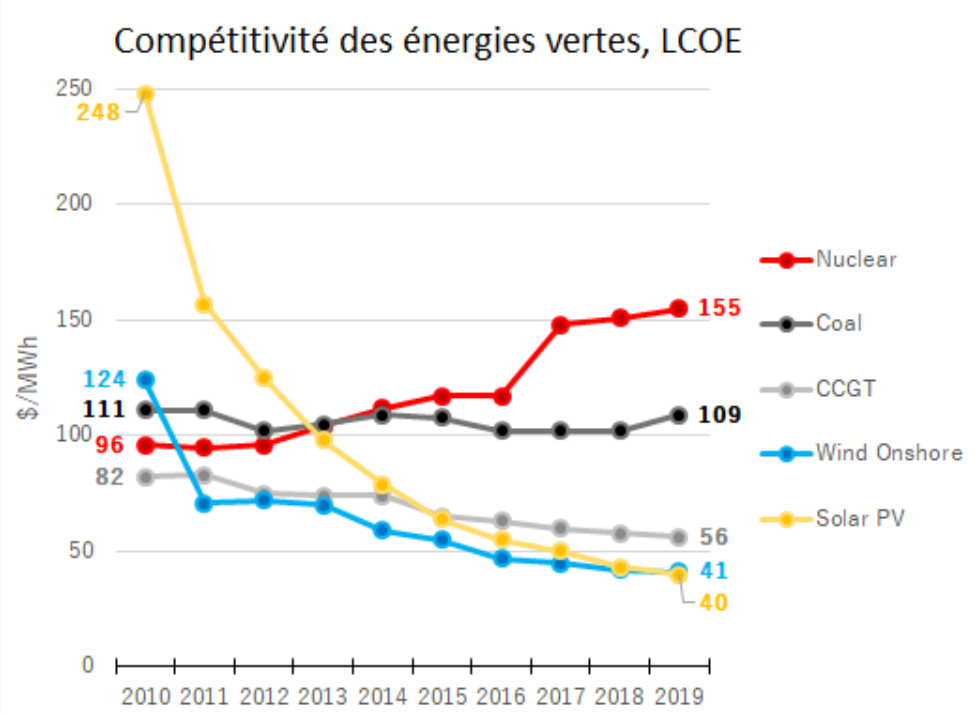
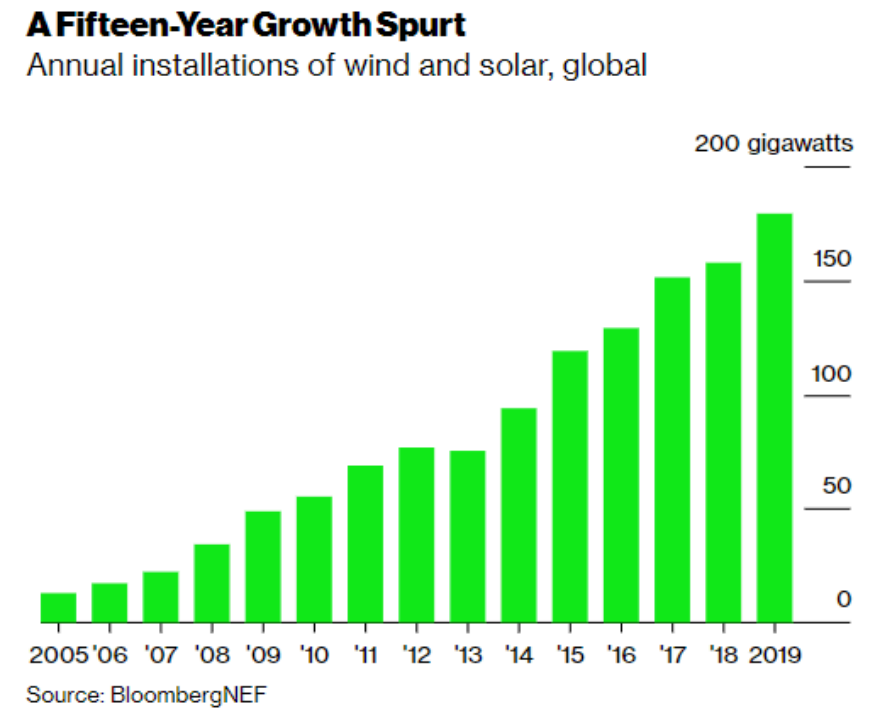
Quelle place pour l'hydrogène dans la transition énergétique?

LANOE Arnaud
16 Mai 2021
Présentation à Da Vinci Luxembourg

La croissance des énergies renouvelables

Une baisse rapide des coûts des énergies vertes





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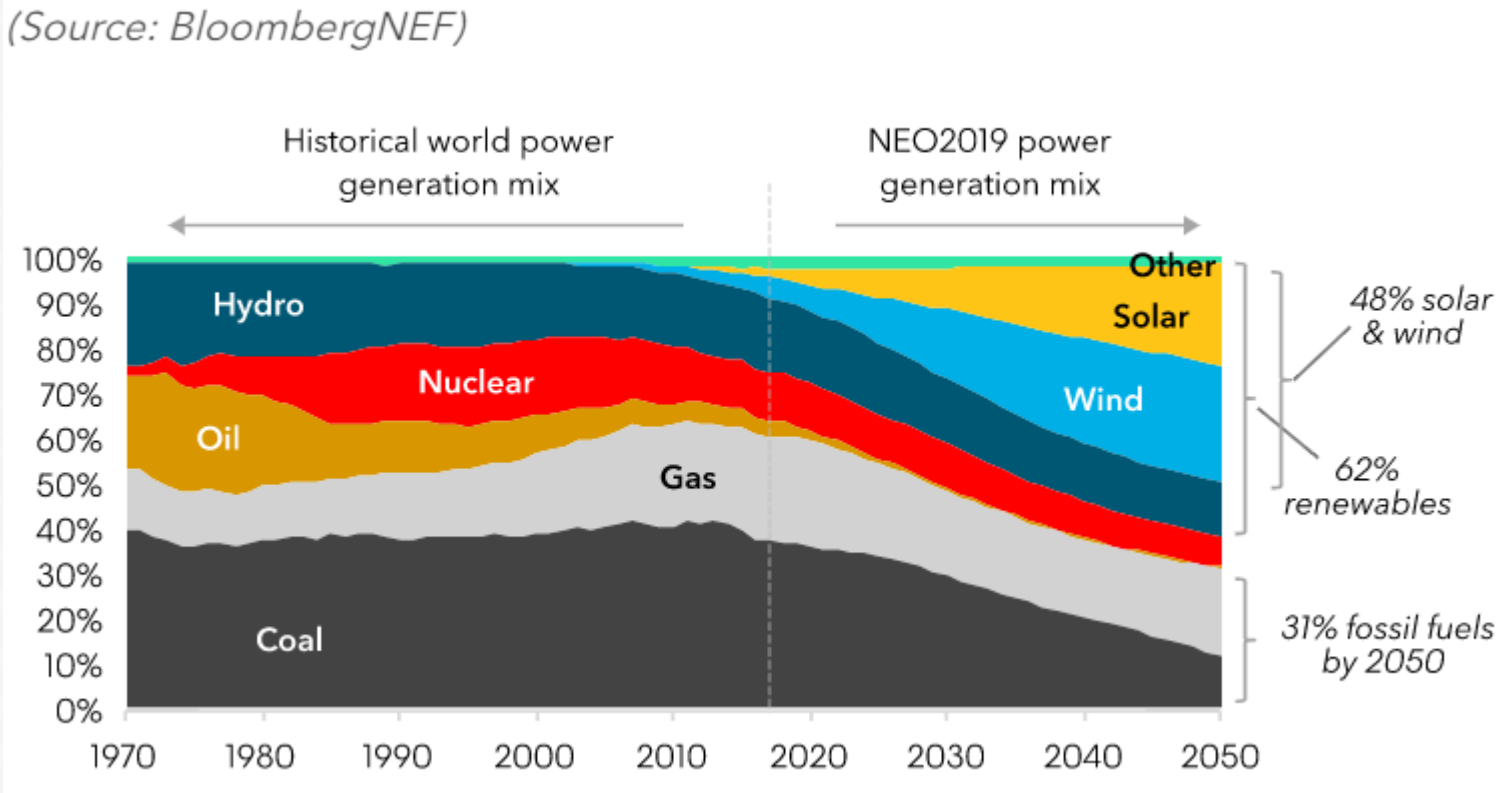
Quelle place pour les énergies renouvelables dans la production d'électricité?

