Shell – EBI Workshop H2 Scale-up Activation

March 13-14, 2020

Ajay Mehta, Joe Powell

Definitions & Cautionary Note

Reserves: Our use of the term "reserves" in this presentation means SEC proved oil and gas reserves.

Resources: Our use of the term "resources" in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves. Resources are consistent with the Society of Petroleum Engineers (SPE) 2P + 2C definitions.

Discovered and prospective resources: Our use of the term "discovered and prospective resources" are consistent with SPE 2P + 2C + 2U definitions.

Organic: Our use of the term Organic includes SEC proved oil and gas reserves excluding changes resulting from acquisitions, divestments and year-average pricing impact.

Shales: Our use of the term 'shales' refers to tight, shale and coal bed methane oil and gas acreage.

Underlying operating expenses are defined as operating expenses less identified items. A reconciliation can be found in the quarterly results announcement.

The companies in which Royal Dutch Shell plc directly and indirectly owns investments are separate legal entities. In this presentation "Shell", "Shell group" and "Royal Dutch Shell" are sometimes used for convenience where references are made to Royal Dutch Shell plc and its subsidiaries in general. Likewise, the words "we", "us" and "our" are also used to refer to Royal Dutch Shell plc and its subsidiaries in general or to those who work for them. These terms are also used where no useful purpose is served by identifying the particular entity or entities. ''Subsidiaries'', "Shell subsidiaries" and "Shell companies" as used in this presentation refer to entities over which Royal Dutch Shell plc either directly or indirectly has control. Entities and unincorporated arrangements over which Shell has joint control are generally referred to as "joint ventures" and "joint operations", respectively. Entities over which Shell has significant influence but neither control nor joint control are referred to as "associates". The term "Shell interest" is used for convenience to indicate the direct and/or indirect ownership interest held by Shell in an entity or unincorporated joint arrangement, after exclusion of all third-party interest.

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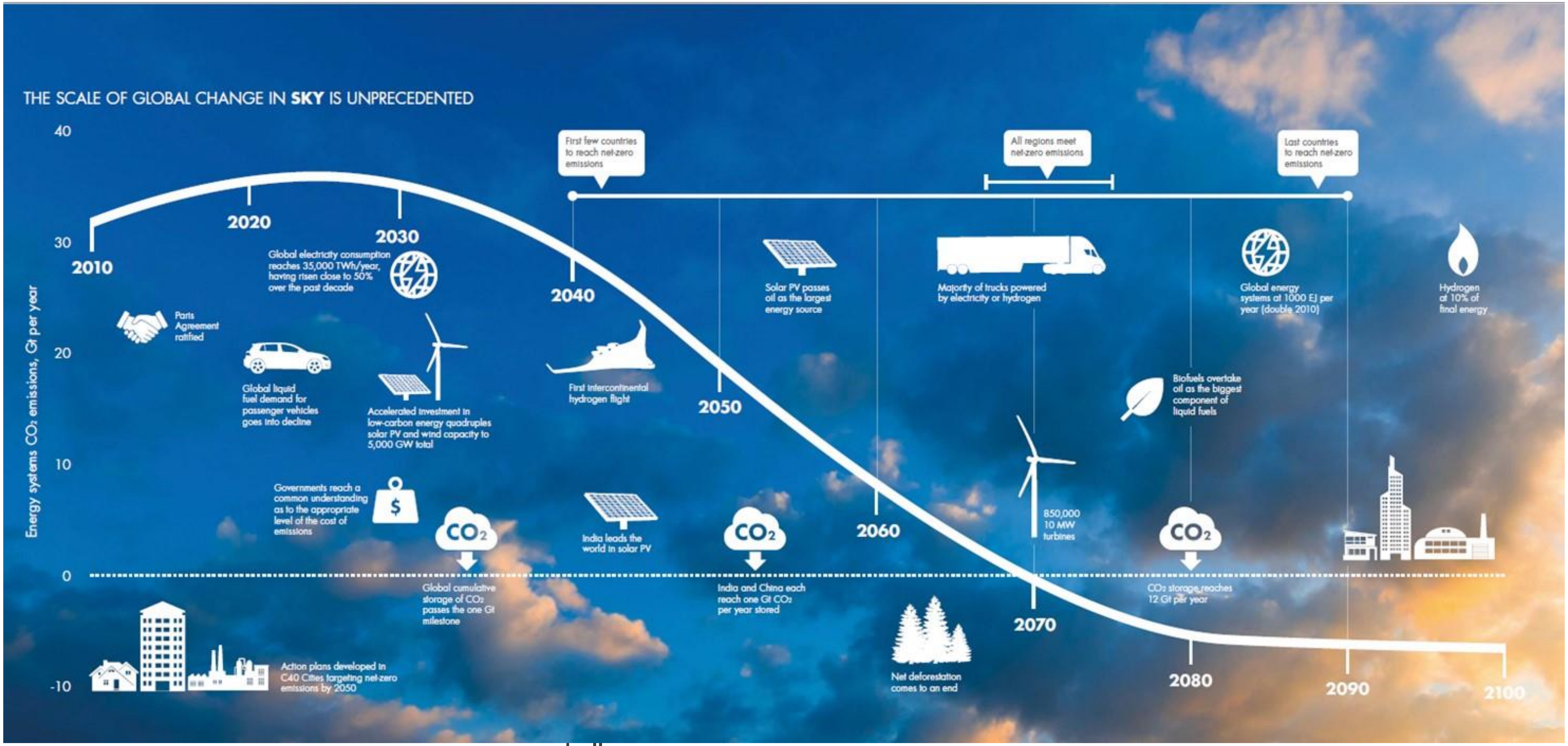
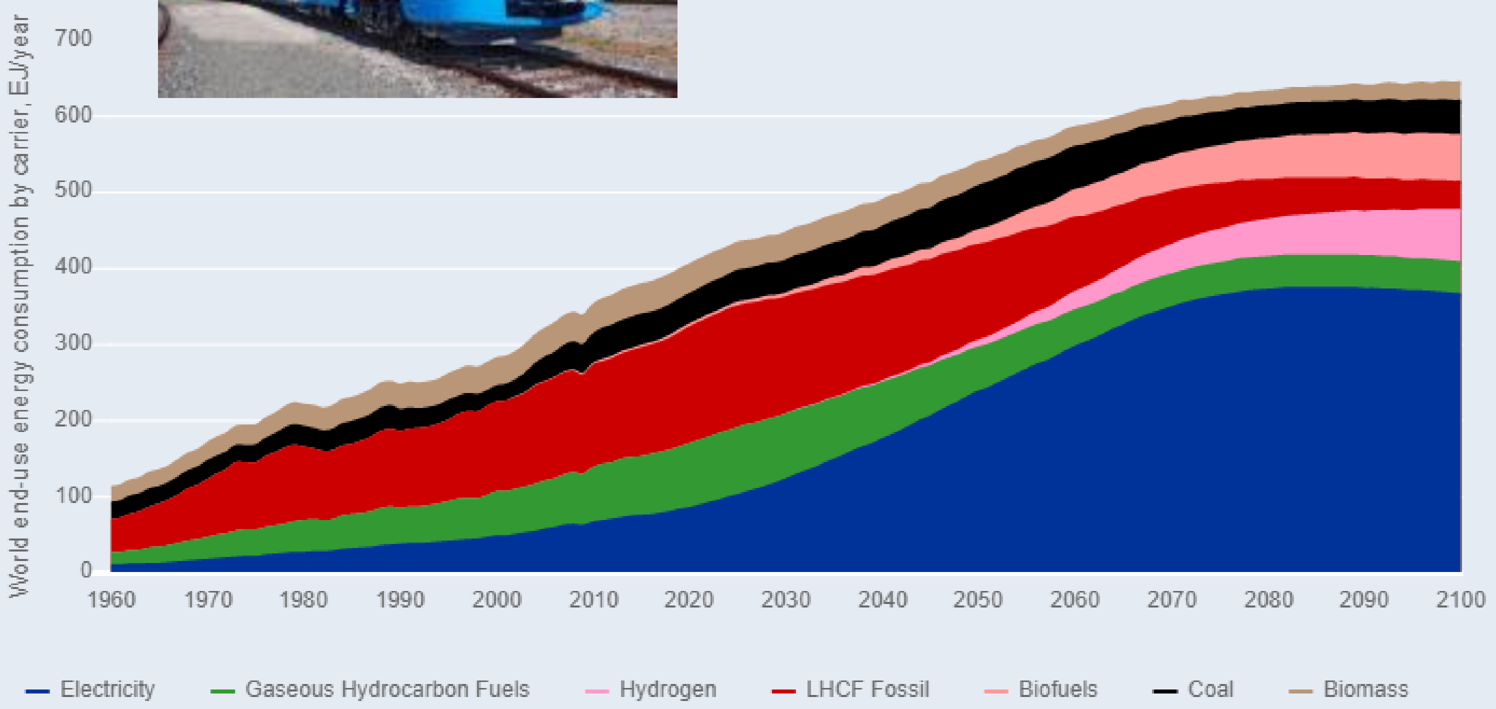
Shell Sky Scenario



