

Technologie, ekonomika i rola magazynowania wodoru w systemie energetycznym

Warsztat | Ministerstwo Klimatu i Środowiska

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600+ Members

We encompass the entire value chain of the hydrogen ecosystem: from production, distribution to end users, including industry, European regions, National Hydrogen Associations, and Global Partners.

40+ Countries from Europe and beyond

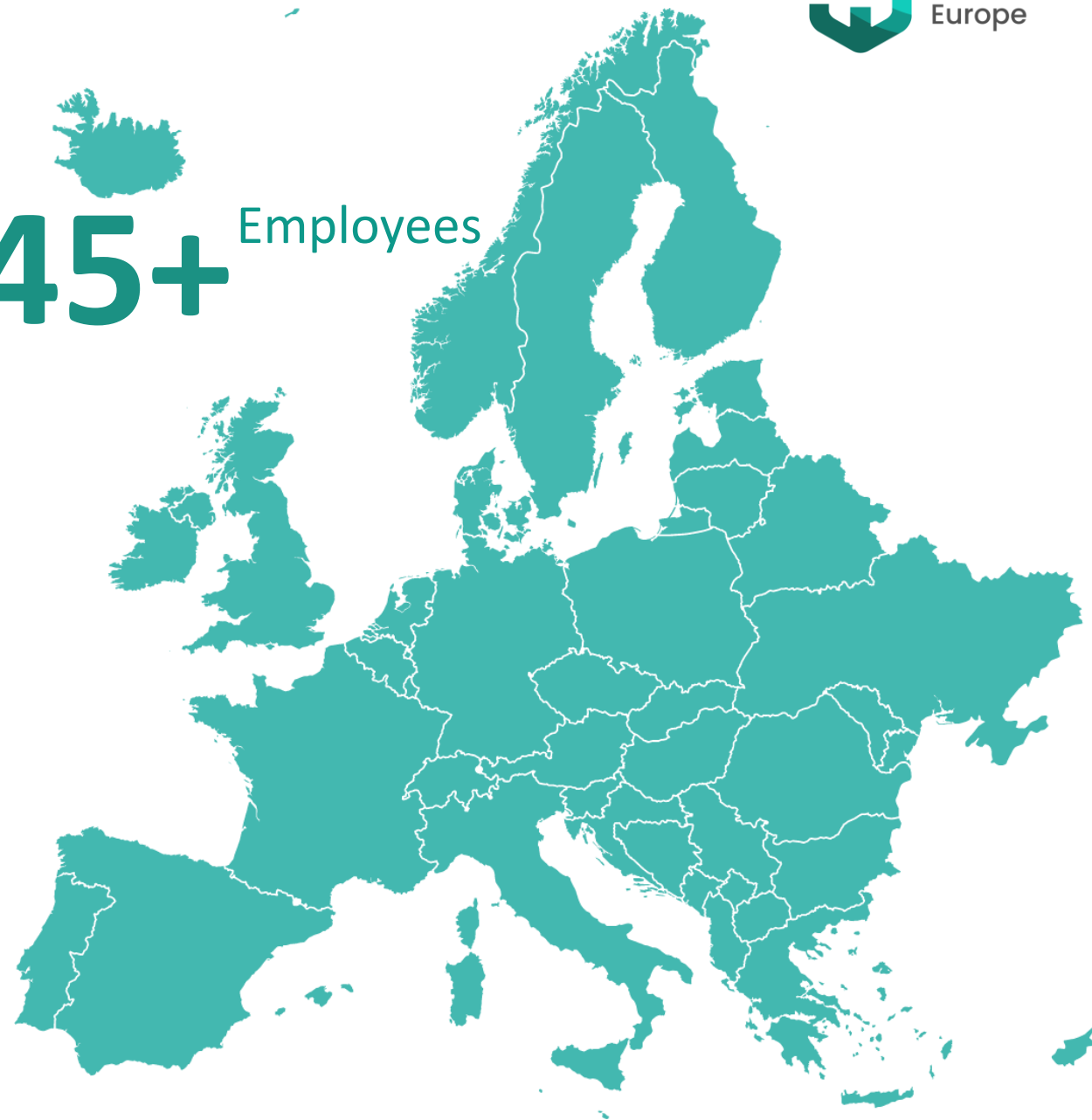


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Potencjalne role magazynów wodoru w systemie



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Potencjalne role magazynów wodoru w systemie



