FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Opportunities from the inclusion of Hydrogen in National Energy & Climate Plans

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Programme Review Days 2019

Brussels, 19-20 November 2019

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ludwig bölkow systemtechnik

PROJECT OBJECTIVE and SCOPE

Objective of the study commissioned by FCH JU:

Identify opportunities for hydrogen energy technologies to contribute to achieving the climate and energy targets of the EU and its Member States effectively and efficiently

Scope:

- EU28, with Member State focus
- Up to 2030
- Renewable & low-carbon hydrogen

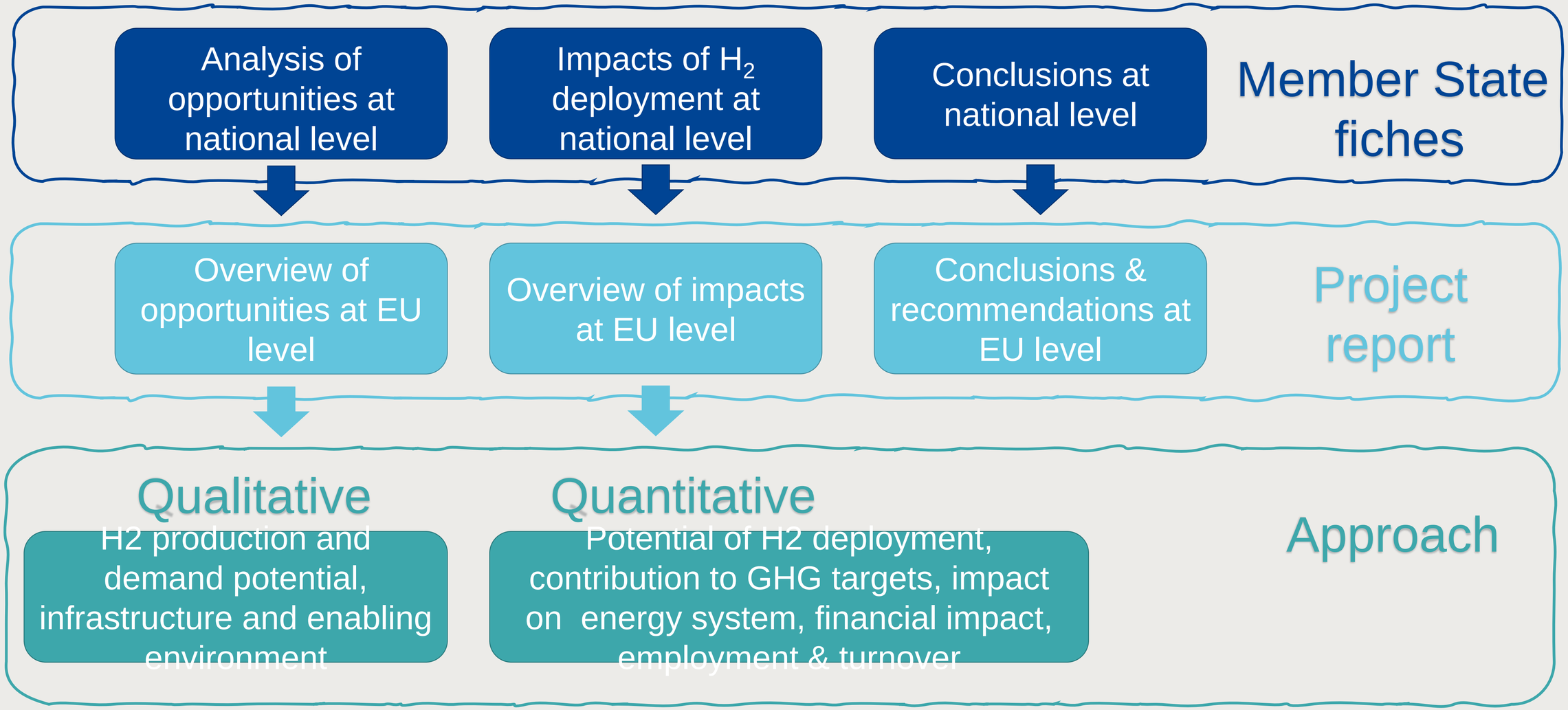
Study team:

Trinomics

ludwig bölkow systemtechnik

Methodology & Deliverables

What will be the outcome of this project?