(Source: BloombergNEF)



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Des innovations à grandes échelles

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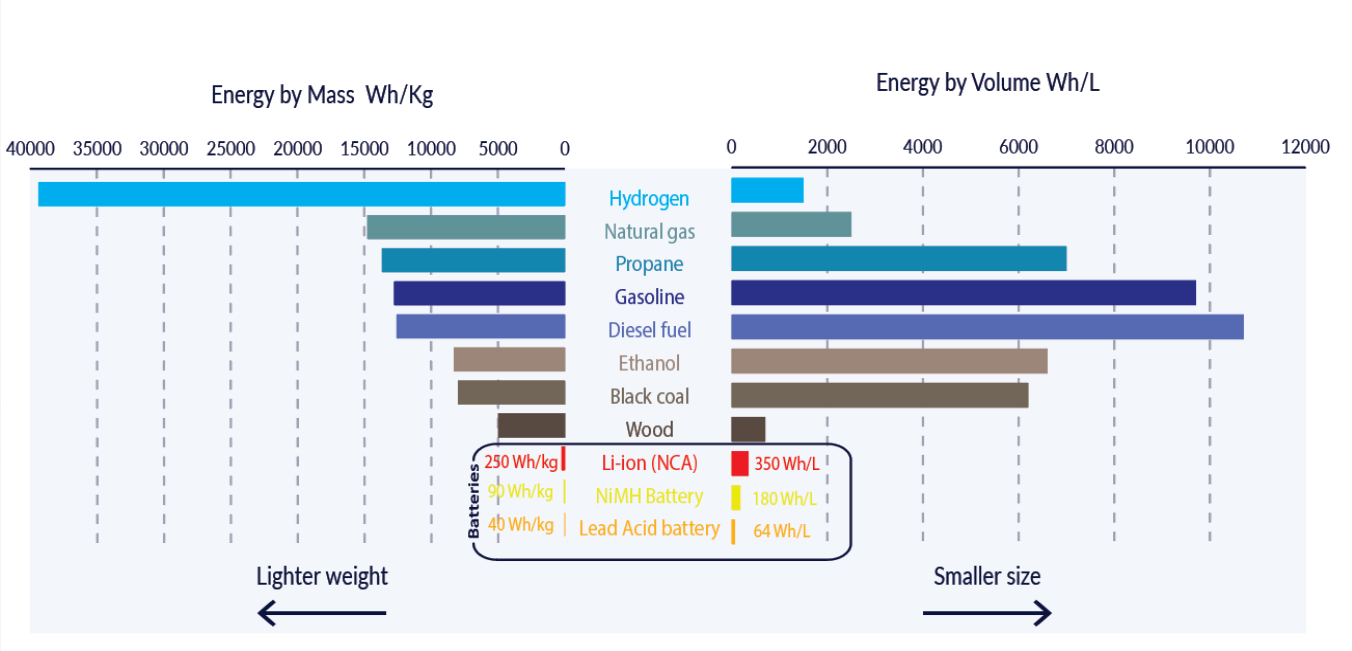
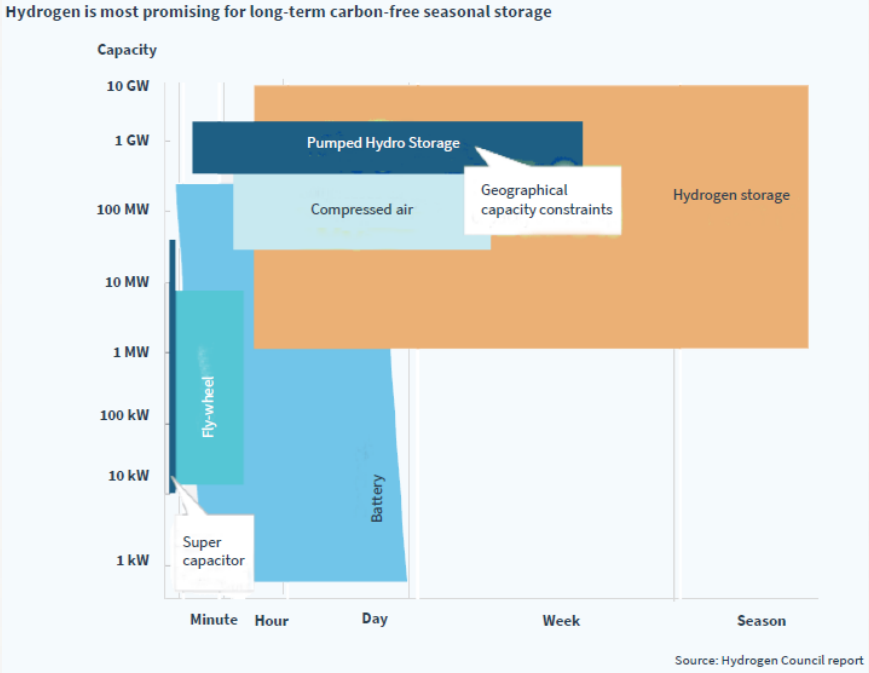
Stocker l'énergie: un enjeu majeur





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Quelle place pour l’hydrogène dans la transition énergétique?