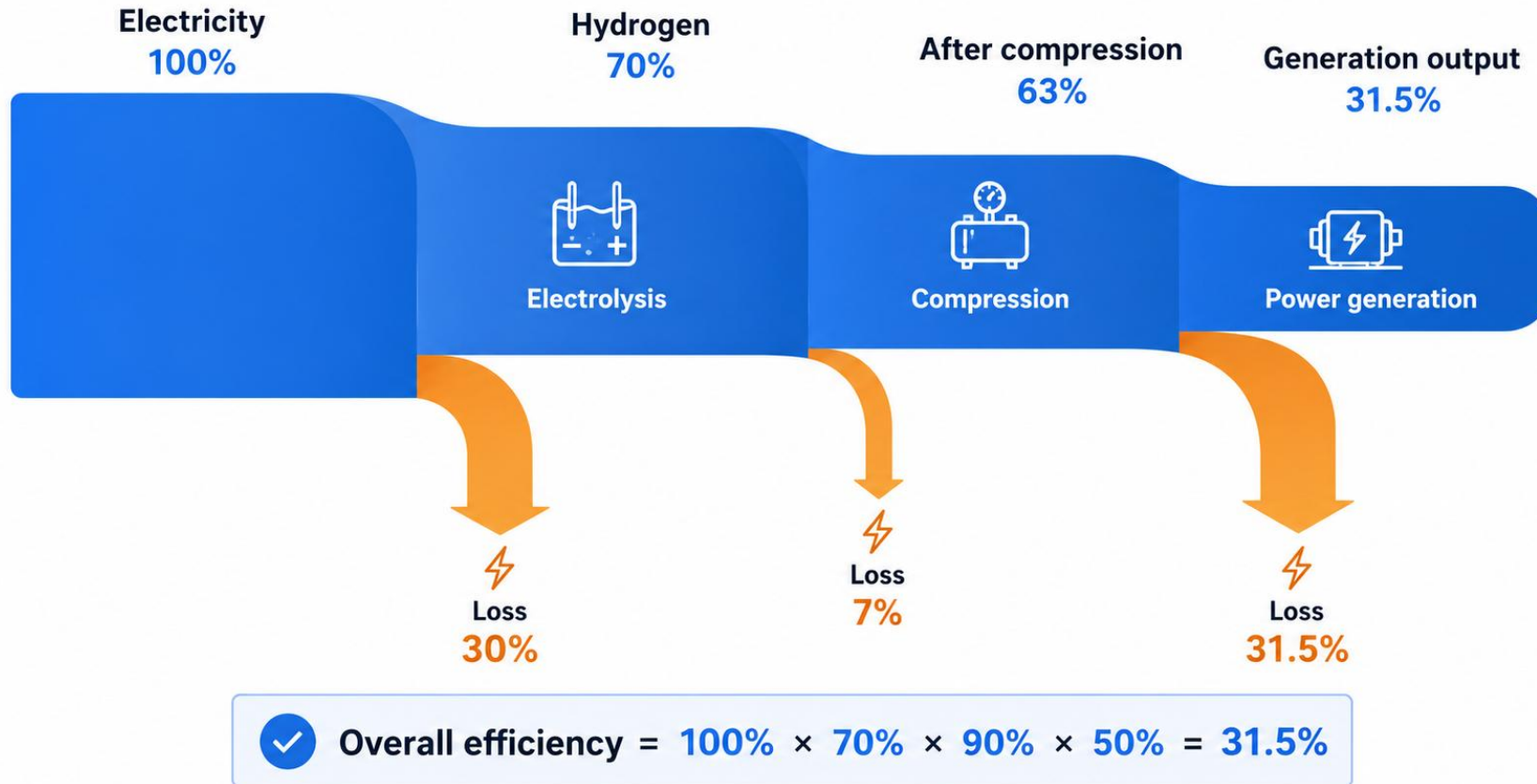
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Main challenge from electricity system's POV

Low roundtrip efficiency compared to alternatives

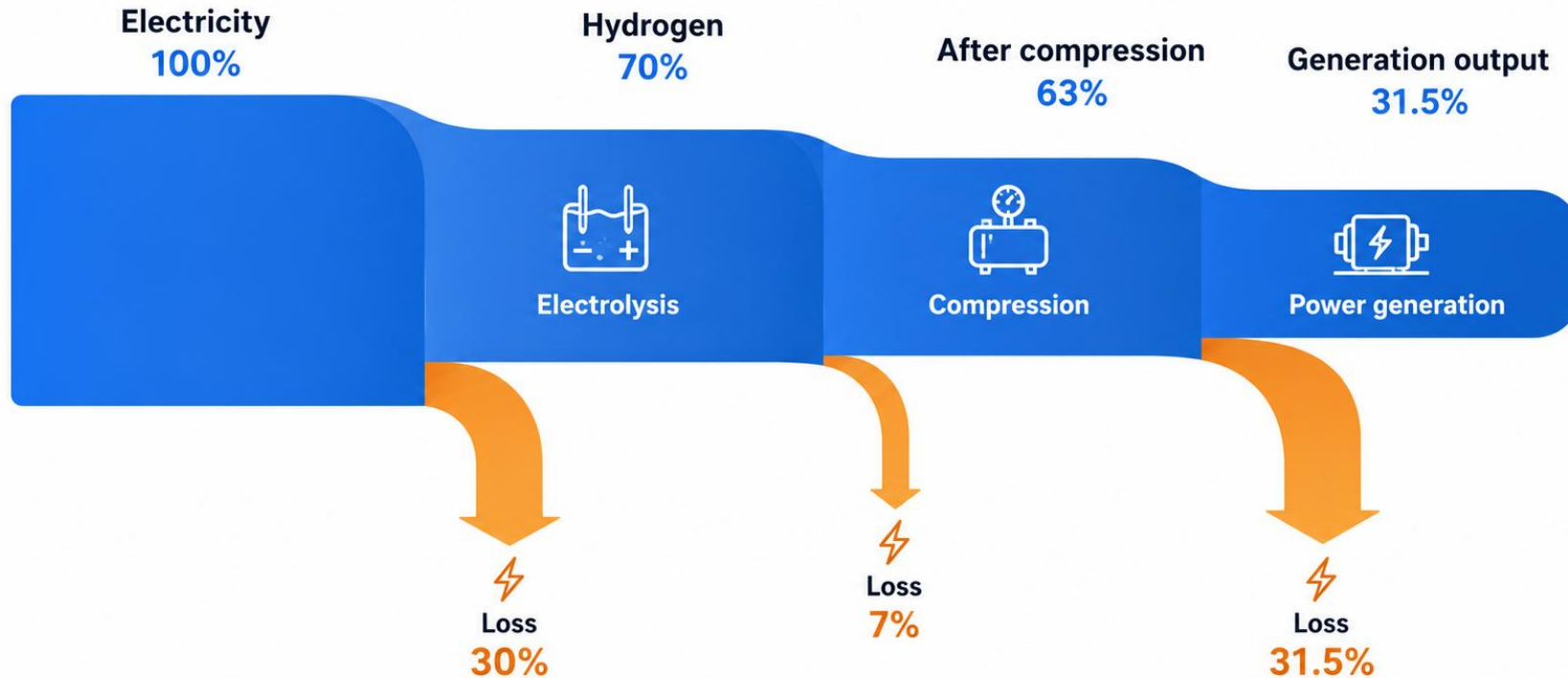
Round-trip efficiency of electricity → hydrogen → electricity



