Introduction to applied EU Hydrogen Policy

(applicable to the case of Ukraine)

Jean-Michel Glachant, Director FSR

(Research assistants Maria Olczak & James Kneebone)

EU Eastern Partnership Network

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RSCAS POLICY PAPERS

RSCAS PP 2020/01
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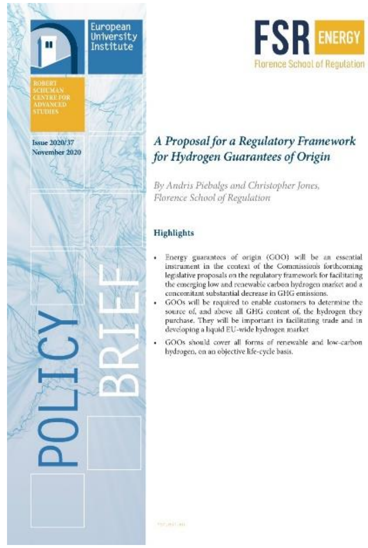
Molecules:
Indispensable in the Decarbonized Energy Chain

Ronnie Belmans and Pieter Vingerhoets



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Issue 2020/37
November 2020

POLICY BRIEF

A Proposal for a Regulatory Framework for Hydrogen Guarantees of Origin

By Andris Piebalgs and Christopher Jones, Florence School of Regulation

Highlights

- Energy guarantees of origin (GOO) will be an essential instrument in the context of the Commission's forthcoming legislative proposals on the regulatory framework for facilitating the emerging low and renewable carbon hydrogen market and a concomitant substantial decrease in GHG emissions.
- GOOs will be required to enable customers to determine the source of, and above all GHG content of, the hydrogen they purchase. They will be important in facilitating trade and in developing a liquid EU-wide hydrogen market
- GOOs should cover all forms of renewable and low-carbon hydrogen, on an objective life-cycle basis.

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Issue 2020/06
February 2020

POLICY BRIEF

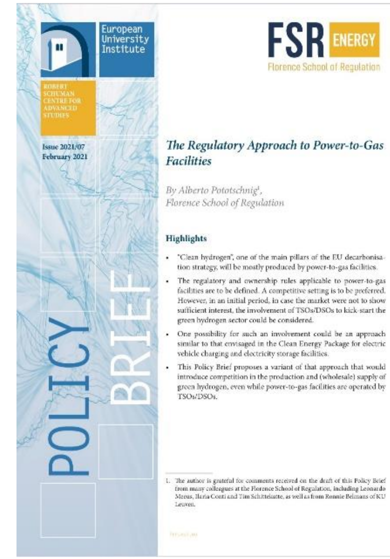
How Many Shades of Green? An FSR Proposal for a Taxonomy of 'Renewable' Gases

By Ilaria Conti, Florence School of Regulation

Highlights

- The role of gas in the future of the EU energy sector has been one of the most debated topics in the last few years. As natural gas (NG) makes up less and less of Europe's energy mix (according to several studies), there is an increasing scope for the development and flexible use of a number of different types of gases (namely *biogas*, *biomethane*, *synthetic methane* (or *syngas* or *renewable methane*) and *hydrogen*.
- Some of these 'new gases' (as we will call them in this paper) may be generated from renewable sources, or from hydrocarbons. A few of these gases are carbon neutral by process; others are responsible for the emissions of greenhouse gases (GHG)[1], despite being of 100% biological origin. Some of them are almost identical in chemical terms, but their carbon footprint may vary quite significantly.
- This complex scenario makes it difficult (and very confusing) to refer to the new gases with non-univocal adjectives such as 'renewable', 'green' or 'no-carbon/low carbon'.
- Therefore, there is a strong need – widely recognised by all the parties in the sector – to agree on a common terminology which could help prevent any misunderstanding when referring to a specific gas; this is even more important in the public debate since the 'new gases' are going to be the subject of upcoming EU regulatory measures.

1. GHG covered by the Kyoto Protocol are the following: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6), nitrogen trifluoride (NF3).



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Florence School of Regulation

Issue 2021/07
February 2021

POLICY BRIEF

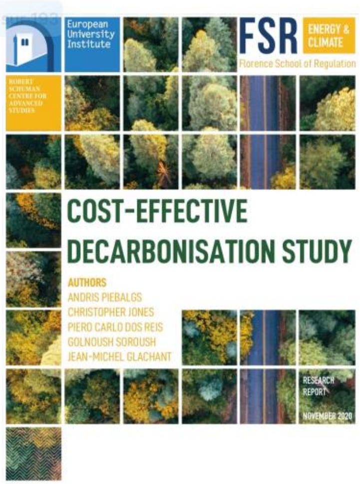
The Regulatory Approach to Power-to-Gas Facilities

By Alberto Pototschnig[1], Florence School of Regulation

Highlights

- "Clean hydrogen", one of the main pillars of the EU decarbonisation strategy, will be mostly produced by power-to-gas facilities.
- The regulatory and ownership rules applicable to power-to-gas facilities are to be defined. A competitive setting is to be preferred. However, in an initial period, in case the market were not to show sufficient interest, the involvement of TSOs/DSOs to kick-start the green hydrogen sector could be considered.
- One possibility for such an involvement could be an approach similar to that envisaged in the Clean Energy Package for electric vehicle charging and electricity storage facilities.
- This Policy Brief proposes a variant of that approach that would introduce competition in the production and (wholesale) supply of green hydrogen, even while power-to-gas facilities are operated by TSOs/DSOs.

1. The author is grateful for comments received on the draft of this Policy Brief from many colleagues at the Florence School of Regulation, including Leonardo Meeus, Ilaria Conti and Tim Schittekatte, as well as from Ronnie Belmans of KU Leuven.