www.shell.com

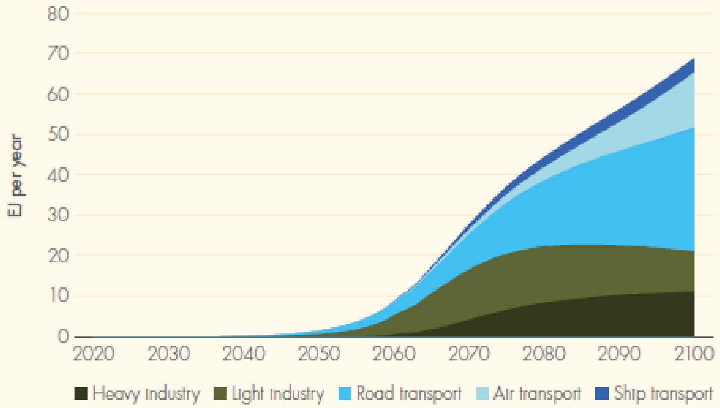
Deep Electrification + Hydrogen & Biofuels to decarbonize End-use



Source: Shell analysis, ***Sky*** scenario

*LHCF : Liquid hydrocarbon fuel

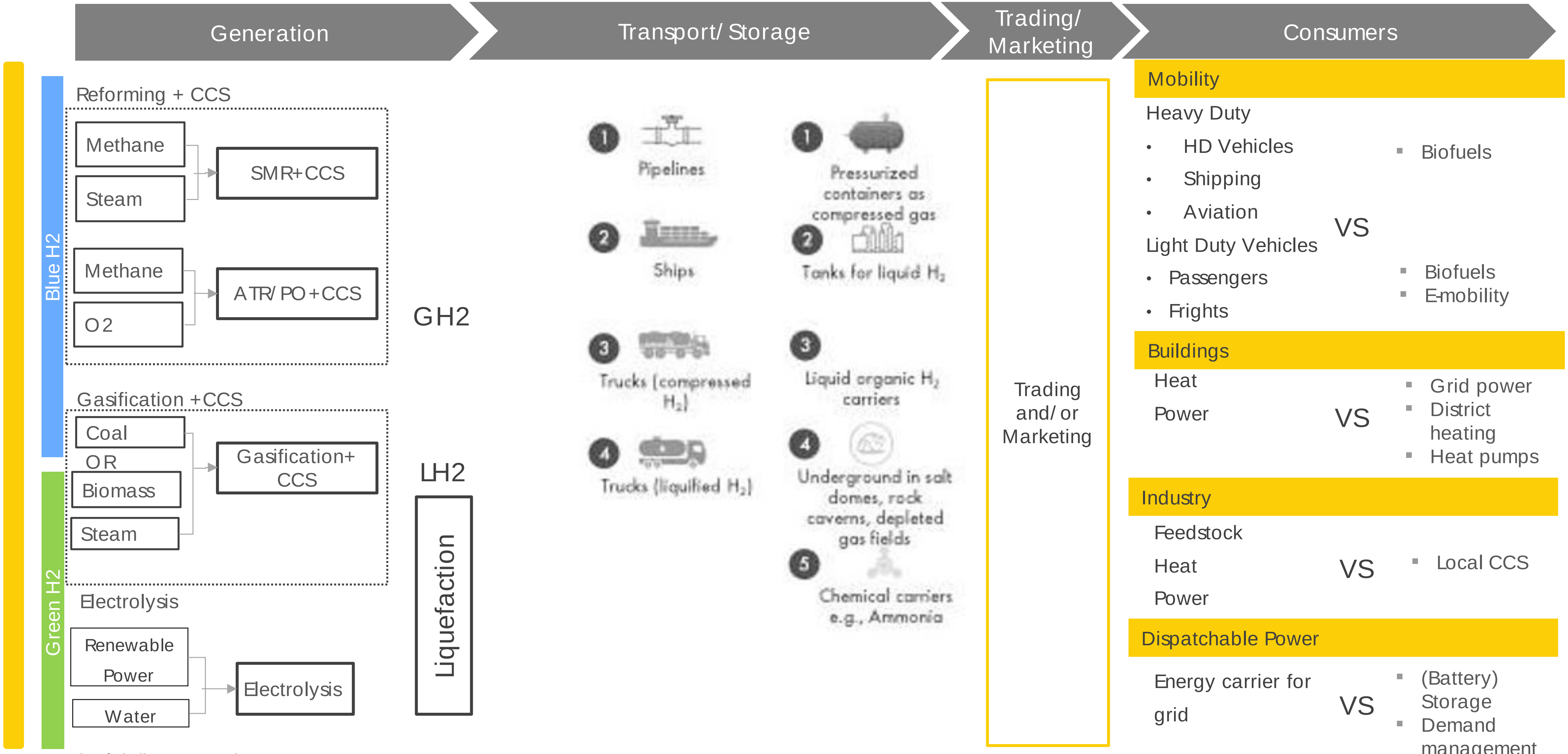
IN **SKY**, HYDROGEN EMERGES AS A MATERIAL ENERGY CARRIER AFTER 2040, PRIMARILY FOR INDUSTRY AND TRANSPORT



