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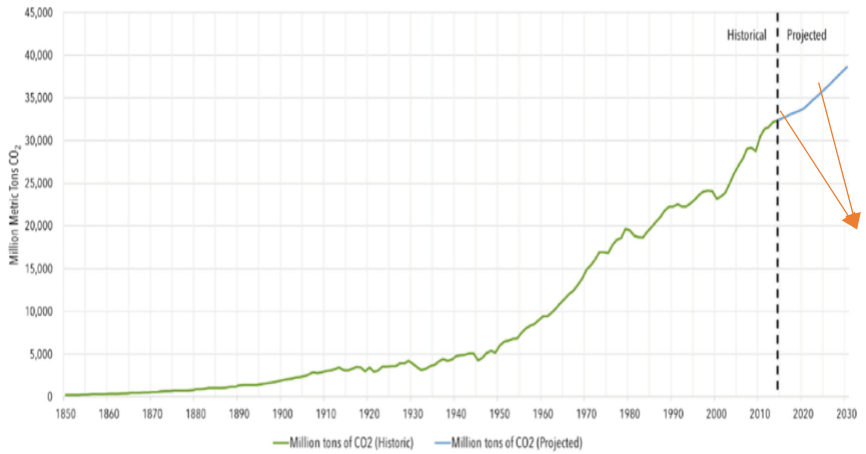
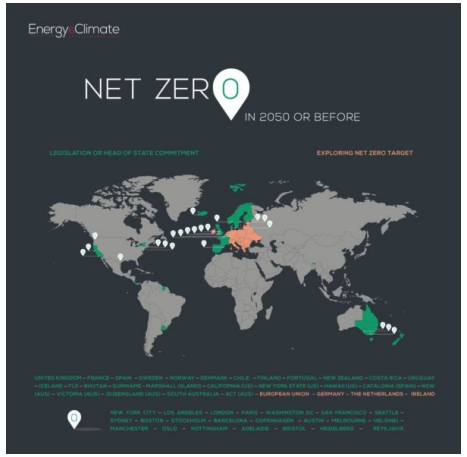
Hydrogen is The New Oil

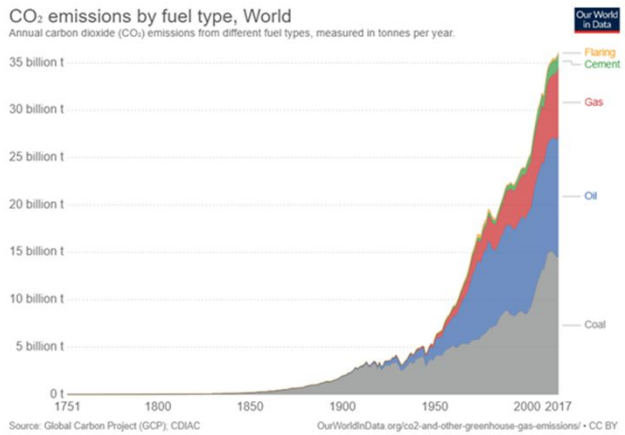
Why hydrogen now

November 2019

Climate emergency: why there is no alternative to green hydrogen







The climate hairpin paradigm, devised by Pr. Patrice Geoffron: the IPCC's Paris-compatible threshold of 45% cut in CO2 emissions by 2030 (from 2010 level) requires an ever steeper reduction rate as emissions keep growing (-7.6% annual now according to UNEP).

Civil society pressures are mounting fast. 15 countries have adopted net zero emissions targets between 2030 and 2050, and so have a large number of cities and territories. The European Union is expected to adopt one soon.

CO2 emissions are mostly caused by coal, oil and natural gas. The hairpin paradigm commands to initiate a massive and immediate phase-out of fossil fuels.

