Waldstein
- Prototype
- Built by ZSW / MAN Solarfuel
- **25 kW** electrolyzer
- 4 MWh/a
- ~ 0,3 households

Meanwhile, in Ingolstadt...



Reinhard Otten
Reiner Mangold

https://www.audi-technology-portal.de/en/mobility-for-the-future/audi-future-lab-mobility_en/audi-future-energies_en/audi-e-gas_en



“We need a 6 MW PtG plant”

Reinhard Otten
Reiner Mangold

**“A scaleup from 25kW to 6000 kW?
Too much risk.”**

“We will do it anyway.”



Die e-gas-Anlage von innen



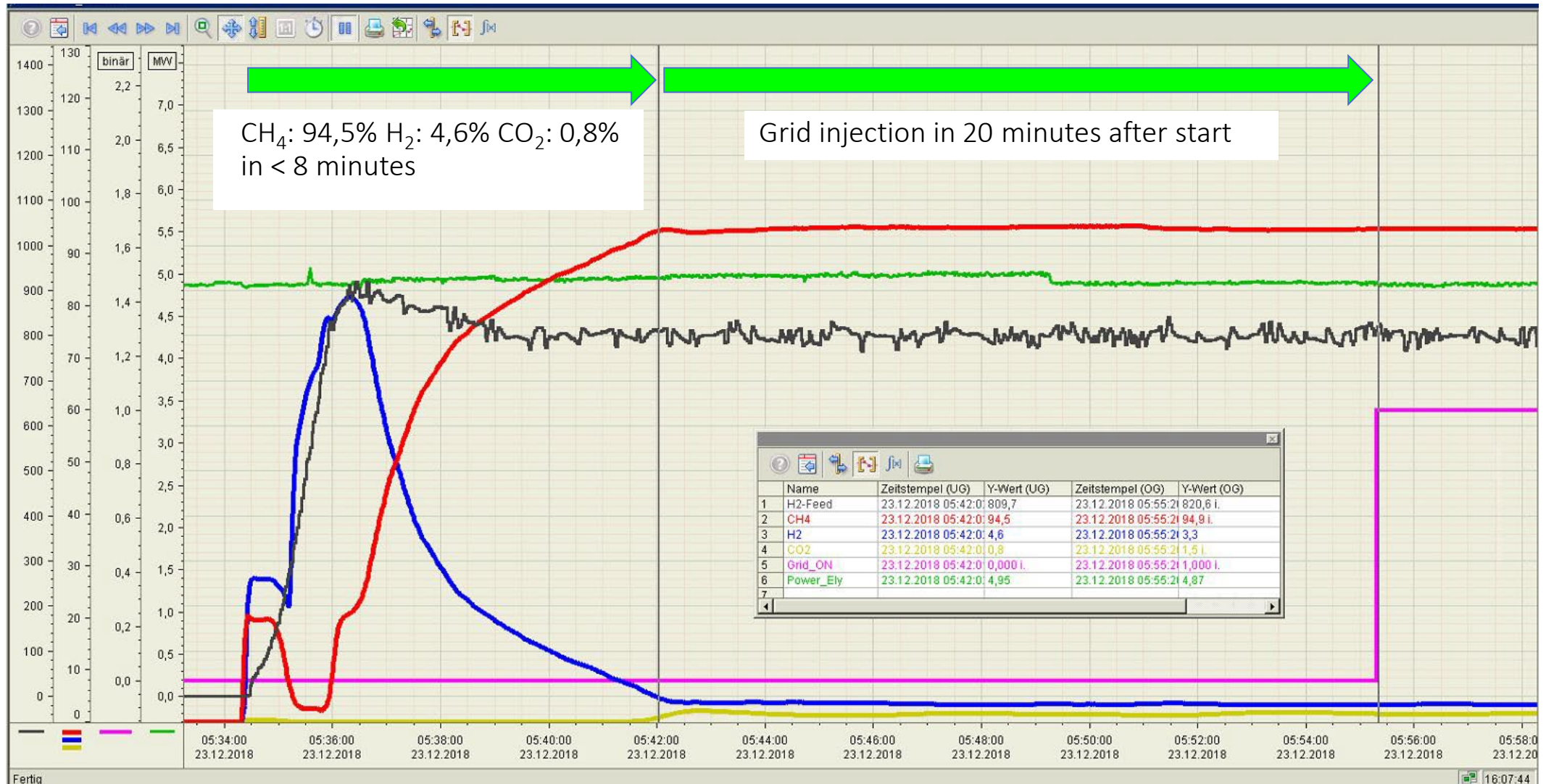
Elektrolyseure (3 x 2 MW)



Methanisierungseinheit



Catalytic methanation is very dynamic



A4 Avant g-tron and A5 Sportback g-tron

-80%

CO₂ emissions (wtw)



The kiwi era

kiwi e-RNG power-to-future plant Werlte

the world's largest green Power-to-Methane plant



- The Werlte plant is the biggest Industrial plant to convert green Hydrogen from electrolysis together with green CO2 into **Renewable Natural Gas (e RNG)**.
- Research capabilities include more than 1,000 sensors in the plant, allowing a continuous monitoring and evaluation of the 10 years operation



Three electrolysis



Amin scrubber



Methanation tower



Liquefier and e-LNG filling station



Hydrogen filling station



Grid injection plant

09.04.2024

kiwi AG The power-to-future company

3

Green H2 for gasoline production



09.04.2024

kiwi AG

54

16.04.2024

20

Customer journey (2021): World's first production of eLNG for a container ship (Customer: MAN)



09.04.2024

WirtschaftsWoche

In Brunsbüttel wurde jetzt das weltweit erste Schiff mit synthetischem Erdgas betankt, das aus erneuerbaren Energien hergestellt wurde. Politiker glauben, dass der grüne Kraftstoff Öl und Kohle ersetzen könnte.