Note: By 2100, hydrogen supplies a quarter of all transport energy demand and over 10% of industrial energy

Source: Shell analysis

H2 Supply Chain & Markets



Shell EBI Hydrogen Market Activation Workshop

Objective

To conduct a workshop that will frame the market/demand context to deploy competitive commercial scale 500t/d Hydrogen supply chain for US by identifying the opportunities (focus in California and Gulf Coast)and provide an early assessment of potential ways forward.

The 2-day virtual workshop will have: Internal and external presentations and break out sessions for opportunity framing discussions.

In Scope

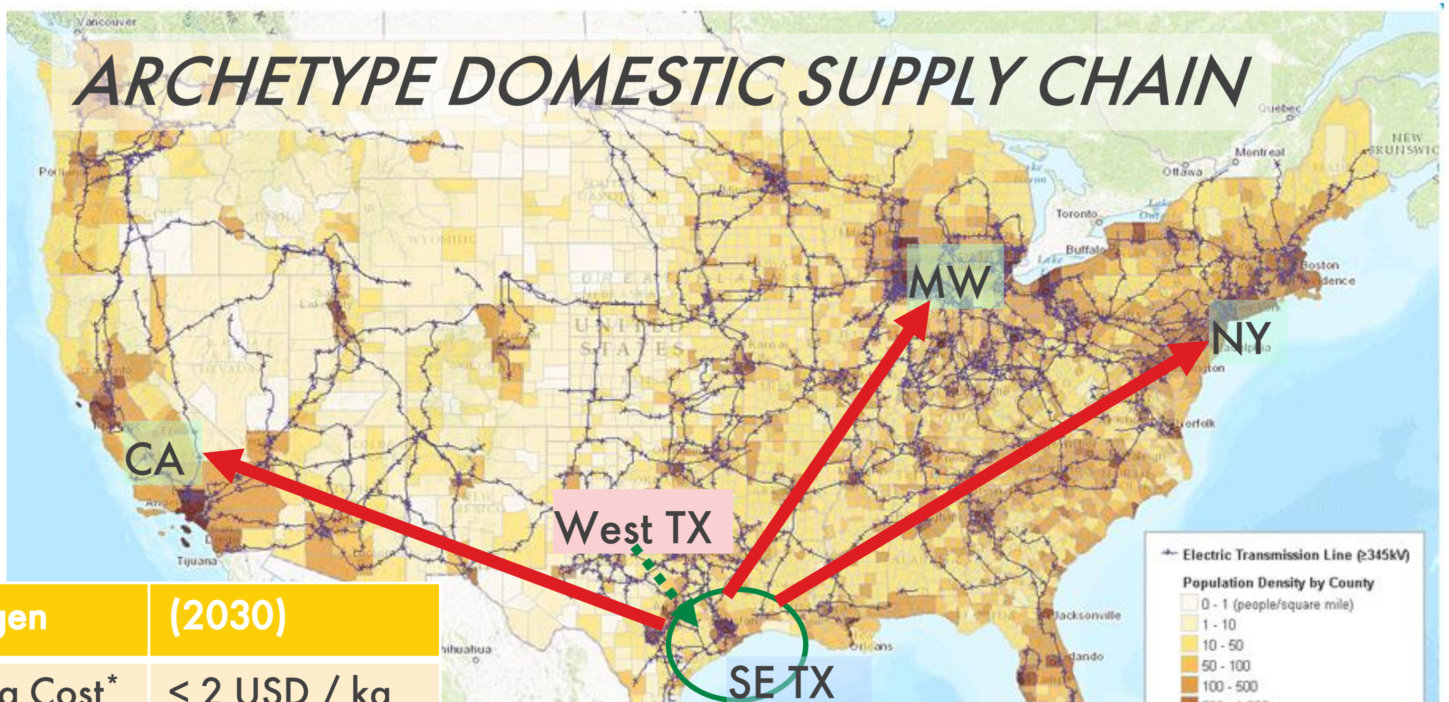
- US region: Focus on California market and Texas/Gulf coast for supply/local market opportunities – consider all sectors LD & HD transport, industry, marine, data centers etc.
- Market activation - Innovative partnership/strategies to create H2 market demand
- Current US, California & Texas policy , subsidies, regional differences and advantages; future policy predictions
- H2 supply chain economics via various pathways

Out of Scope

- Conventional H2 (Grey or Black)