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L'Hydrogène: la production

Steam Methane Reforming (SMR)

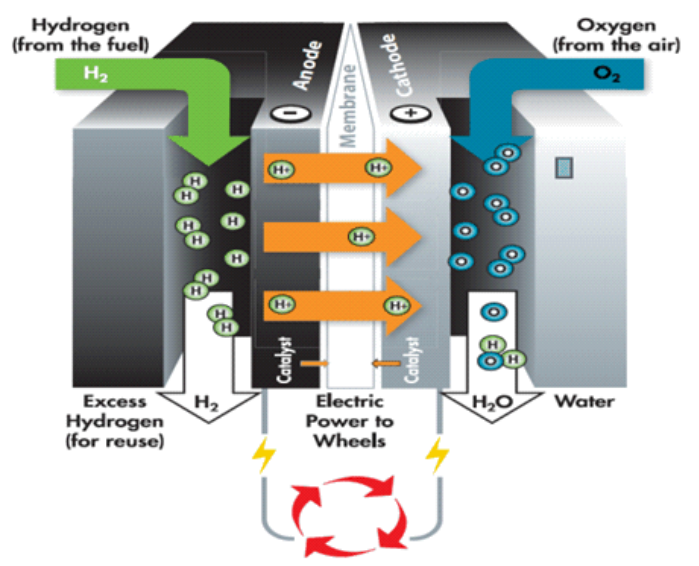
Methane (natural gas) + Water (steam ~900°C) → Carbon dioxide + Hydrogen

$$CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$$

Alkaline and PEM electrolysis

Water + Electricity → Hydrogen + Oxygen

$$H_2O + \text{⚡} \rightarrow H_2 + {}^1/_2\, O_2$$



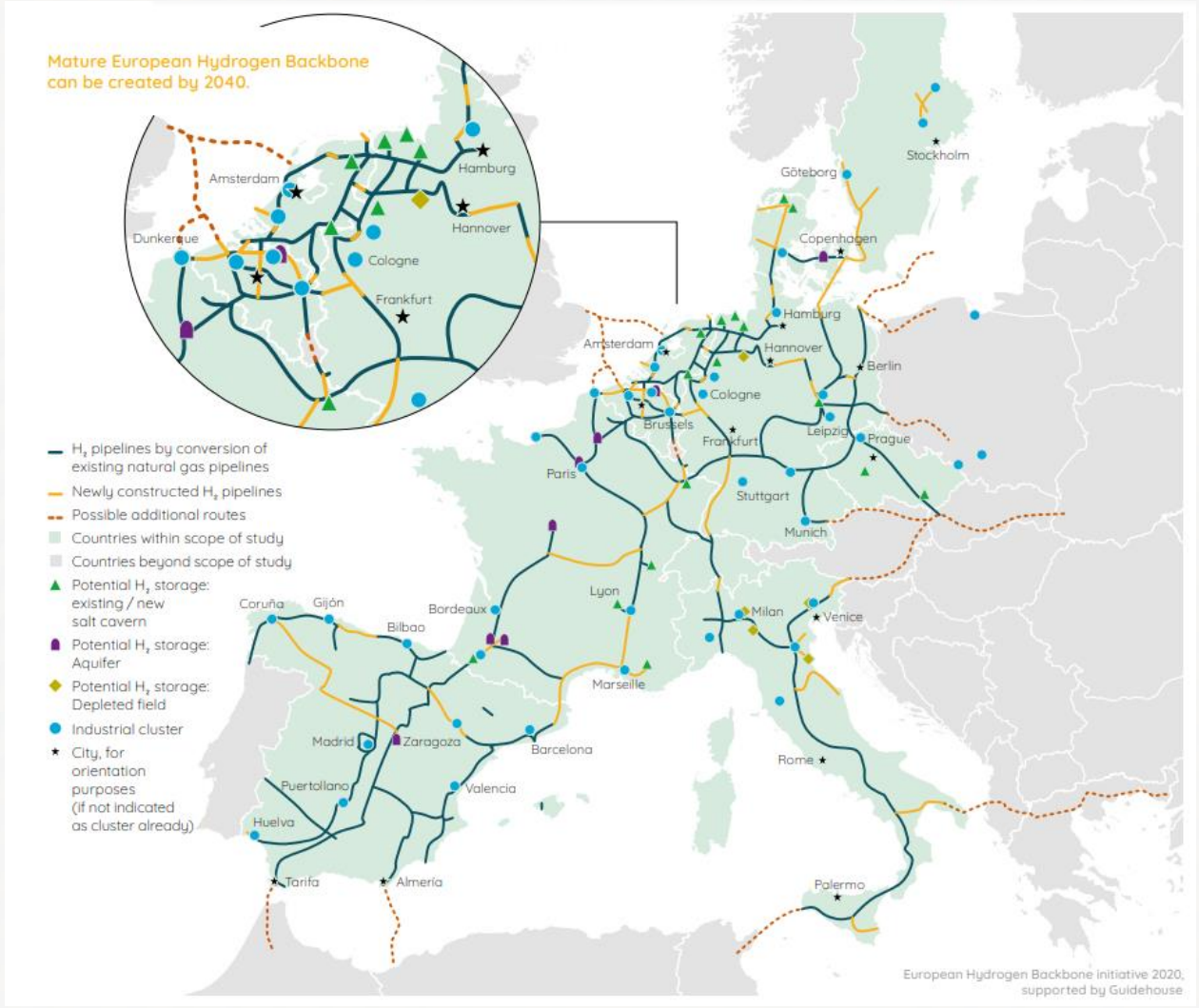
L'Hydrogène: les technologies disponibles

