Global Hydrogen Review: Assumptions annex

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Global Hydrogen Review 2025: Assumptions annex

This annex collects the various assumptions that underpin the analyses throughout the *Global Hydrogen Review 2025*. Global averages are presented for technologies, unless otherwise stated. However, several analyses in the report present regional examples, for which costs will vary with material and labour inputs and differ from the global average. These input parameters reflect choices made by the IEA on the basis of different sources of information consulted.

Renewable electricity cost and full load hours

Solar PV

Region	LCOE (USD/MWh) 2024	LCOE (USD/MWh) STEPS 2030	Full load hours (hr)
China	20	15	2550
Europe	26	19	2170
Latin America	26	18	3060
Middle East	24	13	2810
United States	36	26	2490

Offshore wind

Region	LCOE (USD/MWh) 2024	LCOE (USD/MWh) STEPS 2030	Full load hours (hr)
China	63	44	4120
Europe	52	41	4500
Latin America	86	68	5890
Middle East	121	93	4050
United States	90	63	4940

Onshore wind

Region	LCOE (USD/MWh) 2024	LCOE (USD/MWh) STEPS 2030	Full load hours (hr)
China	32	29	3130
Europe	40	37	3690
Latin America	36	33	4220
Middle East	46	42	3280
United States	36	34	4010

Notes: LCOE = levelised cost of electricity; STEPS = Stated Policies Scenario. Renewable electricity generation costs and full load hours for good resource conditions in a region or country. Additional information on other parameters, including capital expenditure (CAPEX), is available in the IEA Global Energy and Climate Model key input data.

CO_2 prices and costs

CO_2 prices

Region	CO_2 price (USD/t CO_2) 2024	STEPS 2030
Advanced economies	0-70	0-110
Selected emerging markets and developing economies*	0	0
Other emerging markets and developing economies	0	0

* Includes Argentina, Brazil, China and Mexico.

CO_2 transport and storage cost for carbon capture, utilisation and storage

Region	(USD/t CO_2) 2024	STEPS 2030
China	15	12
Europe	47	33
Middle East	14	12
United States	14	12
Rest of the world	23	20

Note: STEPS = Stated Policies Scenario.

Production pathways

Hydrogen

Technology	Parameter	Units	2024	STEPS 2030
Water electrolysis	CAPEX* (global average)	**USD/kWₑ**	2000-2600	1400-1820
	CAPEX* (China)	**USD/kWₑ**	600-1200	450-900
	Efficiency (LHV)	**%**	63%	64%
	Efficiency (LHV) (China)	**%**	58%	62%
	Annual OPEX	**% of CAPEX**	3.0%	3.0%
	Stack lifetime (operating hours)**	**hr**	50000	50000
Natural gas reforming	CAPEX	**USD/kW_{H2}**	720	720
	Efficiency (LHV)	**%**	76%	76%
	Annual OPEX	**% of CAPEX**	4.7%	4.7%
Natural gas reforming with CCUS	CAPEX	**USD/kW_{H2}**	1420	1420
	Efficiency (LHV)	**%**	69%	69%
	Annual OPEX	**% of CAPEX**	4.0%	4.0%
	CO_2 capture rate	**%**	95%	95%
Coal gasification	CAPEX ***	**USD/kW_{H2}**	2640	2640
	Efficiency (LHV)	**%**	60%	60%
	Annual OPEX	**% of CAPEX**	5.0%	5.0%
Coal gasification with CCUS	CAPEX ***	**USD/kW_{H2}**	2750	2750
	Efficiency (LHV)	**%**	58%	58%
	Annual OPEX	**% of CAPEX**	5.0%	5.0%
	CO_2 capture rate	**%**	95%	95%

* CAPEX includes the electrolyser system, electric equipment, gas treatment, plant balancing, and engineering, procurement and construction (EPC). CAPEX of the power generation assets is not included.

