Reviewing energy transition studies in the light of the recent European gas market developments

by **Daniel Brunsch**, Julian Radek, Lars Ostmeier, Christoph Weber

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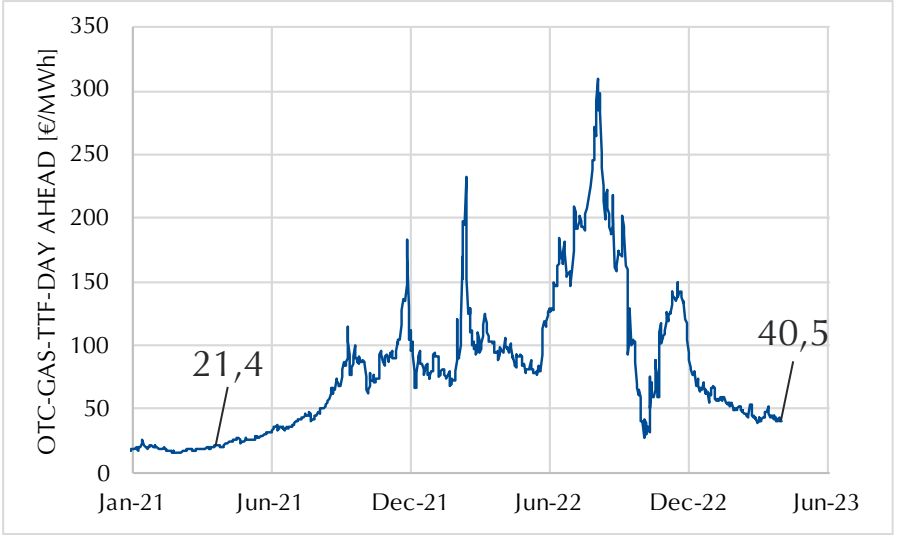
Introduction

- Since Mid-2021, especially after the Russian invasion of Ukraine, natural gas prices on European markets significantly increased
  - Europe turned to other natural gas suppliers (mainly LNG)
  - Prices have declined but still around two times higher than pre-crisis
  - Increased use of coal and oil
- At the same time: Political goal in Germany full decarbonization until 2045

➢ Several studies with transformation pathways for achieving this goal



Source: energate gmbh

➢ Are the projected transition paths still valid given the recent developments?

Study selection - Criteria

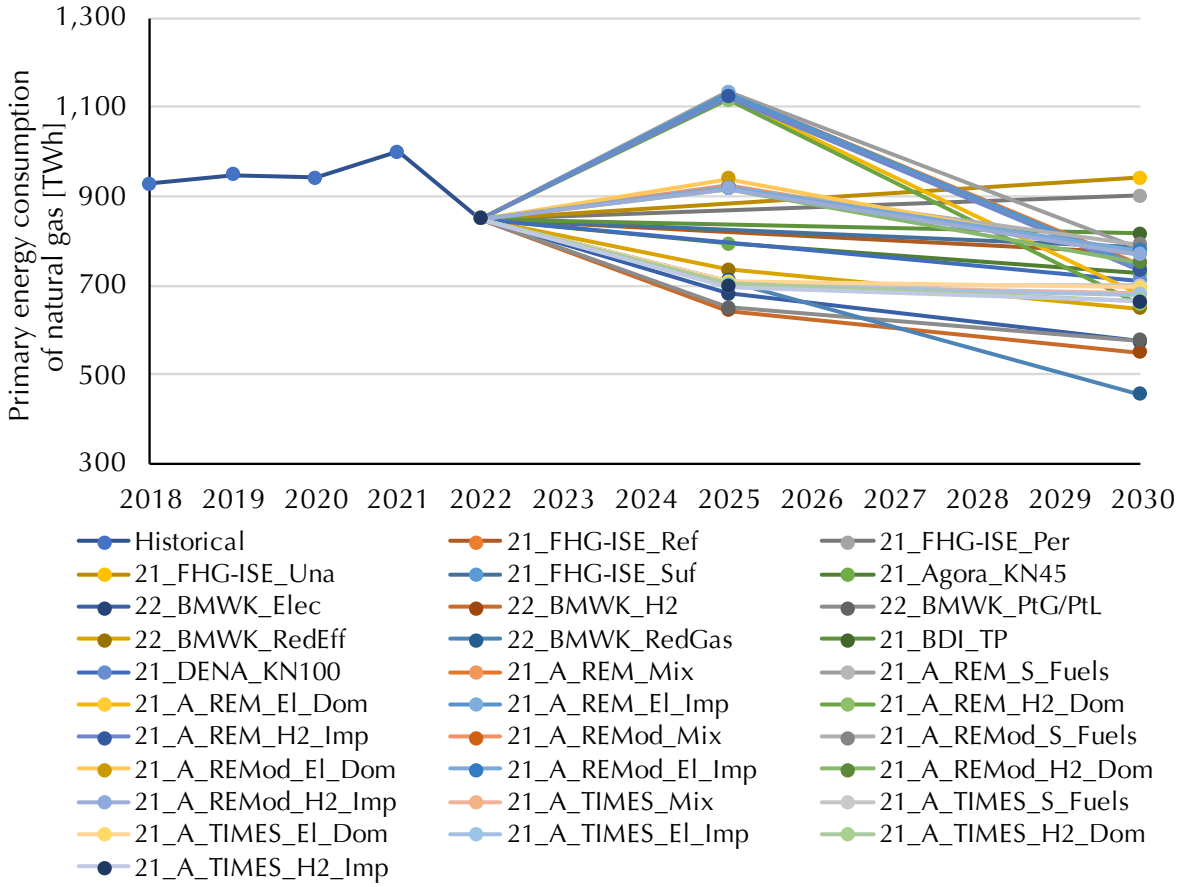
- Selection criteria
  - System studies analyzing Germany
  - Climate neutrality goal in 2045

