PRODUCTION FORECAST BY POWERTRAIN TO 2035

Implications For Manufacturing & Supply Chains

Daniel Harrison, Automotive Analyst

AUTOMOTIVE
FROM ULTIMAMEDIA

WHAT'S DRIVING ELECTRIFICATION?

Drivers

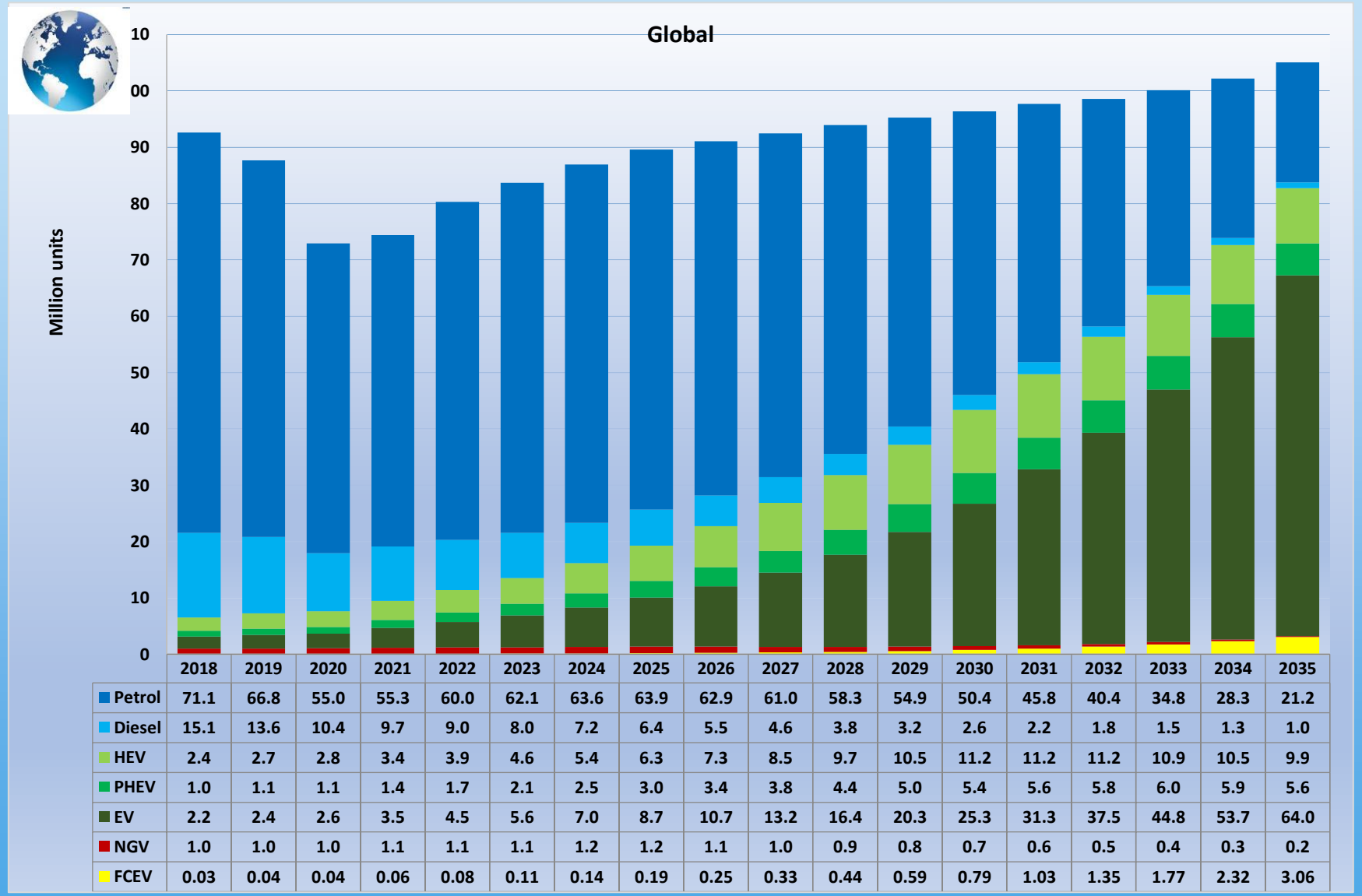
- **Climate change mitigation policies by regional government:** EU's plan for net zero by 2050
- **ICE vehicle ban by national governments** 24 countries have banned ICE vehicles by 2040
- **OEM statements phasing out ICE vehicles.** 6 major OEMs have pledged to stop ICE by 2040
- **Government purchase/usage incentives** most advanced nations have policies driving EV uptake
- **Consumer demand.** Early adopters are keen to go electric for economic & environmental reasons