** Stack lifetime can reach up to 95000 hr. The selected value (50000 hr) comes from the IEA's analysis of the optimum economic lifetime, considering degradation issues.

*** For China, CAPEX is assumed to be 50% of the world average for coal gasification and 52% for coal gasification with CCUS.

Notes: LHV = Lower heating value; STEPS = Stated Policies Scenario; OPEX = operating expenditure; CCUS = carbon capture, utilisation and storage. All CAPEX refers to the installed cost of the technology. 25-year lifetime and a 95% availability factor assumed for hydrogen production from natural gas; 25-year lifetime and 90% availability factor assumed for the production of hydrogen from coal. Availability factors for electrolysis vary depending on the technology considered to supply the electricity and the location of the project. For water electrolysis, water costs and possible revenues from oxygen sales have not been considered in the cost analysis.

Hydrogen-based industrial products

Ammonia (NH_3)

Technology	Parameter	Units	2024
Natural gas reforming	CAPEX (including air separation unit)	**USD/(t NH_3/yr)**	1390 – 2415
	Annual OPEX	**% of CAPEX**	2.9%
	Natural gas consumption	**GJ/t NH_3**	32
	Electricity consumption	**MWh/t NH_3**	0.1
Natural gas reforming with CCUS	CAPEX (including air separation unit)	**USD/(t NH_3/yr)**	1640 – 2855
	Annual OPEX	**% of CAPEX**	2.9%
	Natural gas consumption	**GJ/t NH_3**	34
	Electricity consumption	**MWh/t NH_3**	0.2
Coal gasification	CAPEX (including air separation unit)	**USD/(t NH_3/yr)**	2625 – 4560
	Annual OPEX	**% of CAPEX**	5.8%
	Coal consumption	**GJ/t NH_3**	35
	Electricity consumption	**MWh/t NH_3**	1.0
Coal gasification with CCUS	CAPEX (including air separation unit)	**USD/(t NH_3/yr)**	3190 – 5540
	Annual OPEX	**% of CAPEX**	5.8%
	Coal consumption	**GJ/t NH_3**	40
	Electricity consumption	**MWh/t NH_3**	1.3
Haber-Bosch (using hydrogen from electrolysis)	CAPEX (including air separation unit)	**USD/(t NH_3/yr)**	560 – 980
	Annual OPEX	**% of CAPEX**	2.9%
	Hydrogen consumption	**GJ/t NH_3**	0.2
	Electricity consumption	**MWh/t NH_3**	0.6

Notes: LHV = Lower heating value. All CAPEX refers to the installed cost of the technology. The CAPEX of the Haber-Bosch process does not include the CAPEX of the electrolysis plant. A 25-year lifetime is assumed for all technologies.

Methanol (MeOH)

Technology	Parameter	Units	2024
Natural gas reforming	CAPEX (including air separation unit)	**USD/(t MeOH/yr)**	310
	Annual OPEX	**% of CAPEX**	2.5%
	Natural gas consumption	**GJ/t MeOH**	35
	Electricity consumption	**MWh/t MeOH**	0.1
Natural gas reforming with CCUS	CAPEX (including air separation unit)	**USD/(t MeOH/yr)**	570 – 750
	Annual OPEX	**% of CAPEX**	2.5%
	Natural gas consumption	**GJ/t MeOH**	36
	Electricity consumption	**MWh/t MeOH**	0.2
Coal gasification	CAPEX (including air separation unit)	**USD/(t MeOH/yr)**	750
	Annual OPEX	**% of CAPEX**	5.0%
	Coal consumption	**GJ/t MeOH**	45
	Electricity consumption	**MWh/t MeOH**	1.0
Coal gasification with CCUS	CAPEX (including air separation unit)	**USD/(t MeOH/yr)**	1680 – 2370
	Annual OPEX	**% of CAPEX**	5.0%
	Coal consumption	**GJ/t MeOH**	55
	Electricity consumption	**MWh/t MeOH**	1.5
Fischer-Tropsch (using hydrogen from electrolysis)	CAPEX (including air separation unit)	**USD/(t MeOH/yr)**	220
	Annual OPEX	**% of CAPEX**	2.5%
	Hydrogen consumption	**t H_2/t NH_3**	0.2
	Electricity consumption	**MWh/t MeOH**	1.1