Achieving net zero means finding a proper zero-carbon substitute for the 11,744 million tons of oil equivalent of coal, oil and natural gas consumed in 2018 globally (source: BP Statistical Review), providing a comparable level of energy security and affordability. Electrification with low-carbon sources (renewables and nuclear) is wholly insufficient, as the IEA forecasts a share of electricity of only 23% by 2040. The limited resource, persistently high costs and environmental impact of biofuels constrain their development. CCS only covers 0.1% of current emissions and has no business model except at prohibitively high carbon prices. **There is no alternative to a product which can duplicate all the benefits of oil and gas without the carbon content: mass-scale, competitive green hydrogen.**

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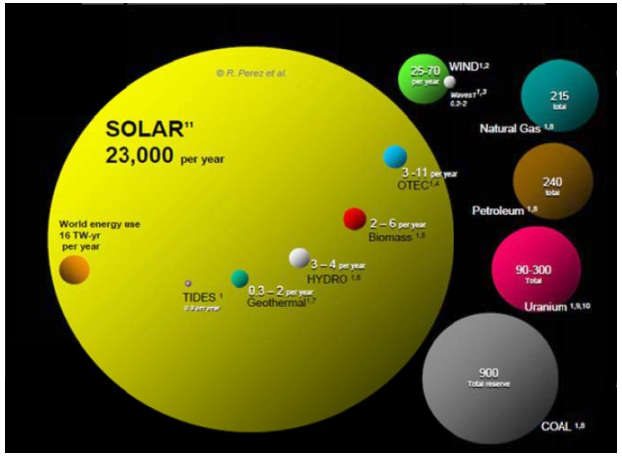
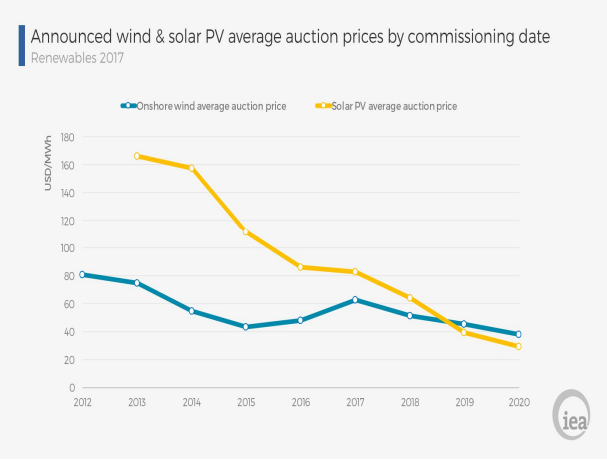
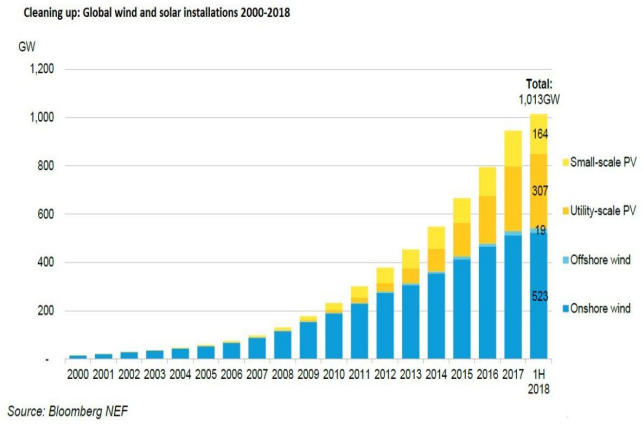
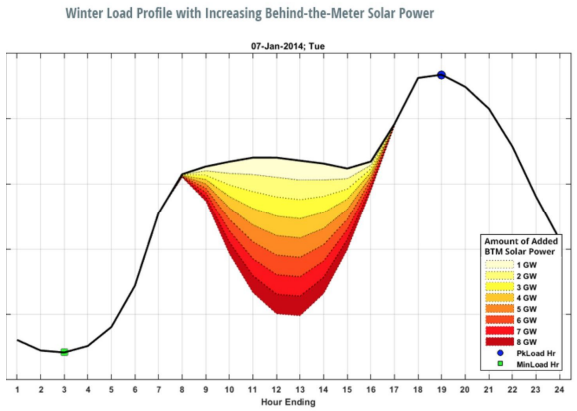
Solar and wind: exponential power flows facing systemic challenges









Solar and wind resources are immense. It would take 0.5% of the earth's land mass to supply 100% of global energy with solar. The availability of key raw materials (silicon) is quasi-infinite.

Solar and wind are now the cheapest sources of power for new installations with prices as low as 15 $/MWh in the US, Mexico, Brazil, Chile, the UAE and Portugal.