----------**ELECTRIFICATION**----------

- **Consumer resistance.** Many still have a negative image and perception of Evs
- **Limited driving range / range anxiety.** Average EV range is still only 200 miles / 320 Km
- **Charging infrastructure.** Highly fragmented, mainly slow chargers, expensive, 4 connector types
- **ICE vs EV TCO varies hugely** depending on local fuel prices: EU is high, US & Middle East is low
- **Higher purchase price.** EVs likely to remain more expensive than ICE until price parity ~2025

Restraints

GLOBAL PRODUCTION FORECAST BY POWERTRAIN

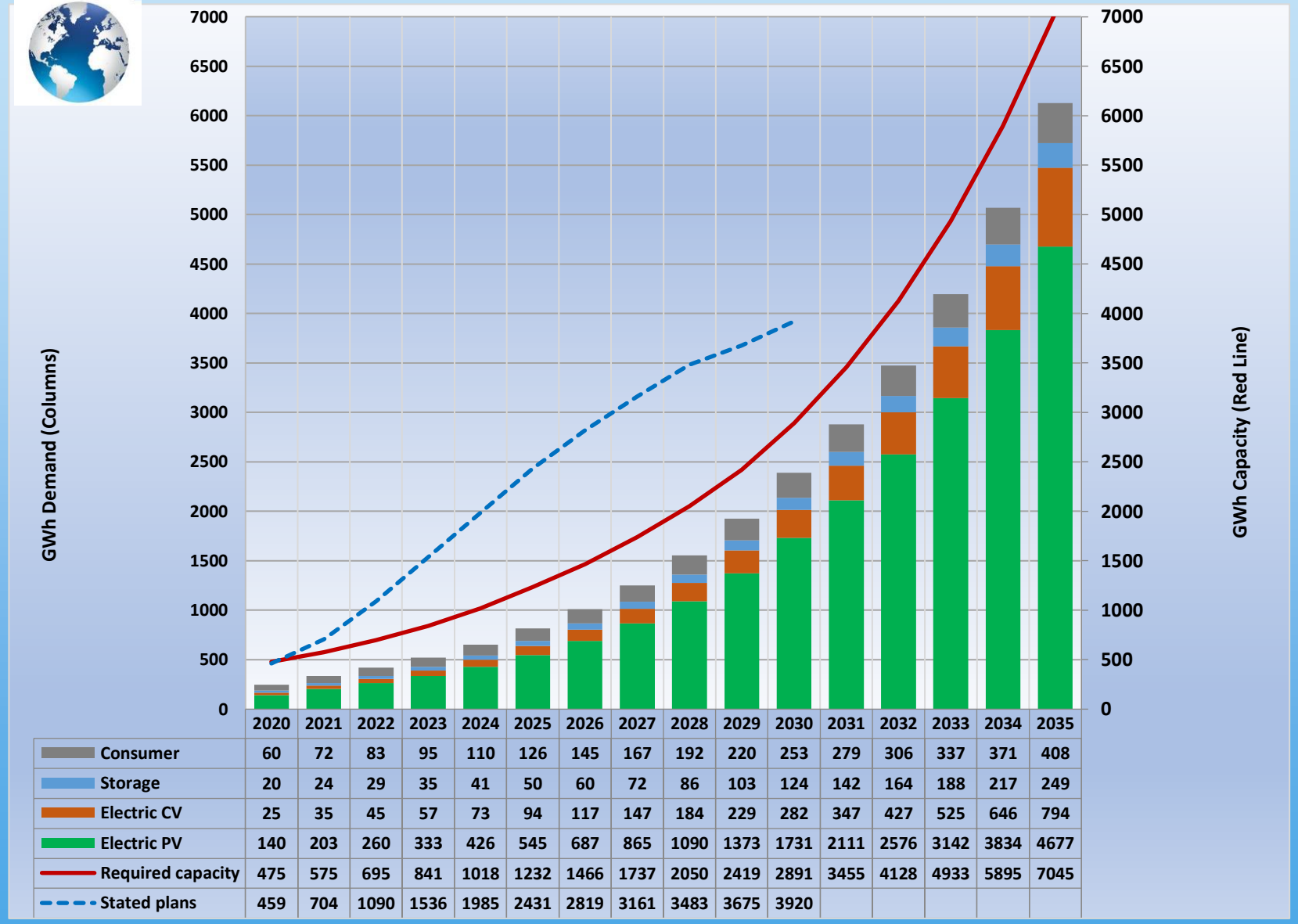


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	71.1	66.8	55.0	55.3	60.0	62.1	63.6	63.9	62.9	61.0	58.3	54.9	50.4	45.8	40.4	34.8	28.3	21.2
Diesel	15.1	13.6	10.4	9.7	9.0	8.0	7.2	6.4	5.5	4.6	3.8	3.2	2.6	2.2	1.8	1.5	1.3	1.0
HEV	2.4	2.7	2.8	3.4	3.9	4.6	5.4	6.3	7.3	8.5	9.7	10.5	11.2	11.2	11.2	10.9	10.5	9.9
PHEV	1.0	1.1	1.1	1.4	1.7	2.1	2.5	3.0	3.4	3.8	4.4	5.0	5.4	5.6	5.8	6.0	5.9	5.6
EV	2.2	2.4	2.6	3.5	4.5	5.6	7.0	8.7	10.7	13.2	16.4	20.3	25.3	31.3	37.5	44.8	53.7	64.0