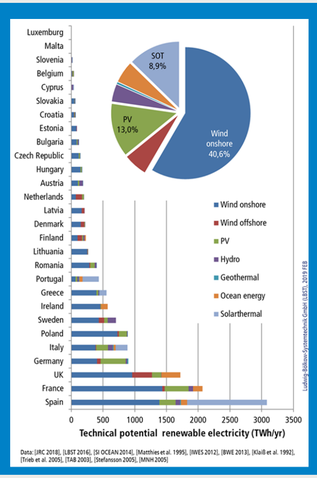


Approach towards opportunity analysis

Assessment of opportunities for hydrogen development across four aspects using indicators

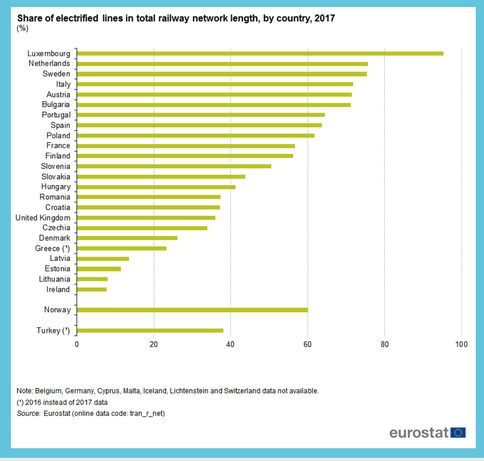
Hydrogen Production Potential

Potential for intermittent renewable electricity



Potential Hydrogen Demand

Non-electrified rail transport

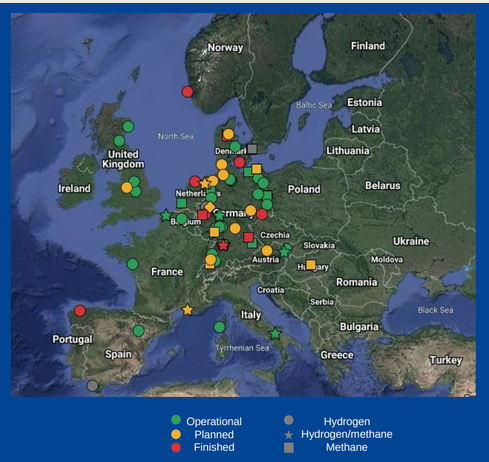


Energy infrastructure

Suitable geological formations for H2 storage

Enabling Environment

Power-to-gas projects



Sources: Trinomics & LBST (2019) & http://europeanpowertogas.vps1.clean-fresh.nl/projects-in-europe/

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Preliminary opportunity analysis results for some MS

Example: Potential Hydrogen Demand

		France	Slovenia	Greece
Industry	Existing H2 use	Ammonia & refineries	-	Ammonia & refineries
	Potential future H2 use	Primary steel	-	-
	Demand for high temperature heat	36%	30%	32%
	Share of natural gas use	37%	34%	21%
Built Environment	Share of natural gas use	29%	10%	8%
	Demand for heating	69%	80%	57%
	Demand for cooling	2%	2%	7%
Transport	Fossil fuel use in rail	15%	33%	72%
	Fossil fuel use in road	92%	98%	97%
	International shipping	3.6%	8.3%	36.7%

**Energy use by international shipping relative to total (domestic) final energy use in transport*

Preliminary opportunity analysis

Example: Hydrogen production potential & its role in energy system flexibility

EU countries with opportunity to produce H_2 based on electricity 'surpluses'

- Substantially higher domestic intermittent renewable electricity **potential** than demand
- "Suitable" gas infrastructure for **H_2** transport and storage

EU countries with opportunity to produce H_2 for energy system balancing

- Substantially higher installed intermittent renewable electricity **capacity** than load
- Limited other low-carbon flexibility options

EU countries with opportunity to produce H_2 based on natural gas with carbon capture

