European Green Deal – Hydrogen is key to Europe‘s industrial development

Hydrogen for Climate Action

How to kick-start Europes Hydrogen economy

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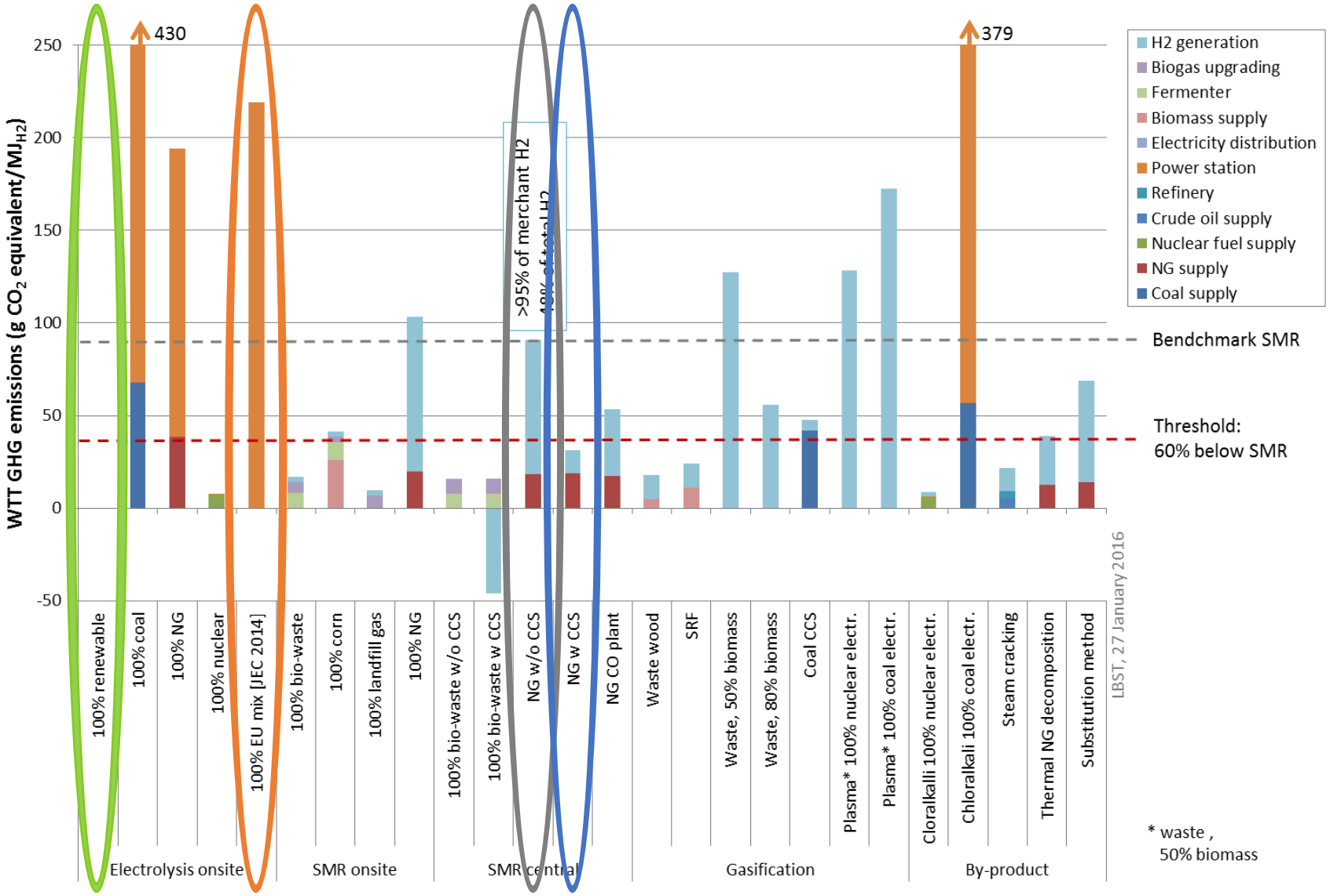
Why Hydrogen ?

- Hydrogen is an environment- and climate-friendly (zero-emmission) energy carrier
- Produced from RES it has the potential to essentially replace fossile-based energy
- It suffers from a supply/demand deadlock which effectively hinders cost reductions by economies of scale
- Once Green Hydrogen becomes available in big quantities at lower cost a lot of applications in mobility, industry and energy sector suddenly become economically viable
- For many required technologies specialized and qualified manufacturers are found in Europe
- At the same time, many MSs are struggling to achieve the agreed emmission reduction targets in sectors which could be decarbonised with Hydrogen and risk significant fines