NGV	1.0	1.0	1.0	1.1	1.1	1.1	1.2	1.2	1.1	1.0	0.9	0.8	0.7	0.6	0.5	0.4	0.3	0.2
FCEV	0.03	0.04	0.04	0.06	0.08	0.11	0.14	0.19	0.25	0.33	0.44	0.59	0.79	1.03	1.35	1.77	2.32	3.06

- **Global:** volumes hit hard in 2020 will take until 2024 to recover
- However, EV sales actually increased
- EV upwards trajectory will continue due to regulation & incentives in many regions
- But some regions are not electrifying as fast such as South America and MEA
- Hence why globally EVs will still be only 61% of production by 2035

Source: OICA, Automotive from Ultima Media

GLOBAL LITHIUM BATTERY CAPACITY FORECAST

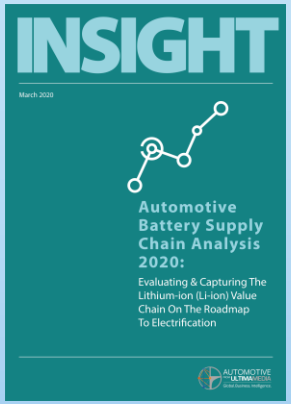


	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Consumer	60	72	83	95	110	126	145	167	192	220	253	279	306	337	371	408
Storage	20	24	29	35	41	50	60	72	86	103	124	142	164	188	217	249
Electric CV	25	35	45	57	73	94	117	147	184	229	282	347	427	525	646	794
Electric PV	140	203	260	333	426	545	687	865	1090	1373	1731	2111	2576	3142	3834	4677
Required capacity	475	575	695	841	1018	1232	1466	1737	2050	2419	2891	3455	4128	4933	5895	7045
Stated plans	459	704	1090	1536	1985	2431	2819	3161	3483	3675	3920					