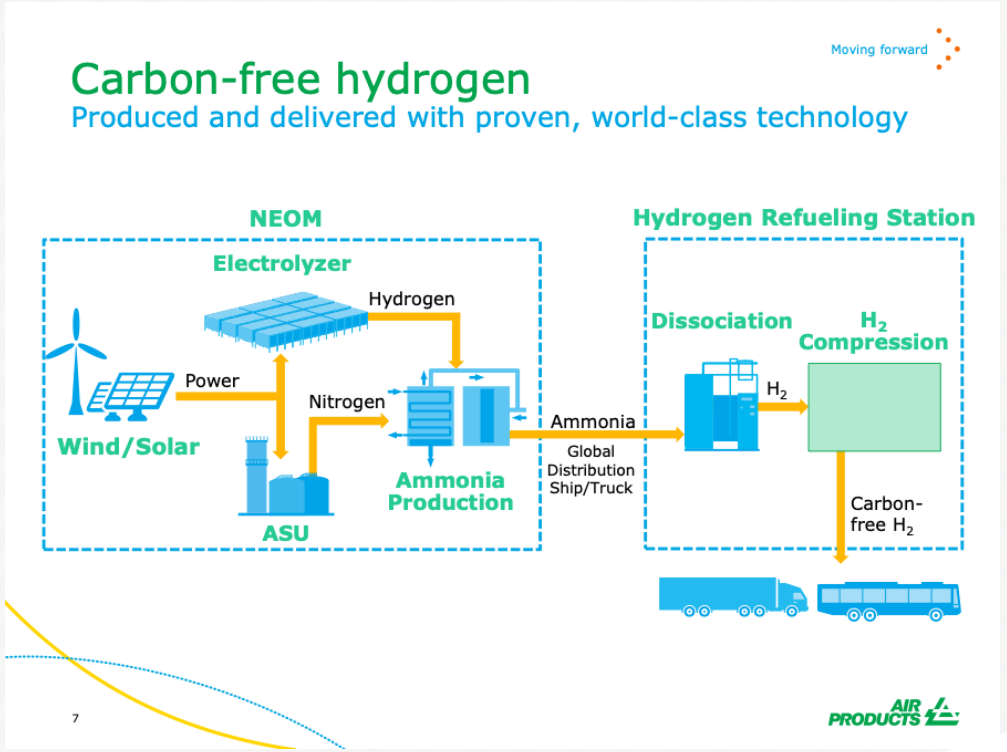
Table 3: Fuel cells comparison

Type of fuel cell	Electrical efficiency (in low heating value)	Applications	Pros	Cons
Proton Exchange Membrane (PEM)	Operates at 80-100°C with 60% efficiency with direct H2; 40% with reformed fuel	Backup, portable power, transportation such as cars, trucks, buses, decentralised energy generation	Quick start up with small size and low weight, requires relatively low temperatures	Requires expensive catalysts and high fuel purities
Alkaline (AFC)	Operates at 50-70°C with 60% efficiency	Military, space, off-grid telecom, transportation, and as backup power	Low temperature and quick start up, with wide selections for low-cost components	Does not operate with CO2 present; electrolyte management and conductivity
Phosphoric acid (PAFC)	Operates at 150-200°C with 40% efficiency	Decentralised energy generation: buildings, hotels, hospitals…	Tolerates fuel impurities with stable productivity	Requires an expensive catalyst and long time to start-up; not as powerful with phosphoric acid vapour
Molten carbonate (MCFC)	Operates at 600-700°C with 50% efficiency	Decentralised energy generation, electric utilities	Relatively high efficiency with fuel flexibility that can be used in a hybrid turbine cycle	Requires high temperatures, which can be highly corrosive, and also a long start-up time
Solid oxide (SOFC)	Operates at 500-1000°C with 60% efficiency	Electric utilities, decentralised energy, alternative backup power	High efficiency, suitable for the hybrid turbine cycle, great fuel flexibility	High temperatures necessary and thus can be corrosive, long start-up times and only allows shutdowns at certain times