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Energy & Storage

MAN Energy Solutions | Company | MAN Energy Solutions | Press Releases | Press details

Thursday, September 30, 2021

World's first bunkering of containership with renewable synthetic natural gas advances sustainable shipping

"This is an important lighthouse project, essentially a proof of concept for the maritime energy

kiwi AG

55

HY2GEN GERMANY ACQUIRES PLANT AND PROJECT PIPELINE OF KIWI AG.



HY2GEN GERMANY ACQUIRES PLANT AND PROJECT PIPELINE OF KIWI AG IN WERLTE AND STRENGTHENS EXPERTISE IN THE PRODUCTION OF RENEWABLE HYDROGEN AND ITS DERIVATIVES.

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Long-term energy storage necessary

Electricity was (and still is) largely generated by fossil fuels, mainly coal and natural gas. When switching largely to Solar and Wind, electricity supply and demand no longer match as before. You will encounter the following phenomena:

- Surplus electricity is generated when sun and wind are out at the same time = **too much energy per hour** to cover the demand per hour
- Deficit of electricity happens when sun and wind are down at the same time = **too little energy per hour** to cover the demand per hour
- Seasonal divergence of demand and production means too much electricity in summer on sunny days and too little in winter; this holds for regions well north of the equator – e.g. in **the European Union**.

These points will get worse in an exponential manner with increasing shares of wind & PV in the electricity system.

Substitution of fossil oil and gas

There are some applications that cannot be defossilized without e-fuels:

- Transport: ships and planes
- Many industrial processes, especially if a hydrocarbon is needed as a raw material for a product (e.g. petrochemical products)
- Power production when „sun and wind are down“ at the same time

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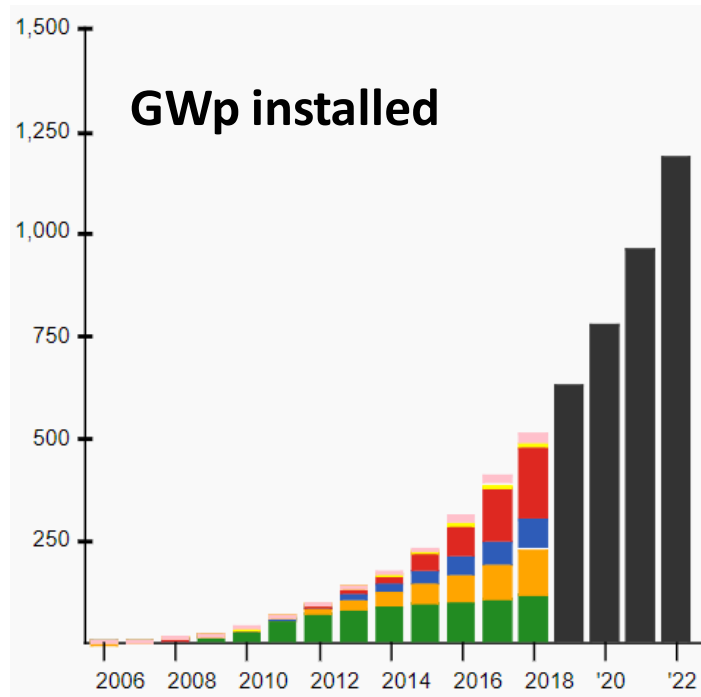
Power-to-methane:

A long story without backing of legislation

How it worked for Solar PV

Experience curve: Installed solar PV capacity has increased by a factor of 10.000

And market price?



PV 1996: ~ 0,1 GW

PV 2006: ~ 3 GW

PV 2021: ~ 1000 GW

--> Factor 10.000

from 1996 to 2021

Sources: IEA 2016; science.org

Market price dropped by -95%

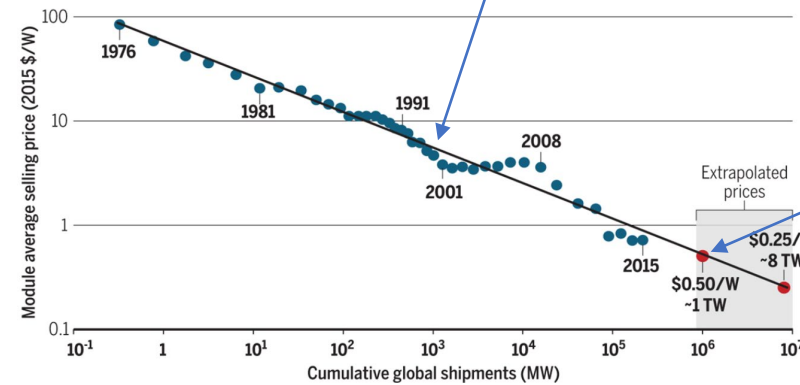
from 1996 to 2020

Why? EEG Germany gave investment security

1996: PV is where electrolysis is today

PV module experience curve

Historically, module prices have decreased as a function of cumulative global shipments (blue dots reflect historical data, red dots reflect extrapolated prices for 1 TW and 8 TW based on the historical trend line). See supplementary materials for data sources.