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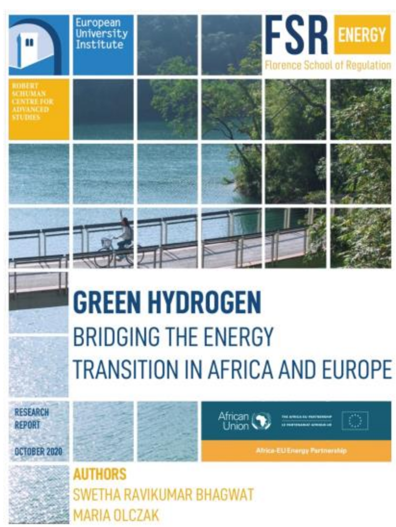
COST-EFFECTIVE DECARBONISATION STUDY

AUTHORS
ANDRIS PIEBALGS
CHRISTOPHER JONES
PIERO CARLO DOS REIS
GOLNOUSH SOROUSH
JEAN-MICHEL GLACHANT

RESEARCH REPORT
NOVEMBER 2020



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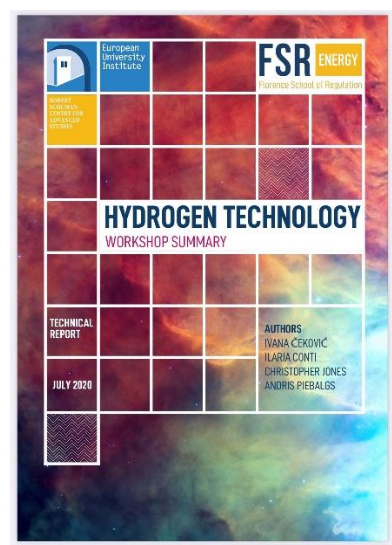
GREEN HYDROGEN
BRIDGING THE ENERGY TRANSITION IN AFRICA AND EUROPE

RESEARCH REPORT
OCTOBER 2020

African Union

Africa-EU Energy Partnership

AUTHORS
SWETHA RAVIKUMAR BHAGWAT
MARIA OLCZAK



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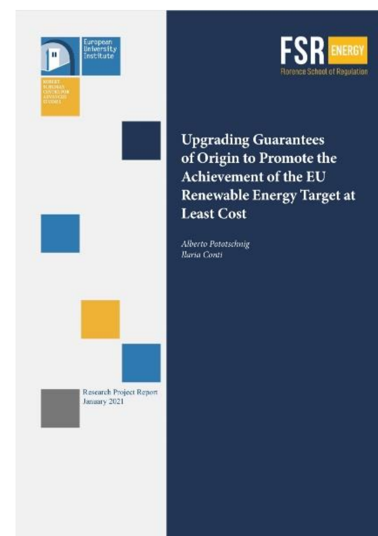
HYDROGEN TECHNOLOGY
WORKSHOP SUMMARY

TECHNICAL REPORT

JULY 2020

AUTHORS
IVANA ČEKOVIĆ
ILARIA CONTI
CHRISTOPHER JONES
ANDRIS PIEBALGS



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Upgrading Guarantees of Origin to Promote the Achievement of the EU Renewable Energy Target at Least Cost

Alberto Pototschnig
Ilaria Conti

Research Project Report
January 2021

EU Hydrogen Policy has 4 basic dimensions

-- -- -- A serious "policy push" addressing real "building blocks"- -- -

(I) Serious "*Policy Push*" - set by the EU & the MS

(II) Real "*Policy Building Blocks*" - among existing EU energy usages

-- -- -- -- Players are to face two major constraints - -- -- --

(III) "*Industrial economics*" constraint - starting with clusters

(IV) "*Market competitiveness*" constraint - starting with handicap

(I) *The Policy Frame* is very serious

1- Serious roots: 3 targets become one big EU "Green Deal"

- **Commission has strengthened our EU energy transition, with -55% GHG target in 2030 and NetZero in 2050**

- **Covid-19 crisis will not slowdown EU energy transition but accelerate it as a lever for EU economic recovery**

- **EU policy is become much larger that historical three "20" Targets set for 2020. EU new strategy is a comprehensive "*Green Deal*" (F.ex also covering the "fairness" of our energy transition).**

- **EU energy policy expanded to changing key energy usages, enlarging the energy transition basis. EU now targets "Ener. *Sector Integration*".**

(I) The Policy Frame

2- From only EU internal frame to an international policy frame

- Paris Agreement 2015 has changed the transition policy frame by creating an international reference.

- The EU accelerated transition goals for 2030-2050 are imitated by South Korea, Japan, China… Today (22-23 April) by US.

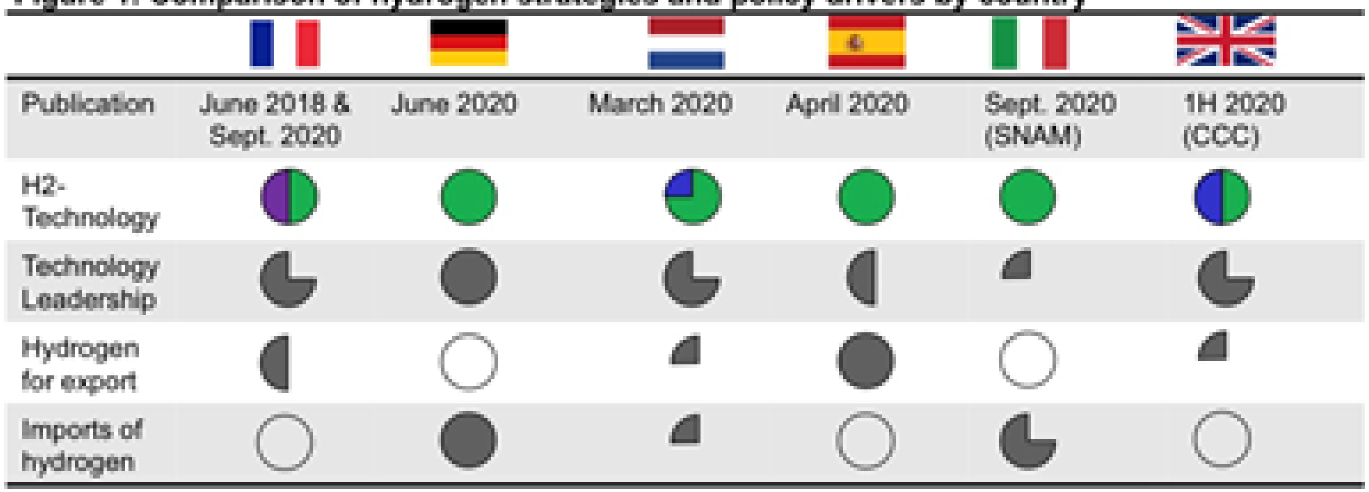
- Use of Covid-19 recovery programmes as lever for accelerating energy transition & building strategic advantages for the future is become common (Japan, South Korea). Both China & US want to lead.

