HYDROGEN MODELLING CAPABILITIES AND REFERENCES OF REKK

V4 Energy Think Tank Platform

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Online workshop
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Agenda

- Hydrogen supply cost modelling
- Hydrogen infrastructure modelling
- Hydrogen demand estimation

Hydrogen supply cost modelling main inputs

Blue Hydrogen LCOH modelling

- Type of technology (SMR/ATR): variable and fixed OPEX, efficiency
- Capacity of the plant
- Investment costs that vary over time and capacity
- Cost of CO2 emission and storage
- Price of natural gas (vary over time)

Green Hydrogen LCOH modelling

- Electrolyzer's efficiency
- Capacity of the plant
- O&M costs of the plant
- Investment cost related to the plant that vary over time and capacity
- Cost of electricity: using hourly wholesale prices or contract based prices

General inputs

- Start year of the operation; start year of the construction
- Lifetime of the project
- WACC, Location factor for CAPEX
- Load factor (changable year-by-year)

Hydrogen supply cost modelling main outputs

- The models can be used to determine the LCOH values of different blue and green hydrogen projects
- Due to the wide range of input variables, significantly different projects can be compared
- Each LCOH value is suitable for comparing differences between countries due to country-specific inputs
- The values of the significant cost elements are also displayed separately in the model
- The model can also be used to generate simplified annual cash flow reports

LCOH values		
	Project A - ATR Plant 1000 MW (2025)	Project B - SMR Plant 300 MW (2040)
Natural gas cost	33,48	26,20
SMR/ATR Plant CAPEX	9,19	8,08
SMR/ATR Plant OPEX	4,36	3,83
Total ETS cost	0,48	9,25
Total CO2 storage cost	14,75	33,13
Total LCOH (EUR/MWh)	62,26	80,47

Example 1: LCOH values of different green Hydrogen projects

Hydrogen supply cost modelling main outputs

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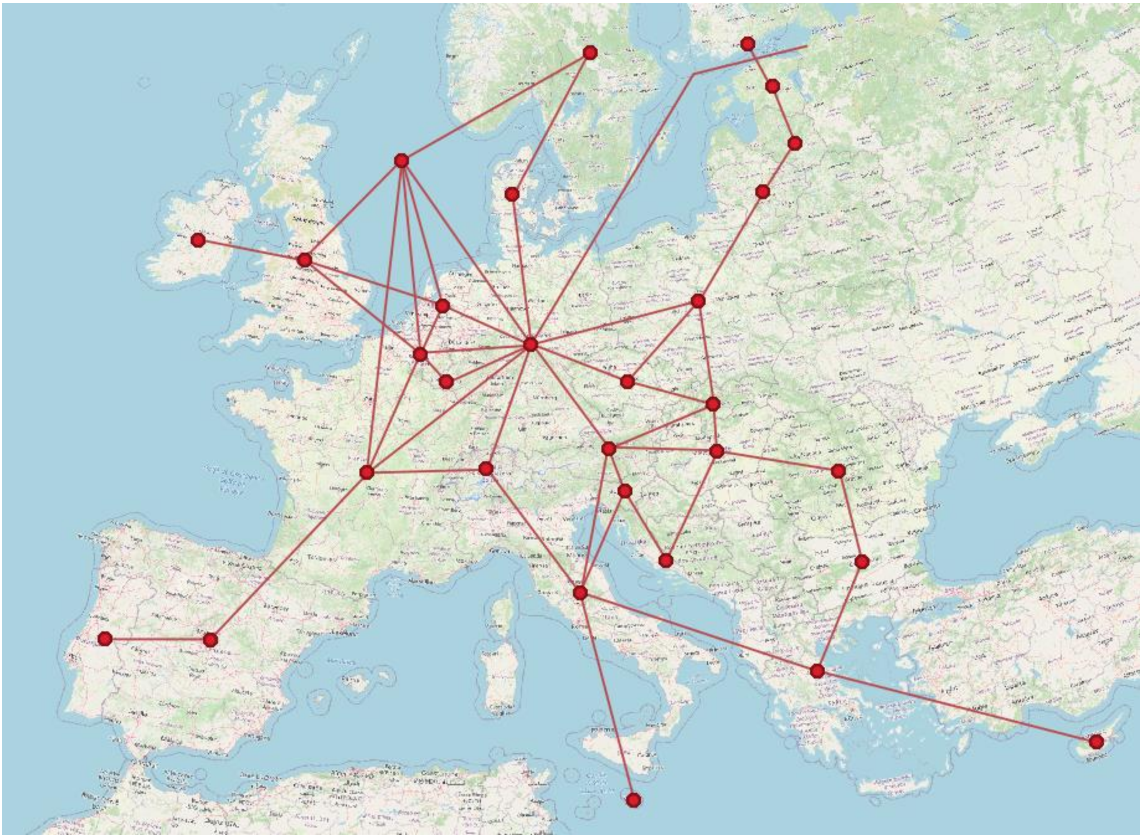
LCOH values		
	Project A - Electrolizer Plant 300 MW (2025)	Project B - Electrolizer Plant 500 MW (2040)
Power	85,57	56,62
Electroliser CAPEX	31,97	18,84
Electroliser OPEX	8,38	4,90
Total LCOH (EUR/MWh)	125,93	80,36