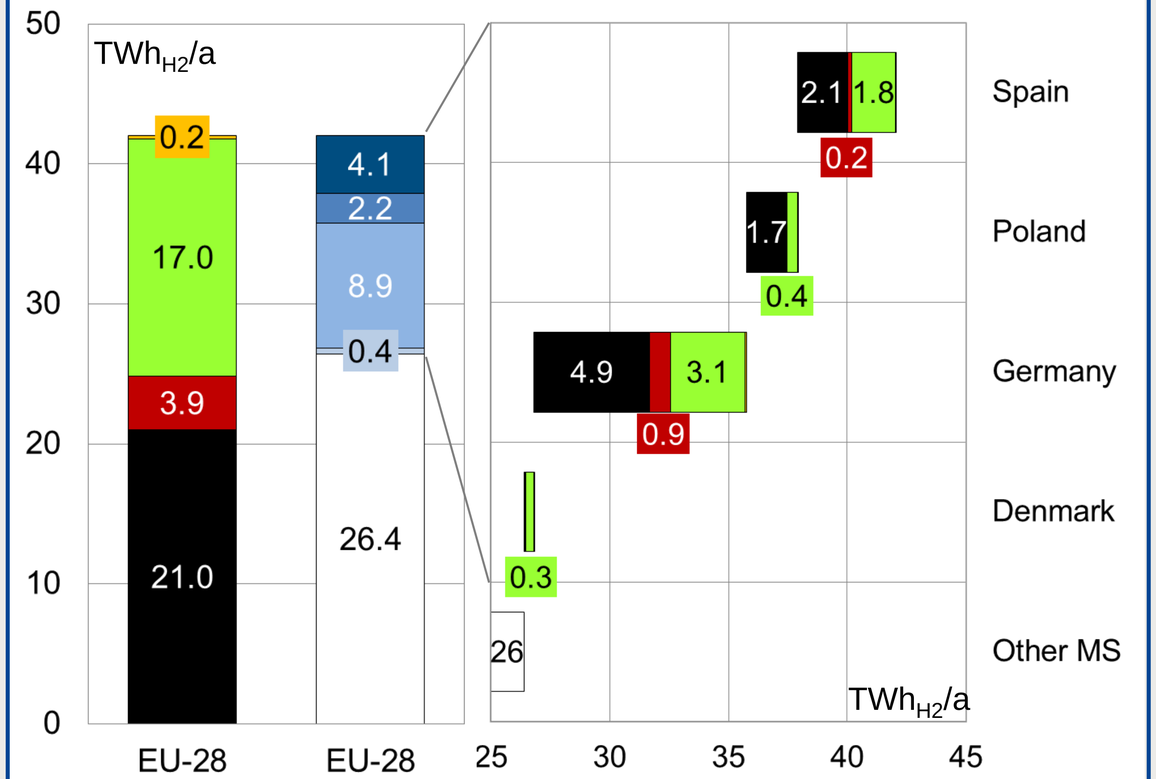
- Suitable CO_2 storage sites
- Relevant knowledge in SMR and CCUS
- "Suitable" gas infrastructure for **H_2** transport and storage