(I) The Policy Frame

3- Hydrogen policy rush in the EU

- Commission H2 Strategy July 2020: certification, support schemes, infrastructure TEN-E, 40 GW electrolyzers, 250-400bn, Neighbourhood Policy & Energy Community, notably Ukraine
- ITRE Committee Parliament 8 April 2021
- Germany June 2020 14TWh nat prod 2030; 90-110 TWh demand
- UK, NL, France, PT, Sp, It, Poland (Western by OIES, March 2021)

Figure 1: Comparison of hydrogen strategies and policy drivers by country



Source: Authors' analysis

(I) The Policy Frame

4- Hydrogen in EU neighbourhood policy (details)

- Commission July 2020 “notably Ukraine”
- Council, January 2021

EU and globally. The EU and its Member States will continue to support the uptake of the EU’s energy acquis, rules and standards, as well as further energy market integration and interconnectivity in line with the European Green Deal, particularly within the EU’s neighbourhood, including the Eastern Mediterranean. The EU will support the ambitions and efforts of countries in the Southern Neighbourhood, Western Balkans and the Eastern Partnership in tackling environmental, climate and energy challenges. The Council welcomes, in this context, the Joint Communication on Eastern Partnership policy beyond 2020 and the Declaration on the Green Agenda for the Western Balkans while looking forward to the upcoming communication on a renewed partnership for the Southern Neighbourhood, in line with the international dimension of the European Green Deal. The Council also stresses the importance of completing the Energy Community Treaty amendment process as soon as possible.

- ITRE EU Parliament April 2021 “safeguarding strategic interests & energy security with Eastern Partnership countries”

(I) The Policy Frame

4- Hydrogen in EU neighbourhood policy (end)

EU to promote opportunities for cooperation on clean hydrogen with neighbourhood, to contribute their clean energy transition & foster sustainable growth and development.

Priority partners – Eastern Neighbourhood, in particular Ukraine, and - Southern Neighbourhood : 40 GW electrolyser capacity in neighbourhood

32 GW in N. Africa + 8 GW in Ukraine

- Predominantly produced with wind, some biomass and solar
- Transported through pipeline to Europe. 5/6 pipelines in total, majority unused. Can be H2 blended to begin, with dedicated H2 when demand is sufficient.

Financing instruments including the Neighbourhood Investment Platform

5- Hydrogen in MS neighbourhood policy

MOU Germany - Ukraine

Visegrád Group too has an interest in hydrogen production & transportation, pipeline (e.g. Druhzba) and shipping (e.g. Danube).

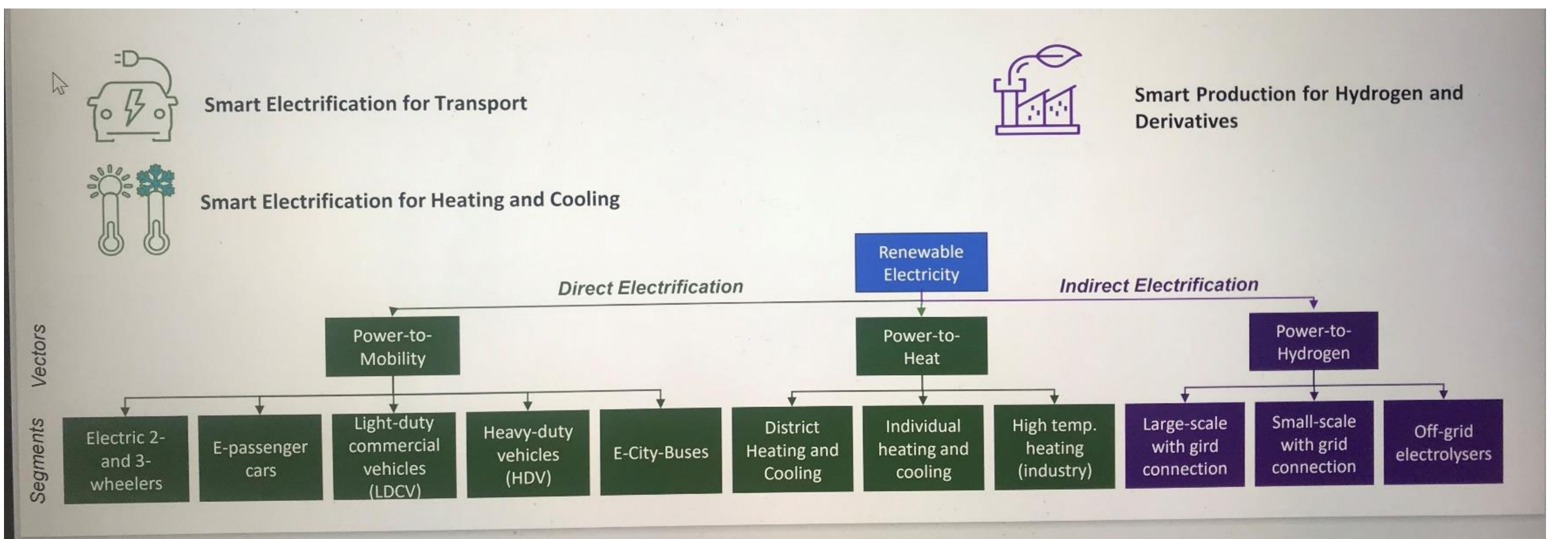
> Hungary to include H2 on the agenda of presidency starting in July 2021

(II) Real *Policy Building Blocks* in current energy uses

1- IRENA "Outlook 2021" & future report "Innovation Landscape"

Direct electrification (*clean mobility; clean heating & cooling*) to deliver 20 % of decarbonization to Net Zero in 2050

Indirect electrification (*clean molecules*) to deliver 10%



(II) Real Policy Building Blocks

2- The current EU energy usages

(Txs to Ronnie Belmans, work to be published soon)

EU 27 in 2019 consumed 11,873 TWh energy (incl. 992 TWh for international transport marine & aviation)

- **Transport 4,358 TWh (incl. international)**
- **Services & Buildings 4,745 TWh**
- **Industry 2,770 TWh**

2,485 TWh were provided by electricity

+ 1,184TWh other renewable energies

Only = 30% of the Total

Our "Net Zero" goal questions > 8,000 TWh

an immense energy area…

(II) Real Policy Building Blocks

3- Easier to electrify: direct electrification

- Transport consumes 3,154 TWh fuels for internal combustion engines

➢ If all combustion engines go electric; consumption of electricity will go up 1,053TWh to 1,263TWh

- Residential & Commercial buildings consumes 1,887 TWh fuels for heating

➢ Deep renovation of buildings can reduce consumption by 60%: only 755 TWh of heat to decarbonize…

➢ Heat pumps can deliver that amount of heat for only 216 TWh of electricity consumption

(II) Real Policy Building Blocks

3- Easier to electrify (end)

- **Heating in industry consume 912 TWh fossil fuels**

➢ **If all electrified, consumption of electricity might increase by 456 TWh**

In Total, these three direct electrifications call for 1,725 to 1,935 TWh of new electricity consumption

= + 70% to + 80% electricity to produce

(II) Real Policy Building Blocks

4- Not easy to electrify: indirect electrification via clean molecules

- Aviation & Maritime consume 1,118 TWh fossil fuels

➢ If they all go to H_2 produced from electricity, consumption of electricity rises by 1,662 TWh. If other fuels (ammonia, methanol, etc.) even substantially higher.