Zero emission is difficult to achieve



* waste ,
50% biomass

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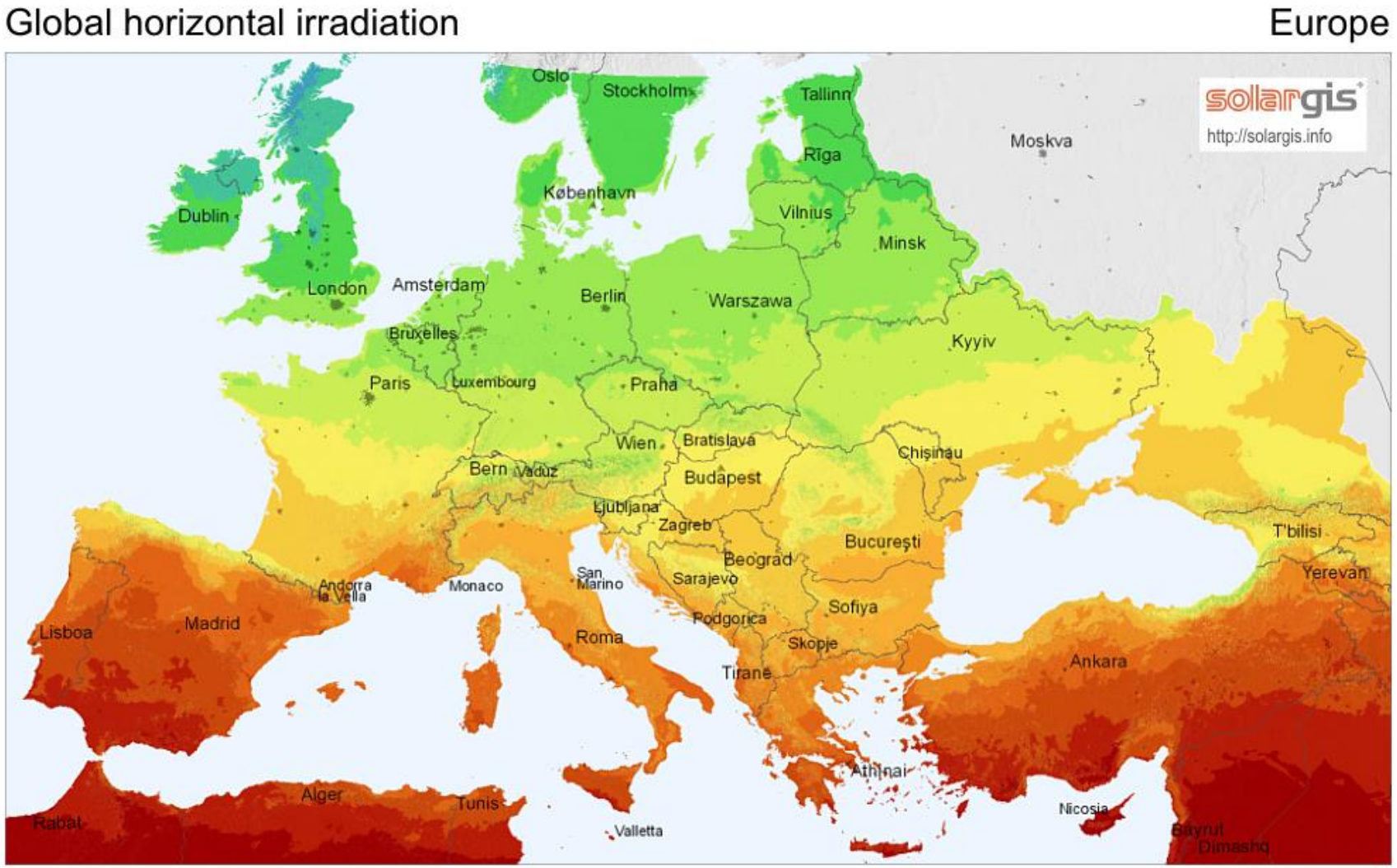
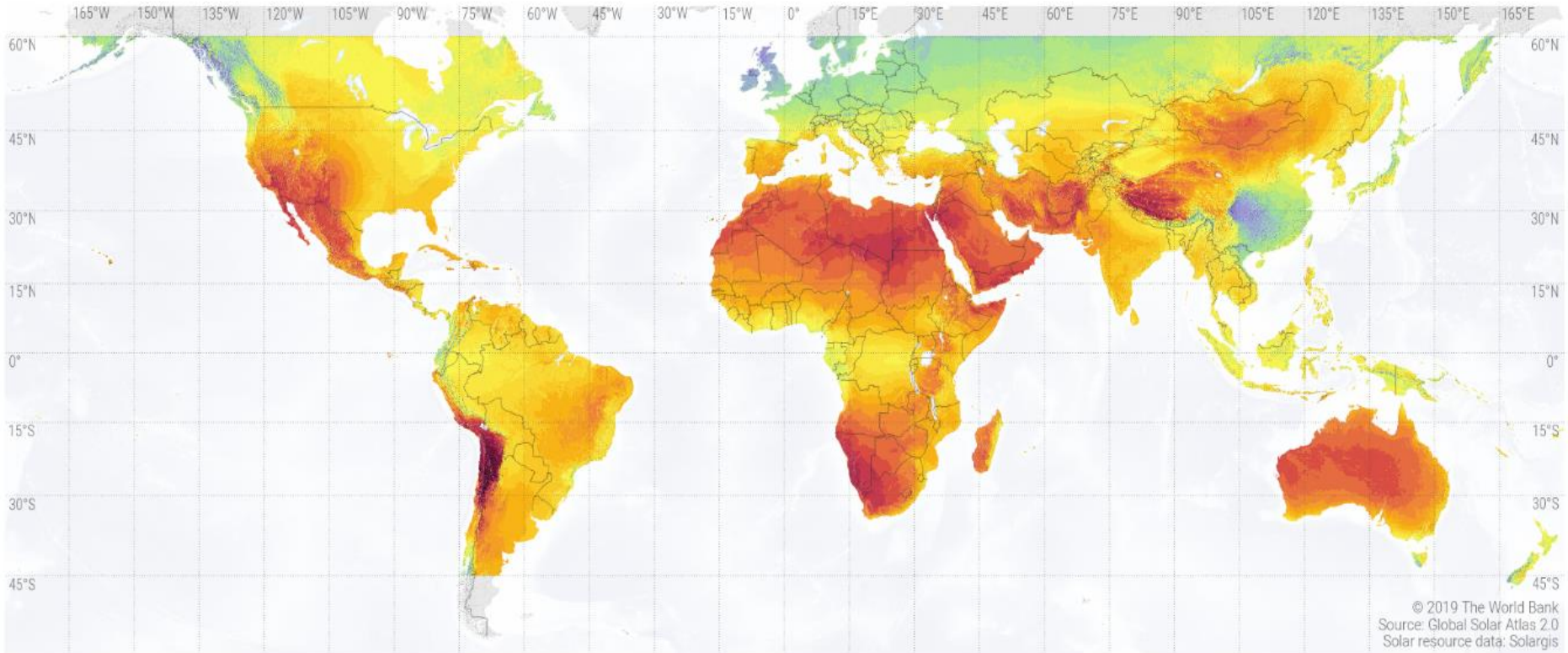
European Solar Energy Potential