Main challenge from electricity system's POV

Low roundtrip efficiency compared to alternatives

Round-trip efficiency of electricity → hydrogen → electricity



✓ Overall efficiency = $100\% \times 70\% \times 90\% \times 50\% = 31.5\%$

VS

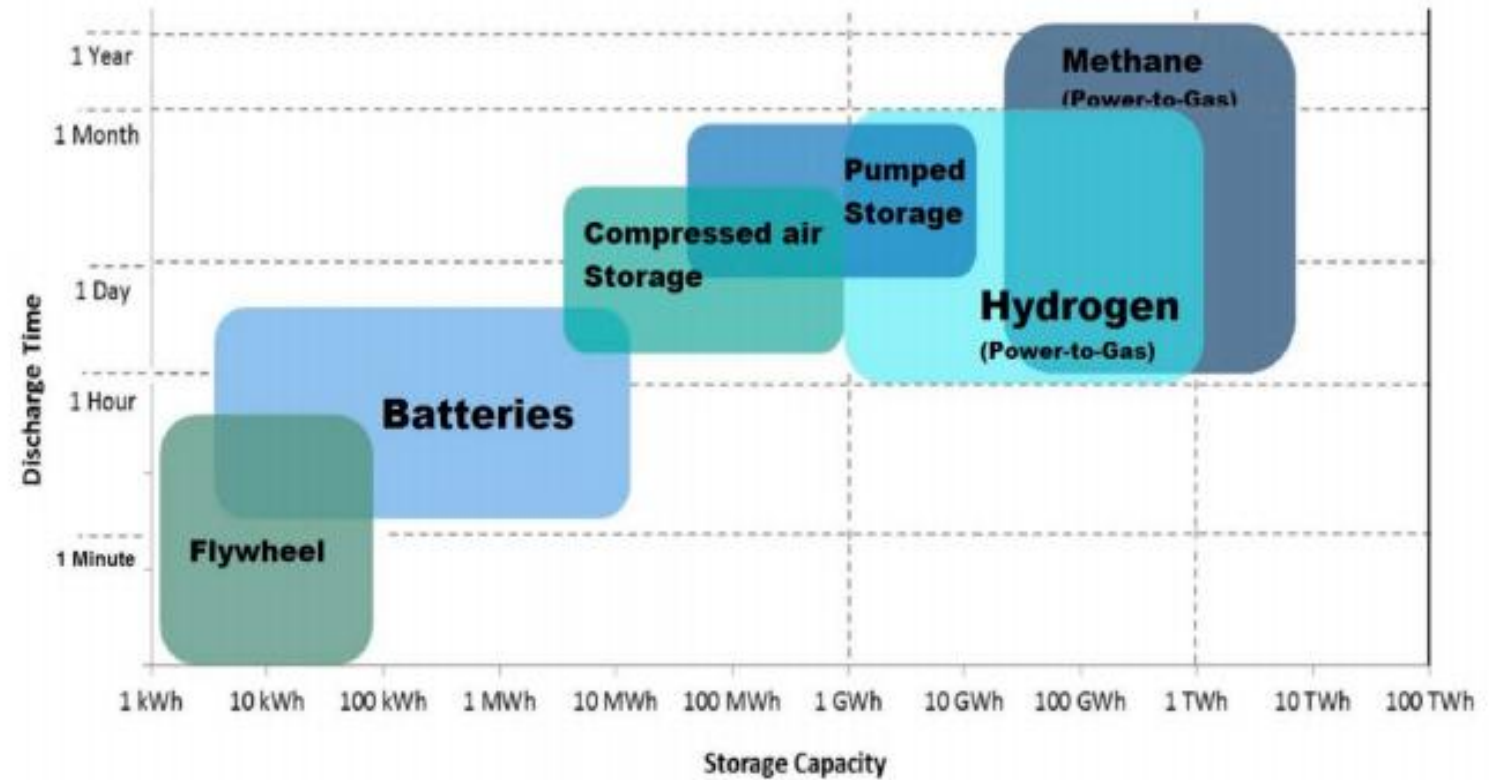
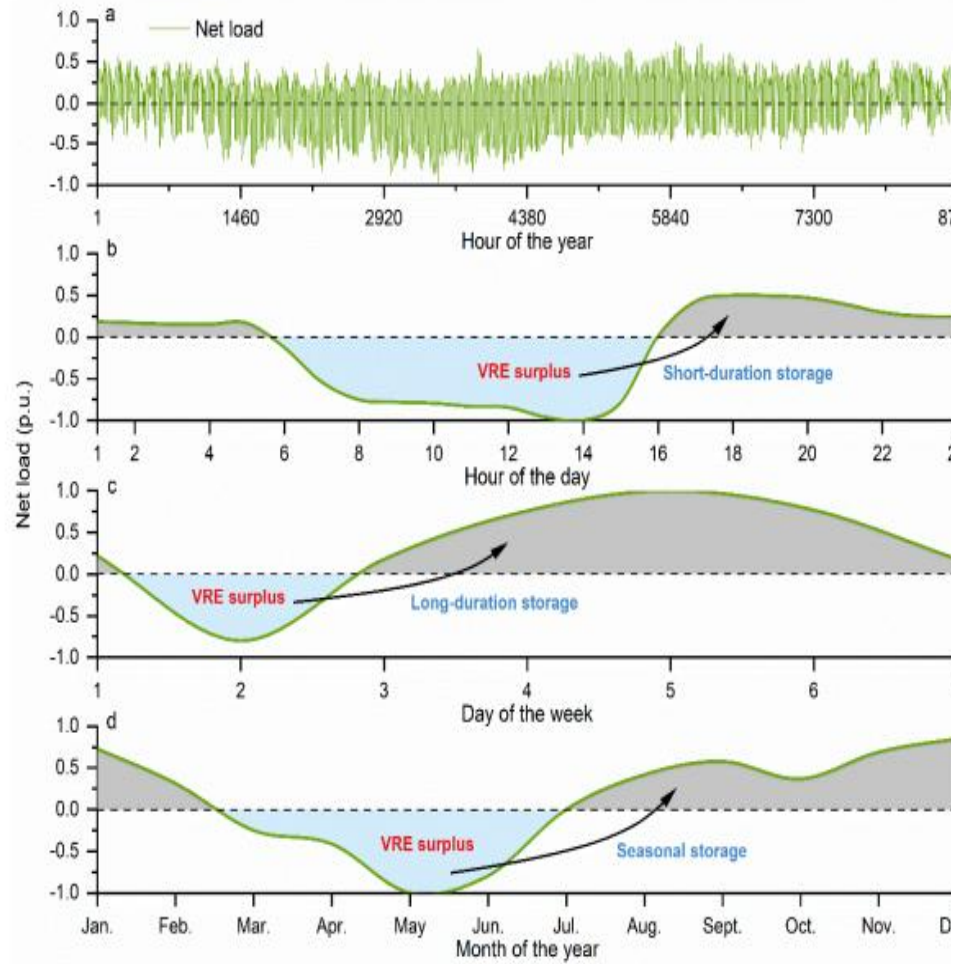
BESS 90%