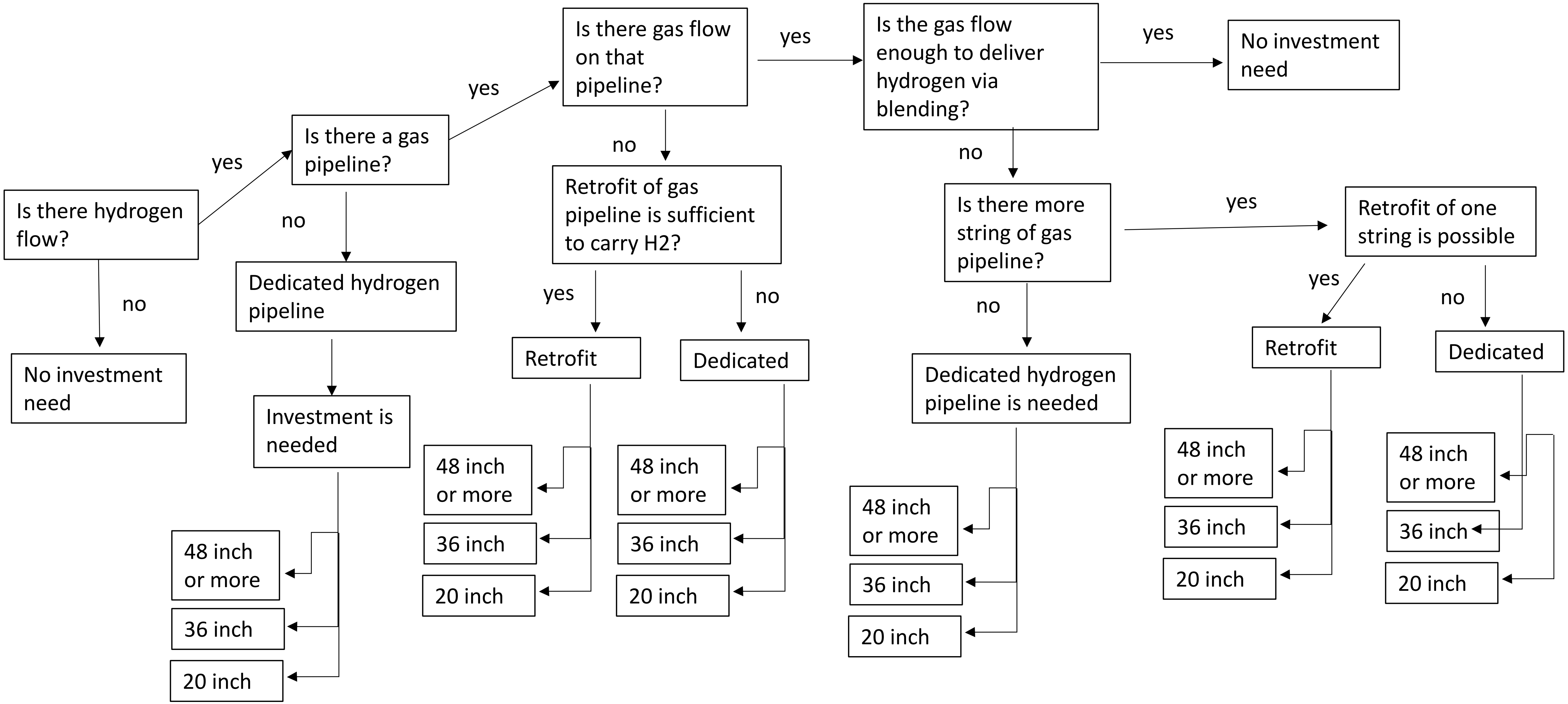
Example 2: LCOH values of different green Hydrogen projects