- **Stated capacity (blue line)**
- Although it appears there is enough gigafactory capacity up to 2030 - plans could be delayed. But we foresee a capacity crunch after 2030 – unless more plants are built
- **Required capacity (red line)**
- The capacity needed to meet demand. However, plants rarely produce more than 70% - 80% of stated capacity.
- **Demand (green + orange)**
- Demand based on our EV sales & / production forecasts
- Also factoring in that average EV battery of ~60 KWh will likely increase over time

Source: Automotive from Ultima Media

RAMPING UP THE LITHIUM BATTERY SUPPLY CHAIN



- **It's an immense challenge** to create & rapidly scale up an entirely new supply chain
- **New companies** to the automotive sector, e.g. chemical industry, mining industry etc.
- **Lithium battery capacity must increase by at least 6 times by 2030**, or there will be shortages
- **More gigafactories** will be required but this requires huge capital expenditure
- **Upstream challenges** of battery components and raw materials are an even bigger challenge
- **Recycling becomes more important** as volumes rise - to create a closed loop / circular economy
- **Regionalisation is needed** to recapture the valuable battery supply chain, and build in resilience
- **Sustainability regulations** EU trying to compete on environmental criteria, not price/performance
- **Investment risk exists** with disruptive technology such as solid state batteries and hydrogen FCEV

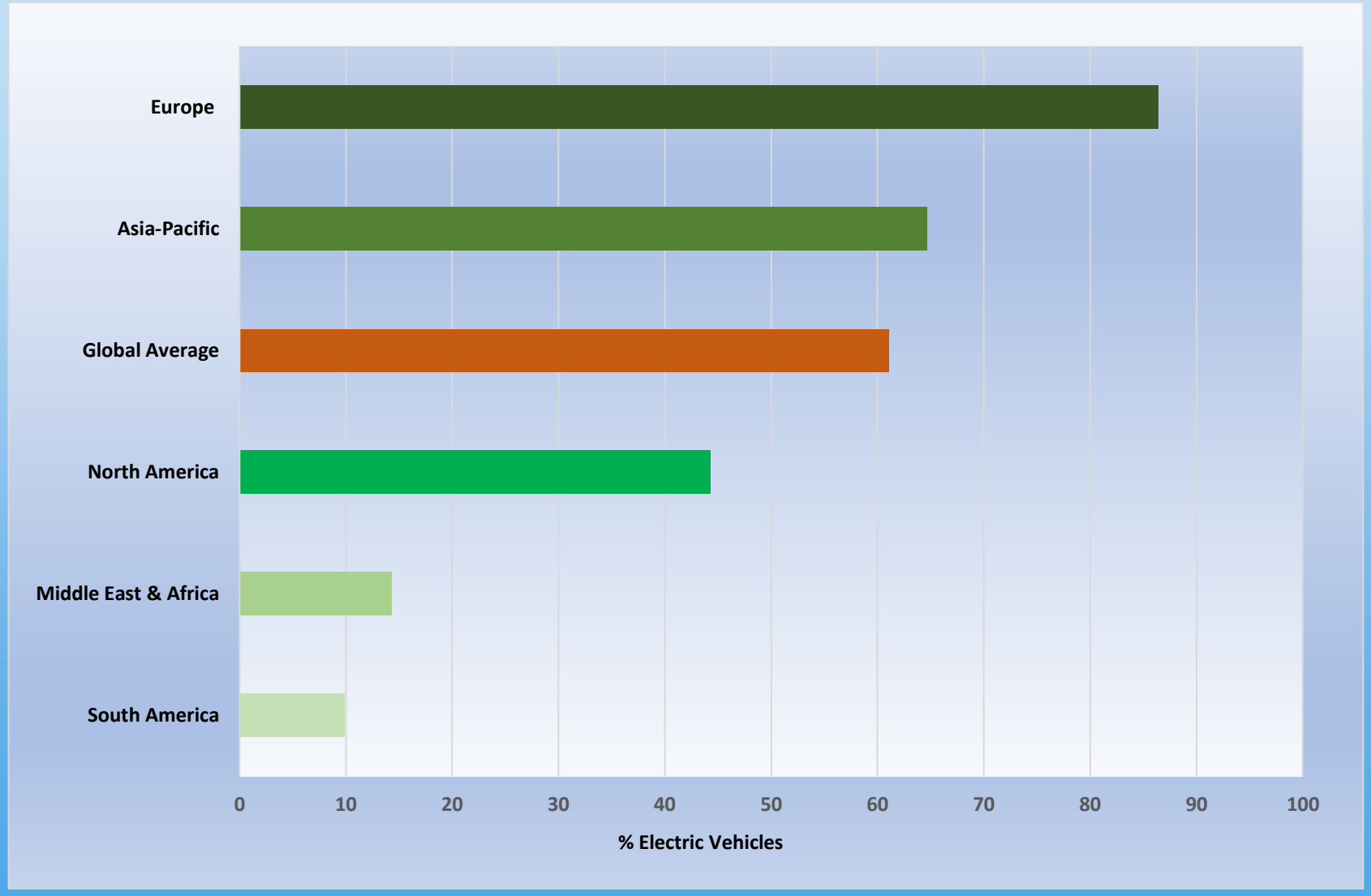
REGIONAL LITHIUM BATTERY CAPACITY FORECAST