- Steel industry (if fully Hydrogen Direct Reduction) might consume 540 TWh of electricity to get its H_2
- Industry today consumes 293 TWh of H_2, but 54% for refineries. Standard electrolyzers could produce non-refineries demand with 200 TWh electricity

In Total, these three indirect electrifications call for 2,400 TWh of new electricity consumption; 30 to 45% more than direct electrifications. Calling to double today's electricity generation.

(III) Major Industrial Economics constraint: the clusters

1- Basics of Hydrogen industrial economics

- **Hydrogen is a dangerous product (explosive) delivered only from a specific infrastructure**
- **This specific infrastructure is costly**

Transportation model unit cost assumptions

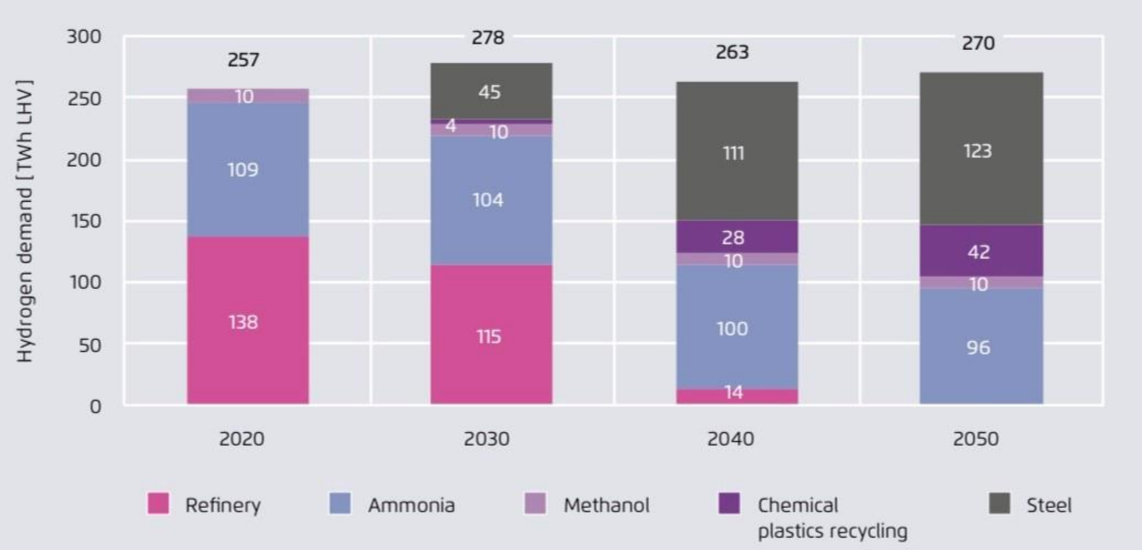
Item	Reference	Source	Cost	Units
New pipeline	ASSET [a)]	Guidehouse	4.60	€ / MWh / 600km
		BNEF	9.60	€ / MWh / 600km
		IEA	11.40	€ / MWh / 600km
		DNV GL	45.00	€ / MWh / 600km
		BNEF - min	16.10	€ / MWh / 600km
		BNEF - max	49.80	€ / MWh / 600km

(III) Major Industrial Economics constraint

2- Clusters are zones of demand big enough to minimize delivery costs

- Agora Energiewende study (Feb 2021) chose size of 3TWh (2040, 2050)
- But what H2 demand there in 2050? 60% gone; 60% new…

Industrial hydrogen demand from 2020 to 2050 within the specific demand sectors in TWh per year Figure 1

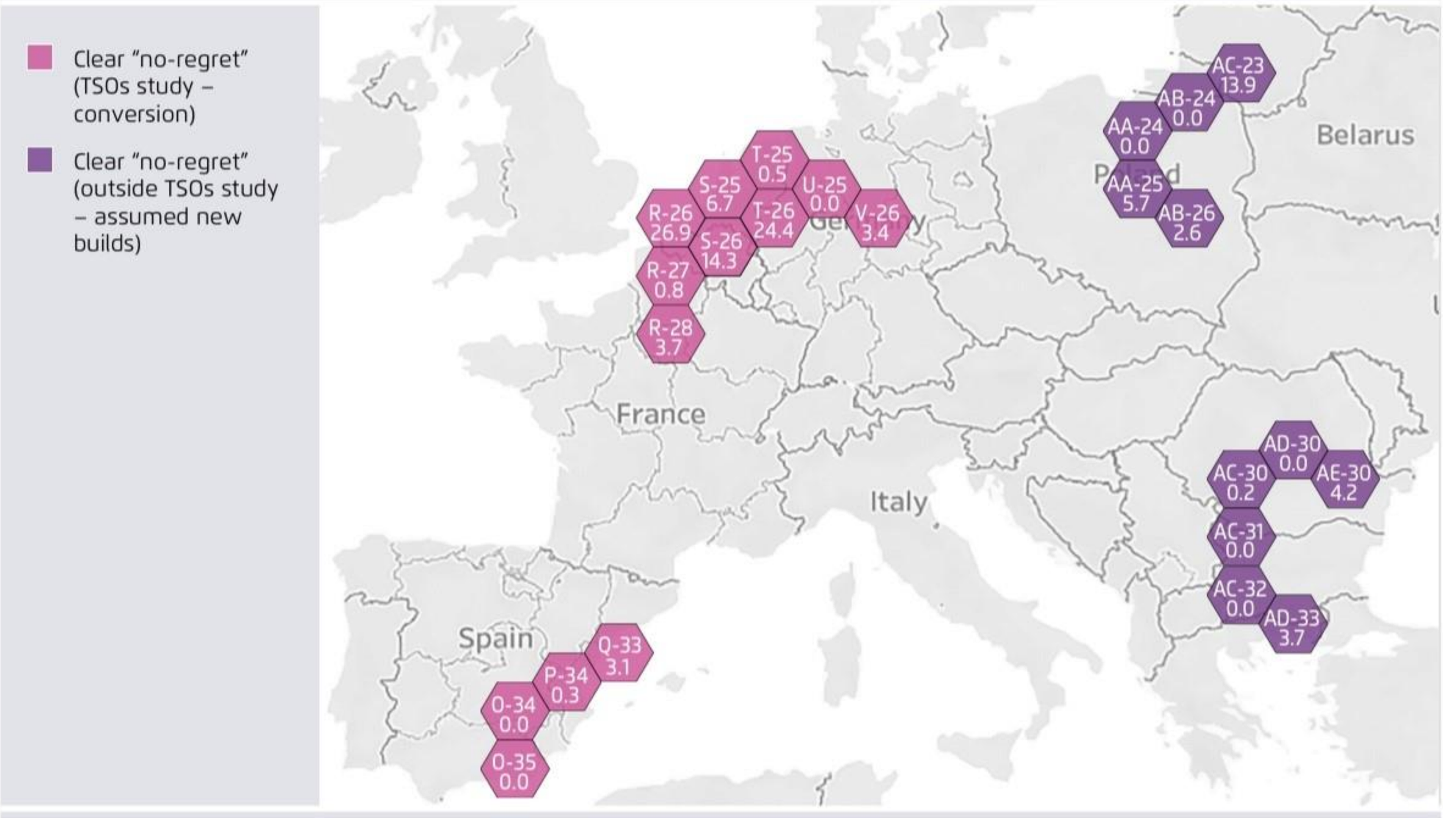


AFRY (2021).