- Selected studies
  - 2021 - Fraunhofer – 4 scenarios
  - 2021 - Agora – 1 scenario
  - 2022 - BMWK – 5 scenarios
  - 2021 - BDI – 1 scenrio
  - 2021 - Dena – 1 scenario
  - 2021 - Ariadne – 6 scenarios (calculated with 3 different models)

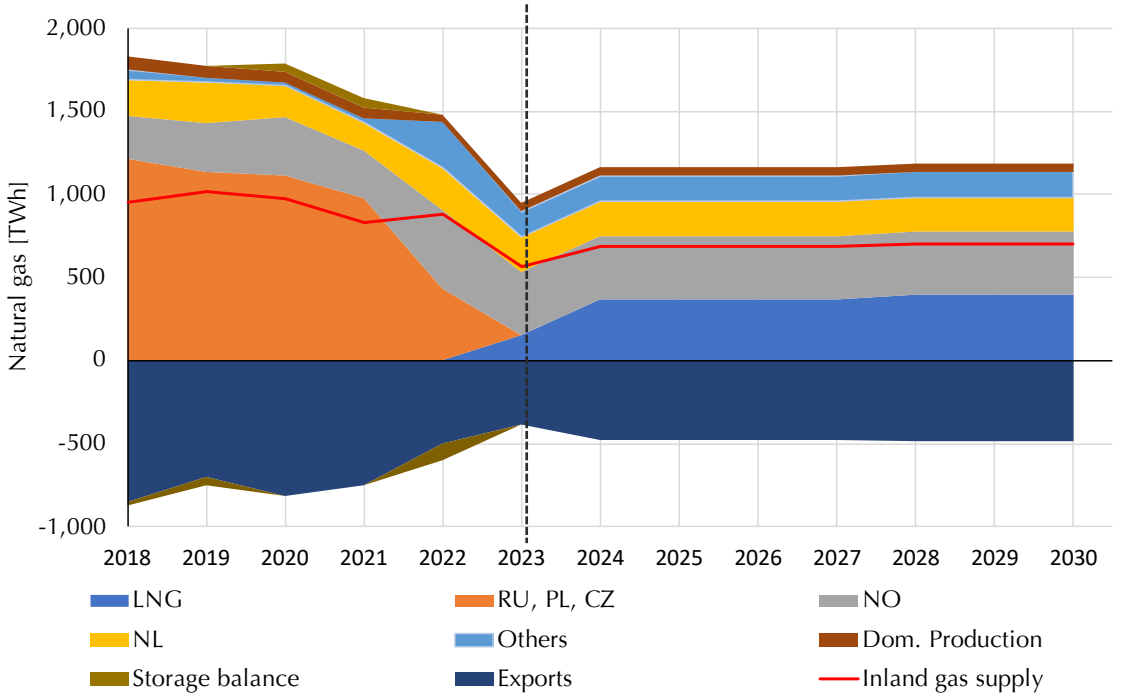
Study selection - Overview

Initiator/ project	Authors and publication year	Study	Selected scenarios	Abbreviation
–	**Fraunhofer ISE (2021)**	Wege zu einem klimaneutralen Energiesystem	Reference	21_FHG-ISE_Ref
			Persistence	21_FHG-ISE_Per
			Unacceptance	21_FHG-ISE_Una
			Sufficiency	21_FHG-ISE_Suf
Agora, Stiftung Klima-neutralität	**Prognos, Öko-Institut and Wuppertal-Institut (2021)**	Klimaneutrales Deutschland 2045	KN2045	21_Agora_KN45
BMWK	**Fraunhofer ISI et al. (2022)**	Langfristszenarien für die Transformation des Energiesystems in Deutschland	T45-Elec	22_BMWK_Elec
			T45-H2	22_BMWK_H2
			T45-PtG/PtL	22_BMWK_PtG/PtL
			T45-RedEff	22_BMWK_RedEff
			T45-RedGas	22_BMWK_RedGas
BDI	**Boston Consulting Group (2021)**	Klimapfade 2.0	Target Path	21_BDI_TP
dena	**EWI (2021)**	dena-Leitstudie Aufbruch Klimaneutralität	KN100	21_DENA_KN100
Kopernikus-Projekt Ariadne	**Luderer, Kost and Sörgel (2021)**	Deutschland auf dem Weg zur Klimaneutralität 2045	Mix	21_A_REM_Mix
			Syn_Fuels	21_A_REM_S_Fuels
			Elec_Dom	21_A_REM_El_Dom
			Elec_Imp	21_A_REM_El_Imp
			H2_Dom	21_A_REM_H2_Dom
			H2_Imp	21_A_REM_H2_Imp
			Mix	21_A_REMod_Mix
			Syn_Fuels	21_A_REMod_S_Fuels
			Elec_Dom	21_A_REMod_El_Dom
			Elec_Imp	21_A_REMod_El_Imp
			H2_Dom	21_A_REMod_H2_Dom
			H2_Imp	21_A_REMod_H2_Imp
			Mix	21_A_TIMES_Mix
			Syn_Fuels	21_A_TIMES_S_Fuels
			Elec_Dom	21_A_TIMES_El_Dom
			Elec_Imp	21_A_TIMES_El_Imp
			H2_Dom	21_A_TIMES_H2_Dom
			H2_Imp	21_A_TIMES_H2_Imp

Primary energy consumption of natural gas and overview of historical and projected natural gas supply in TWh