Region	Current plants	Future confirmed plants	Total current plants + future confirmed plants	2020 capacity (GWh, % share)	2030 capacity Forecast (GWh, % share)
Asia Pacific	102	63	165	370 GWh (78%)	1,564 GWh (55%)
Europe	14	39	53	60 GWh (13%)	950 GWh (33%)
North America	10	22	32	45 GWh (9%)	340 GWh (12%)
Total	126	124	250	475 GWh	2,854 GWh

- Global battery capacity is expected to increase by 6-fold by 2030
- North America capacity 45 GWh in 2020 (9% share) forecast to grow more than 7-fold to 340 GWh in 2030 (but still only a 12% share)
- Asia Pacific dominates with 78% share of global capacity in 2020, but...
- ...Europe will experience the fastest growth expanding 16-times by 2030 to 950 GWh

Source: Automotive from Ultima Media

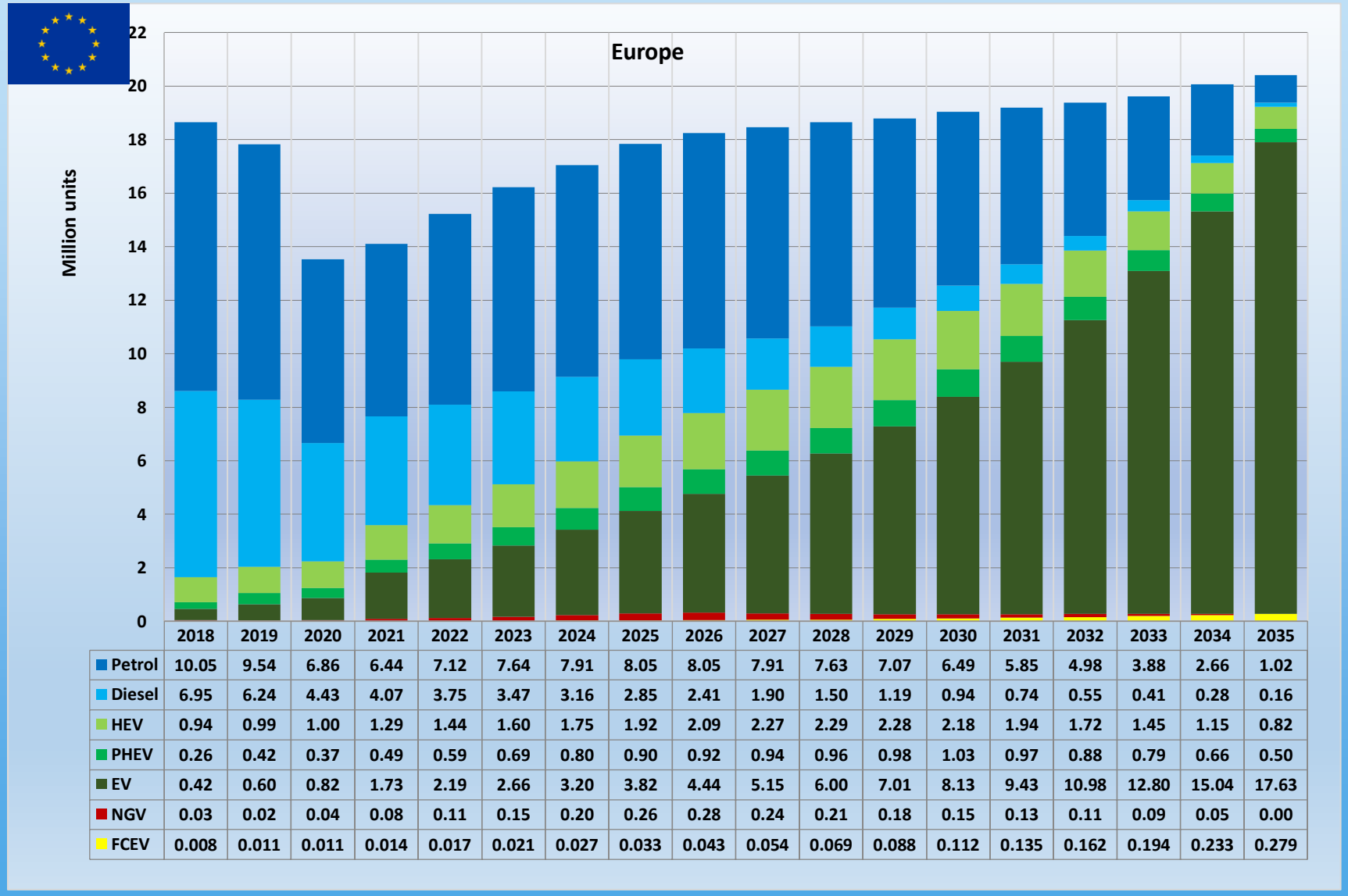
REGIONAL ELECTRIC VEHICLE PRODUCTION 2035