PHS 70-80%

CAES 60-70%

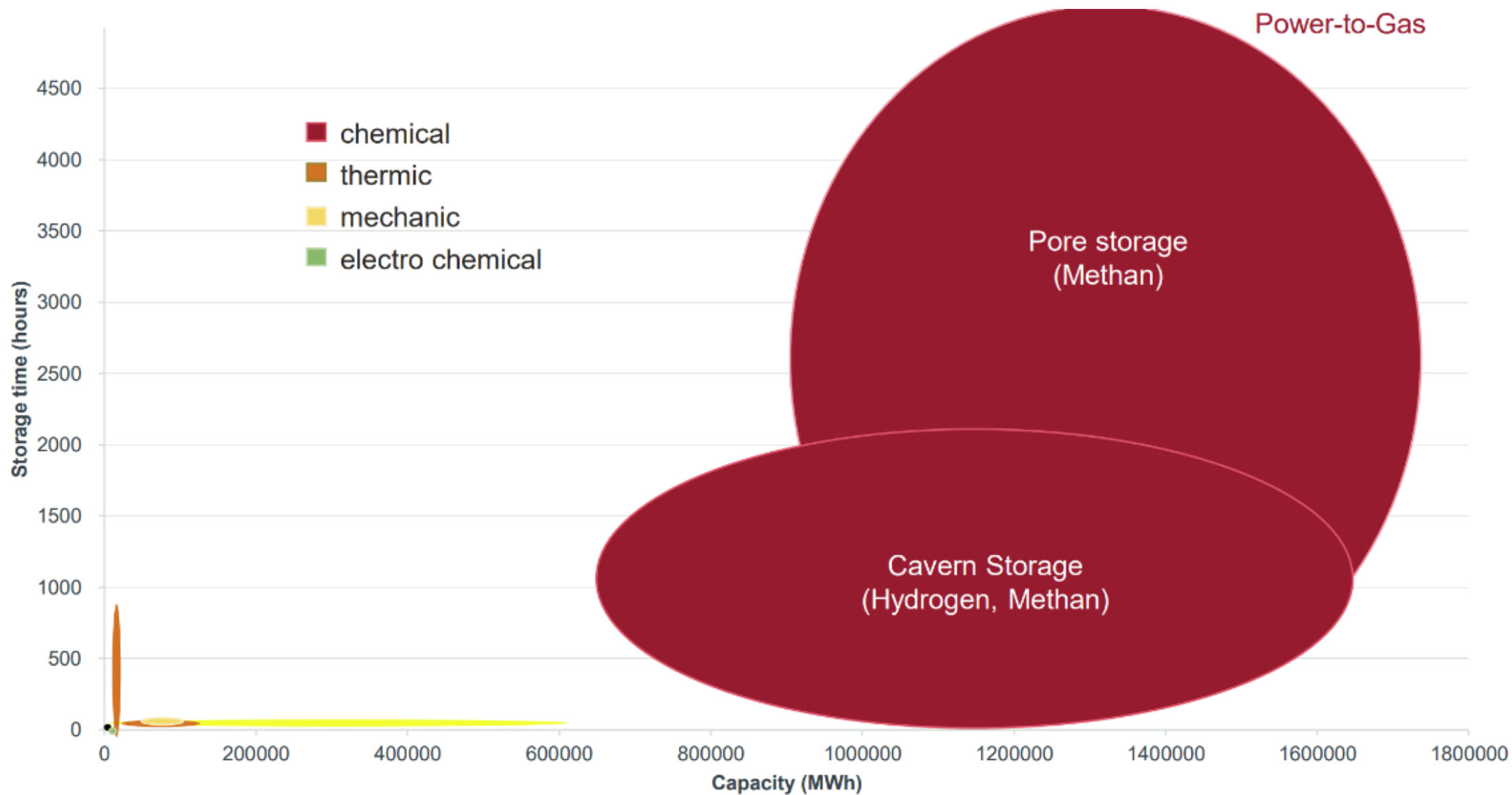
The opportunity? The need for seasonal storage

Flexibility is needed across different timeframes



Source: School of Engineering, RMIT University (2015)