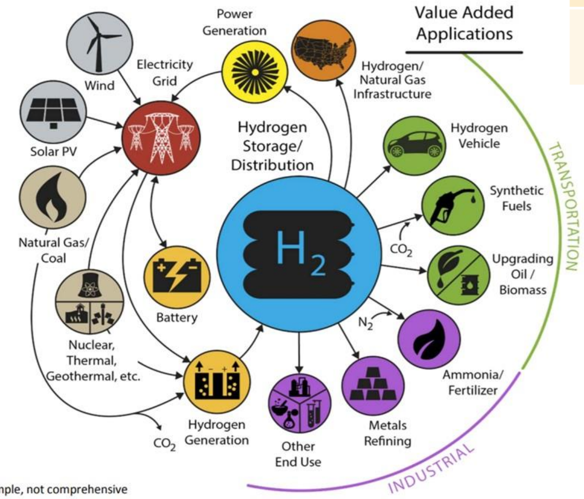
US Opportunities

- Green / clean H_2 from West TX renewable + SE TX (Houston GC) waste heat
  - SMR/ Methane pyrolysis / water electrolysis
- H_2 heavy duty trucking, industry
- Commercial ride-share (Uber fleet)?
- City lift trucks / buses?
- H_2 Rail transit to US States with clean energy incentives; H_2 + NH_3 pipelines
  - LH_2 or NH_3
- Leveraged demo hub



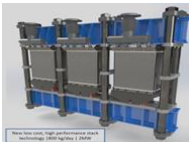
Clean Hydrogen	(2030)
Manufacturing Cost* Dispensed Cost	< 2 USD / kg < 4 USD / kg
Scale (per Site)	> 1500 kg / d

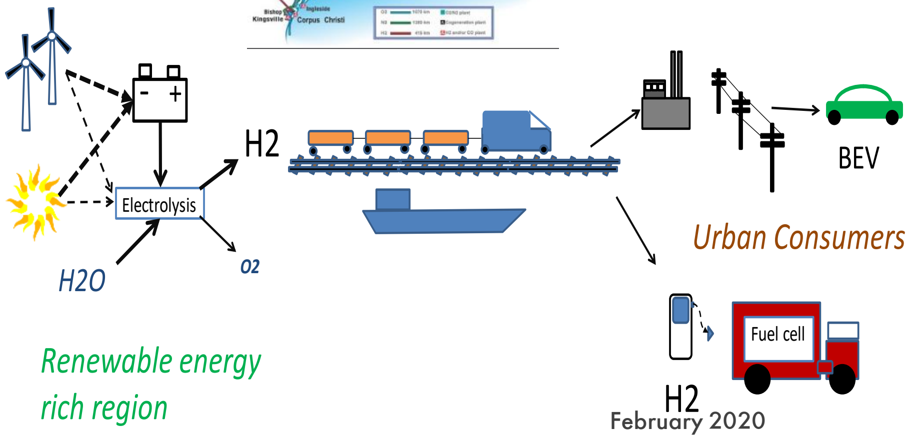
H_2 at Scale Energy System



*Illustrative example, not comprehensive
Source: NREL

Fuel Cell Electric Vehicle Prototype 2





* Distributed small/medium scale

Hydrogen costs & services

Component	SMR + CCS $/kg	Wind electrolysis $/kg	Solar electrolysis $/kg
Process	1.26	5.24	8.87
Process range	1.03 - 2.16	3.56 - 10.82	3.34-17.3
CCS	0.60	0.00	0.00
Delivery	2.00	2.00	2.00
CSD*	0.90	0.90	0.90
Total	4.76	8.14	11.77
45Q+LCFS	-2.37		
Net cost CA H2	2.39		

B. Parkinson, P. Balcombe, J.F. Speirs, A.D. Hawkes, K. Hellgardt, Levelized cost of CO 2 mitigation from hydrogen production routes, Energy Environ. Sci. 12 (2019) 19–40. *Sustainable Gas Institute, Imperial College London*

Today (local hydrogen refueling, 10,000 vehicles scale)

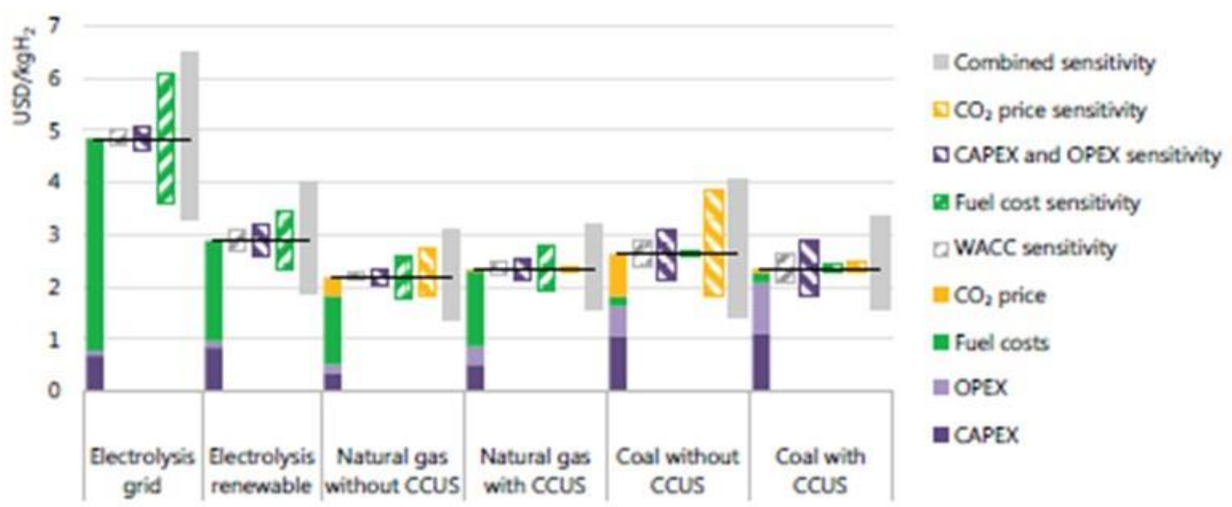
- $10 - $18/kg dispensed cost in California
- € 9,5 ($10,5) dispensed cost Germany
- $7 / kg dispensed cost Texas?

* Compression, storage, and dispensing

Cost reduction via H2@Scale!