Notes: LHV = Lower heating value. All CAPEX refers to the installed cost of the technology. The CAPEX of the Fisher-Tropsch process does not include the CAPEX of the electrolysis plant. A 25-year lifetime is assumed for all technologies.

Infrastructure

Indicative investment for ammonia export terminal infrastructure by illustrative port archetype

Port archetype	Investment* (USD million)
Naturally sheltered jetty port	90
Naturally sheltered quay wall port	170
Open coastal jetty port with breakwater in shallow water	190
Open coastal jetty port with breakwater in deep water	1 100

*This cost estimate is a conceptual, order-of-magnitude assessment with an uncertainty of about ±50%.
Notes: The cost estimate includes indicative values for various infrastructure elements, though not all are applicable to every port archetype. These may comprise berthing infrastructure (jetties, mooring piles, quay walls), superstructure (loading arms, manifolds, pipelines, support frames, security elements), dredging (where required in shallow waters), land preparation, and, in open coastal ports, a potential breakwater to provide shelter against wind and waves. Together, these components represent the indicative port setup required to receive an ammonia tanker with a deadweight tonnage (DWT) of around 60 000 DWT.

Total cost of ownership

The truck total cost of ownership analysis presented in the *Global Hydrogen Review 2025* follows the same methodology as the analysis presented in the *Global Electric Vehicle Outlook 2025* report (see Annex A: Total Cost of Ownership). This annex provides an update on the technoeconomic assumptions considered for the use cases included in the *Global Hydrogen Review 2025*. For further details on methodology and assumptions, please refer to the annex of the *Global Electric Vehicle Outlook 2025*.

Vehicle production costs, specifications, and payload

Truck powertrain components

Powertrain type	Component	Value
Diesel	Engine power	325 kW
Battery electric	Electric drive power	350 kW
	Battery pack size	800 kWh
	On-board charger	44 kW
Fuel cell electric	Electric drive power	350 kW
	Fuel cell power	362 kW
	Battery pack size	70 kWh
	On-board charger	6.6 kW
	700 bar hydrogen tank size	80 kg

Notes: Powertrain sizing values are for a United States class 8 (or equivalent) tractor truck. The 80 kg hydrogen tank has a usable capacity of 67 kg. Fuel cell power is sized to provide 275 kW of power after 25 000 hours of operation.

Sources: Diesel engine power and battery electric battery pack size are adapted from National Renewable Energy Laboratory; fuel cell stack and fuel cell battery sizing are taken from US Department of Energy; electric drive power, on-board charger, and hydrogen tank sizes are taken from Riccardo.

Direct manufacturing costs of powertrain components, 2024 and 2030

	Units	United States		European Union		China	
Component	**USD (2024)**	**2024**	**2030**	**2024**	**2030**	**2024**	**2030**
Electric drive	USD/kW	80	75	70	70	44	42
Power electronics (e-drive inverter box)	USD/kW	27	26	24	24	15	14
DC/DC converter	USD	540	525	485	470	295	290
Heating, Ventilation, and	USD	8 555	8 340	6 590	6 425	2 995	2 920

Component	Units USD (2024)	United States 2024	United States 2030	European Union 2024	European Union 2030	China 2024	China 2030
Air Conditioning; electrical and air brakes							
Battery and electronics thermal management (BEV)	USD/kW	19	17	17	16	11	10
Battery and electronics thermal management (FCEV)	USD/kW	8	7	7	7	5	4
Fuel cell system	USD/kW	365	230	330	210	200	130
Battery (FCEV)	USD/kWh	510	385	510	385	280	210
Battery (BEV)	USD/kWh	190	100	190	100	85	70
On-board charger	USD/kW	65	60	60	55	36	33
700-bar hydrogen tank	USD/kg	1 010	860	910	770	560	470