SOLAR RESOURCE MAP

PHOTOVOLTAIC POWER POTENTIAL



Long-term average of photovoltaic power potential (PVOUT)

Daily totals:	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4
												kWh/kWp
Yearly totals:	730	876	1022	1168	1314	1461	1607	1753	1899	2045	2191	2337

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The Future Challenges

- „Clean Planet for all“ forsees more than a doubling of electric energy
- Public „nervousity“ regarding extra costs of climate
- To optimize costs Renewable energies need to be transported long way
- Renewable energies are not available 24 hours/12 months
- The electricity grid reaches its hard limits (depends on MSs)
- High costs of the electricity grid for long distances

Big scale renewable energy ...

... triggers big scale green Hydrogen

Everybody agrees on need for 2050 net-zero

How to get there?

The Hydrogen based options

Small is beautiful

National solutions

Global approach

Small is beautiful

- Up to 20 MW
- Local solution
- Grid electricity or bio mass
- Reasonable investment size
- „Hydrogen Valley“ component

7 –> 5 € / kg H_2

B National solutions

- Up to 2 GW
- Relevant impact to national grid
- Balancing issues
- Significant investment size
- Additionality ?
- Non-trivial distribution cost

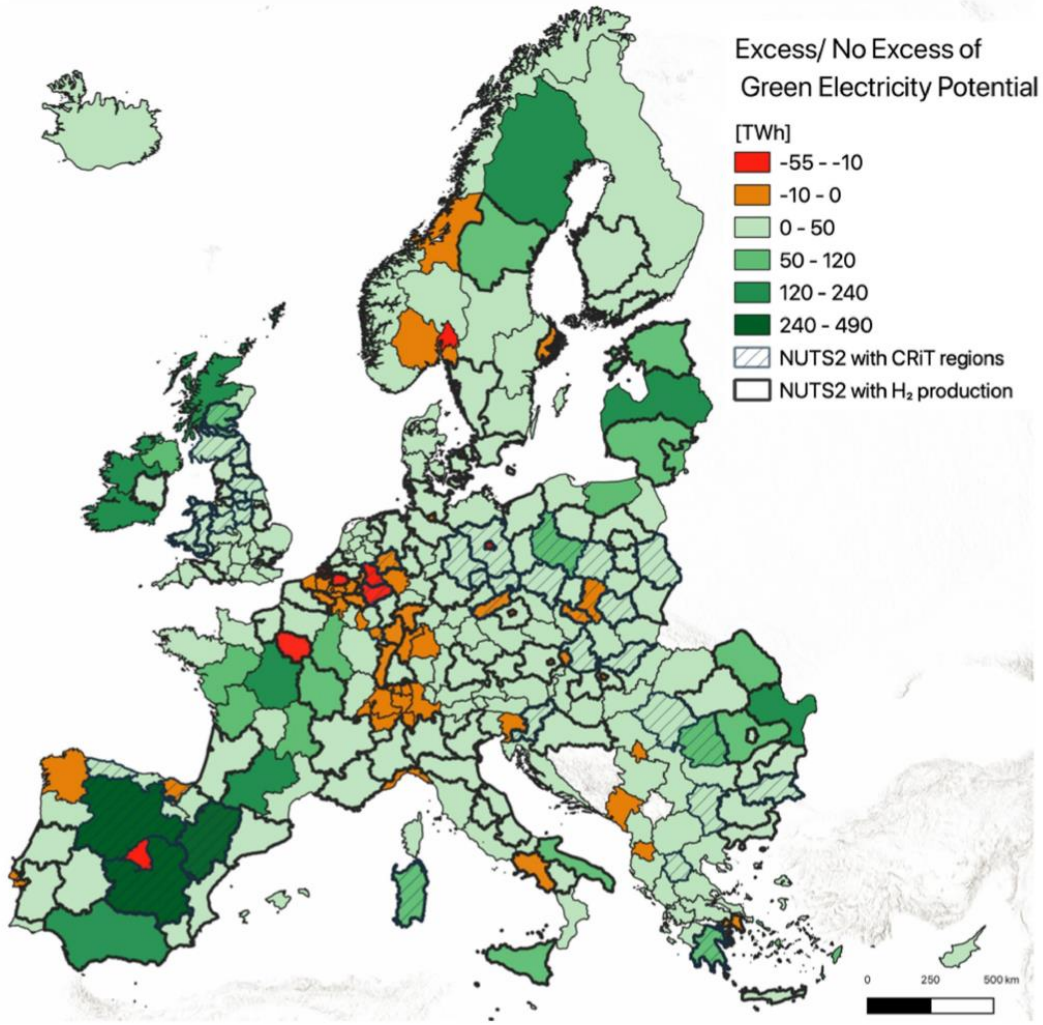
5 –> 3 € / kg H_2

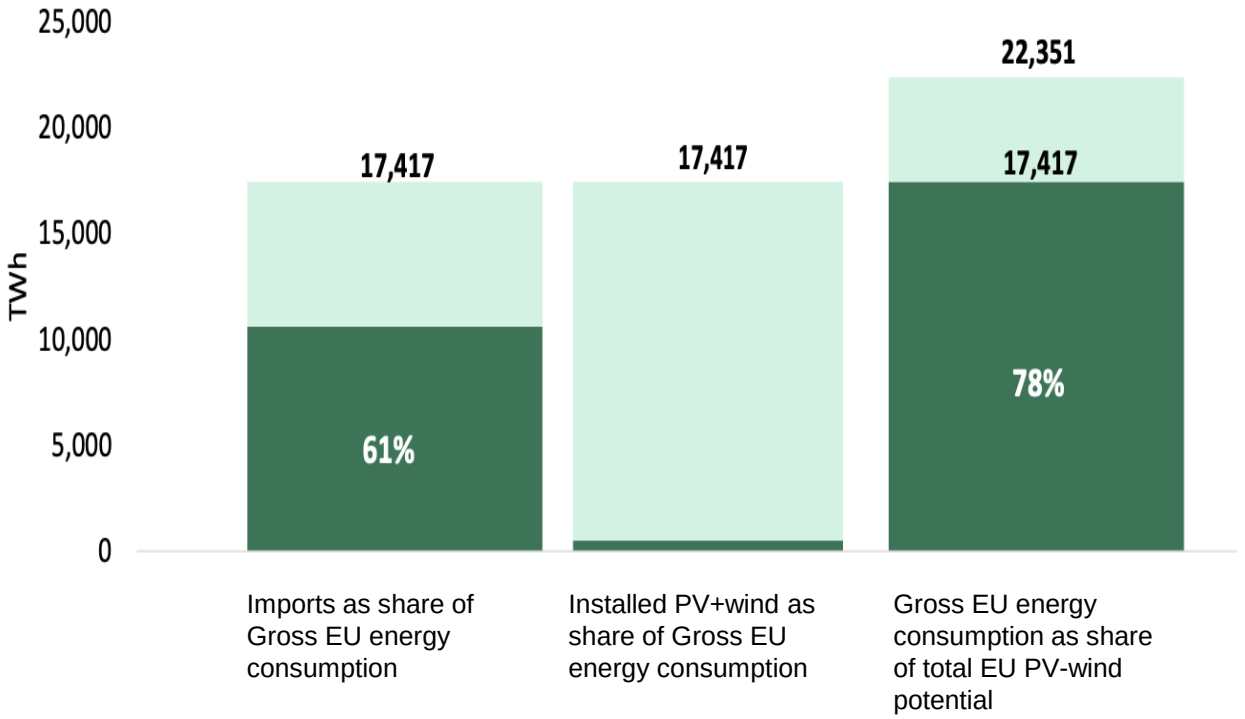
Global solutions

- Serious climate impact
- Production at the lowest cost locations
- Big throughput pure hydrogen pipeline networks required
- Massive industrial applications possible
- Fast track to commercial viability

2 –> 0,9 € / kg H_2

Renewable potential in the EU





We could go it alone, but not individually

Green Hydrogen from PV in the desert

10 € /MWh RE

= equiv.