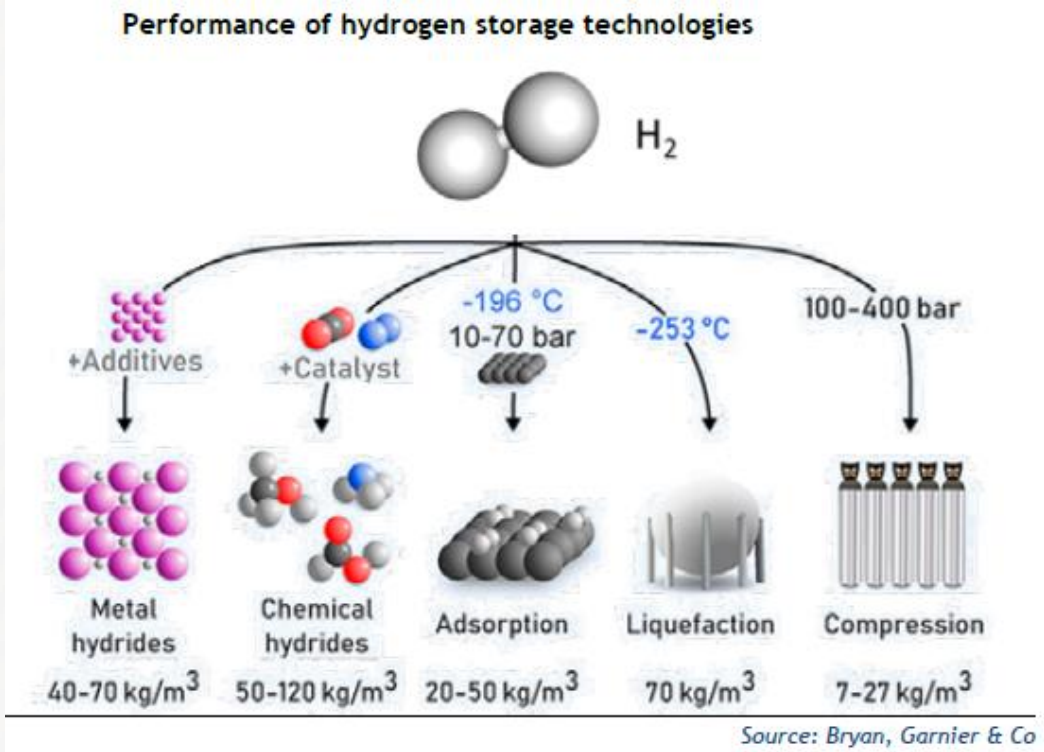
Source: Kepler Cheuvreux

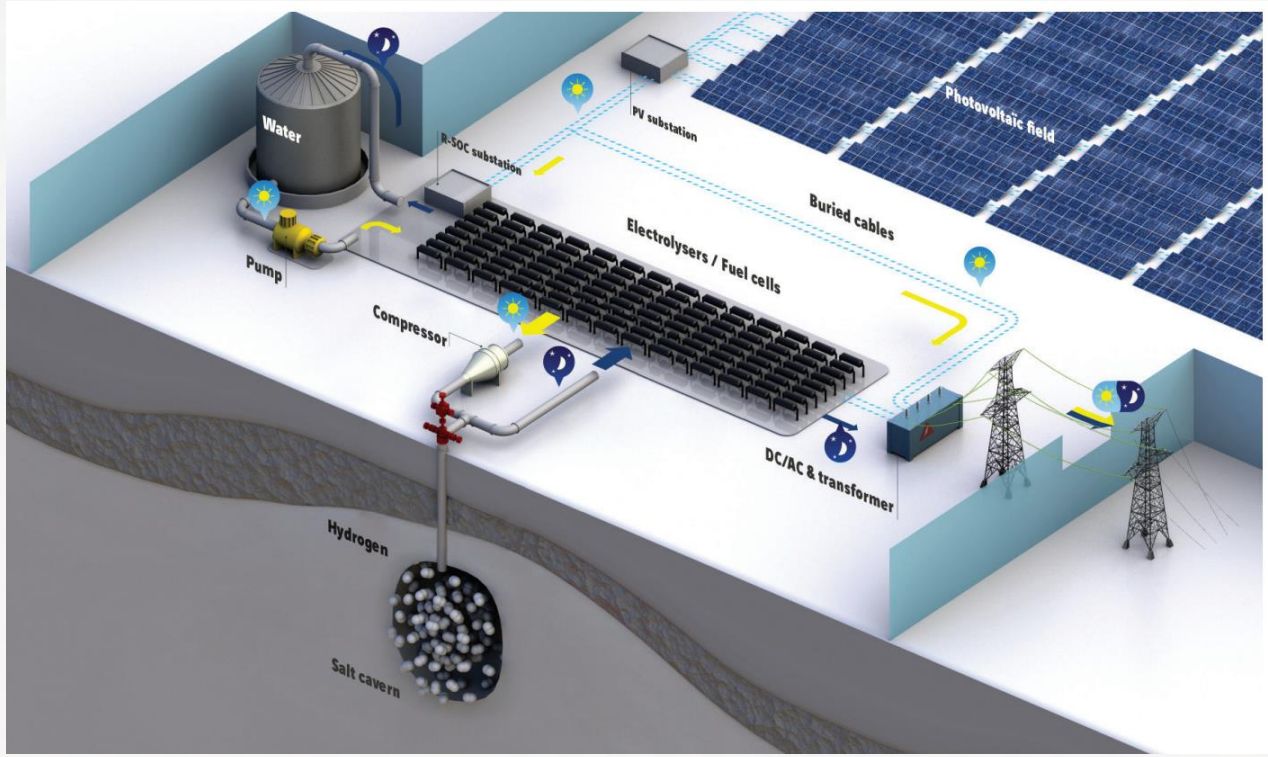
L'Hydrogène: le transport





L'Hydrogène: le stockage





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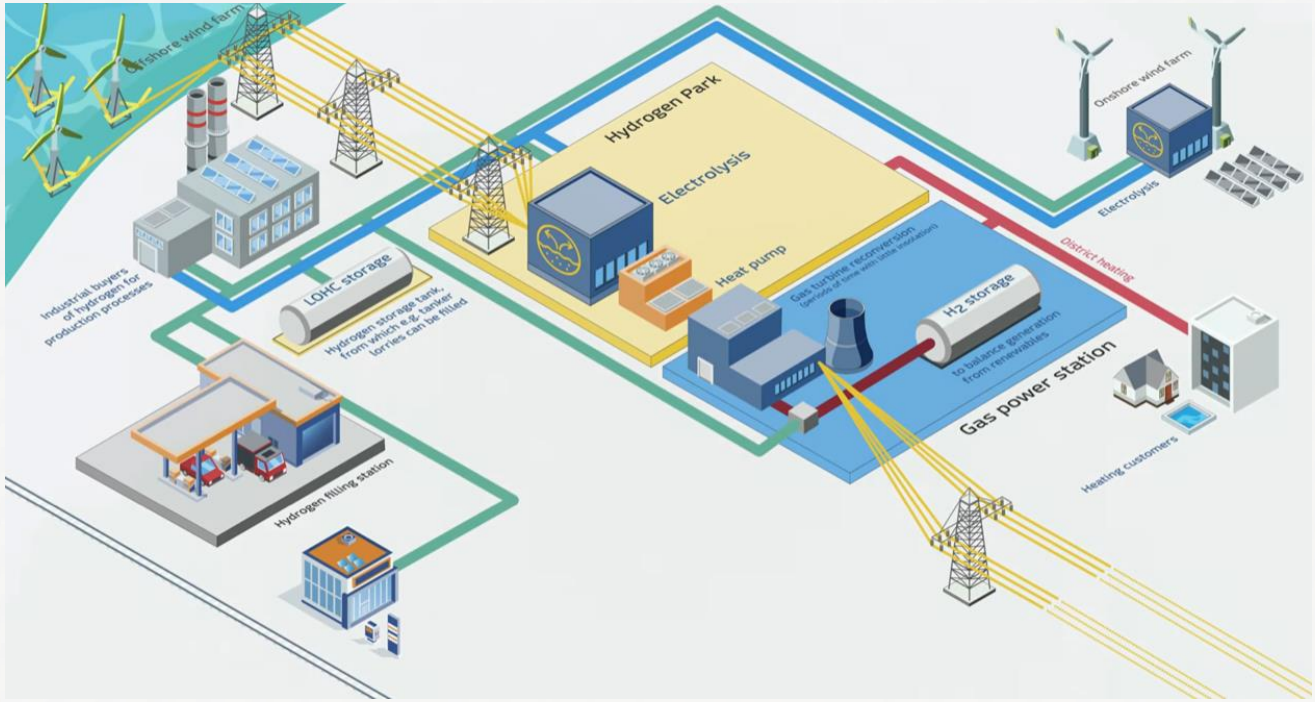
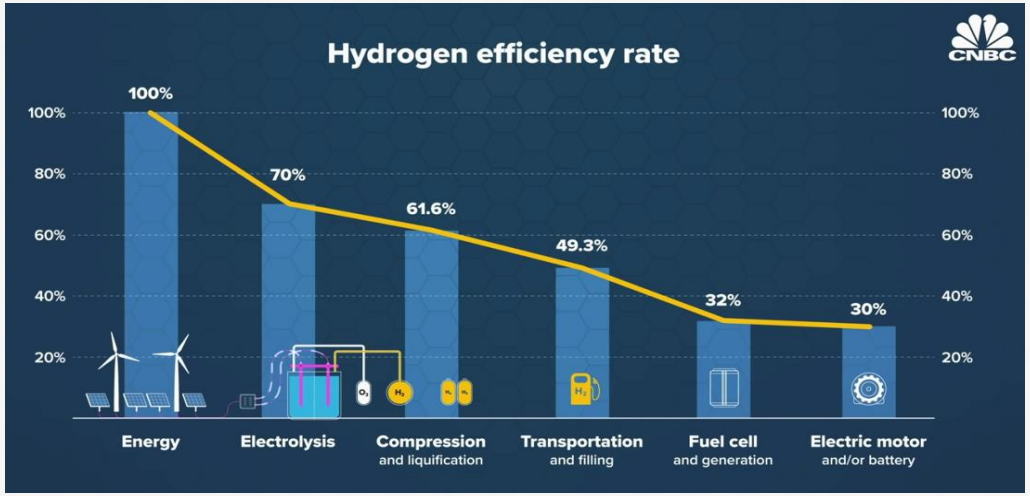
L’Hydrogène vert: prometteur mais nécessite de lourds investissements