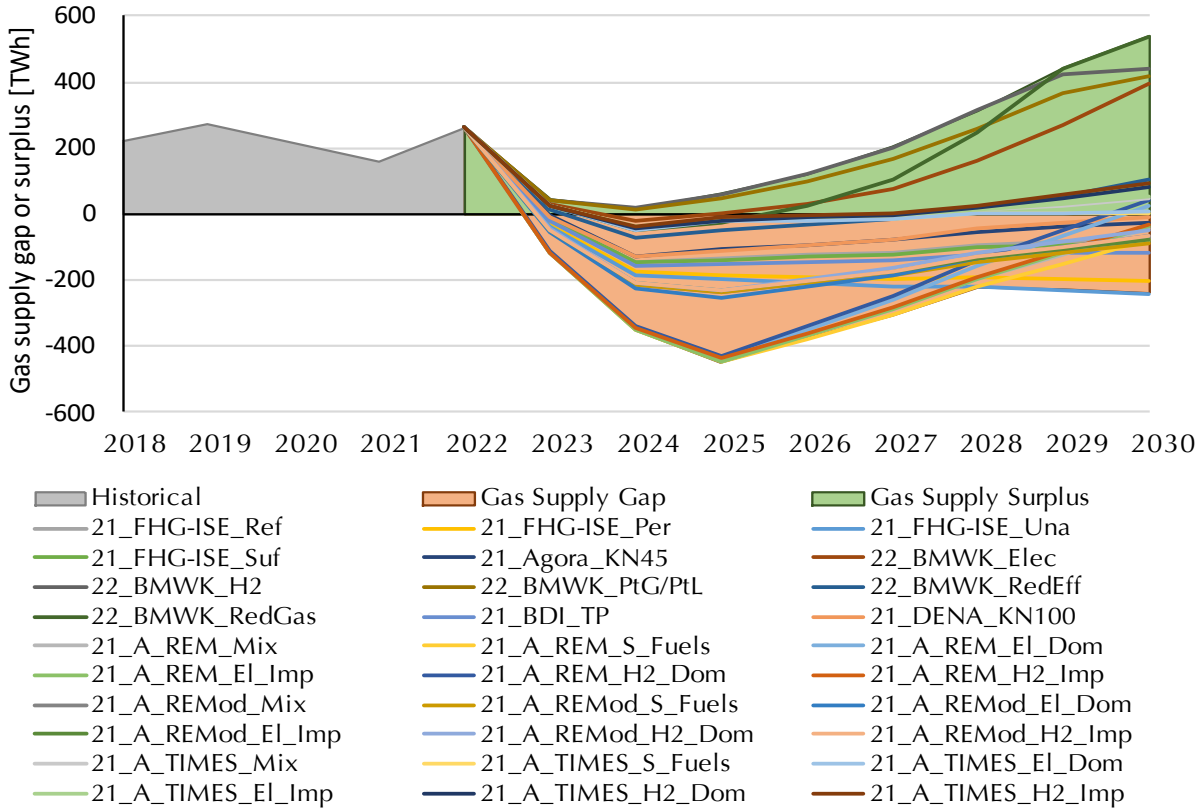
Source: Bundesnetzagentur (historical data)



Sources: Bundesnetzagentur (historical data), EWI (LNG capacities)

Gas supply gap

- Gas supply situation
  - \+ Storage filling level (0 ≤ level < max. Volume)
  - \+ Calculated inland gas supply
  - – Primary energy consumption of natural gas from the scenarios
  - = **Gas supply surplus (+) / gap (-)**
  - Gas supply gap is not carried over into the following year
- ➢ In 28 out of 30 scenarios, a gas supply gap occurs at least once
- ➢ Options to avoid a supply gap
  1. Increase imports
  2. Reduction of gas demand
  3. Substitution with hydrogen