IEA (2019). https://www.iea.org/reports/the-future-of-hydrogen

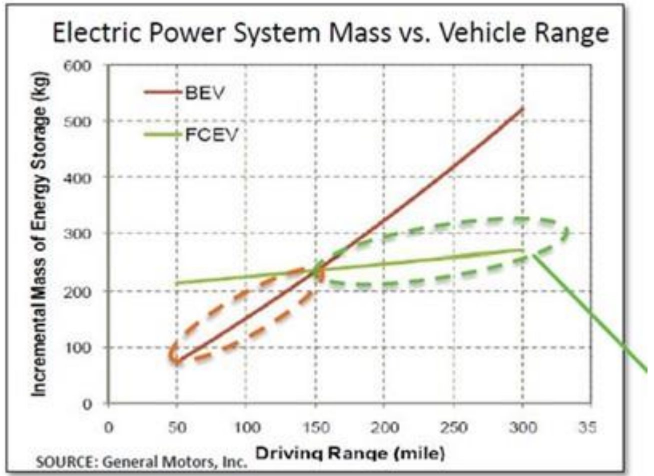
Figure 16. Hydrogen production costs for different technology options, 2030



Notes: WACC = weighted average cost of capital. Assumptions refer to Europe in 2030. Renewable electricity price = USD 40/MWh at 4 000 full load hours at best locations; sensitivity analysis based on +/-30% variation in CAPEX, OPEX and fuel costs; +/-3% change in default WACC of 8% and a variation in default CO_2 price of USD 40/tCO_2 to USD 0/tCO_2 and USD 100/tCO_2. More information on the underlying assumptions is available at www.iea.org/hydrogen2019.

Source: IEA 2019. All rights reserved.

In the near term, hydrogen production from fossil fuels will remain the most cost-competitive option in most cases.

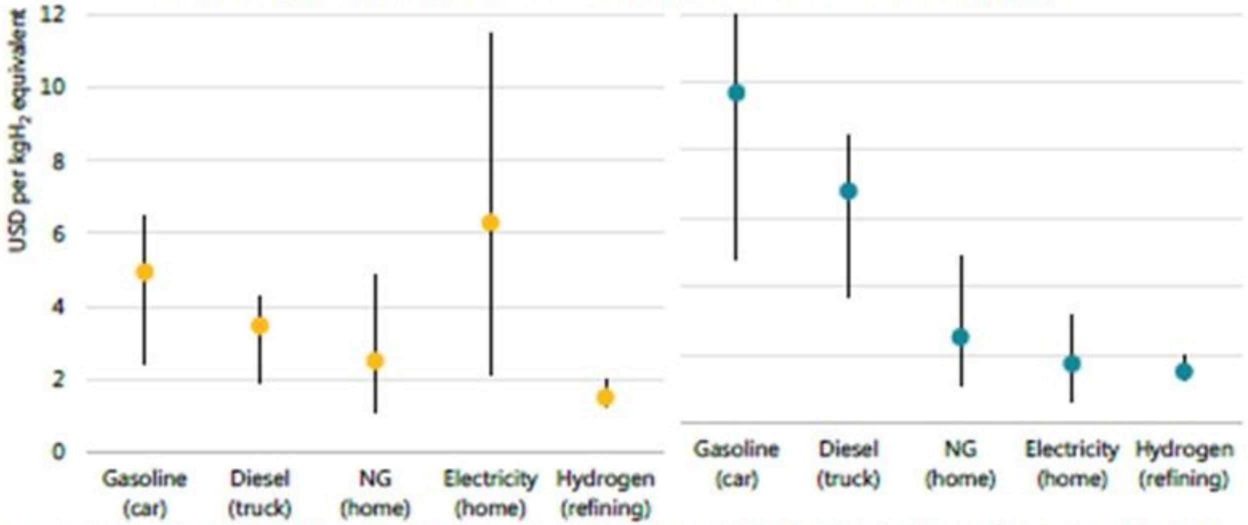


GM: Fuel Cell HDV advantages: long haul, commercial fleets

Viability of Hydrogen Economy?

Price paid for energy services

Figure 65. Today's fuel prices in hydrogen-equivalent terms on an energy basis (left) and accounting for the relative efficiencies to provide the same service (right)



Notes: Average prices paid in IEA countries plus China. Prices include taxes and tariffs. Fuel cell and motor drivetrain assumed to be 95% more efficient than an internal combustion engine. Heat pump assumed to be 3.6 times more efficient than heating with hydrogen. NG = natural gas.

Source: IEA (2018a), *World Energy Prices 2018*.

After accounting for the efficiency of converting hydrogen to motive power, the price paid by car drivers for gasoline is equivalent to nearly USD 10/kgH$_2$, which is achievable for delivered hydrogen costs in many regions by 2030.

IEA (2019). https://www.iea.org/reports/the-future-of-hydrogen

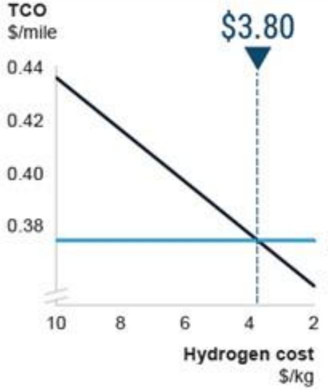
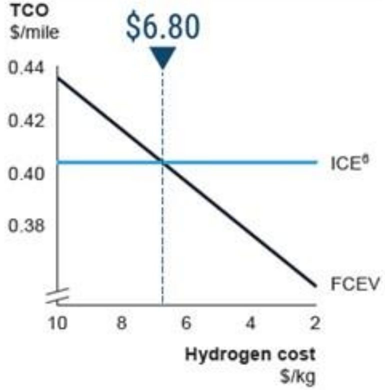
Total cost of ownership SUV

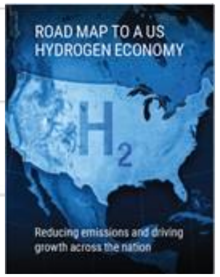
http://www.fchea.org/us-hydrogen-study (2020)

Exhibit 38

SUV TCO analysis

TCO per mile ($/mile) in 2030

	Assumption 1 ICE efficiency of 39 mpg	Assumption 2 ICE efficiency of 29 mpg
Capex[1,2]	FCEV: Hyundai Nexo – 39K ICE: Honda Pilot – 32K	FCEV: Hyundai Nexo – 39K ICE: Honda Pilot – 32K
Lifetime	200,000 miles ~35 miles/day	200,000 miles ~35 miles/day
Efficiency	FCEV: 5 kWh battery 0.015 H$_2$ kg/mile (67 GGE[3]) ICE: 39 mpg[4]	FCEV: 5 kWh battery 0.015 H$_2$ kg/mi. (67 GGE[3]) ICE: 29 mpg[5]
Break-even price of hydrogen at the pump		



Infrastructure

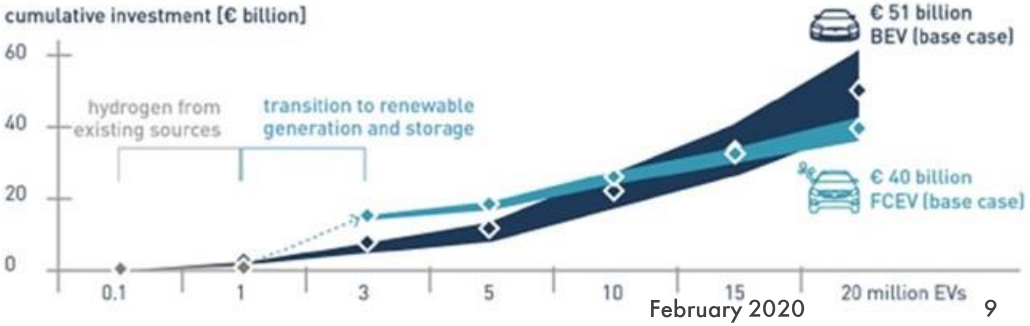


Figure 0-2: Comparison of the cumulative investment of supply infrastructures.