Low costs have set off an exponential growth of solar and wind across the planet. In just one country (Spain) there are over 200 GW of solar projects.

Power grids and markets are facing limits in the integration of massive volumes of variable solar and wind through duck curves and negative prices.

Solar and wind are fully capable of substituting fossil fuels, even though they only represent 3% of global energy demand at the moment: the available resource is commensurate, they are modular and can be deployed quickly, their costs are ultra-competitive and are expected to keep falling until 2030 due to technology improvements (cell efficiency, size of turbines), manufacturing efficiencies (scale) and project optimization (risk management). Limits are now being felt in many geographies (California, Chile, Australia…) because of variability, the intrinsically small potential of battery storage and as electricity only represents less than 20% of energy demand. **If the flow of solar and wind is to meet its full potential, electrons must be transformed into transportable and storable molecules.**

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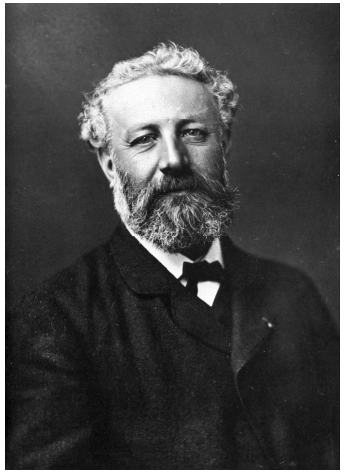
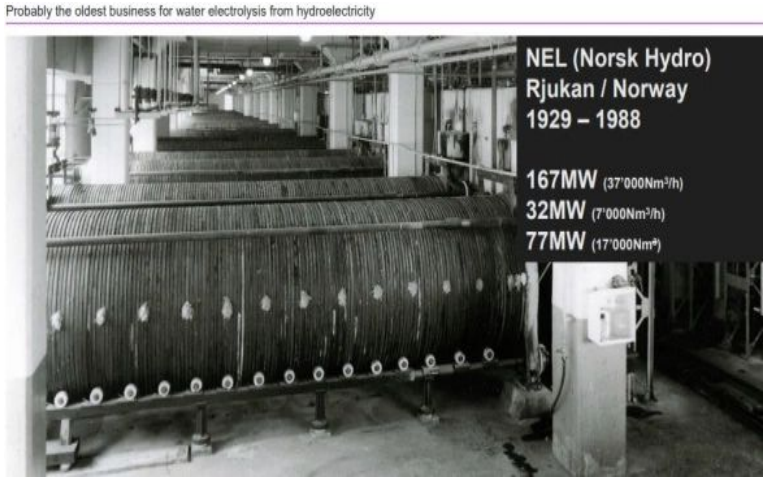
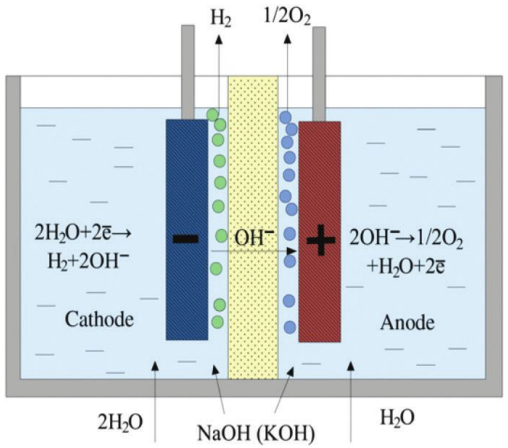
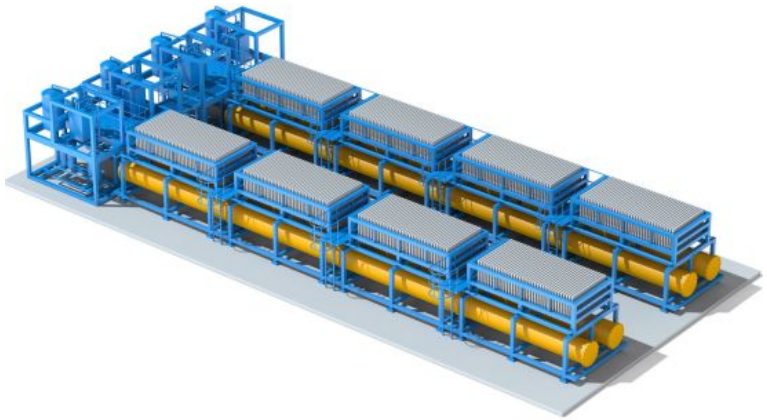
Electrolysis: low-cost hydrogen from a proven technology









"I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable." (Jules Verne, 1874).