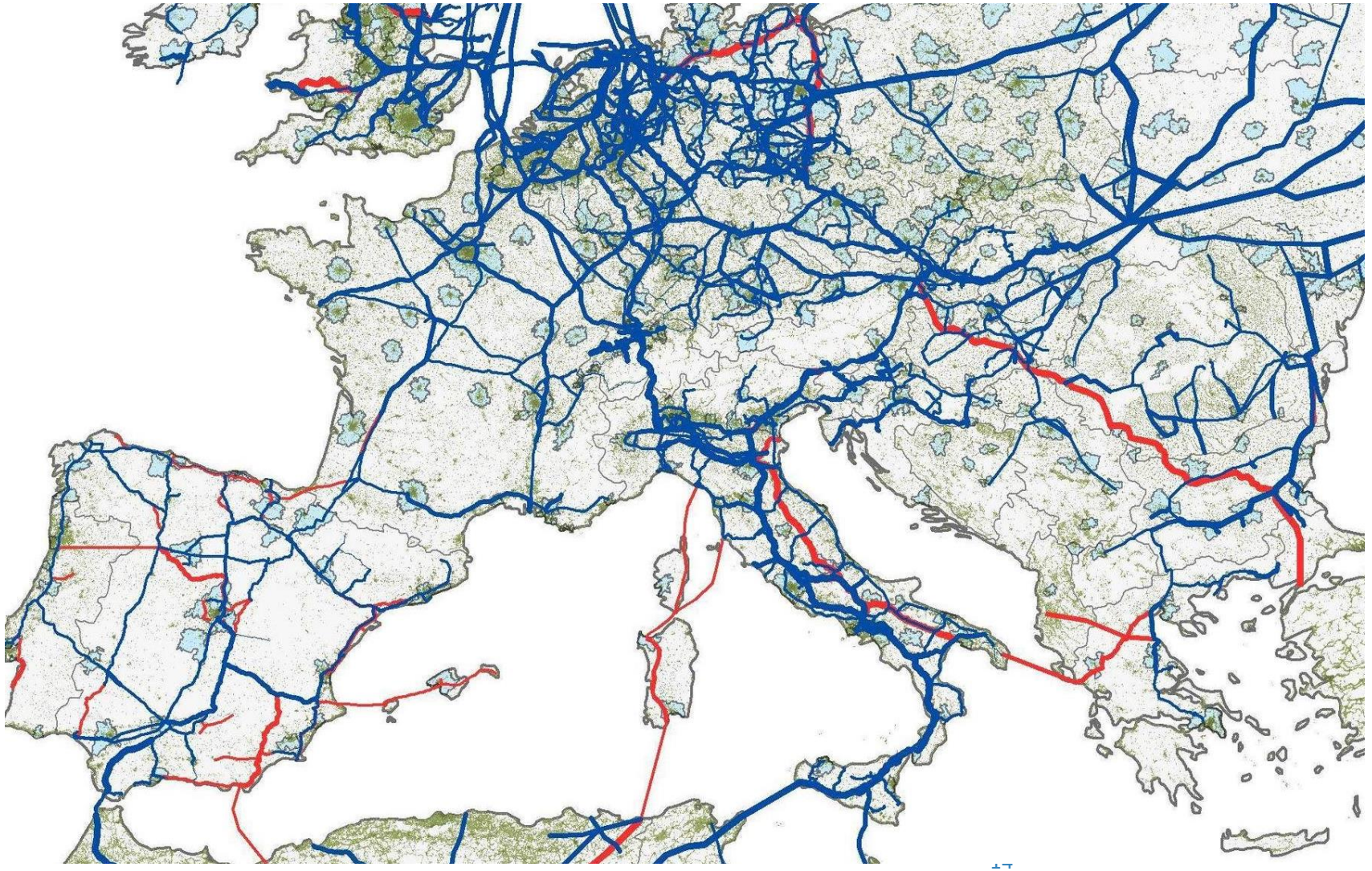
0,3 €/kg H2 + equipm

0,6 €/kg H2 incl CAPEX

0,9 €/kg H2 sustain.

➔ **0,9 €/Kg production**

Repurposing existing NG Pipelines



- EU Hydrogen Backbone Study