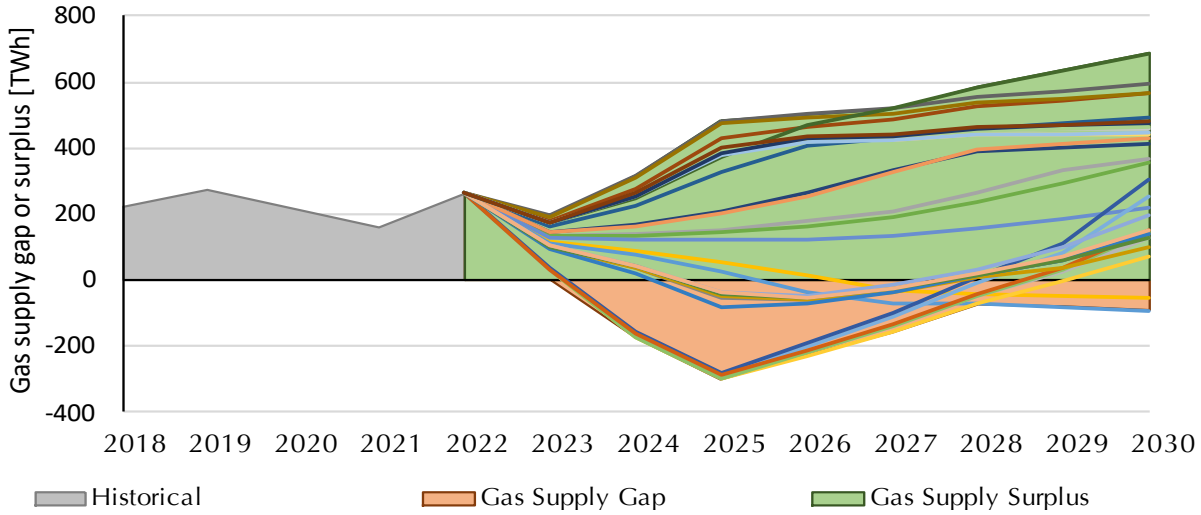


Increase of natural gas imports from other sources

- In 2022, pipeline deliveries from Norway, the Netherlands and other sources (especially Belgium) were significantly increased