**Energy use by international shipping relative to total (domestic) final energy use in transport*

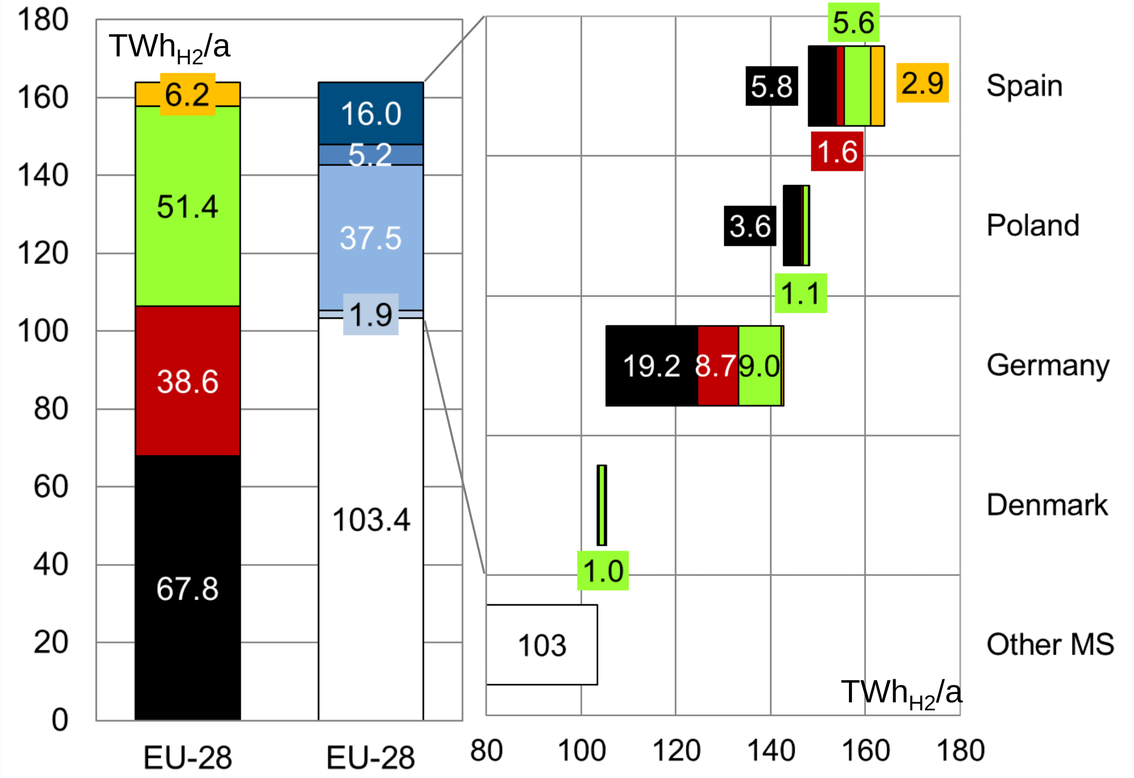
Preliminary impact assessment results

Demand for hydrogen by 2030 in EU-28 and selected Member States in “Low” and “High” scenarios

Low scenario



High scenario



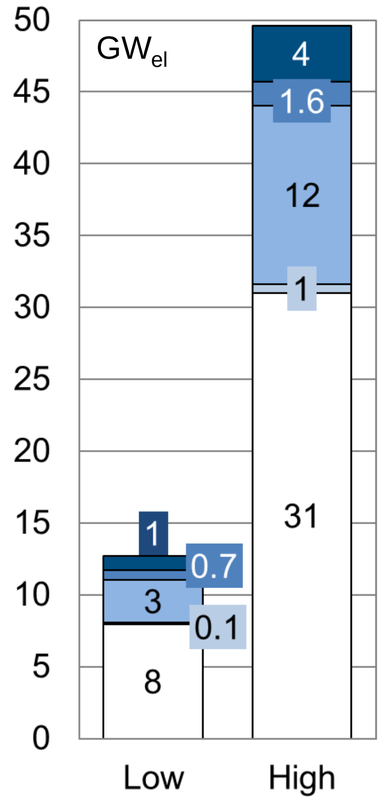
Other MS = Member States | Denmark | Germany | Poland | Spain | Industry | Buildings | Transport | Power

Preliminary impact assessment results

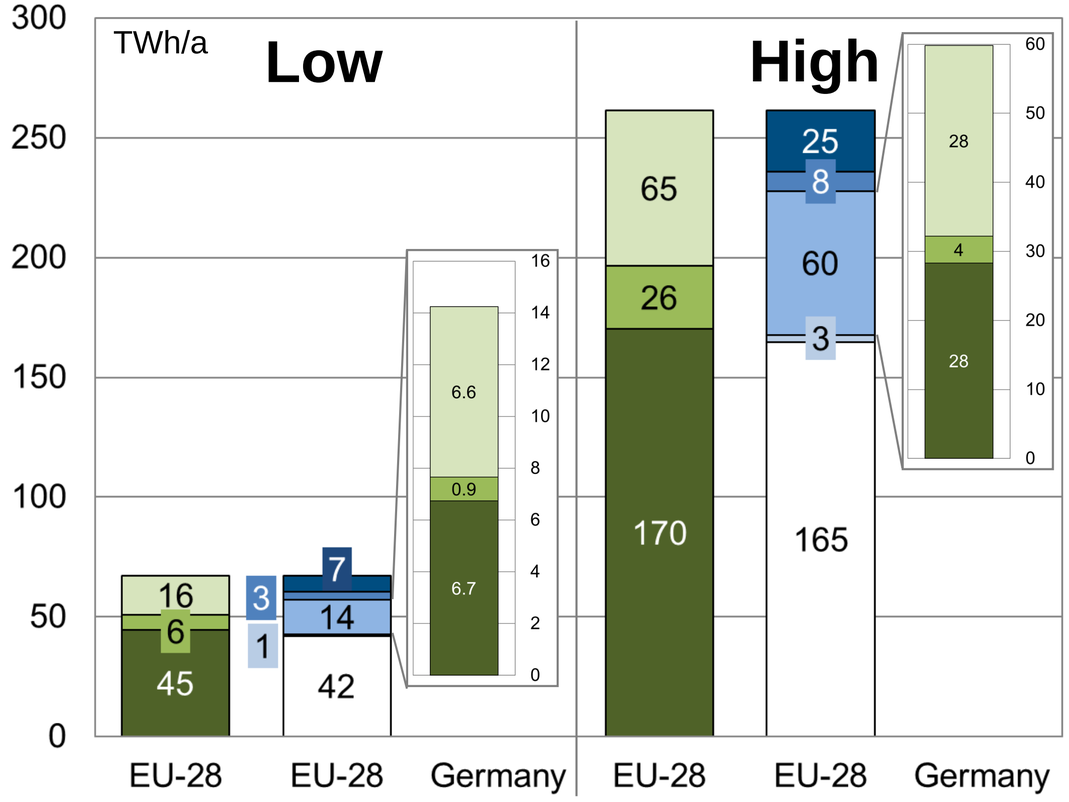
Required size of hydrogen technologies and infrastructure in EU-28 and selected Member States