- Initial network could be set-up quickly
- 11 ct/kg H2/1000km LC

➔ 0,3 €/kg transmission

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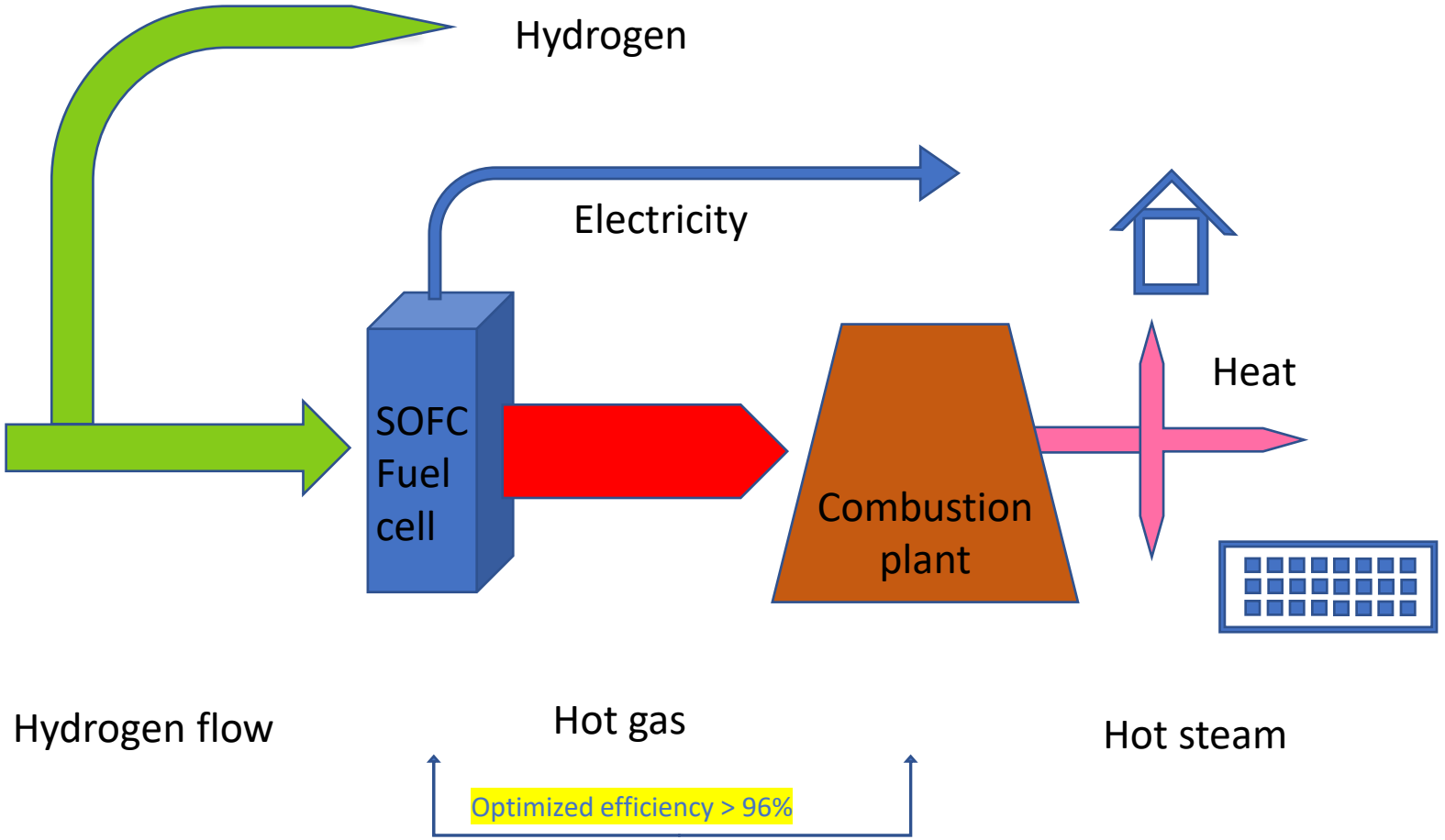
H2 Reconversion to electricity and heat