- Assumption
  - pipeline-bound deliveries continue like in 2022

➢ Gas supply gaps occur in 14 out of 30 scenarios at least once

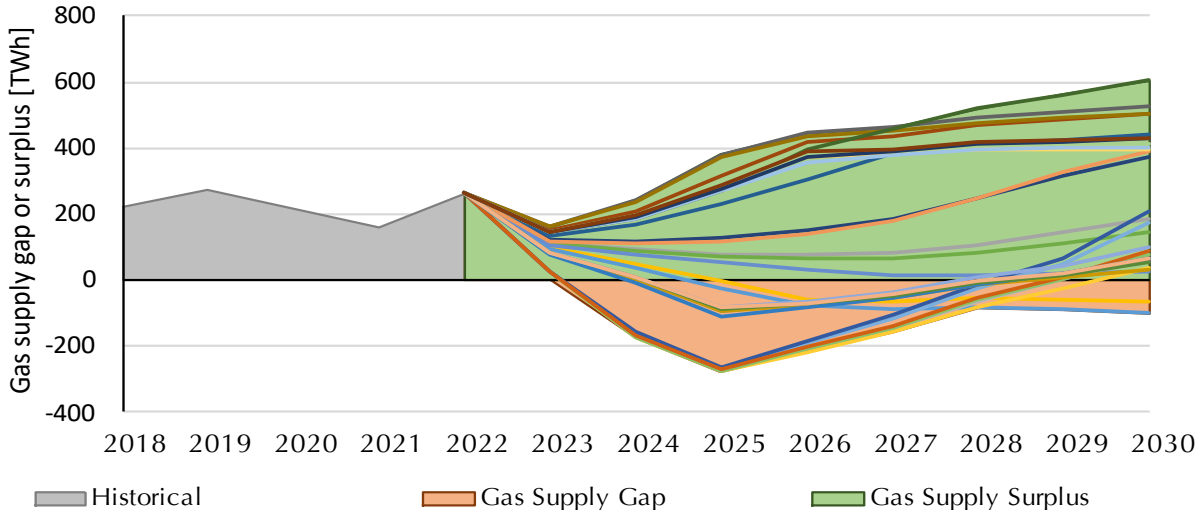


Further reduction of natural gas demand