Available energy storage technologies



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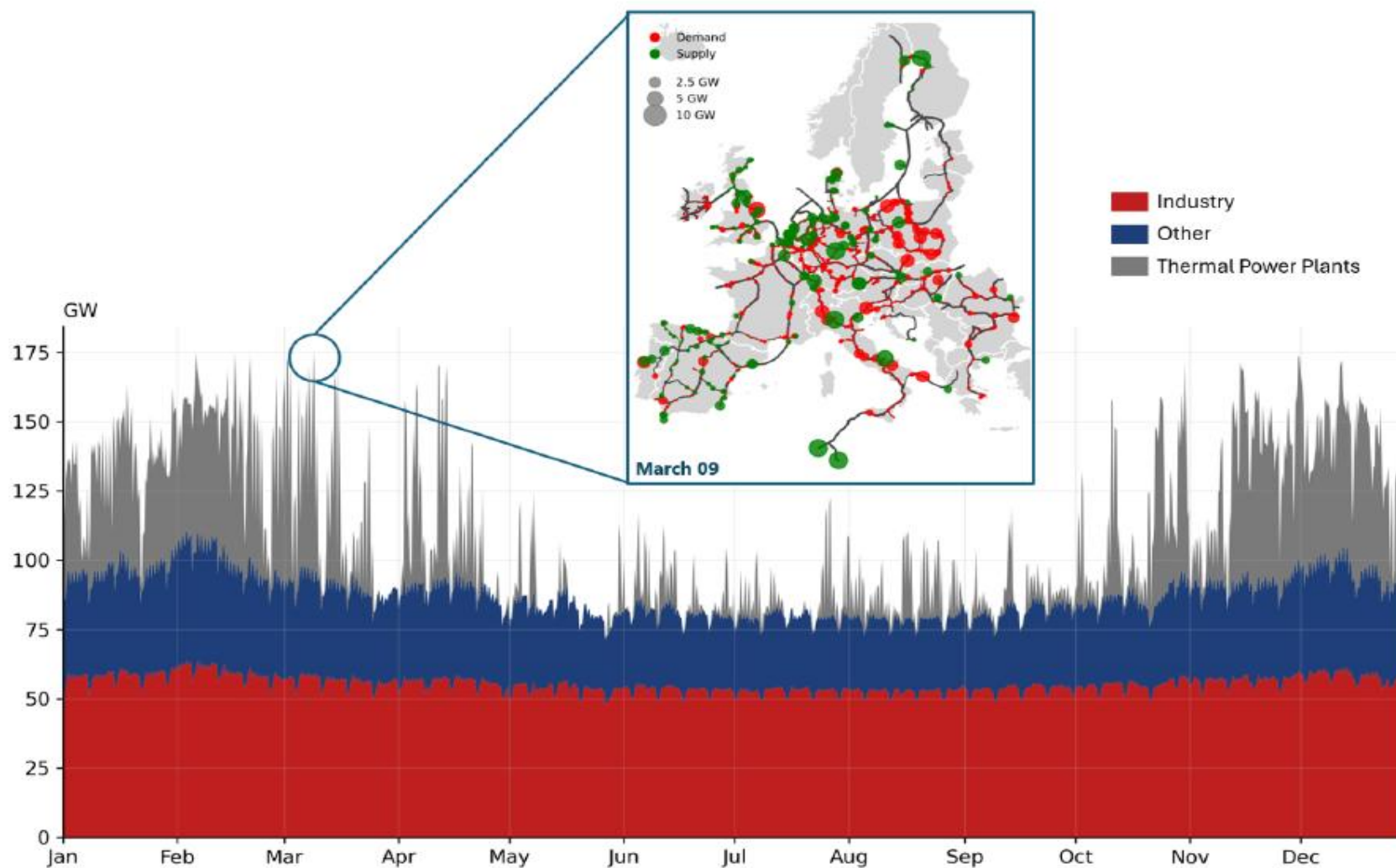


Figure 20: Hourly hydrogen demand in 2040 in the Core Scenario and spatial distribution of hydrogen demand and supply in the maximum-demand hour.

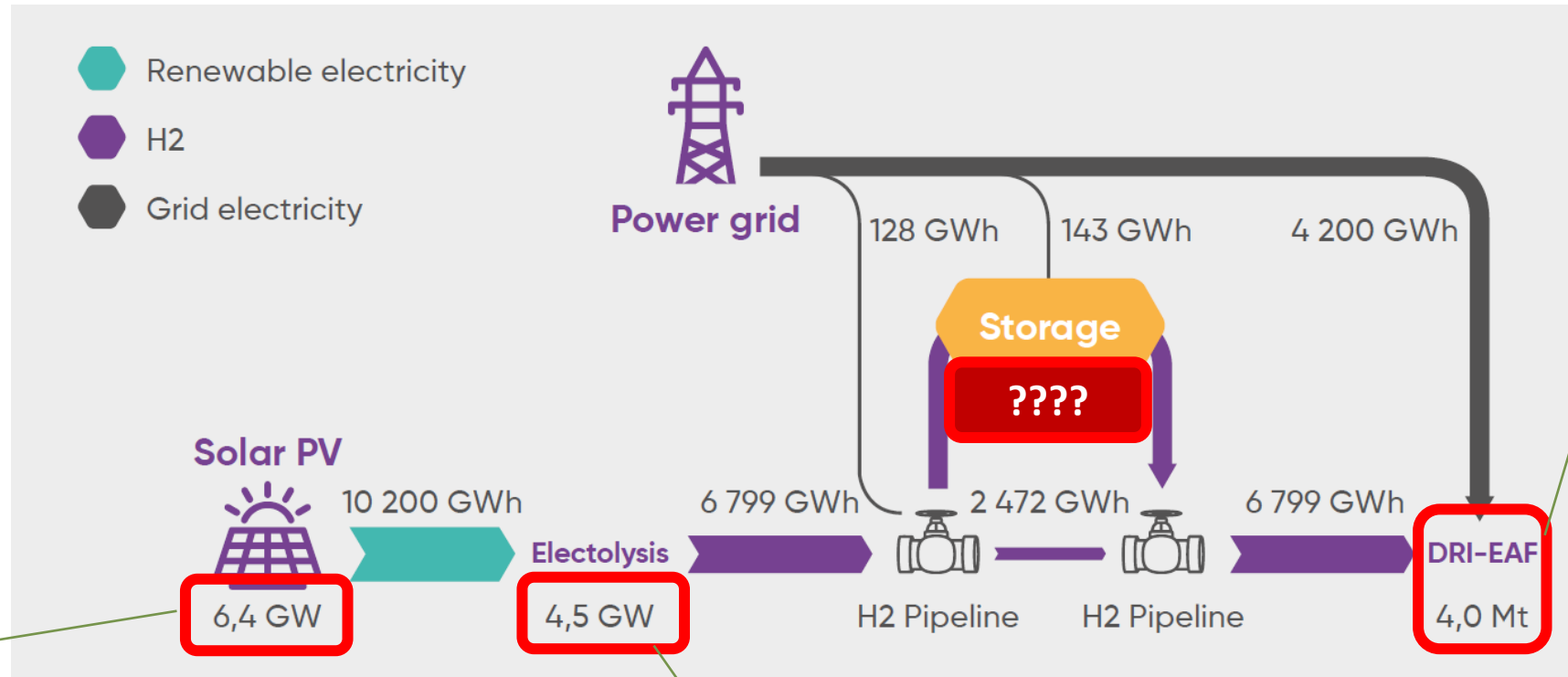


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How much storage is enough to enable fuel switch for industry?