- **Europe** electrifies at the fastest rate **86.4%** by 2035
- **Asia Pacific** electrifies faster at **64.7%** by 2035 than global average
- **Global Average = 61.1%**
- **North America** electrifies at **44.3%** in 2035 slower than the global average
- **Middle East & Africa** electrifies very slowly at **13.8%** by 2035
- **South America** electrifies at the slowest rate of **9.9%** by 2035

Source: Automotive from Ultima Media

EUROPE PRODUCTION FORECAST BY POWERTRAIN

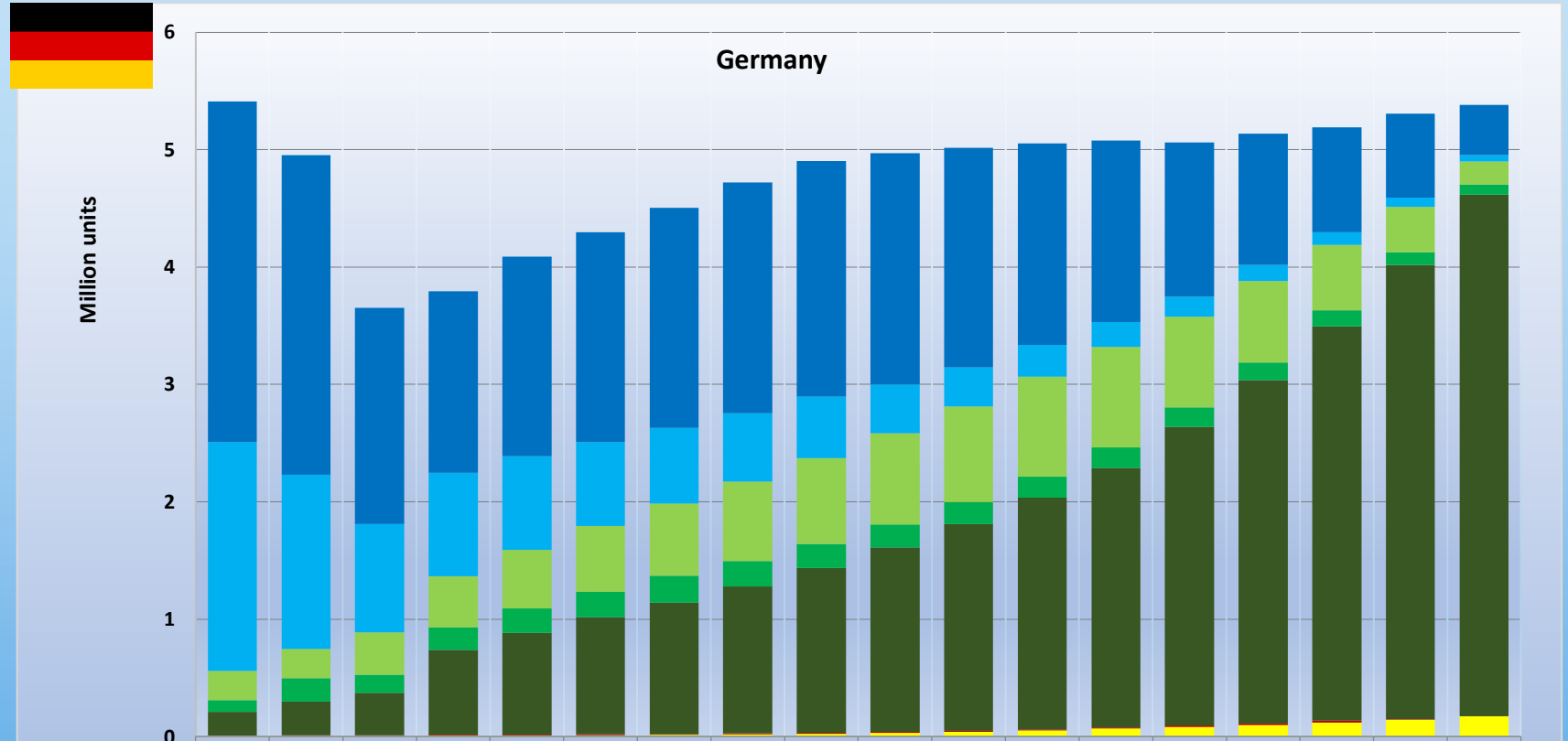


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	10.05	9.54	6.86	6.44	7.12	7.64	7.91	8.05	8.05	7.91	7.63	7.07	6.49	5.85	4.98	3.88	2.66	1.02
Diesel	6.95	6.24	4.43	4.07	3.75	3.47	3.16	2.85	2.41	1.90	1.50	1.19	0.94	0.74	0.55	0.41	0.28	0.16
HEV	0.94	0.99	1.00	1.29	1.44	1.60	1.75	1.92	2.09	2.27	2.29	2.28	2.18	1.94	1.72	1.45	1.15	0.82
PHEV	0.26	0.42	0.37	0.49	0.59	0.69	0.80	0.90	0.92	0.94	0.96	0.98	1.03	0.97	0.88	0.79	0.66	0.50
EV	0.42	0.60	0.82	1.73	2.19	2.66	3.20	3.82	4.44	5.15	6.00	7.01	8.13	9.43	10.98	12.80	15.04	17.63
NGV	0.03	0.02	0.04	0.08	0.11	0.15	0.20	0.26	0.28	0.24	0.21	0.18	0.15	0.13	0.11	0.09	0.05	0.00
FCEV	0.008	0.011	0.011	0.014	0.017	0.021	0.027	0.033	0.043	0.054	0.069	0.088	0.112	0.135	0.162	0.194	0.233	0.279

Source: ACEA, VDA, SMMT, Automotive from Ultima Media

- **Europe:** Production mainly regionally focused, (except for Germany) so tracks fairly closely with demand. Production will be 86.4% EVs by 2035 and highest in the world
- 95g CO2/km target for 2021 with tightening targets for 2025 and 2030
- Strong EV incentives
- New “Fit for 55” proposal bans ICE sales by 2035
- ICE *production* not banned and can continue after 2035 for export
- New Euro 7 proposal could make ICE unviable