- Gas savings were around 15 % in 2022

- Assumption
  - ➢ In every year gas saving reach also 15 % like in 2022

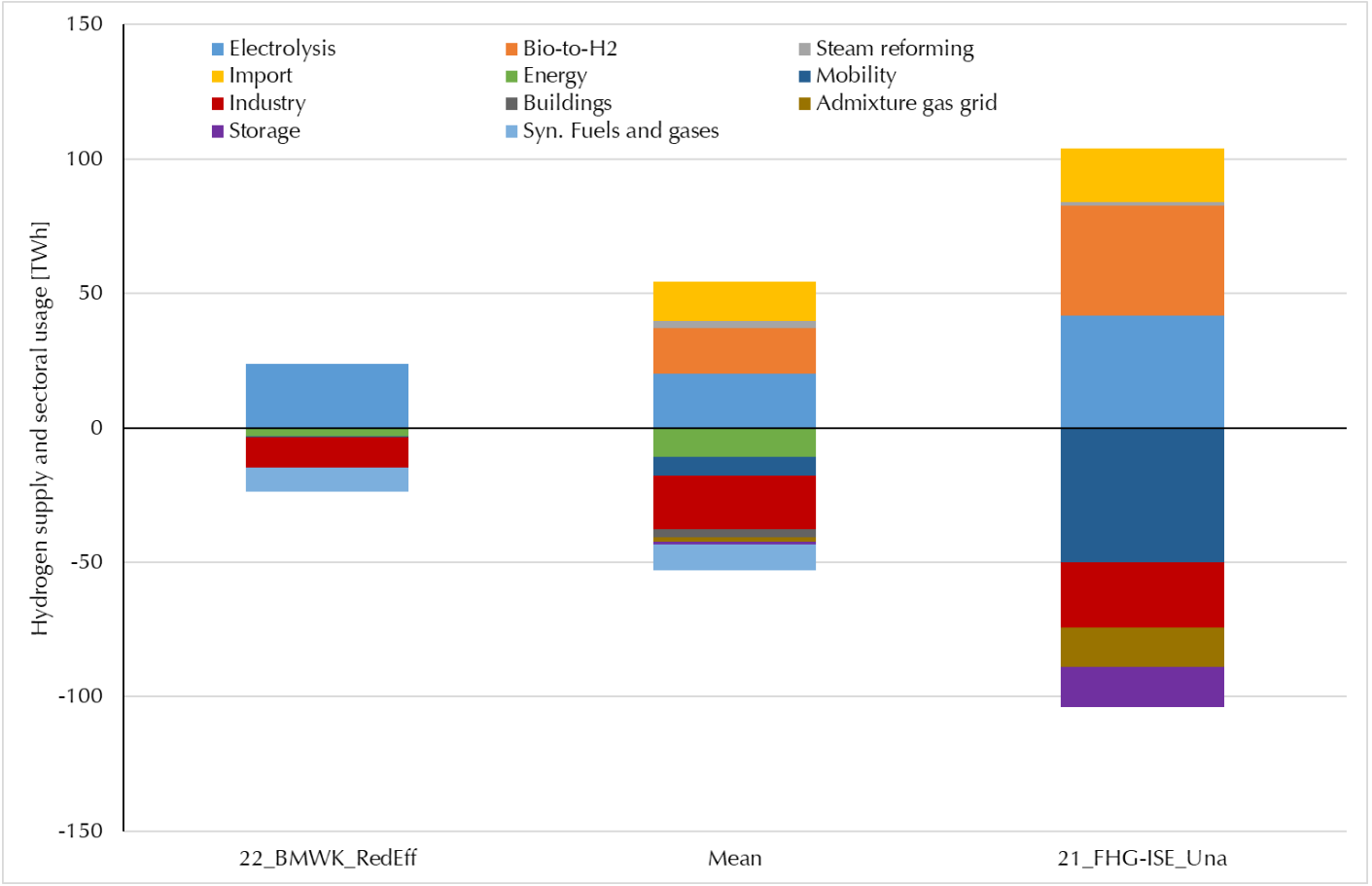
➢ Only in 16 of 30 scenarios, a gas supply gap occurs at least once