(III) <u>Major Industrial Economics constraint</u>

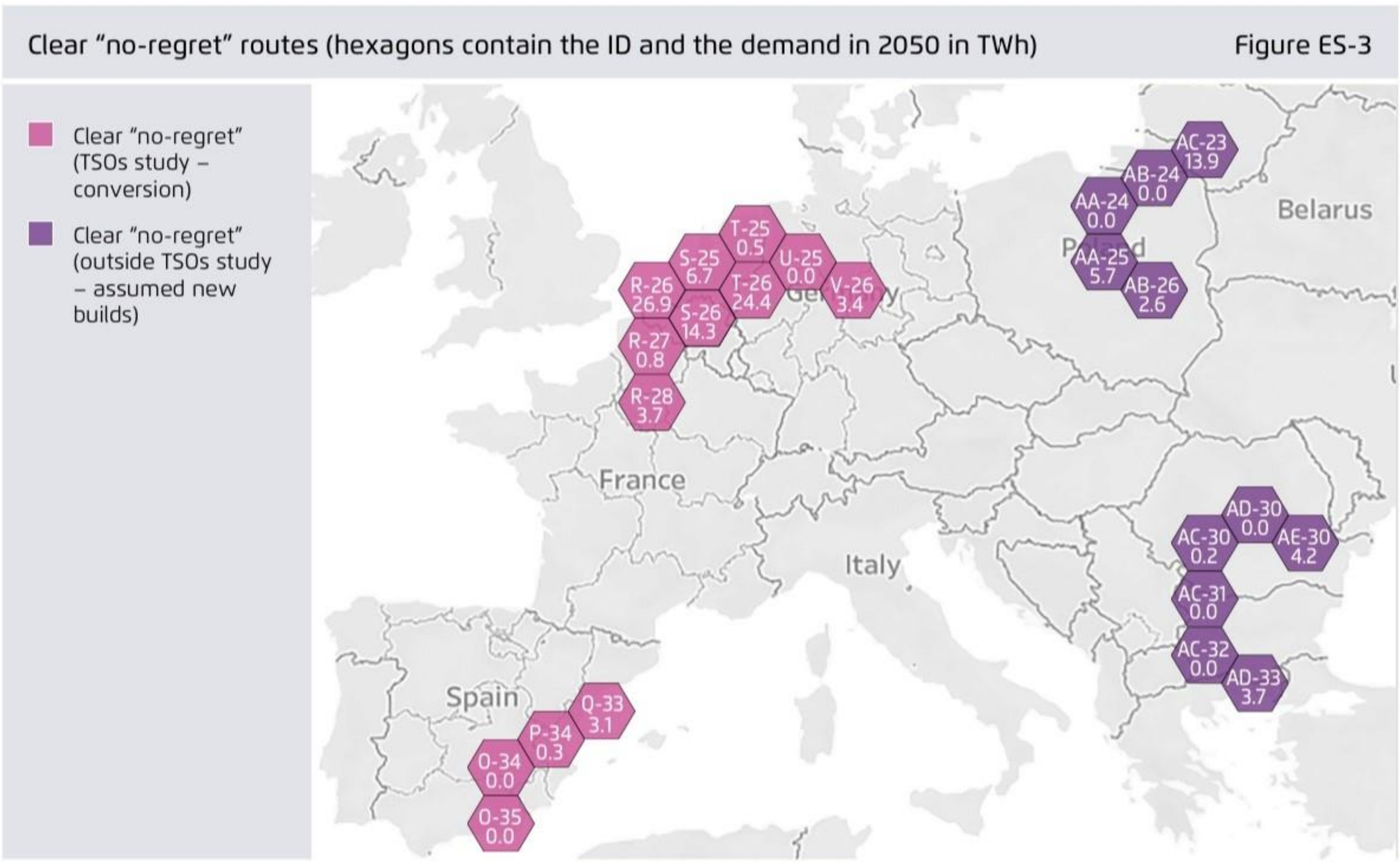
- **Agora Energiewende study (Feb 2021) chose size of 3TWh (2040, 2050)**
- **And calculated where H2 demand clusters could locate in 2050**

Clear "no-regret" routes (hexagons contain the ID and the demand in 2050 in TWh) Figure ES-3



(III) Major Industrial Economics constraint

- **Agora Energiewende "No Regret" H2 demand clusters 2050 do not match in Eastern EU with the Gas TSOs study July 2020**



(III) Major Industrial Economics constraint

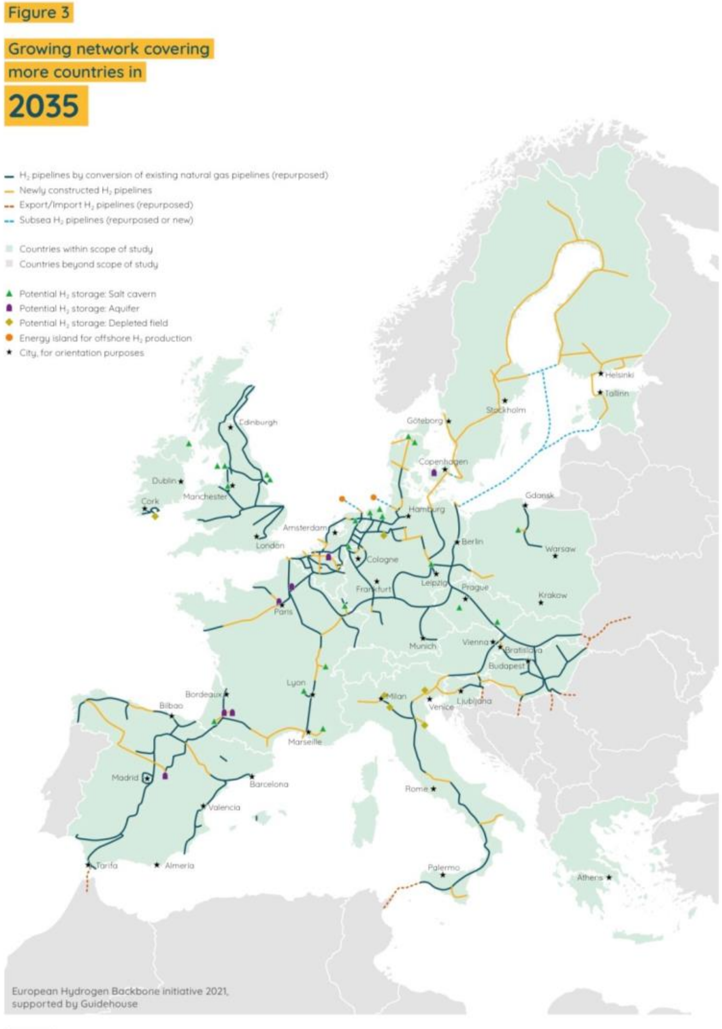
- **But Gas TSOs published April 2021 new study : New map 2030**