Cost of deliverables

- Green H2

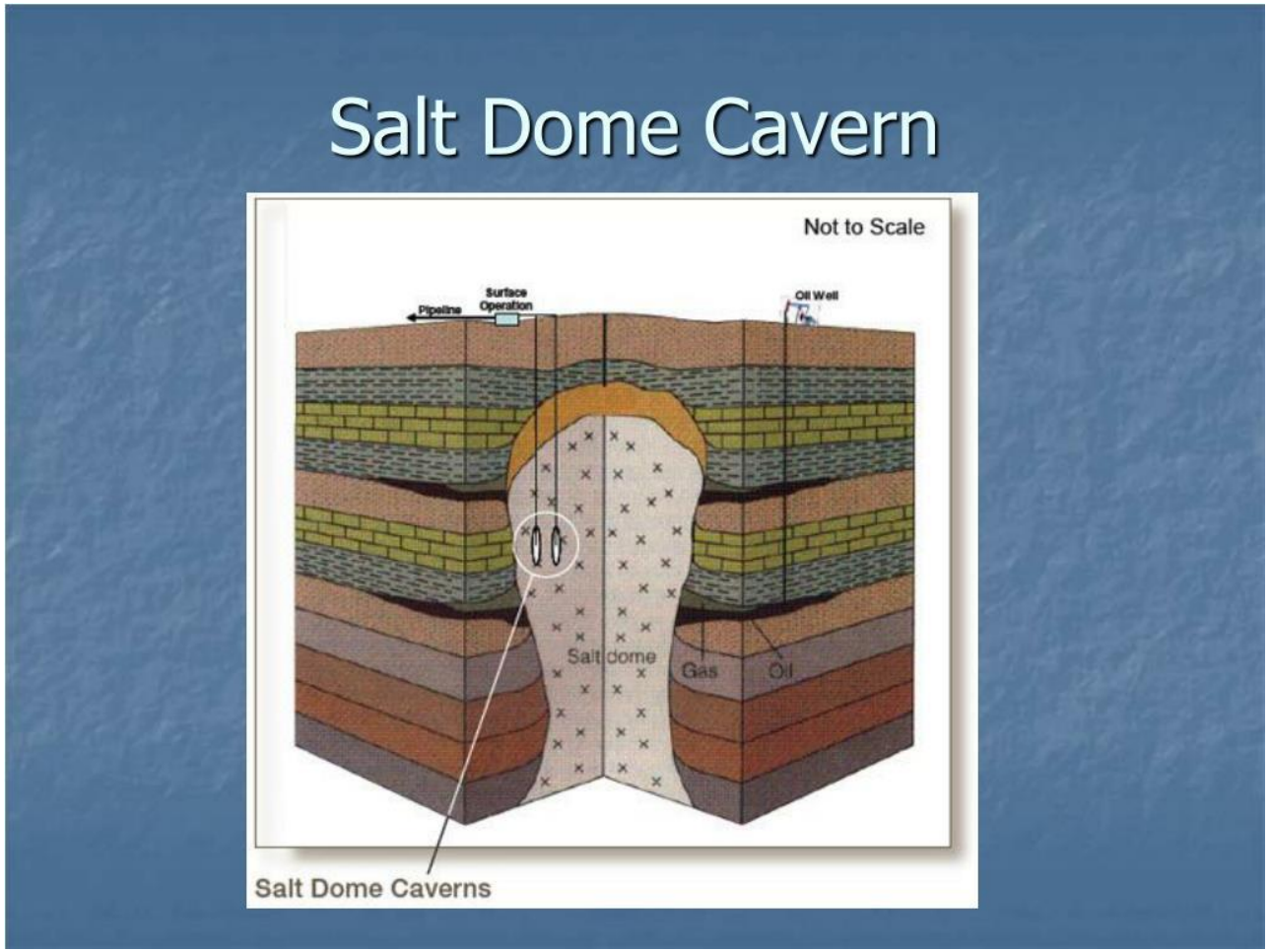
at 1,5 €/kg

- Renewable Electr. at 40 €/MWh

- (District) Heat

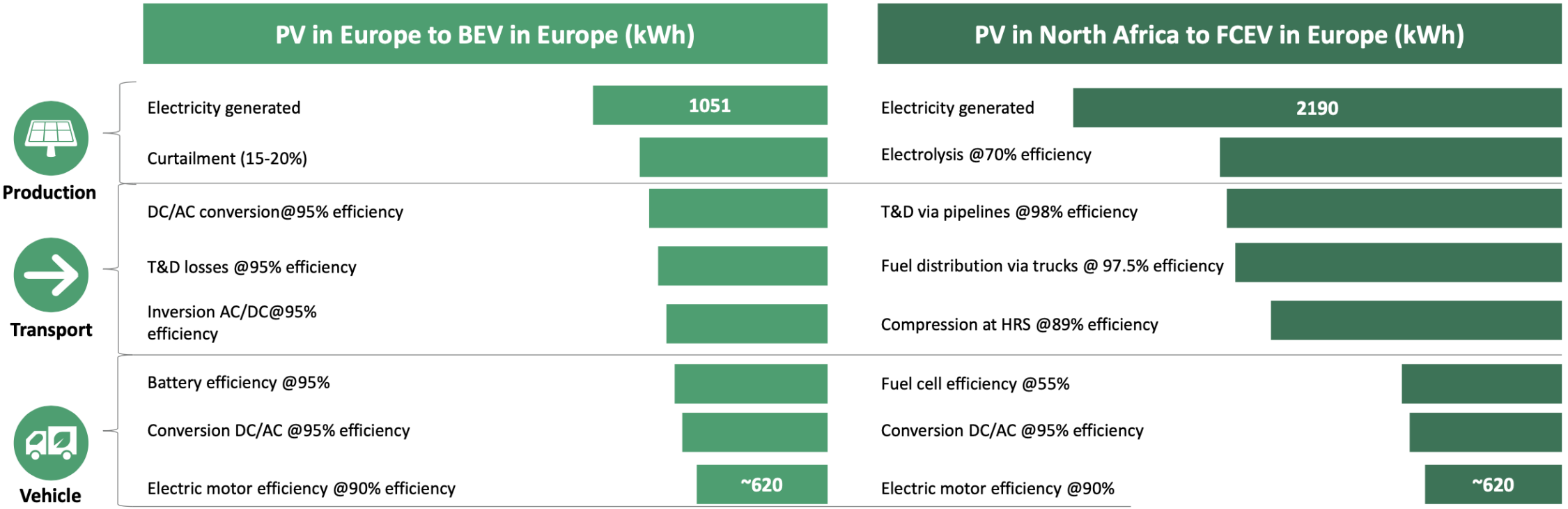
at 55 €/MWh

Seasonal Hydrogen Storage



- Hydrogen can be stored in salt caverns
- test case in the EU in Groningen
- Studies show sufficient capacity all over EU