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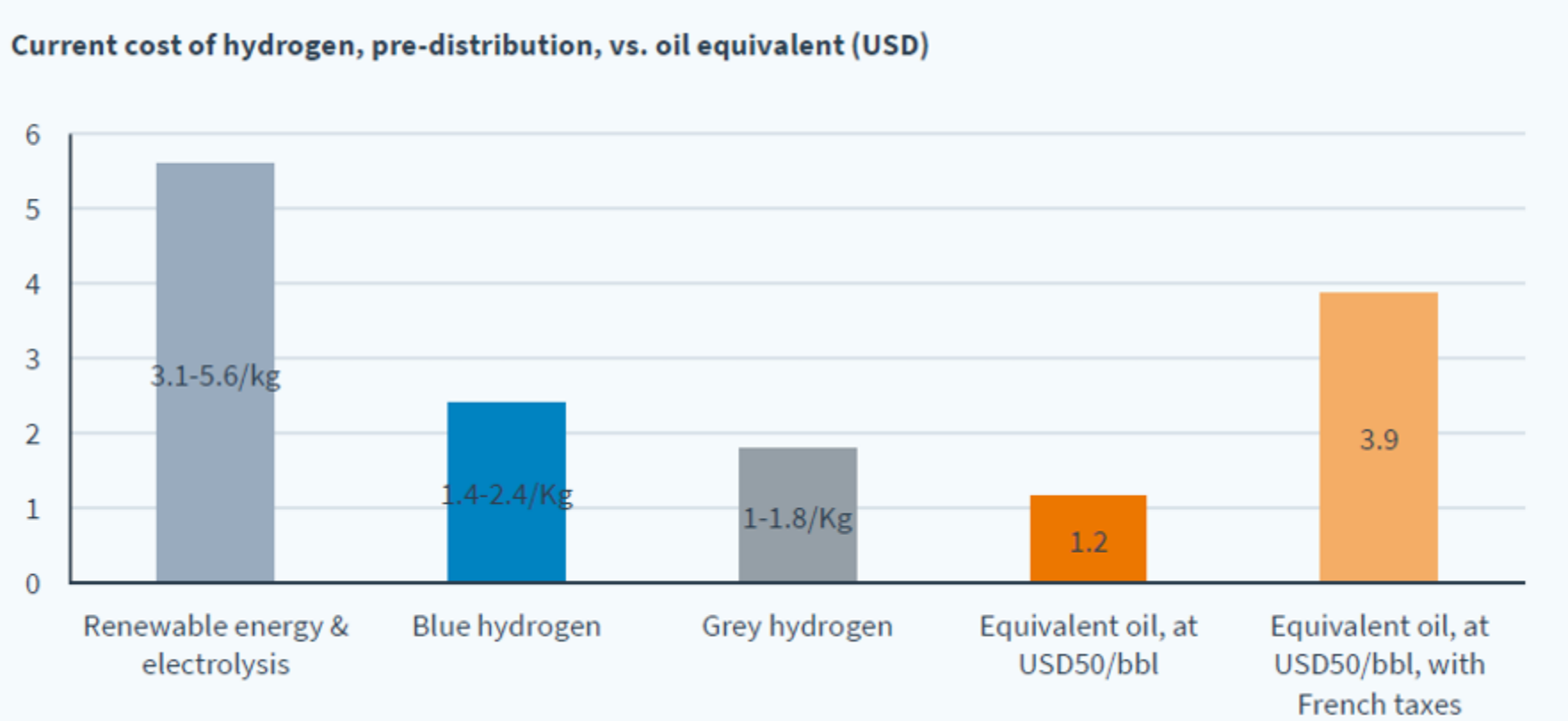
L’Hydrogène vert: pas encore compétitif



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L'Hydrogène vert: quelle sensibilité de coût?

Exhibit 14 | Renewable hydrogen from electrolysis production cost scenarios[5], USD/kg hydrogen

Cost of renewable hydrogen with varying LCOE and load factors
USD/kg H_2

< USD 2/kg | USD 2-3/kg | USD 3-4/kg | > USD 4/kg | Viable medium-term (<2030)

LCOE	Capex electrolyser	USD 750/kW					USD 500/kW					USD 250/kW				
UDD 0/MWh	5.7	2.8	1.9	1.4	1.1	4.2	2.1	1.4	1.1	0.9	2.8	1.4	0.9	0.7	0.6
USD 10/MWh	6.1	3.3	2.4	1.9	1.6	4.7	2.6	1.9	1.5	1.3	3.2	1.9	1.4	1.2	1.0
USD 20/MWh	6.6	3.8	2.8	2.4	2.1	5.2	3.0	2.3	2.0	1.8	3.7	2.3	1.9	1.6	1.5
USD 30/MWh	7.1	4.2	3.3	2.8	2.5	5.6	3.5	2.8	2.5	2.2	4.2	2.8	2.3	2.1	2.0
USD 40/MWh	7.5	4.7	3.8	3.3	3.0	6.1	4.0	3.3	2.9	2.7	4.6	3.2	2.8	2.6	2.4
USD 50/MWh	8.0	5.2	4.2	3.7	3.5	6.5	4.4	3.7	3.4	3.2	5.1	3.7	3.2	3.0	2.9
USD 100/MWh	10.3	7.5	6.5	6.1	5.8	8.9	6.7	6.0	5.7	5.5	7.4	6.0	5.6	5.3	5.2
Load factor		10%	20%	30%	40%	50%	10%	20%	30%	40%	50%	10%	20%	30%	40%	50%