(III) Major Industrial Economics constraint

- **Gas TSOs new study April 2021: with corridors in 2035**

Biggest change in Central &Eastern is import route for Ukrainian H2

With large diameter pipelines
Cost around Euro 0.10 per kg



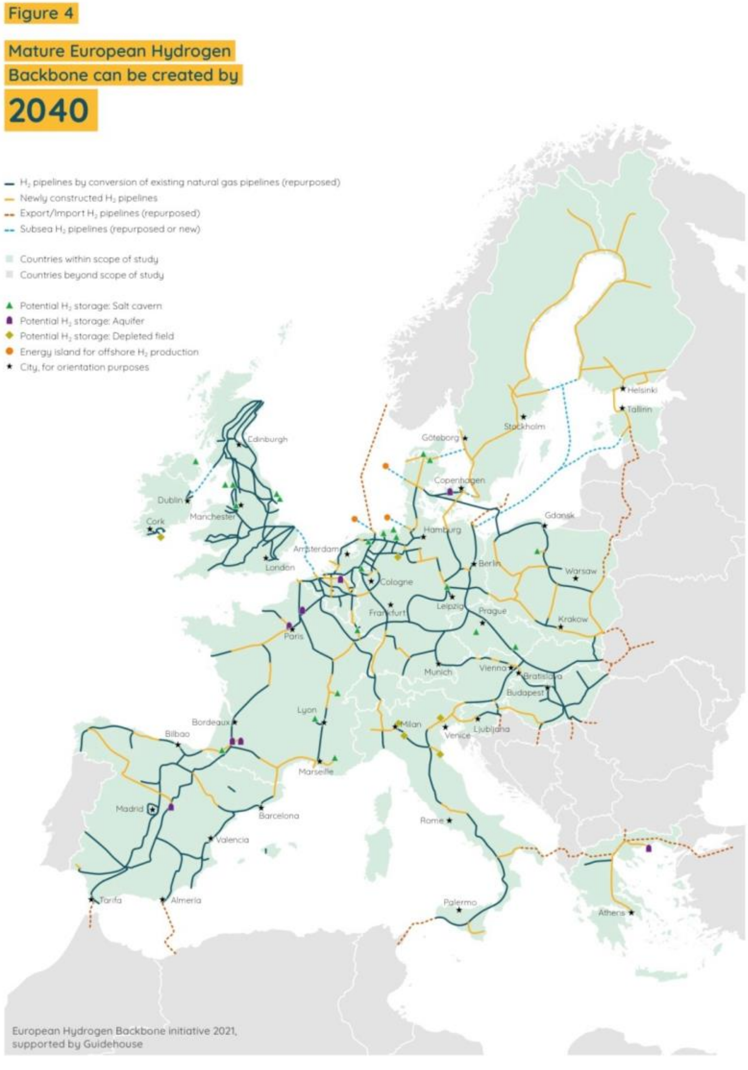
(III) Major Industrial Economics constraint

- **Gas TSOs new study April 2021: Here 2040, EU wide market**

Cost range Euro 0.11-0.21 per kg

Because it combines small

& large diameter pipes.



(IV) Market Competitiveness starts with handicap

1- The size of the market

Demand in Agora study (270 TWh H2, under 9mt, in 2030-2050) is for ammonia & methanol, steel, & plastics.

- It does not consider producing clean fuels for aviation or maritime which today consume 1,000 TWh of polluting fuels.
- 270 TWh H2 call for about 400 TWh electricity, either 100 GW wind offshore or 15O GW wind onshore

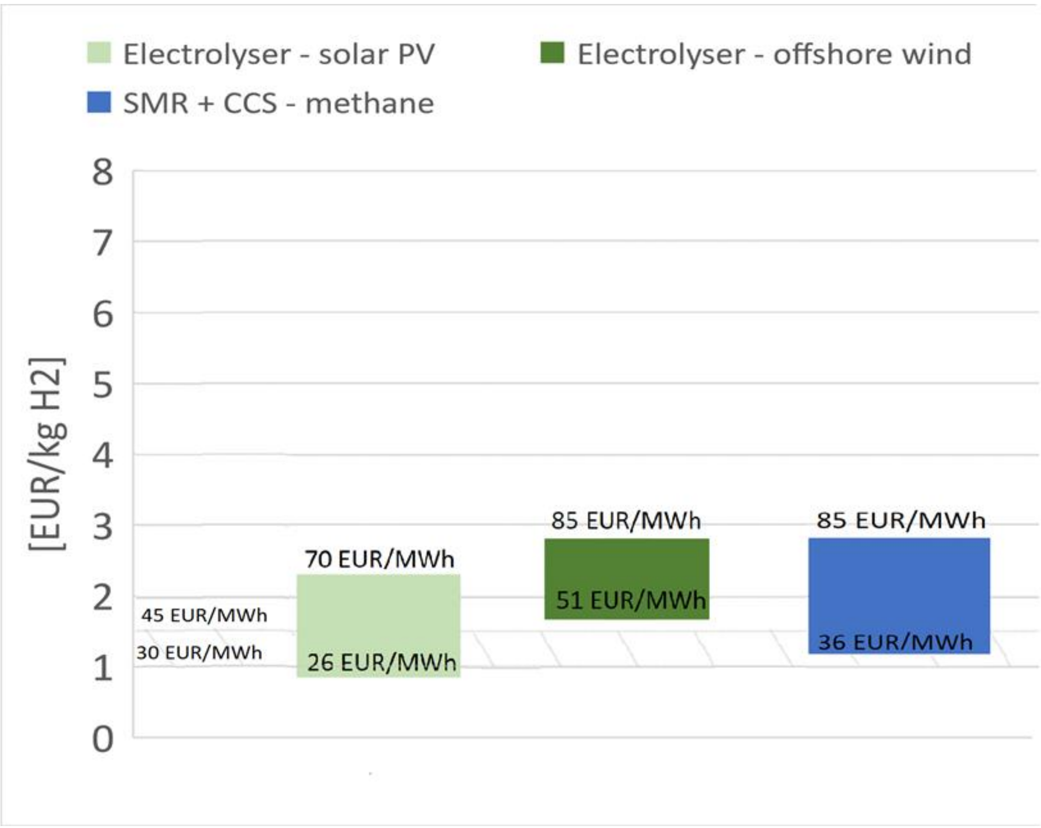
2- But market shares implies market competitiveness