The electrolysis of water and brine for the production of ammonia and caustic soda has been practiced at industrial scale for over a century. Alkaline electrolysis is the most tested technology, and offers 70% efficiency. PEM (Proton Exchange Membrane) is more expensive and SOFC (high temperature) is still at low TRL levels.

Industry leaders Thyssenkrupp and Nel (formerly Norsk Hydro) are massively ramping up new capacity and reducing costs with modular units.

Electrolysis costs are collapsing as industry leaders are ramping up GW-scale electrolyzer production. While small-scale electrolyzers still carry price tags as high as 1 000 $/kW (EPC included), vendors are offering prices as low as 400 $/kW for 20-MW units. Vertical integration and just-in-time manufacturing for GW-scale units offer the potential of reducing costs to 200 $/kW with present technology. The need for water is limited (the hydrogen contained in a liter of water is equivalent to 0.4 liter of oil). Optimal hydrogen production costs are to come from jointly located electrolysis and solar (or wind), avoiding the high cost of power transmission. **Thanks to the game changer of 15 $/MWh power, hydrogen can produced without subsidy for as low as 1 $/kg or 25 $/MWh (equivalent to 43 $/barrel of oil).**

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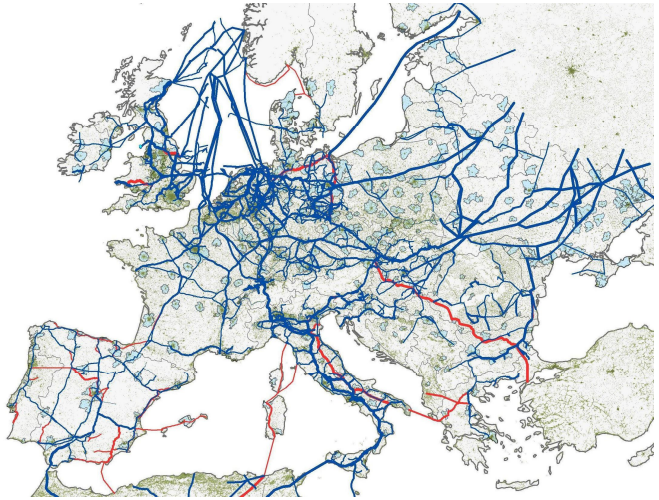
Natural gas grids: mass-scale transmission and storage of hydrogen



The use of hydrogen in gas grids is not new: town gas, produced from coal, which provided energy to buildings and factories from 1850 onwards, was composed of hydrogen and carbon monoxide in equal parts.

Studies from some of Europe's largest TSOs such as Enagás, SNAM, OGE and Gasunie have showed that the vast majority of existing gas transmission and storage (salt caverns) can be reused for hydrogen (blended with natural gas or pure) with very limited investment.

Transcontinental hydrogen transport is best achieved under the form of ammonia (NH3) through existing tanker and terminal capacity.

The use of natural gas grids for the transmission and storage of hydrogen is a key enabler. Europe's gas transmission capacity is 8 times larger than its power transmission capacity and costs are 10 times cheaper. Gas storage capacity is also a magnitude bigger: natural gas storage (mostly underground) in France is 130 TWh, compared to 0.06 TWh for pumped and battery storage (which is expected by BNEF to reach only 52 minutes globally by 2040). Gas TSOs have a strong motivation to convert their grids to hydrogen as net zero policies threaten to strand their asset bases. Provided hydrogen is transmitted in large-diameter, existing pipes, transmission costs can be as low as 0.1 $/kg, **making it possible to cheaply and reliably deliver millions of tons of green hydrogen to users everywhere.**

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Users: the urge for zero-carbon, secure and low-cost energy

For industry users, green hydrogen is a substitute for grey hydrogen (from fossil fuels) in the production of ammonia and methanol. It can also replace coking coal for the production of steel.