Hydrogen infrastructure modelling

- REKK EGMM and REKK Hydrogen Infrastructure model
- Based on gas model infrastructure
- Coverage: EU27+CH+NO+UK
- Nodes are central nodes, location: EU NUTS 0 2021 centroids
- Tariffs: distance-based, on nodes
- Adding new connections: to provide link from all markets to all markets
- Model capabilities:
    - feasibility of hydrogen transport between countries
    - Identification of gas transmission retrofit and dedicated hydrogen pipeline investment need
    - Level of blending

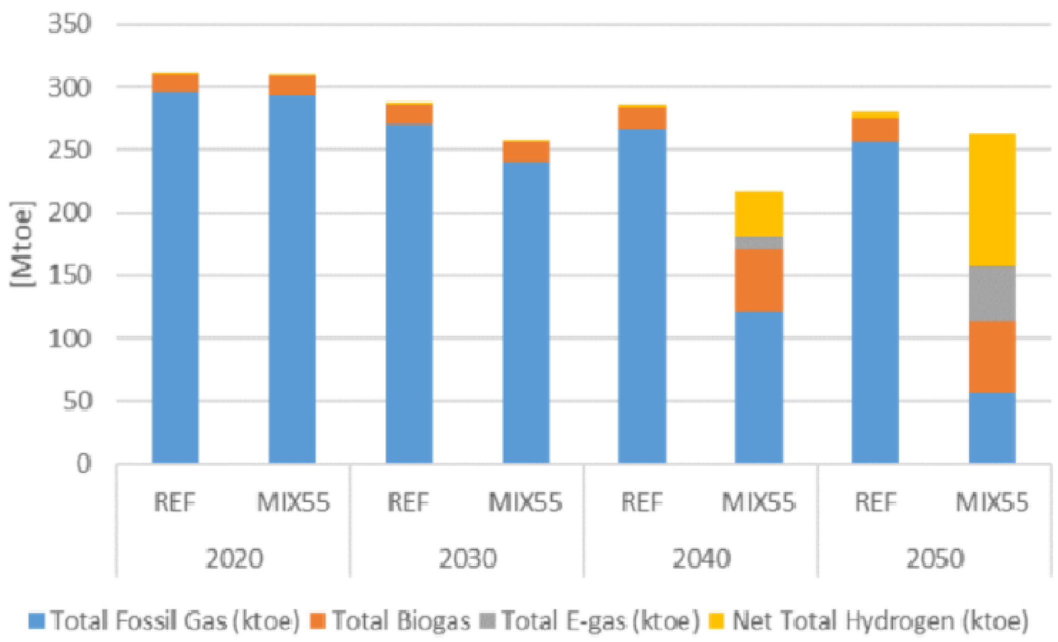


Methodology for investment need estimation



Need for infrastructure re-purposing: changing role of natural gas

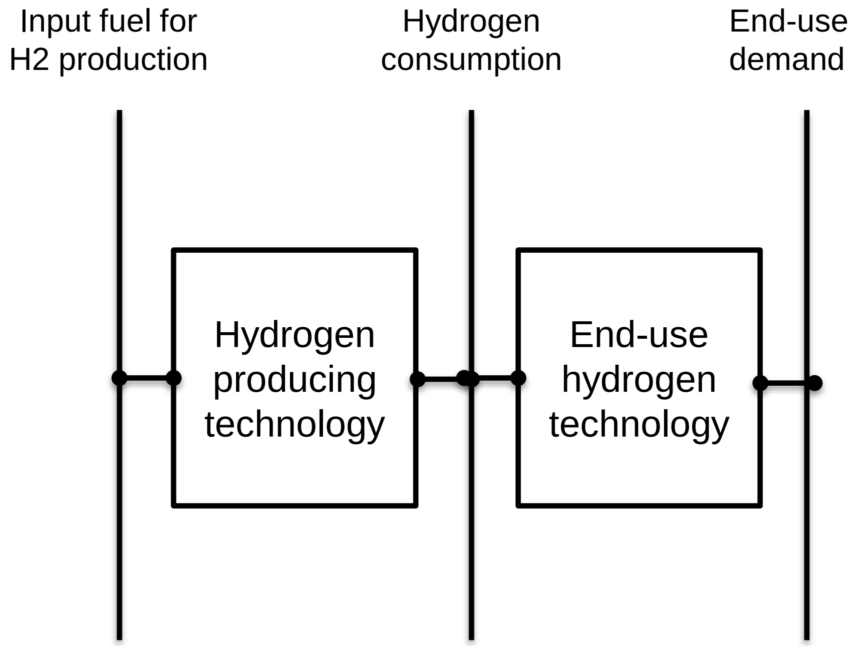
- By 2050, only about the third of the 2020 capacities will be used for methane transport.
- Blending is not a long-term solution for hydrogen transport.
- Hydrogen is transported via retrofit gas pipelines or dedicated new hydrogen infrastructure. About 60% of the network is retrofit gas pipeline in the Mix55 scenario
- Investment cost for hydrogen systems is estimated slightly below the cost of European Hydrogen Backbone study
- During the transition, there is a risk for over-investment.
- Gas infrastructure needs to be retrofitted or decommissioned on the long-run. By 2050, no unabated fossil gas will be transmitted on the EU network.