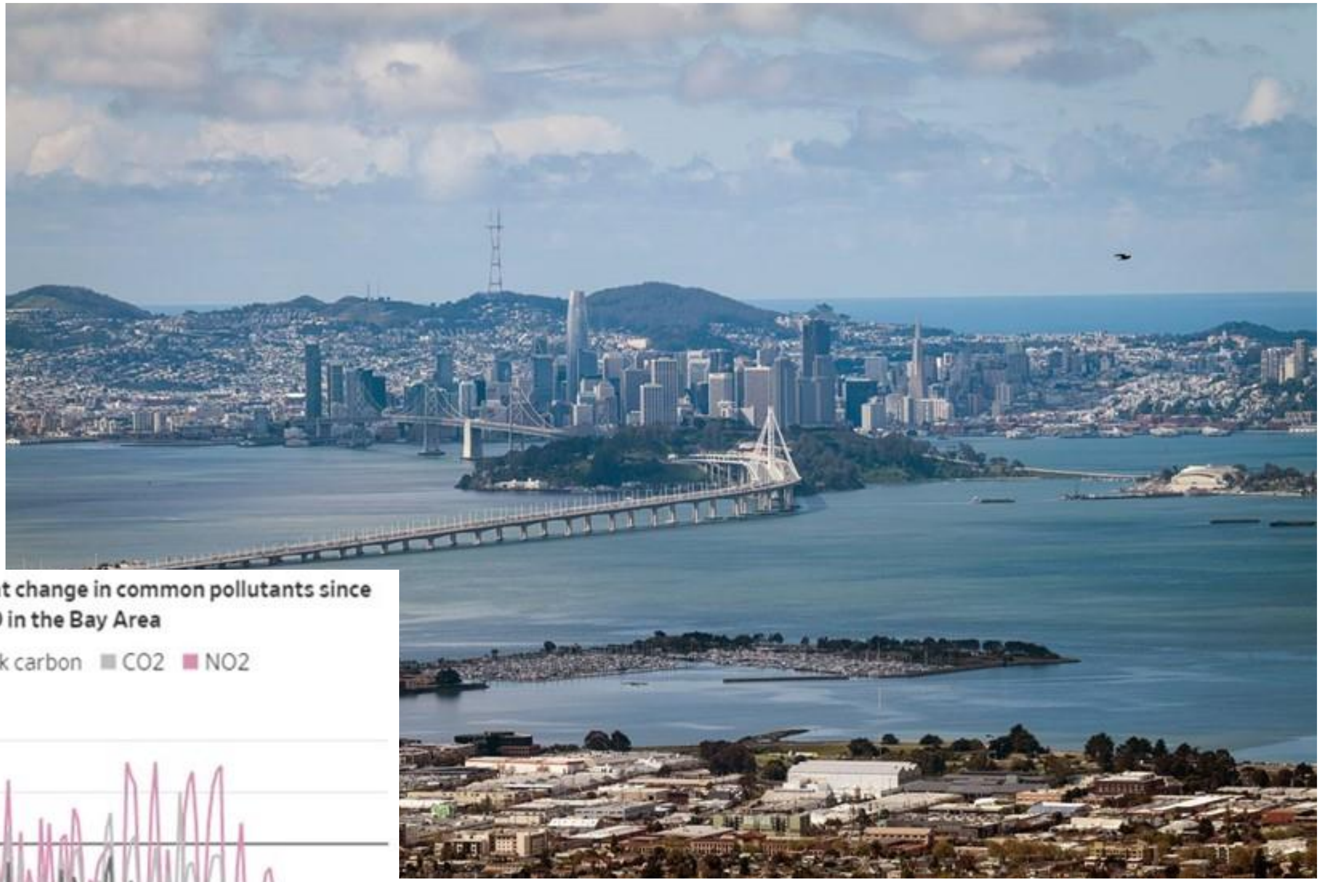
H2 Mobility Comparative Analysis of Infrastructures: Hydrogen Fueling and Electric Charging of Vehicles, Martin Robinius, Jochen Linßen, Thomas Grube, Markus Reuß, Peter Stenzel, Konstantinos Syranidis, Patrick Kuckertz and Detlef Stolten, Energie & Umwelt / Energy & Environment Band / Volume 408 ISBN 978-3-95806-295-5: **Forschungszentrum Jülich Research Centre and the H2 Mobility**

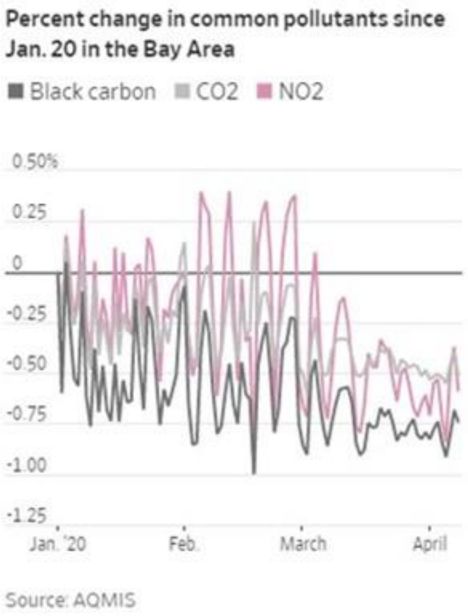
Stakeholder Market Forces

*Rebecca Elliott and Bradley Olson, Sept. 22, 2019 WSJ

SCOPE-3 Emissions:

"greenhouse-gas emissions from the oil byproducts they sell, such as gasoline. These releases constitute roughly 88% of major oil-and-gas companies' greenhouse-gas footprint, according to estimates from Redburn, a London-based research firm"*