Thyssenkrupp in Duisburg has 4 x as much as on the graph



4 Mtpa of steel would require 200 ktpa of hydrogen → 10,2 TWh of Renewable electricity

Depending on capacity factor.
Solar PV only would require up to 5 GW
Grid connected running at full load would require „only“ 1,3 GW

What does 1 day of H2 storage look like?

- Average primary steel plant in the EU has a capacity of ~4 Mtpa of steel
- Switching to H2 DRI would require around 200 ktpa of hydrogen
- 1 day of storage = 550 tonnes of storage capacity
- Standards steel tank storing H2 at 200 bar and 100 m3 volume stores around 1.4 tonnes of H2



X 400

What does 1 day of H₂ storage look like?

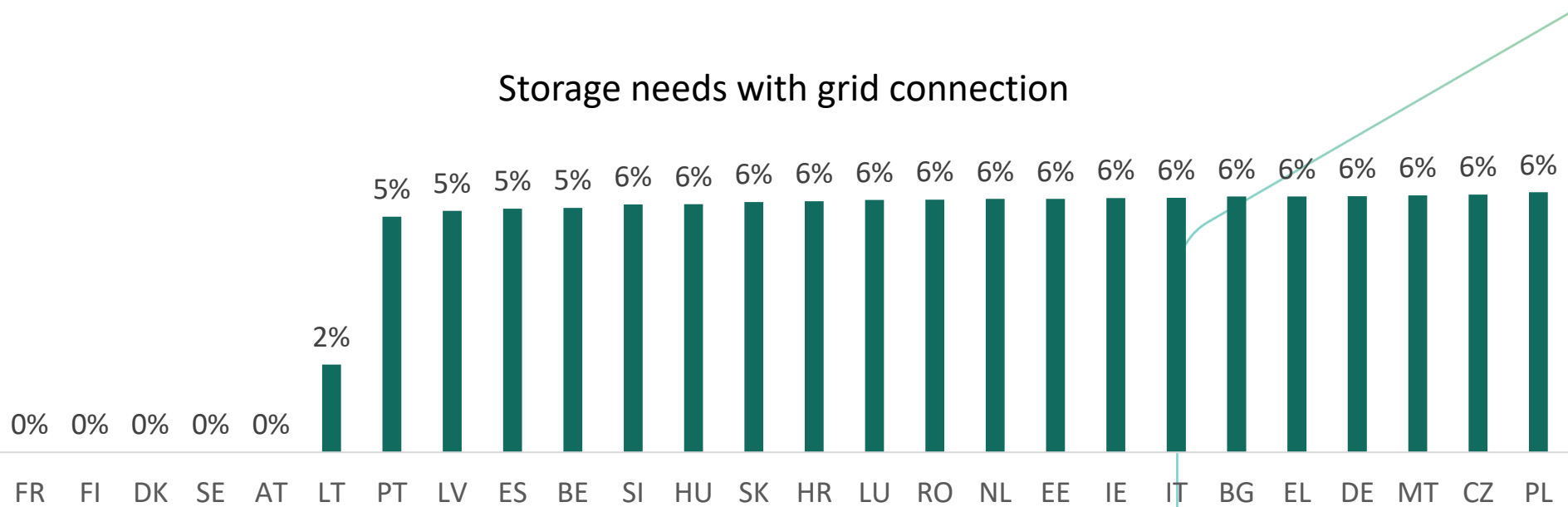
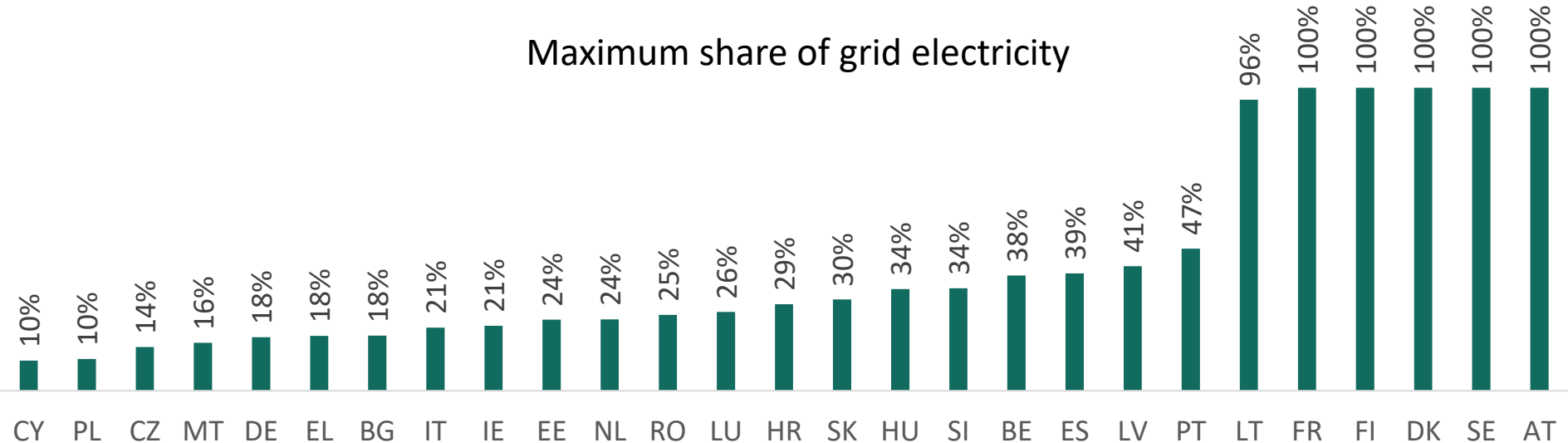


The regulatory framework is making it even more difficult



- At least 42% of used hydrogen needs to be renewable
- Renewable sources need to be “additional”
- Renewable sources cannot be subsidized
- From 2030 renewable energy production needs to be matched to hydrogen production on hourly basis
- No other low carbon electricity sources (e.g. nuclear) are recognised
- DNSH criteria requires ALL hydrogen to be at least low carbon for any state aid supported project
- ...