- Cost estimates are very promising

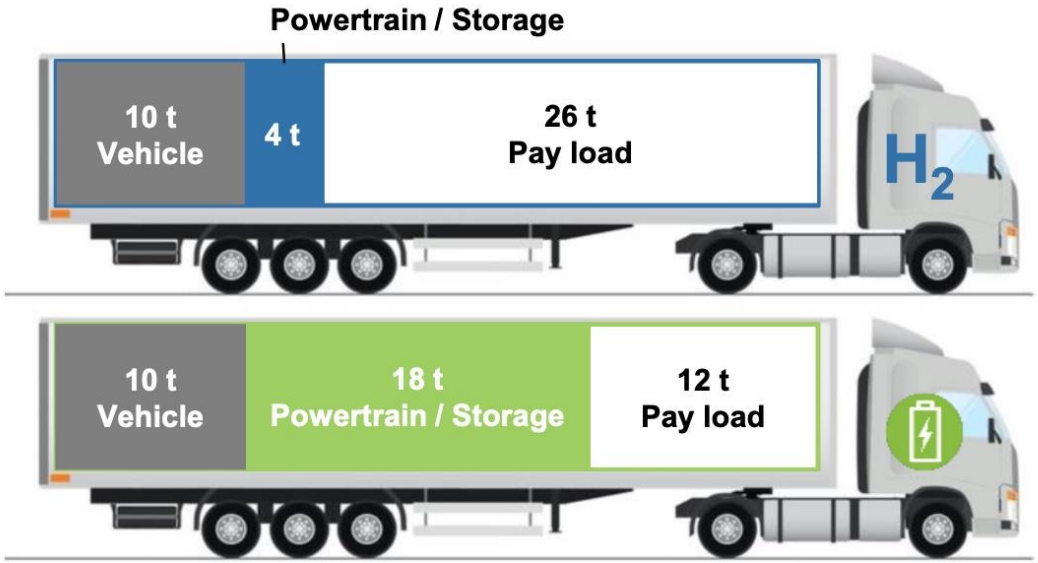
Comparing BEV to FCEV fuel supply systems



- „Additionality“ issue
- Load on electricity grid
- Buffering /dispatchability
- Costs for charging infrastructure

- Offloading electricity grid
- Seasonal storage possibility
- Lower system cost

Long distance Battery trucks are not energy efficient !