SOURCE: McKinsey

Facteurs de soutient pour le développement durable

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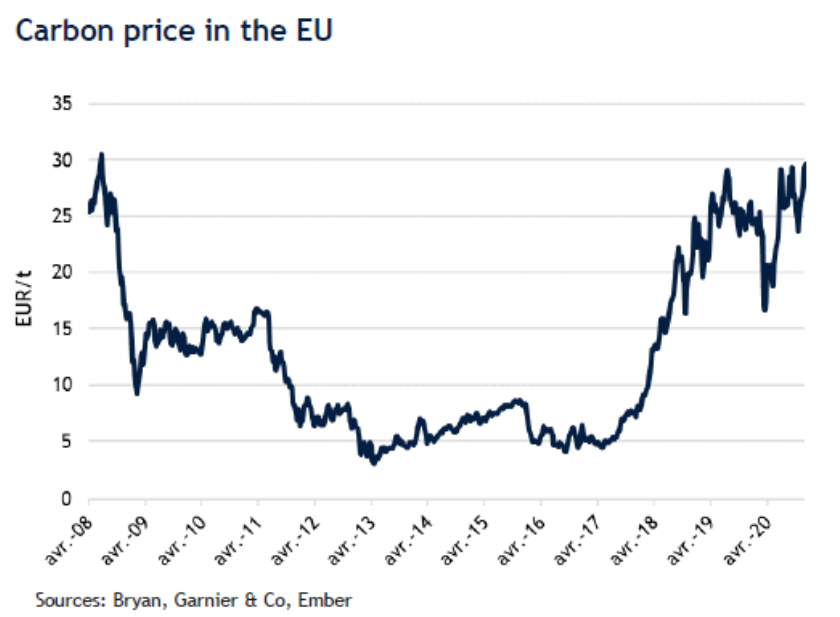
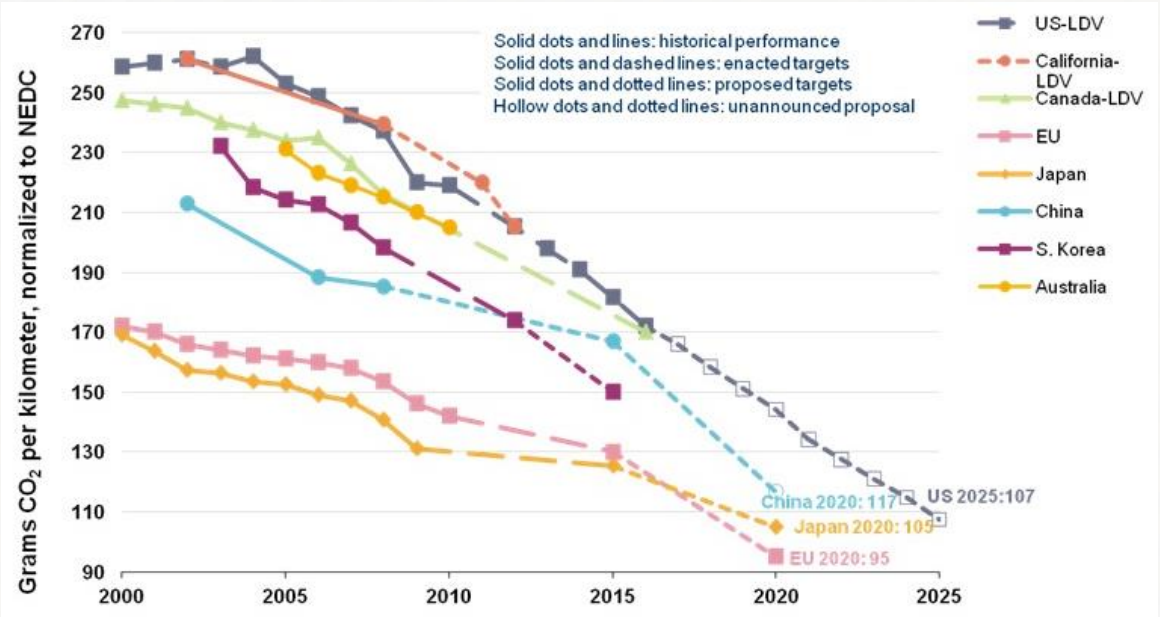
Une règlementation stricte envers les émissions de carbone





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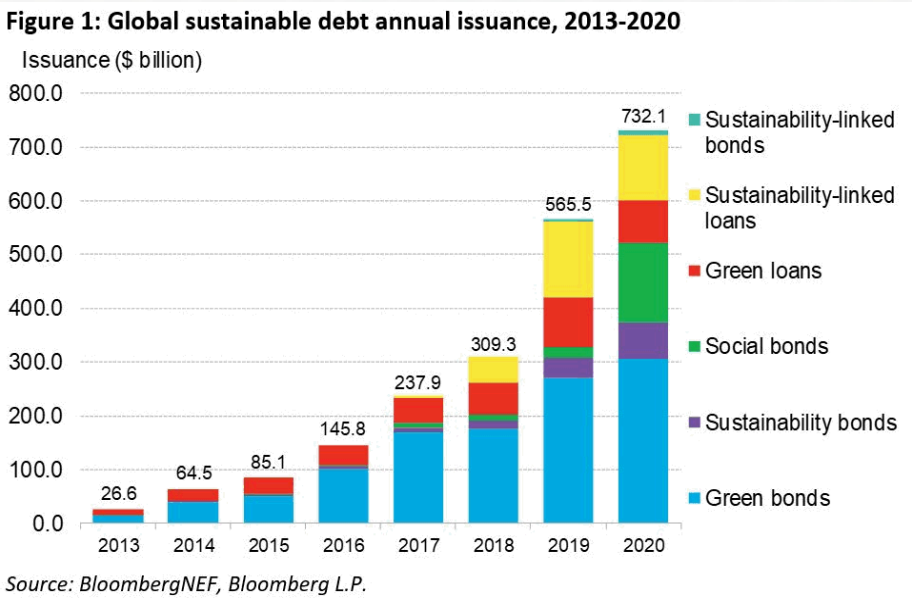
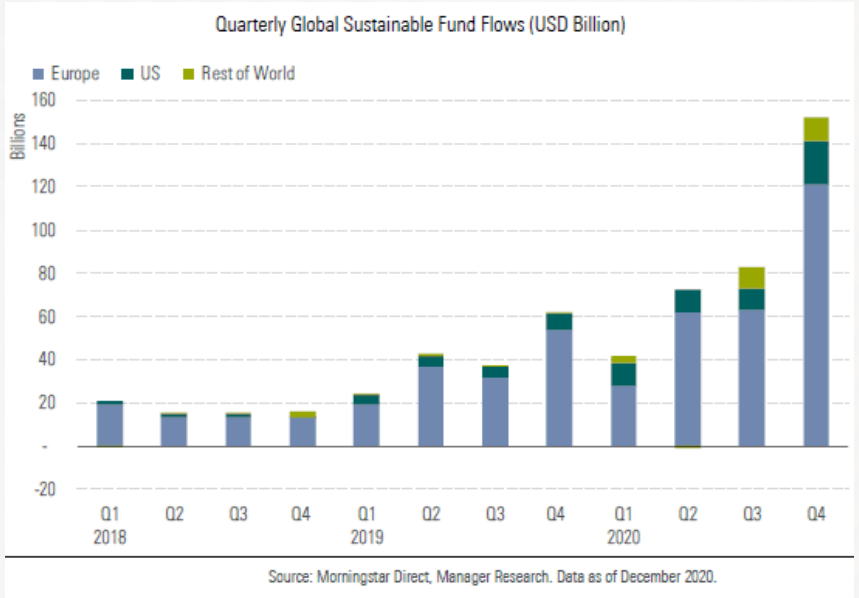
Le développement d'une finance responsable

Figure 1: Global sustainable debt annual issuance, 2013-2020



Source: BloombergNEF, Bloomberg L.P.



Source: Morningstar Direct, Manager Research. Data as of December 2020.