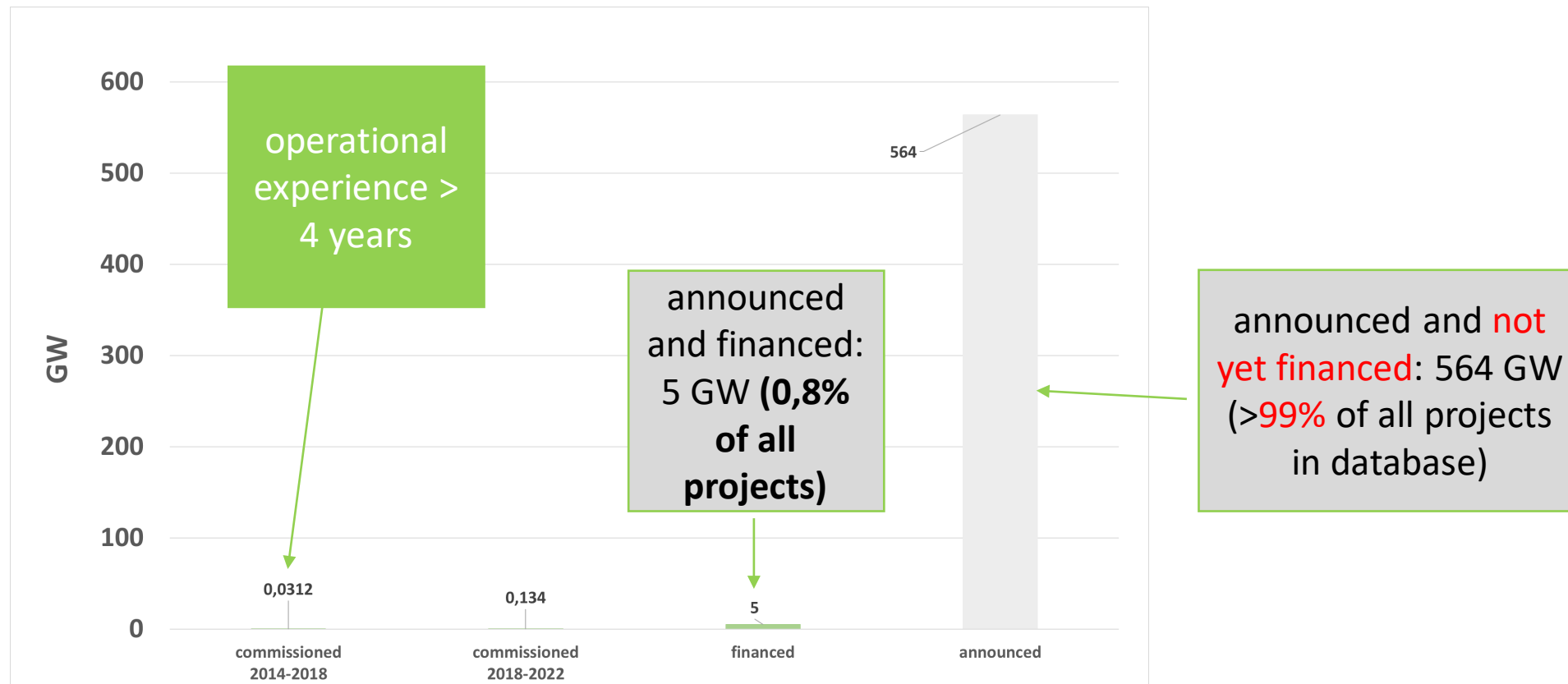


today's market price

Sources: IEA 2016; science.org

Of all announced PtX projects, less than 1% are financed

PtX project status according to IEA's H2 projects database including "H2 only" projects



Sources: IEA (2022)

Summary

- The production process of eRNG is one of the most efficient PtX processes
- Capex is < 10% of total Capex of a PtG plant
- eRNG is pure methane and can be transported in the existing infrastructure
- The process needs CO₂ for production
- eRNG growth has been very limited due to lacking legislative boundary conditions
- eRNG costs can hit fossil benchmark within a decade due to experience curve and increasing seasonal wind / PV overcapacity
- eRNG (or pure H₂, given H₂ infrastructure) is necessary for times of renewable electricity scarcity (“no wind, no sun”) when share approaches 100% RE
- eRNG can be used today to decarbonize trucks, ships, and all processes that use natural gas today (Germany 2022: 1400 TWh!)