For energy users in industry and buildings, hydrogen can replace natural gas and coal to produce 24/7 fully dispatchable heat and power either through blending of refurbishing of existing turbines, a well-known process with offers from key vendors.

For transport users, hydrogen can replace gasoline and diesel in trucks (rather than cars, where batteries make more sense), buses and trains. Shipping can substitute heavy fuel oil through green ammonia.

Industrial, energy and transport users are clamoring for a zero-carbon energy source or feedstock which can match the performance of oil, natural gas and coal in terms of energy security and affordability. Green hydrogen, fitting in existing oil and gas transmission and storage infrastructure, can meet this requirement, unlike variable renewable power or expensive bio-fuels. The supply of subsidy-free 25 $/MWh green hydrogen means no extra costs for users in energy-importing regions such as Europe and Asia, assuming 15 $/MWh (or 5 $/mmBTU) breakeven LNG prices and 10 $/MWh carbon value. **Substituting fossil fuels at no extra cost allows users to address the existential threat of carbon risk, enhance competitiveness, explore new markets and satisfy communities and stakeholders.**

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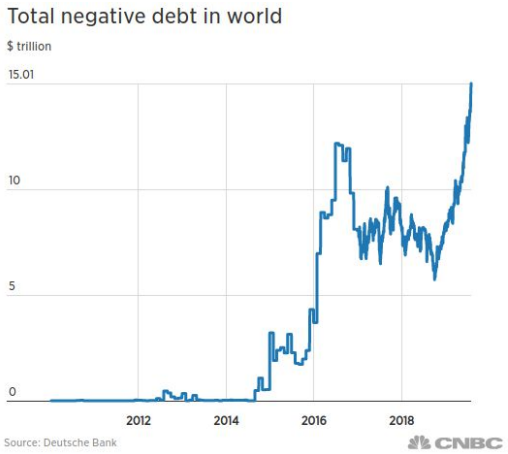
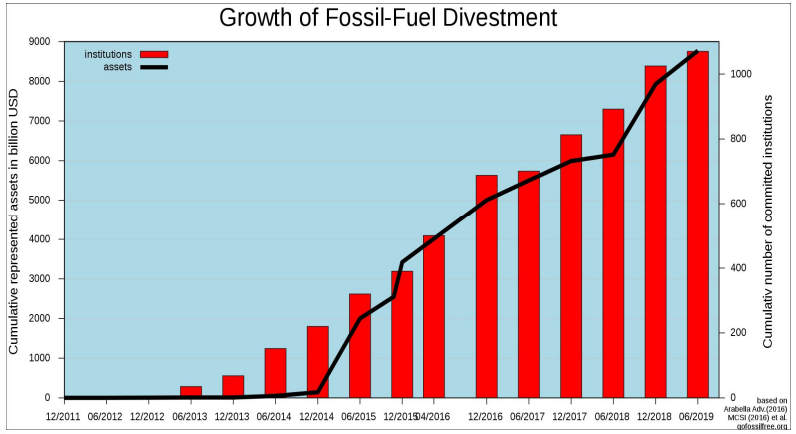
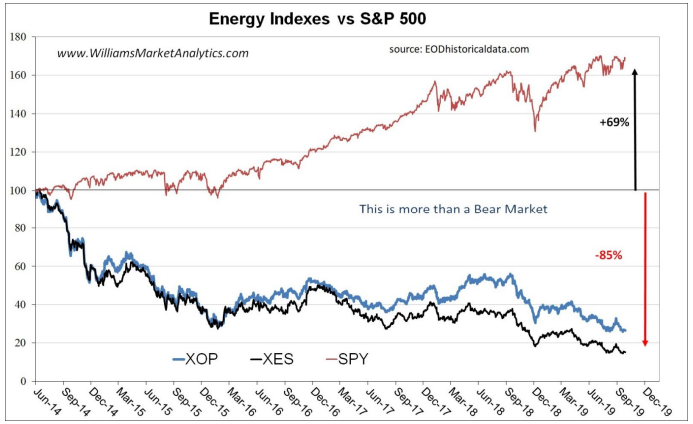
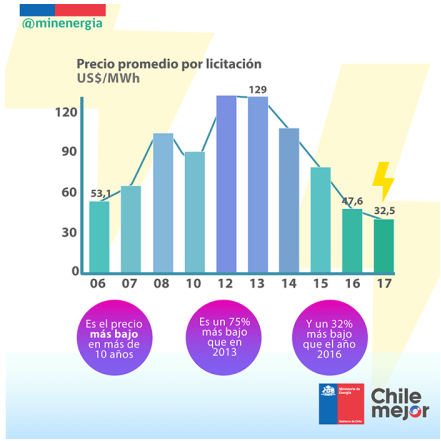
Investors: seeking protection from crippling carbon and volatility risk