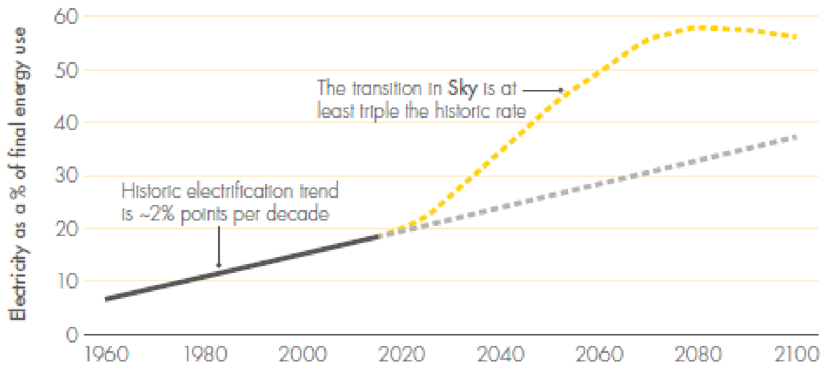


Pandemic panorama: Skies were clear above San Francisco, on March 25, about a week after California's stay-at-home order took effect. PHOTO: DAVID PAUL MORRIS/BLOOMBERG NEWS

Coronavirus Offers a Clear View of What Causes Air Pollution: Jim Carlton, WSJ May 3, 2020
With factories and vehicles idle, nitrogen dioxide levels hit lows not seen since the early 20th century; 'We didn't know…how significantly it could drop'

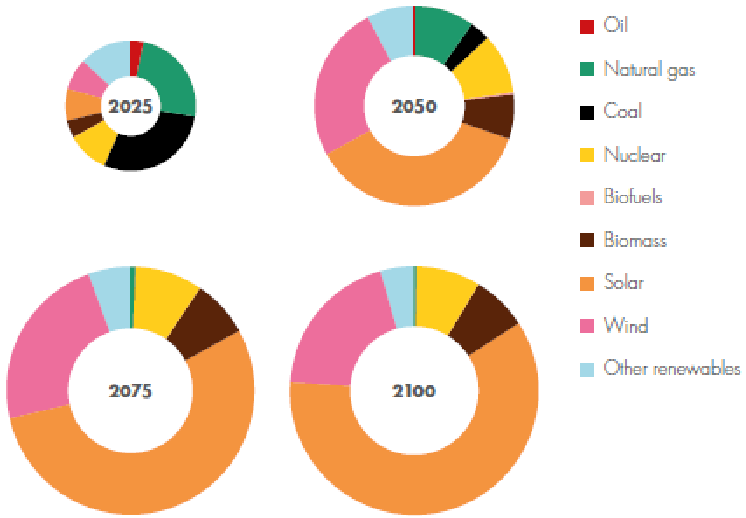
Electrification and Hydrogen (Synergy)

CURRENT ELECTRIFICATION TRENDS ARE NOT SUFFICIENT FOR SKY



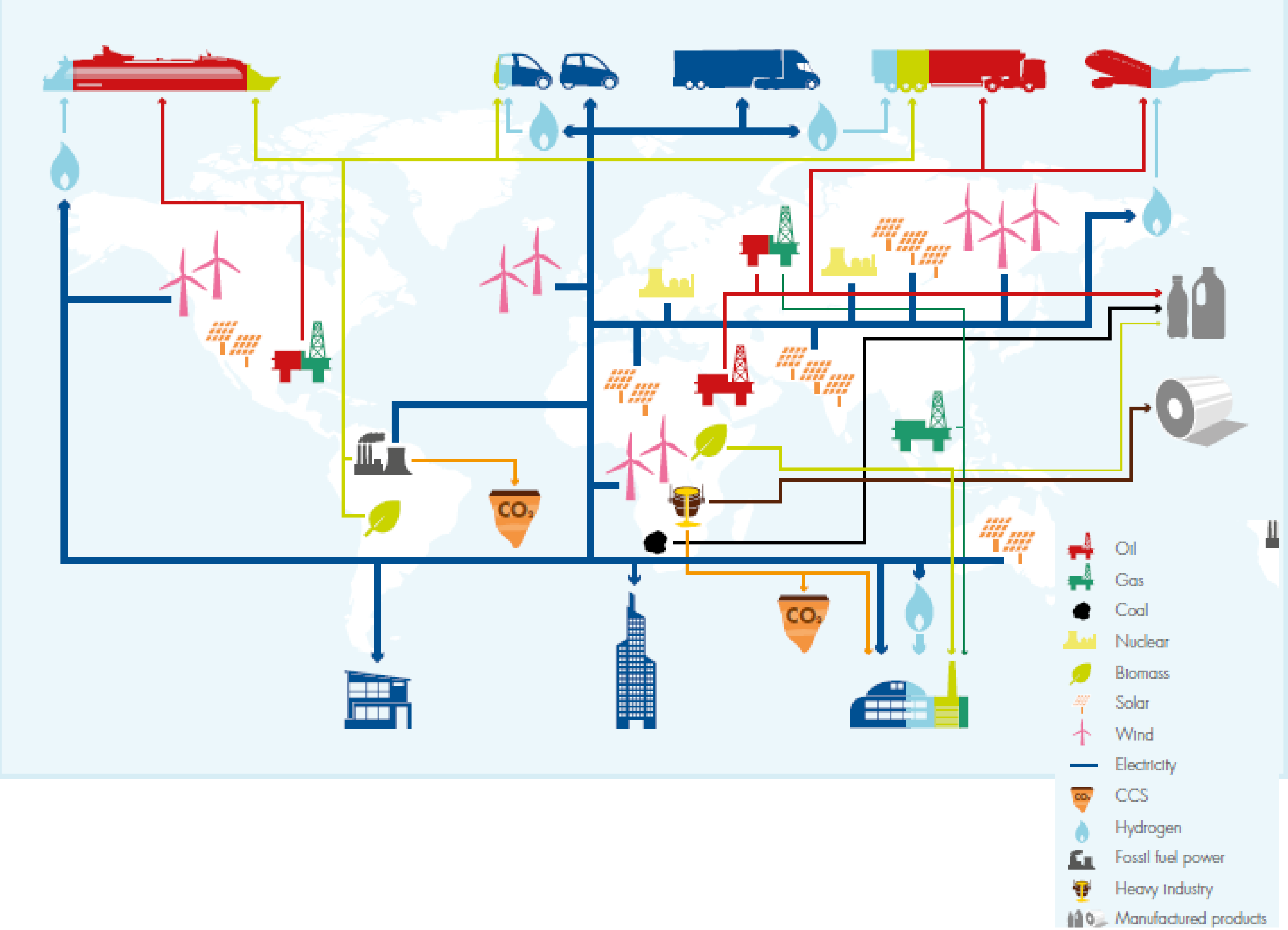
Source: Shell analysis, IEA (historical data)