What about using grid electricity?



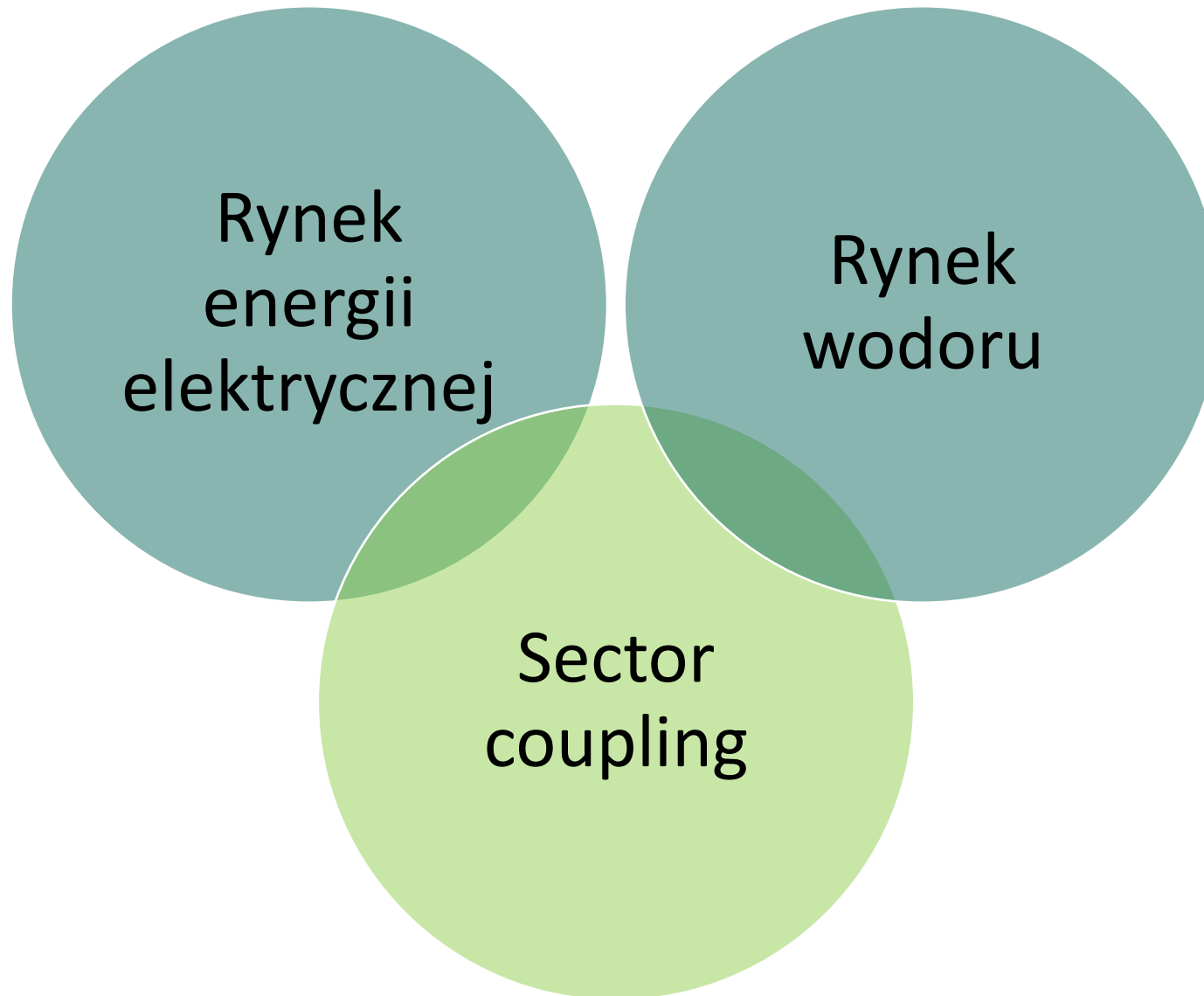
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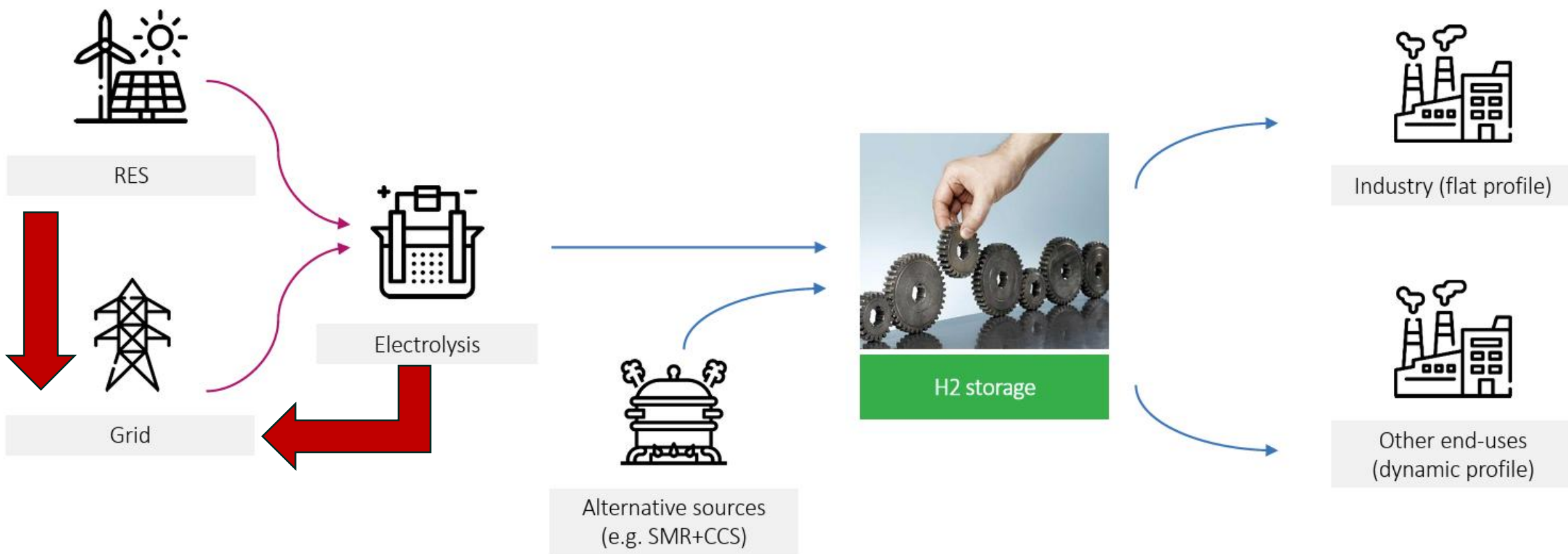
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Technologie