Notes: "BEV" = battery electric vehicle; "FCEV" = fuel-cell electric vehicle. "Battery" includes battery cells, pack and the battery management system. In the case of BEVs the battery chemistry is assumed to be lithium iron phosphate (LFP), for FCEVs it is lithium nickel cobalt manganese oxide (NMC). "Fuel cell system" costs include economies of scale and learning effects equal to production volumes of 1 000 units and 20 000 units per year in 2024 and 2030, respectively. Values below USD 50 have been rounded to the nearest USD 1; values above USD 50 have been rounded to the nearest USD 5.

Sources: Battery costs are adapted from Bloomberg New Energy Finance, fuel cell system costs are adapted from US Department of Energy, hydrogen tank costs are adapted from US Department of Energy, electric drive, battery and electronics thermal management, on-board charger, DC/DC converter, hydrogen tank, and power electronics are adapted from Riccardo.

Estimated purchase price of a heavy-duty diesel truck (ICET), 2024 and 2030

	United States 2024	United States 2030	European Union 2024	European Union 2030	China 2024	China 2030
Driveline, cab, and chassis	40 400	39 300	31 100	30 300	14 100	13 800
Powertrain	66 000	69 300	50 800	53 400	23 100	24 300
Manufacturing and assembly	7 400	7 600	5 700	5 900	2 600	2 700
Indirect costs and margins	41 000	41 800	31 600	32 300	14 300	14 700
Total	**154 800**	**158 200**	**119 200**	**121 800**	**54 200**	**55 400**

Notes: Prices in USD (2024) for a United States class 8 (or equivalent) tractor truck with a 325 kW engine, as specified in the previous tables. "Powertrain" includes the engine and all balance of plant. Manufacturing and assembly costs are assumed to be 7% of production costs of the components, and indirect costs and margins are 36% of the total production cost, equally applied across all regions. All values are rounded to the nearest USD 100. The bottom-up calculated totals were validated against values from the California Air Resources Board (for the United States and European Union) and International Council on Clean Transportation (ICCT) (for China).

Sources: Values for the share of total costs from the driveline, cab and chassis; from manufacturing and assembly costs; and from indirect costs and margins are taken from Riccardo.

Estimated purchase price of a heavy-duty fuel cell electric truck, 2024 and 2030

	United States		European Union		China	
	2024	2030	2024	2030	2024	2030
Finished chassis and cab	40 400	39 400	31 100	30 300	14 100	13 800
Powertrain	41 200	39 200	37 000	35 300	22 700	21 600
Battery	35 800	26 900	35 800	26 900	19 700	14 800
Fuel cell	132 400	84 000	119 200	75 600	72 800	46 200
Hydrogen tank	81 000	68 900	72 900	62 000	44 500	37 900
Manufacturing and assembly	9 900	7 700	8 900	6 900	5 200	4 000
Indirect costs and margins	122 700	95 800	109 800	85 300	65 300	50 300
Total	**463 400**	**361 800**	**414 700**	**322 200**	**243 500**	**187 900**

Notes: Costs in USD (2024) for a United States class 8 (or equivalent) tractor truck with a 380 kW fuel cell system, hydrogen tank with 50 kg of usable capacity, and a 350 kW electric drive unit. Powertrain includes the electric drive unit, electronics and thermal management units, a 70 kWh battery, and all balance of plant. Manufacturing and assembly costs are assumed to be 3% of production costs of the components with indirect costs and margins of 36% of the total production cost, equally applied across all regions. All values are rounded to the nearest USD 100. The bottom-up calculated totals were validated against values from the California Air Resources Board (for the United States and European Union) and ICCT (China).