THE ELECTRICITY MIX SHIFTS HEAVILY TO SOLAR THROUGH THE CENTURY



Note: The diameter of the pie chart represents the total electricity demand.
Source: Shell analysis

SKY IN 2070 – AN ELECTRICITY-BASED ENERGY SYSTEM



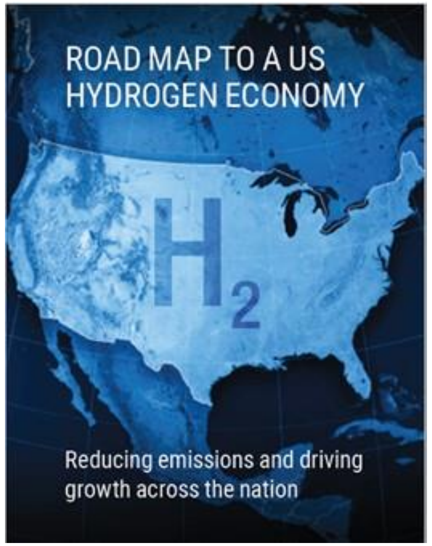
August 2019

U.S. Hydrogen Roadmap (2019)

Exhibit 6
Scaling hydrogen – ambitious road map milestones

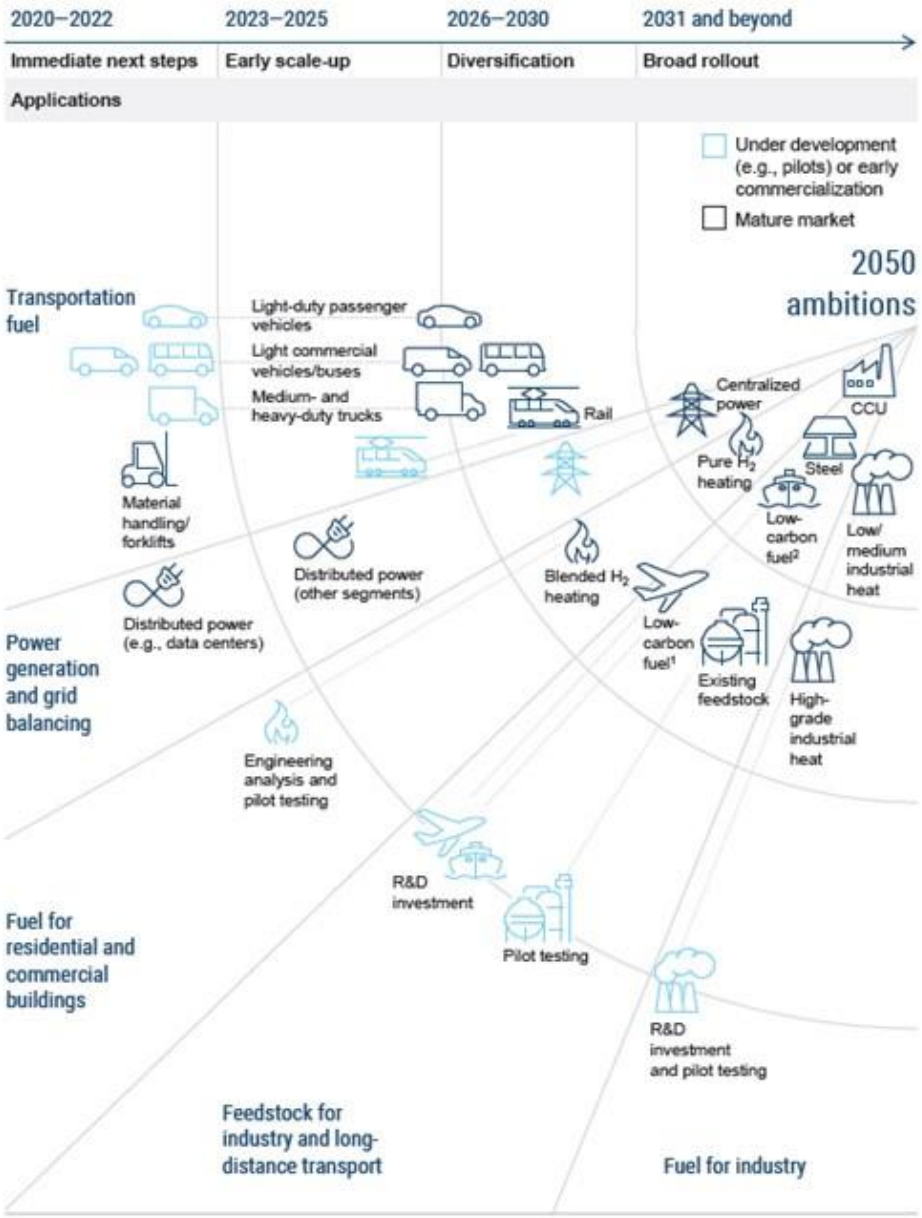
	Today	2022	2025	2030
	Immediate next steps	Early scale-up	Diversification	Broad rollout
H_2 demand, metric tons	11 m	12 m	13 m	17 m
FCEV sales	2,500	30,000	150,000	1,200,000
Material-handling FCEVs	25,000	50,000	125,000	300,000
Fueling stations[1]	63	165[2]	1,000[2]	4,300[3]
Material-handling fueling stations[4]	120	300	600	1,500
Annual investment		$1 bn	$2 bn	$8 bn
New jobs[5]		+50,000	+100,000	+500,000

1 Includes both fueling stations in operation and in development
2 Stations of 500 kg/day; does not include material-handling fueling stations
3 Stations of 1,000 kg/day; does not include material-handling fueling stations
4 Data from Plug Power
5 Includes direct, indirect, and resulting jobs, building on an estimated 200,000 jobs in the sector today



http://www.fchea.org/us-hydrogen-study

Exhibit 5
Hydrogen applications road map



1 Carbon capture and utilization (for chemicals production)
2 Biofuel, synfuel, ammonia