Overview of possible technologies to store hydrogen underground

Salt caverns are not the only option – but are a clear front runner

HyUnder Project Benchmarking of Selected Storage Options		Salt Caverns	Depl. Oil Fields	Depl. Gas Fields	Aquifers	Lined Rock Caverns	Unlined Rock Caverns	Weighted Coefficient
Safety	Tightness of Storage	++	+	++	++	+	-	2
	Feasibility to prove tightness	++	++	++	+	o	-	2
	Practical experience	++	o	+	+	o	o	2
Technical feasibility	Working gas capacity	+	++	++	++	o	-	1.5
	Flexibility	++	o	o	o	+	+	1.5
	Content of impurities	++	-	o	+	++	+	1.5
	Damage to storage by reactions	++	-	-	-	++	++	1.5
Investment costs	Exploration efforts	+	+	++	-	o	o	1
	CAPEX	+	+	++	+	-	-	1
Operation	Static and dynamic stability	++	+	+	+	++	+	0.5
	OPEX	++	o	+	+	++	o	0.5
Rank		1	5	2	3	4	6	

Legend: ++ Very good + Good o Fair - Poor -- Insufficient

80 Underground Hydrogen Storage projects under development



Source: h2inframap.eu

9.1 TWh

large-scale hydrogen projects have been announced in the EU to be commissioned by 2030

36 TWh

gap between scheduled and needed projects by 2030

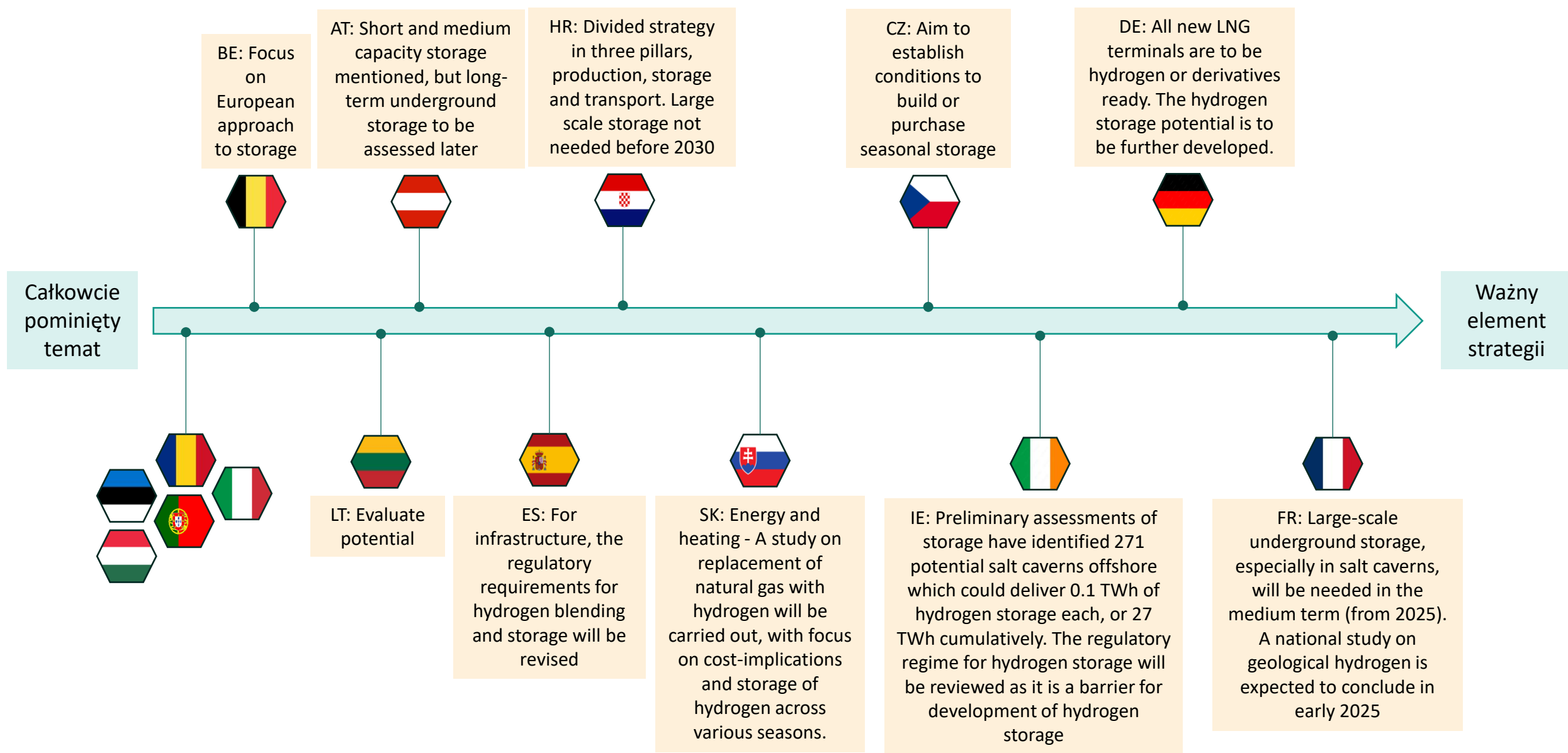
36 billion

investments required to narrow the gap

Source: H2eart for Europe

Jak to widzą inni

Miejsce magazynów wodoru w strategiach innych krajów UE



Thank You



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