Sources: Values for the share of total costs from the driveline, cab, and chassis; from manufacturing and assembly costs; and from indirect costs and margins are adapted from Riccardo.

Estimated purchase price of a heavy-duty battery electric truck, 2024 and 2030

	United States		European Union		China	
	2024	2030	2024	2030	2024	2030
Finished chassis and cab	40 400	39 300	31 100	30 300	14 100	13 800
Powertrain	47 500	44 900	42 800	40 400	26 100	24 700
Battery	152 000	78 900	152 000	78 900	69 700	55 600
Manufacturing and assembly	7 200	4 900	6 800	4 500	3 300	2 800
Indirect costs and margins	89 000	60 500	83 800	55 500	40 800	34 900
Total	**336 100**	**228 600**	**316 400**	**209 700**	**154 100**	**131 800**

Notes: Costs in USD (2024) for a United States class 8 (or equivalent) tractor truck with a 350 kW electric drive unit, and an 800 kWh battery. Powertrain includes the electric drive unit, electronics and thermal management units, on-board charger, and all balance of plant. Manufacturing and assembly costs are assumed to be 3% of production costs of the components, with indirect costs and margins of 36% of the total production cost, equally applied across all regions. All values are rounded to the nearest USD 100. The bottom-up calculated totals were validated against values from the California Air Resources Board (for the United States and European Union) and ICCT (for China).

Sources: Values for the share of total costs from the driveline, cab, and chassis; from manufacturing and assembly costs; and from indirect costs and margins are adapted from Riccardo.

Estimated unladen weight of a heavy-duty tractor-trailer, 2024 and 2030

	2024			2030		
	Diesel	BEV	FCEV	Diesel	BEV	FCEV
Truck chassis and cab	6 700	6 700	6 700	5 200	5 200	5 200
Powertrain or motors	2 200	600	600	2 200	600	600
Battery	-	4 200	300	-	3 500	300
Fuel cell	-	-	1 200	-	-	800
Hydrogen tank	-	-	1 600	-	-	1 600
Trailer	7 000	7 000	7 000	7 000	7 000	7 000
Total (kg)	**15 800**	**18 500**	**17 300**	**14 400**	**16 300**	**15 500**

Notes: Estimates are for a United States class 8 (or equivalent) tractor-trailer. The weight of the diesel battery is included in powertrain. Battery electric trucks are assumed to use lithium iron phosphate (LFP), and fuel cell electric trucks lithium nickel cobalt manganese oxide (NMC); in 2024 and 2030 these are assumed to have energy densities of 190 Wh/kg and 230 Wh/kg, and 250 Wh/kg and 280 Wh/kg, respectively. All values are rounded to the nearest 100 kg.

Sources: Values for the specific mass of diesel trucks, hydrogen tanks, fuel cells, powertrain or motors, and trailers come from the ICCT, and were validated against assumptions from Riccardo.

Energy prices and fuel economy

Prices of diesel, electricity and hydrogen, 2024 and 2030

	Units	United States		European Union		China	
Fuel	USD (2024)	2024	2030	2024	2030	2024	2030
Diesel	USD/kWh	0.11	0.12	0.17	0.19	0.11	0.11
Diesel	USD/L	1.14	1.18	1.70	1.88	1.10	1.14
Electricity	USD/kWh	0.16	0.16	0.24	0.23	0.08	0.08
Hydrogen	USD/kWh	0.16	0.15	0.20	0.18	0.14	0.12
Hydrogen	USD/kg H_2	5.27	4.94	6.56	6.07	4.55	3.86

Notes: Hydrogen prices are composed of the weighted levelised cost of production and distribution (~USD 1.5/kg H_2), an assumed margin of 6%, and 10% tax. Underlying electricity prices are the same at both the depot and during en-route charging, with the difference between them due exclusively to the differences in the infrastructure costs.

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