Institutional investors are being confronted with the challenge of negative interest rates, with over 15 Tn$ of negative yielding assets. Infrastructure investments (especially energy) offer an alternative with steady yields.

The fossil-fuel divestment movement is growing fast, powered by powerful trends: ethical pressures stemming from the growing awareness of the climate emergency, the collapse of fossil fuel shares and the stranded assets paradigm.

As shown by the collapse of wholesale power prices in Chile following the exponential growth of solar, investors in variable renewables are set to be confronted with massively devalued asset values after PPAs or FiTs expire.

Carbon risk, negative interest rates, falling oil & gas shares, stranded fossil fuel assets and devalued variable renewable assets (as non-dispatchable solar and wind profiles lose value fast with the growth of variable renewables) are major threats to institutional portfolios globally. Green hydrogen assets (upstream (solar, wind and electrolysis) and midstream (transmission, shipping and storage)) potentially offer very attractive opportunities, acting as an insurance policy against carbon risk. **The association of competitive, dispatchable, transportable and storable energy assets and long term agreements (through consortium or government-backed PPAs) with bankable off-takers offer investors a trillion-dollar opportunity and the perspective of sound long term cash flows with attractive returns.**

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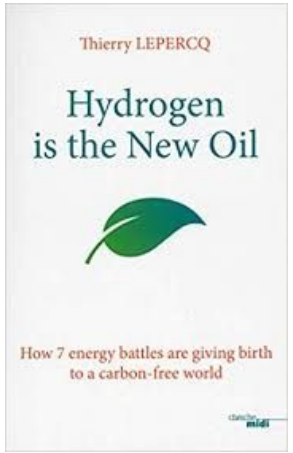
Soladvent: vision and experience to incubate mass-scale hydrogen



Soladvent is a professional service and investment company founded by Thierry Lepercq. After a 15-year career in technology finance, Thierry Lepercq founded Solairedirect in 2006, a pioneer of competitive solar globally (France, India, US, Mexico, Brazil, Chile, South Africa…) with 3 GW+ built and project prices as low as 20 $/MWh. The company was acquired in 2015 by energy giant Engie, and Thierry Lepercq joined its Executive Committee in charge of research, technology and innovation. He then established Engie Fab, an incubation unit for mass-scale projects in the areas of shared and electric mobility, digital energy platforms, dispatchable renewable power and green hydrogen. Thierry Lepercq left Engie in October 2018 to launch Soladvent. He is the author of “Hydrogen is the New Oil”, a book published in March 2019 in French, English and Spanish, which describes how seven energy revolutions are opening the gates to a zero-carbon world based on hydrogen. The book has received significant media coverage and critical acclaim, in a context of fast mounting public interest for hydrogen.

Since October 2018 Soladvent has mobilized a dozen professionals and several consulting firms to conduct strategic analysis an modeling, investigate the technical and regulatory challenges of mass-scale green hydrogen, and to design business models. The team includes professionals from Europe and Asia with senior backgrounds in the following areas: renewable energy development, hydrogen and industrial gases, oil & gas projects and infrastructures, energy market platforms, chemical industry research and technology, structured financing and M&A, public affairs…

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A collaborative incubation process

Industry associations, international organizations, think tanks

Hydrogen Europe
REN21
Institut AMADEUS
SolarPower Europe
European Commission
TechTour
WORLD ENERGY COUNCIL
iea
AFHYPAC
Capenergies