To beat "*Blue* Hydrogen" (Grey Hydrogen + 25 % costs for CCS) "*Green* Hydrogen" needs *costs of renewables 20-30$MWh; **electrolyzer costs down (-30%? -50%?) to compensate low capacity factor, or **higher capacity factor than wind 30%-50%

(IV) Market Competitiveness

Market Competitiveness time horizon dimensionS: 2030 or 2050?

***Florence School* calculations for 2030** (Glachant – Dos Reis, to be published next week)

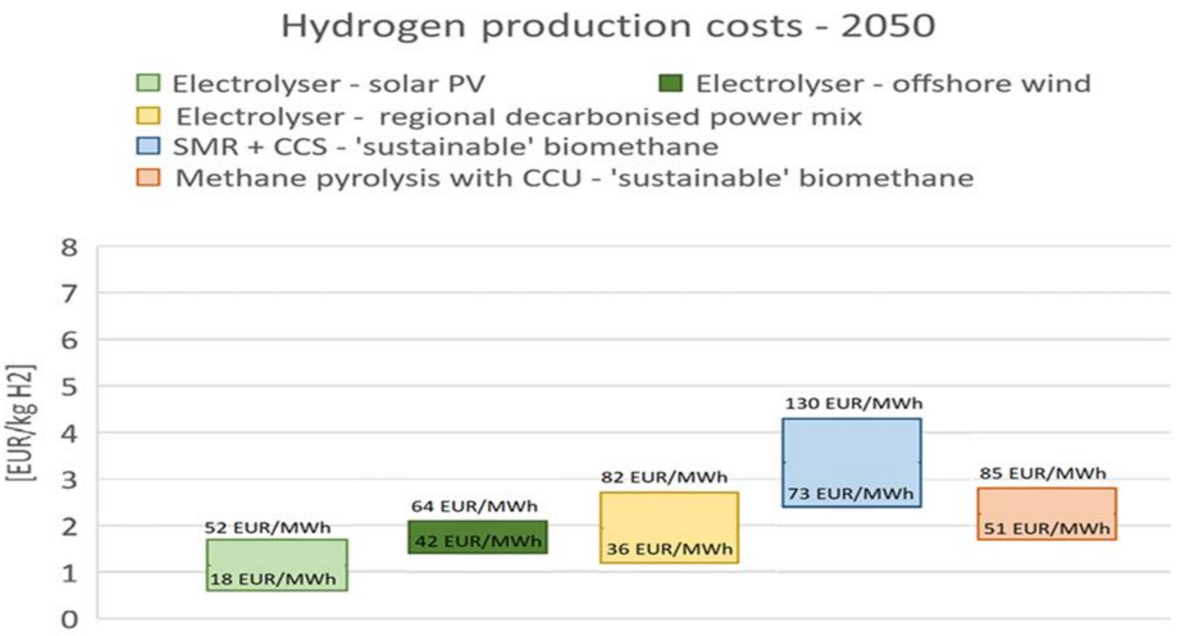


Benchmark:
'Grey hydrogen' costs today
without cost of CO2
[1 - 1.5 EUR/kgH2]

(IV) Market Competitiveness

Florence School calculations for 2050

More technologies might be mature and transform H2 industry



(IV) Market Competitiveness

Florence School calculations are school exercises with many parameters. Let see how many parameters for 2030 calculations.

Technologies	Electrolyser & solar PV	Electrolyser & offshore wind	SMR + CCS & natural gas
Costs – 2030 (Note: LHV used for conversion)	0.9-2.3 EUR/kgH2 27-70 EUR/MWh	1.7-2.8 EUR/kgH2 52-85 EUR/MWh	1.2-2.8 EUR/kgH2 36-85 EUR/MWh
Cost driver 1	Electricity price 10-25 EUR/MWh	Electricity price 36-46 EUR/MWh	Natural gas price 3–32 EUR/MWh
Cost driver 2	Efficiency- LHV 69-75%		Efficiency-LHV 69%
Cost driver 3	Full load hour factor 15%-38%	Full load hour factor 40%-57%	CAPEX 1155 EUR/kW-H2
Cost driver 4	Electrolyser CAPEX 98-200 EUR/kWel		CO2 transport & storage 55. EUR/tCO2