* HRS =Hydrogen refuelling station

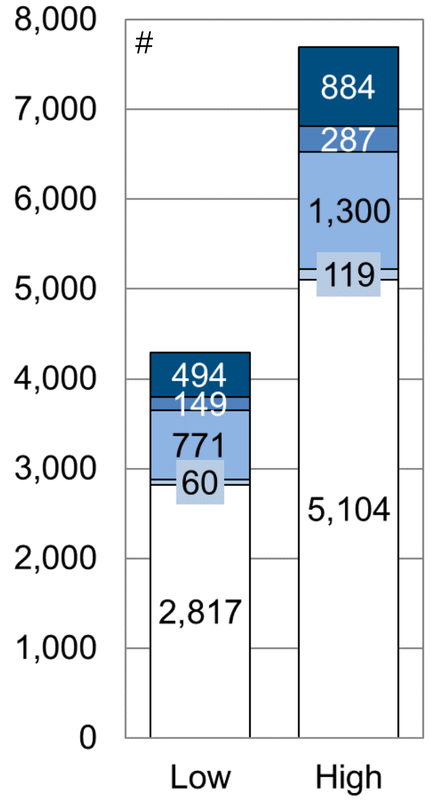
Electrolysis (EU-28)



Primary energy input (EU-28 & Germany)



HRS* (EU-28)



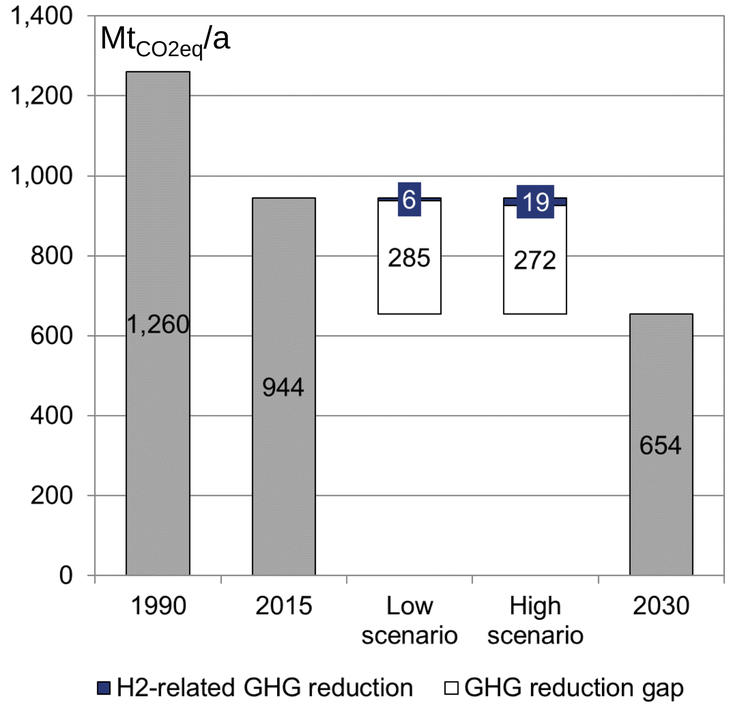
Other MS = Member States | Denmark | Germany | Poland | Spain | Photovoltaics | Wind offshore | Wind onshore

Preliminary impact assessment results

Example: Impact on environment, economy and security of supply for Germany by 2030