Natural gas TSOs

GRTgaz
enagas
Open Grid Europe
SoCalGas
snam
TERĒGA
FLUXYS

Renewable energy developers

VALOREM
TUNUR
ERG
FALCK RENEWABLES
GRUPPOFALCK

Hydrogen value chain players

thyssenkrupp
nel
McPhy
YARA

Consultants

STRATEGEN
CVA Corporate Value Associates
LONGREACH CAPITAL

Soladvent has mobilized key stakeholders of the hydrogen value chain, and taken a significant part in the growing public debate, marked by recent landmark reports by the IEA, BNEF and IRENA. It has conducted research involving detailed technical and economic modeling. It also has organized key events gathering a total of 300+ participants (experts, scientists, consultants, industrial companies, infrastructure operators, start-ups, financial investors, government officials, : "Solar gas as a competitive alternative to fossil fuels" (Paris, February 13th, 2019), "Solar hydrogen: a key opportunity for Morocco" (Rabat, October 15th,2019) and "Hydrogen landing program" (Rotterdam, November 29th, 2019). Soladvent has been featured as a speaker in over 20 energy events globally in the last 12 months.

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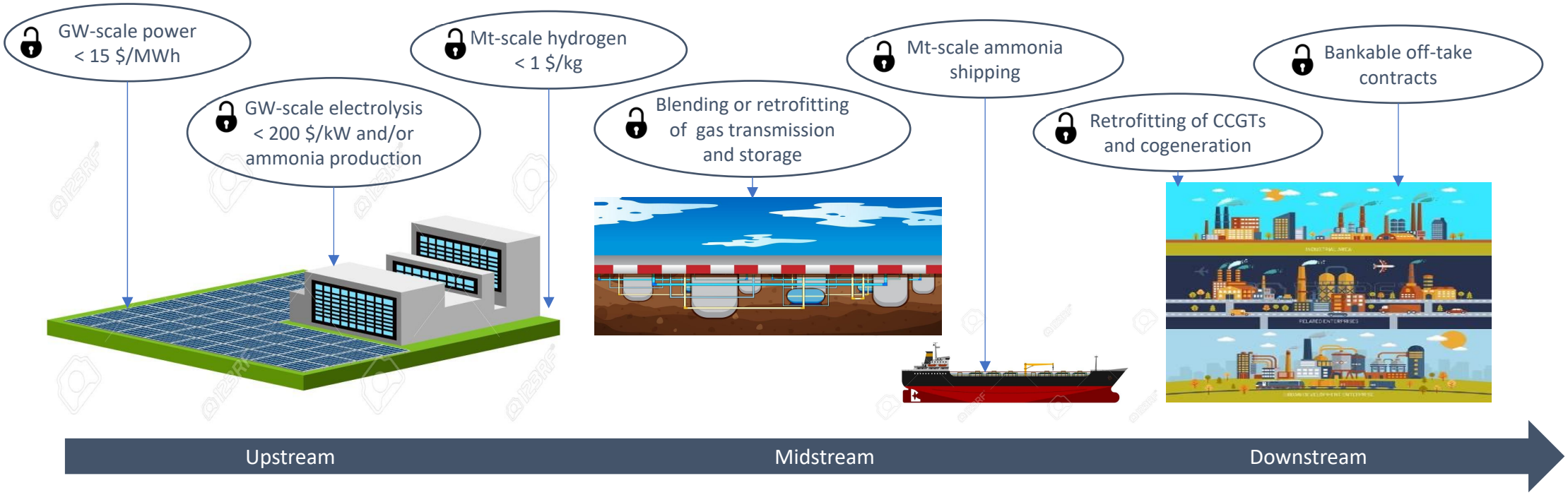
Unlocking the potential of mass-scale hydrogen



It is necessary to bring together key stakeholders to unlock the flow of mass-scale green hydrogen to feedstock and energy users. The objective should be to open the market by engineering the mass-scale production of green hydrogen at LNG breakeven level prices (< 1 $/kg), enabling the transformation of existing transmission, storage, shipping and turbine infrastructure to hydrogen and securing long term off-take contracts with bankable counterparties, the key to financing. One should aim at securing such distinct advantages such as scale, systematic cost cutting approach and value chain optimization.

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