Hydrogen Fuel Cell

Battery

> 2x more traffic

Refueling / Charging Duration

	Power in MW	Duration in h
H2 - TK 16 HF	15	0,2
BEV - 500 kW	0,5	4,2
BEV - 1 MW	1	2,1

Hydrogen Fuel Cell

TtW Energy

<u>3 kWh/km</u>

Battery

> 2x more traffic

<u>2 x 2,1= 4,2 kWh/km</u>

Fit for 55

- 3000 pages of text to implement green deal
- 1000 hydrogen is mentioned
- RED2 revision – more hydrogen friendly
- RFNBOs new definitions – 50% renewable requirements
- HRS every 150 kms on TEN-T corridors
- Hydrogen infrastructure included in TEN-E
- 50% of industrial hydrogen to be renewable
- EU wide fuel certification system to include H2

Current pathways to roll-out hydrogen

- The ETS Innovation Fund
- IPCEIs
- The Recovery Fund & the Structural Funds
- EU & National Climate Programs
- Flagship & Lighthouse Projects
- Financial Market Triggers & Taxonomy Rules
- Political Costs of Fossil energies

Want more info on hydrogen?

https://ec.europa.eu/growth/industry/policy/european-clean-hydrogen-alliance

https://www.ech2a.eu

https://hydrogeneurope.eu/

https://fch.europa.eu/

https://www.fch.europa.eu/european-hydrogen-week

http://s3platform.jrc.ec.europa.eu/hydrogen-valleys

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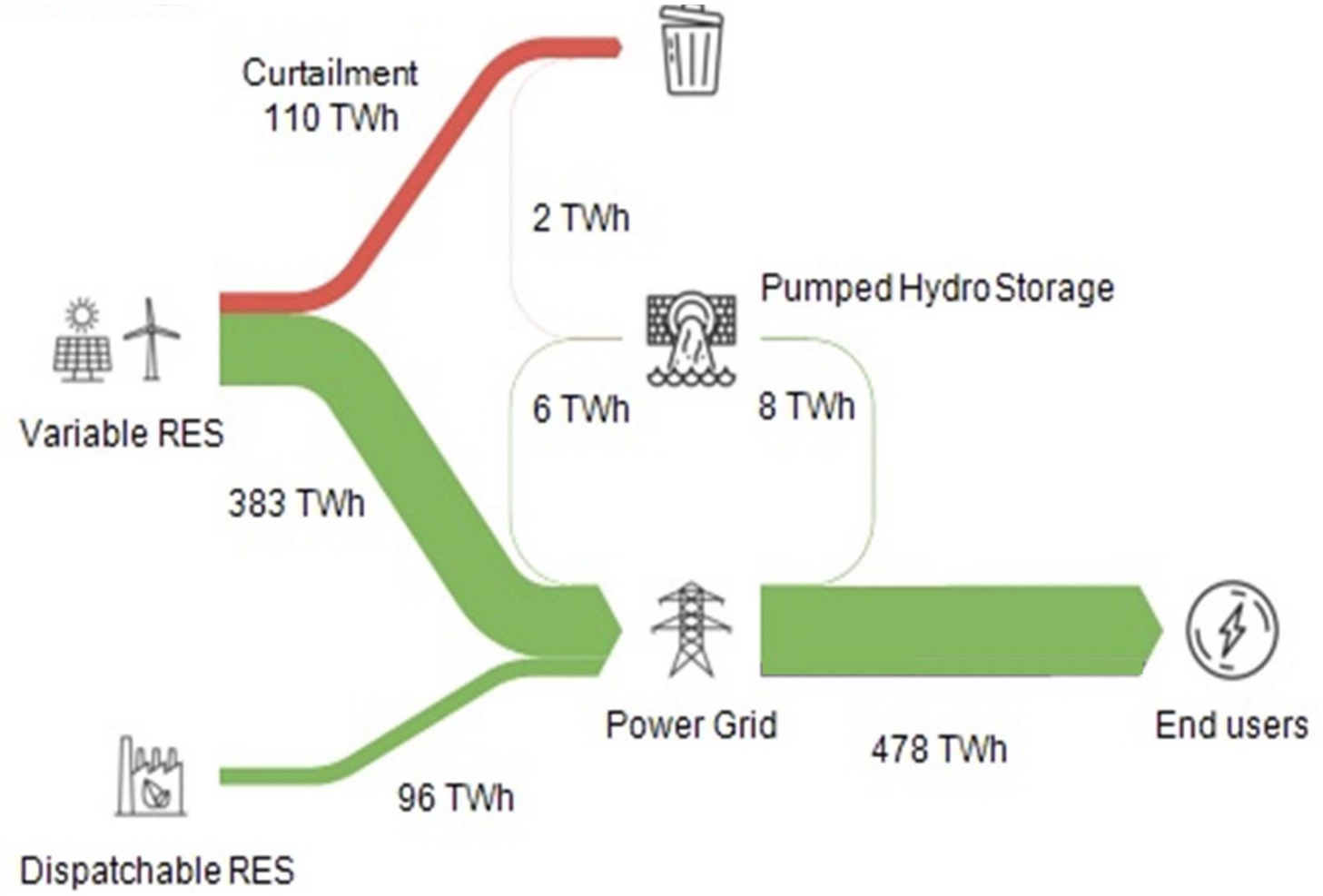
The renewable electricity circuits today



The problem zones

- Short term fluctuations
- Seasonal disparities
- Storage
- Long distance transmission