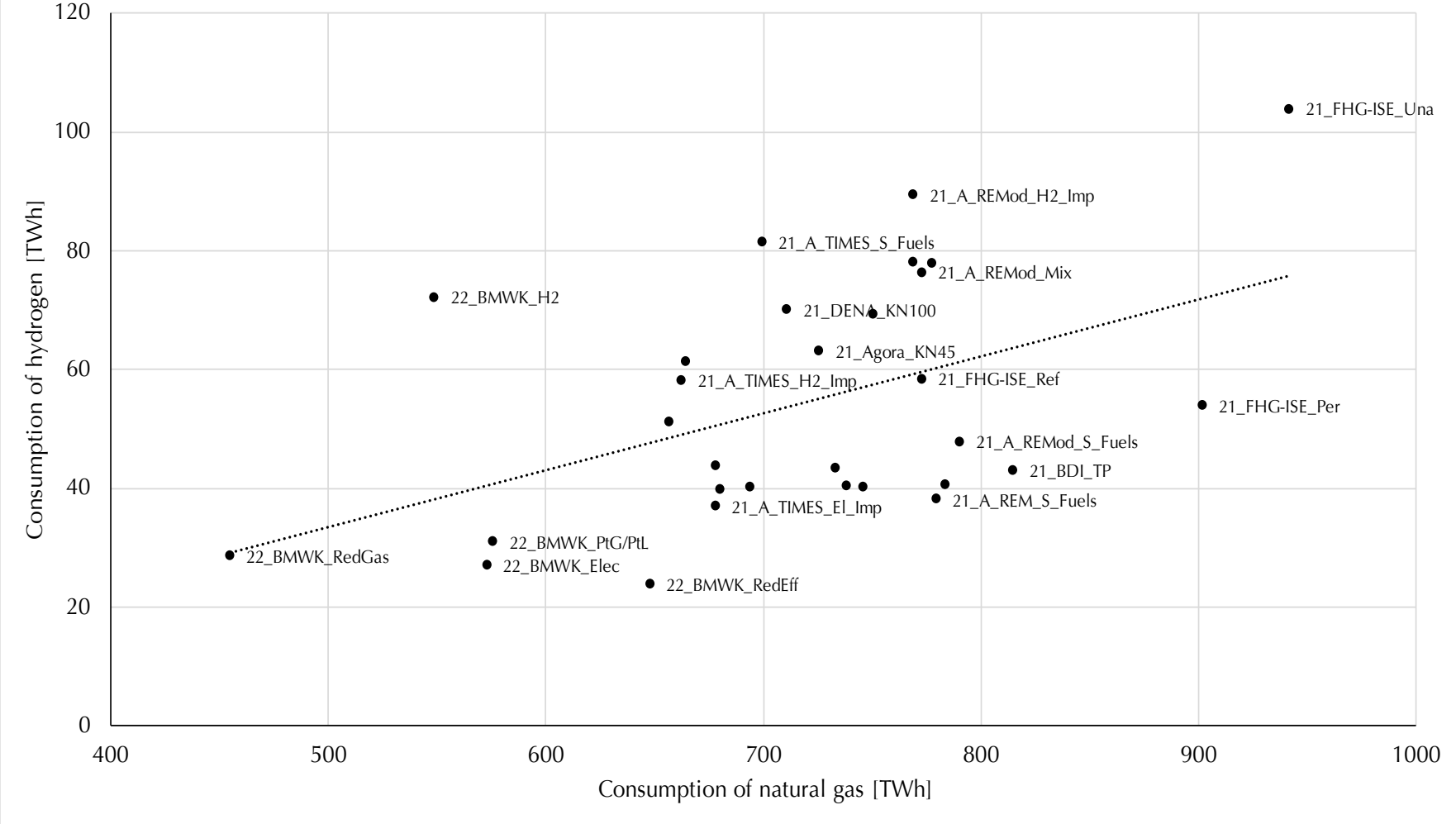
Substitution with hydrogen – Supply and usage in 2030

- Hydrogen supply and usage varies strongly between scenarios
  - Ca. 100 TWh
  - Mean around 54 TWh
- On average, heterogenous supply sources and sectoral usage

➢ Rather low compared to natural gas supply



Correlation of natural gas and hydrogen consumption



Main conclusions (I)

- Bottlenecks possible until 2030 without reduction of gas demand or continued savings
  - Smaller supply gaps in scenarios that focus rather on electrification than on use of gases (e. g. BMWK scenarios)
  - Substitutes necessary if gas demand is to be reduced (electricity or hydrogen)

- Substitution by electrification requires substantial investments in renewable energies
  - Electrification of the building and industry sectors should be accelerated
  - Climate goals impede increased usage of coal and oil for power production
  - Achievement of ambitious renewable goals should be the main target

- Conclude long-term contracts with supply countries
  - Goal is to achieve high import levels similar as in 2022 (e. g. from NO and NL)

Main conclusions (II)

- High usage of hydrogen is hardly related to a substitution of natural gas consumption
  - Natural gas consumption mainly substituted by electricity
  - In fact, rather positive correlation between consumption of natural gas and hydrogen

- Contribution of hydrogen to reduction of supply gap is only possible if…
  - It does not use the import capacities reserved for LNG
  - It does not rely on renewable power production that would be used for electrification of other sectors (e. g. industry or buildings)

➢ Comprehensive substitution of natural gas with hydrogen requires increased import capacities and/or additional renewable generation capacities.

Thank you for your attention!

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