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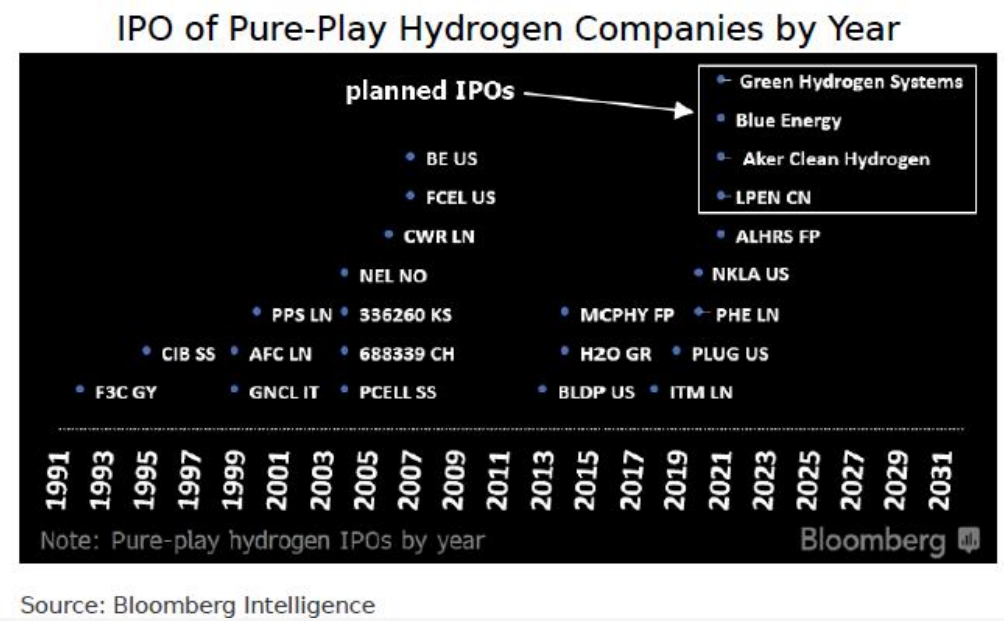
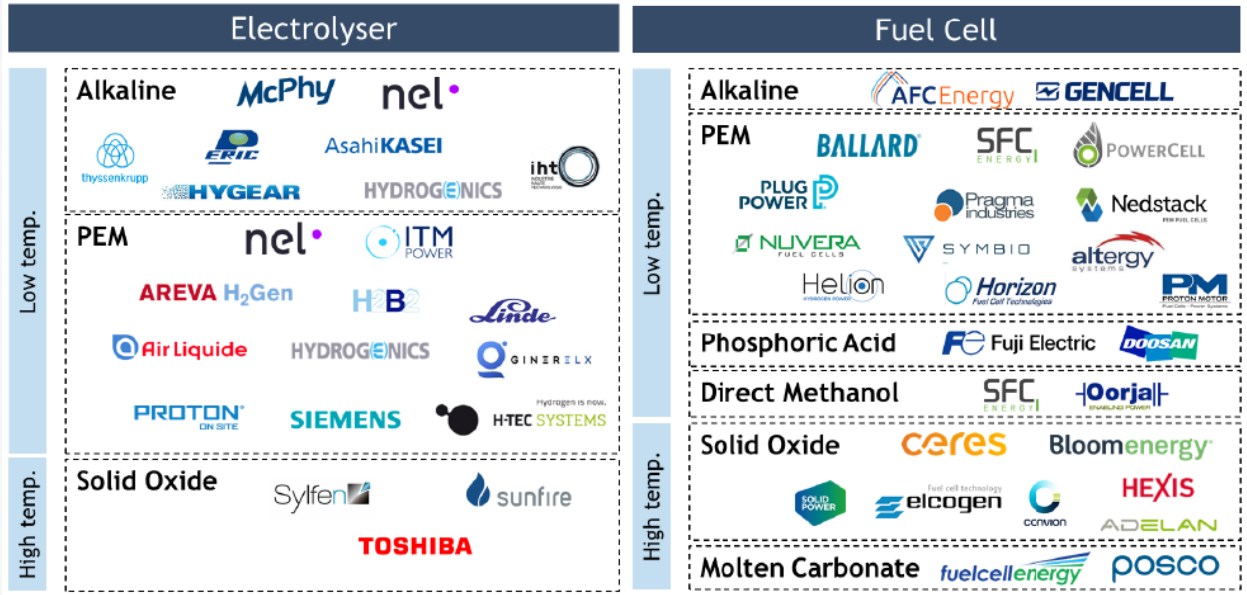
Des cotations en bourses et levées de capitaux multiples



Source: Bloomberg Intelligence

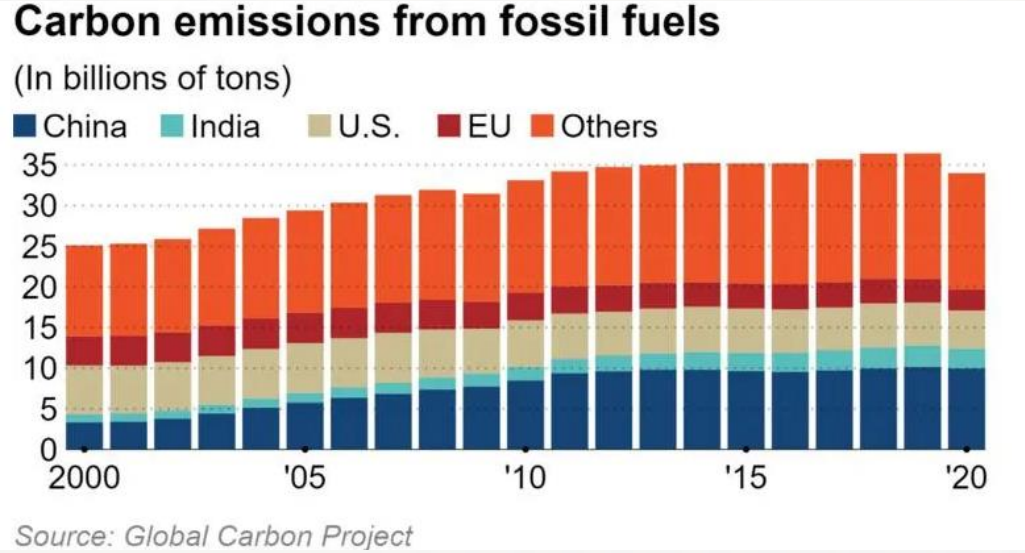


Plans de relances environnementaux

En Europe: Green deal, neutralité carbone 2050, $1,8tn d'investissements d'ici 2027

Aux USA: Biden propose un plan de relance centré sur l'infrastructure et la transition énergetique: EST $2tn.

En Chine: neutralité carbone 2060



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