Source: PRIMES

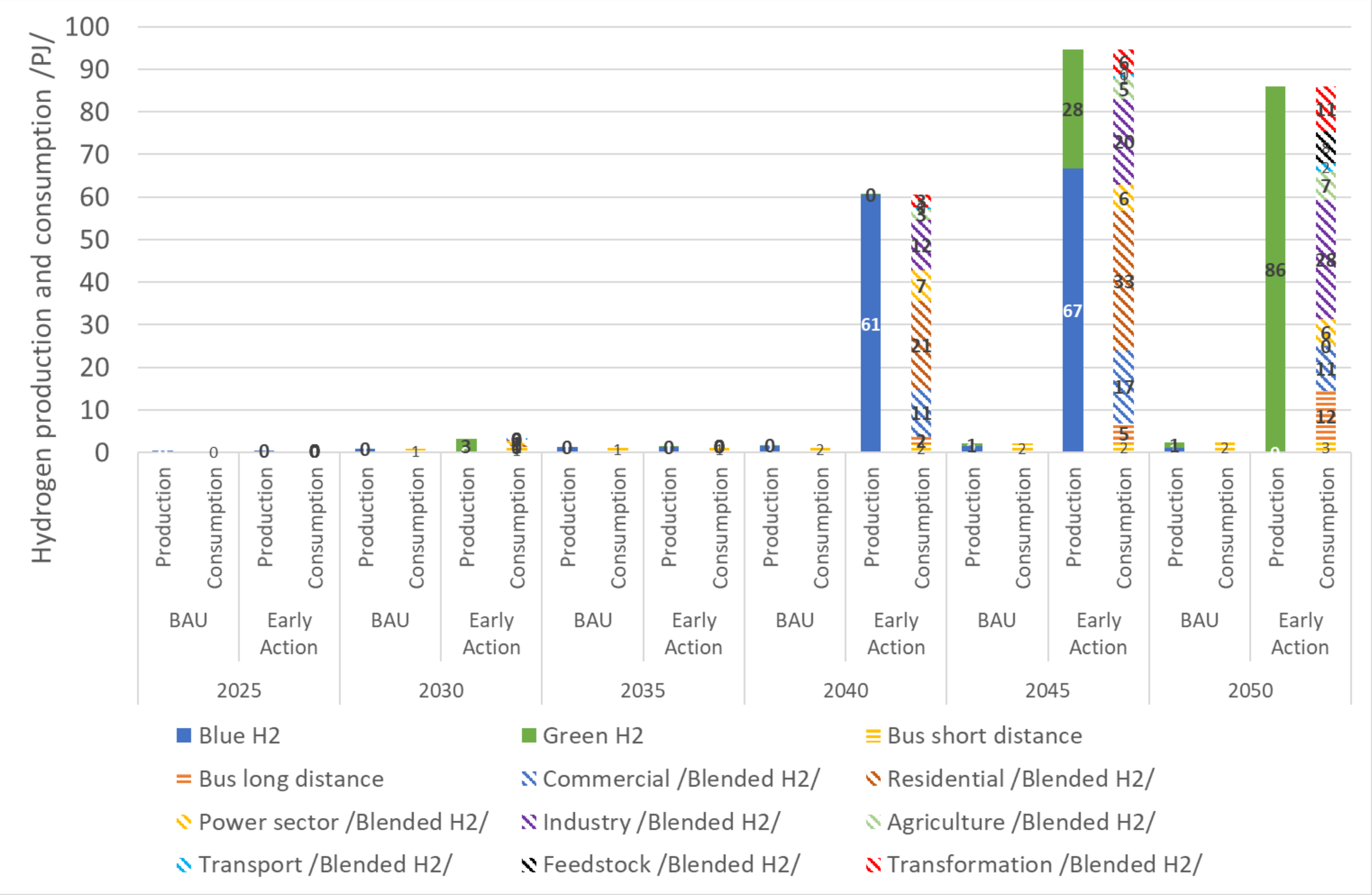
Modelling hydrogen production and consumption with HU-TIMES

- Hydrogen production and consumption are modelled **endogenously**:
  - The model can decide whether to use end-use hydrogen technologies (e.g. fuel cell bus or blended hydrogen) with *pre-defined techno-economic parameters*,
  - based on the exogenous end-use demand (e.g. passenger-kilometer for short-distance personal transport),
  - cost minimization perspective and
  - on other constraints (e.g. net zero GHG emission by 2050).
- Given the increasing hydrogen consumption by end-use technologies, the HU-TIMES model can decide to invest in either **grey**, **blue** or in **green hydrogen producing technology**.
- End-use hydrogen technology/consumption can appear in the following sectors:
  - Industry: Iron and steel production (blast furnace)
  - Transport: Fuel cell vehicles, e.g. buses, cars, medium and high duty vehicles.
  - Blended hydrogen in the natural gas infrastructure (maximum volume share of H2: 0.1% in 2025, 2% in 2030, 10% in 2035, 20% in 2040, 35% and 50% in 2045 and 2050, respectively.



Estimating H2 demand for the Hungarian Long Term Strategy's Early Action scenario

REKK SFPA Slovak Foreign Policy Association INSTYTUT JAGIELLOŃSKI AMO.CZ



- Widespread use of hydrogen is essential to reach net zero GHG emission in HU by 2050.
- H2 consumption only appears in the transport sector (i.e. buses) in the BAU scenario after 2045 – hydrogen produced in electrolyzers.
- Hydrogen consumption increases significantly after 2040 in the alternative scenario, especially for blended hydrogen in residential and commercial sectors. Major decline in blended H2 consumption in residential sector in 2050 due to electrification.
- Blue hydrogen is more competitive in the 2040s, however – due to electrification – green hydrogen is the single source in 2050.

THANK YOU FOR YOUR ATTENTION