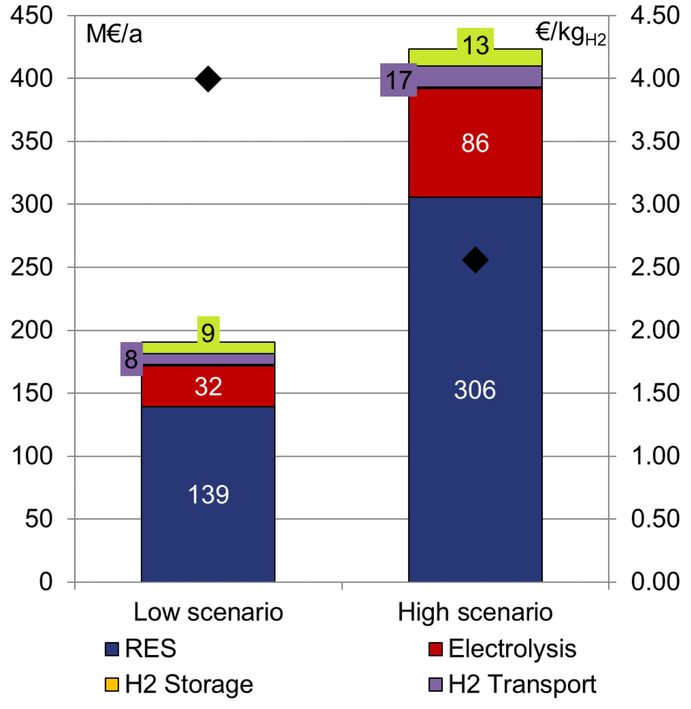
Einvironmental impact

GHG emission in Germany



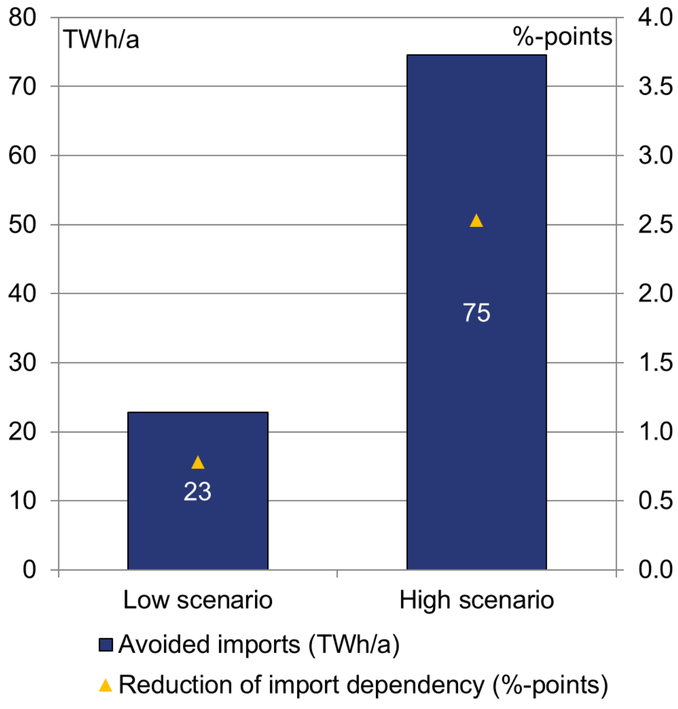
Financial impact

Germany in 2030



Impact on supply security

Germany in 2030



Additional quantitative indicators: annual costs, H_2 price, value added, jobs, gas and power gird changes, end users

Preliminary opportunity and impact analysis results (EU-28 by 2030)

- ✓ Opportunity for production of H2 from renewable electricity (mainly wind) in most MS
- ✓ Opportunity for using existing natural gas infrastructure in most MS
- ✓ Opportunity for low-carbon H2 production in few MS with suitable CO2 storage sites
- ✓ Hydrogen demand ranging from 40-160 TWh_{H2} in 2030, mainly in industry and transport
- ✓ Electrolysis capacity between 10-50 GW with comparatively high utilisation of 2,000-6,000 h
- ✓ Network of 4,000-7,500 hydrogen refuelling stations
- ✓ Reduction of GHG emissions by 20-65 Mt_{CO2eq}/a (1 to 4% of required reduction by 2030)
- ✓ Investment needs (w/o gas+power infrastructure and end users) ranging from 70-250 B€ and annual costs of 5-12 B€/a
- ✓ Low hydrogen prices between 2-4 €/kg_{H2} in “high” and 3-10 €/kg_{H2} in “low” scenario
- ✓ Avoided fossil fuel imports of 95-285 TWh in 2030 reducing import dependency