(IV) Market Competitiveness

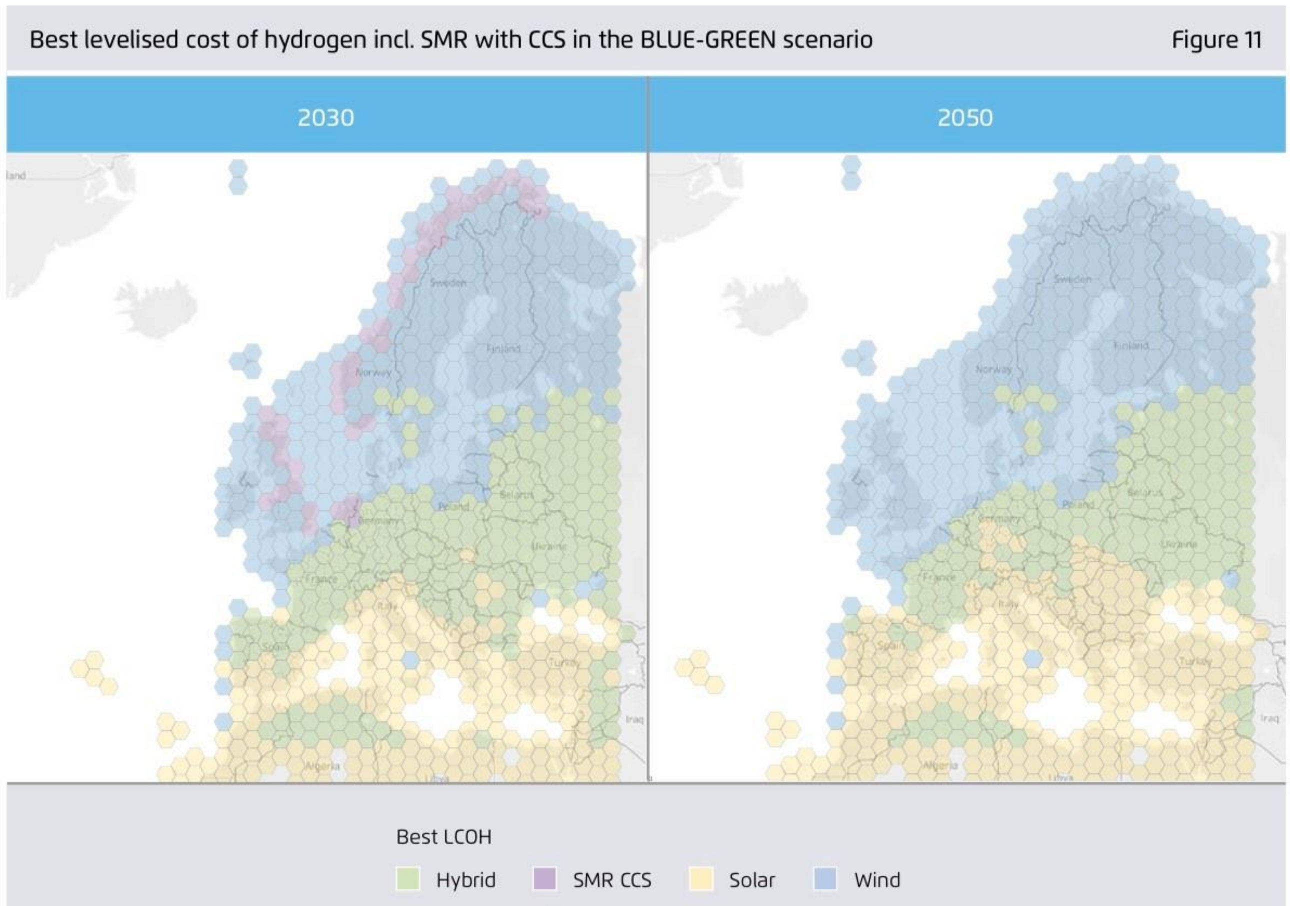
<u>Market Competitiveness has a locational dimension</u>

***In 2030: 4 types of "cluster competitiveness", not linked by corridors**

***Corridors come from 2035**

***Imports by sea**
When?
Game Changer?
High fixed costs
Low marginal

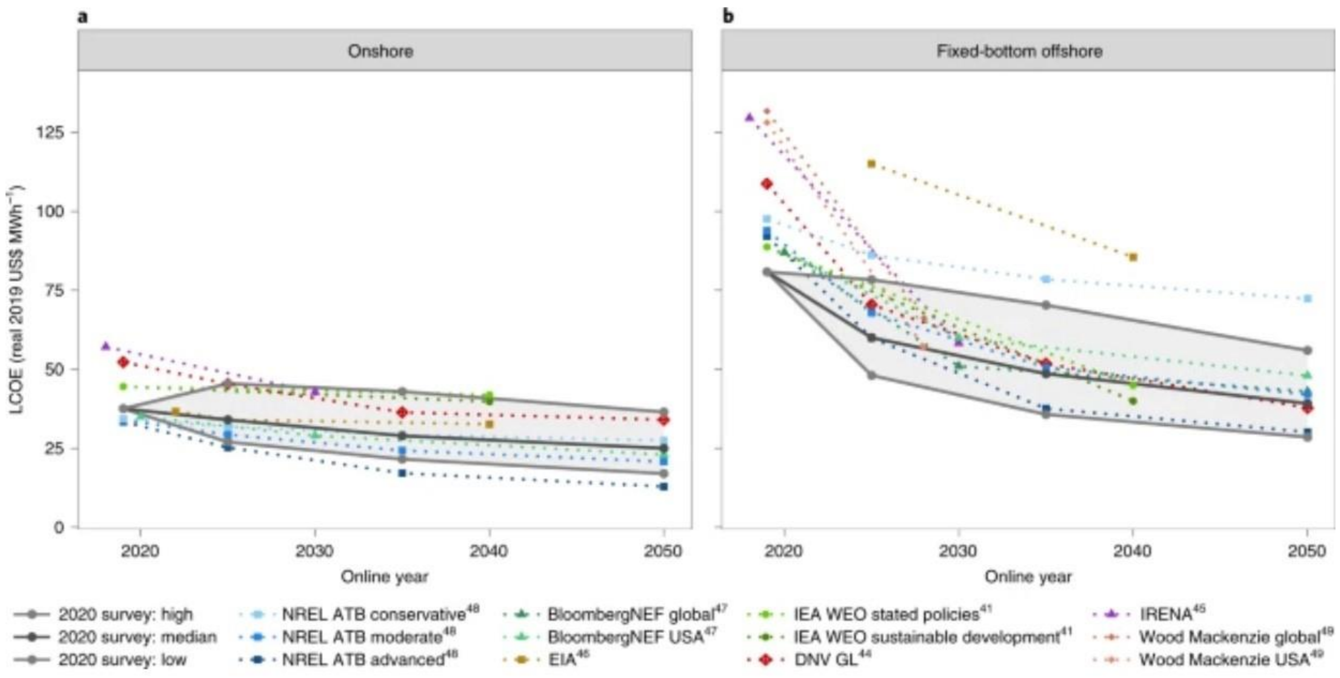
***Blue H2 dead in 2050**



(IV) Market Competitiveness

But we may too have many good surprises.
See new wind costs research published by "*Nature Energy*" (15 April 2021).
Onshore might go under Euro 25 MWh from 2030, Offshore under 40 in 2035

Fig. 8: Comparison of 2020 survey results with other contemporaneous LCOE forecasts.



Conclusions: a lot of promises & of challenges

<:> <u>4 dimensions to combine in applied EU hydrogen policy</u>:
Beware too fast, too general statements.
Beware the many risks & uncertainties.
Beware the different horizons and time-scales.

<:> <u>The 3 first dimensions</u>
****Policy Frame***
*****Policy Building Blocks***
******Industrial Economics***
are more the "internal jobs" of the EU & EU Member States.

<:> <u>The 4th</u>
Market Competitiveness
definitively the job of Ukraine.

>> Good luck to Ukraine & very welcome into our EU H2 market!

Email : jean-michel.glachant@eui.eu

Tweeting on Twitter: @JMGlachant ~88 000 tweets

Web site: http://fsr.eui.eu/