GERMANY PRODUCTION FORECAST BY POWERTRAIN

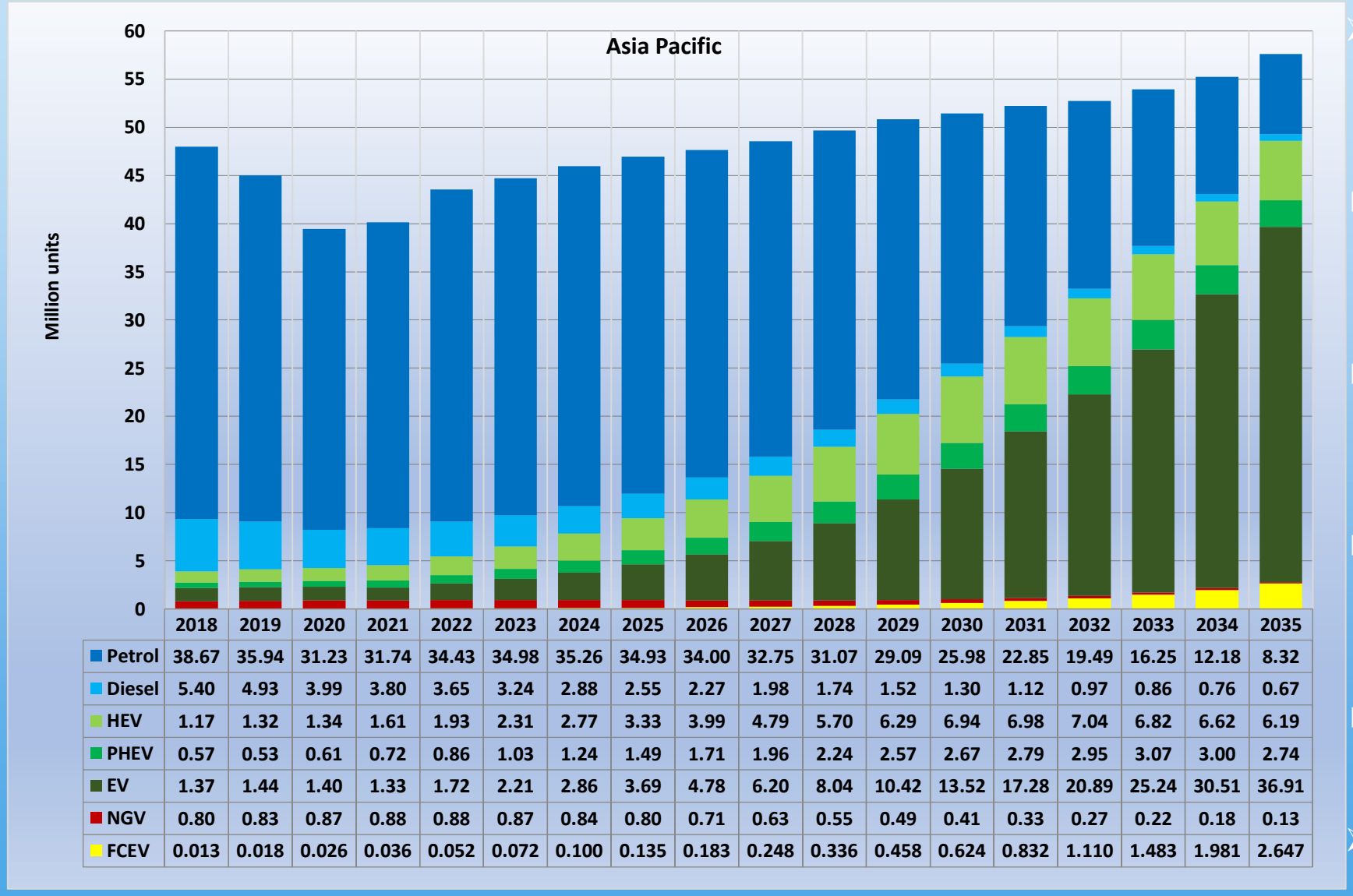


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	2.90	2.72	1.84	1.55	1.70	1.79	1.87	1.97	2.01	1.97	1.87	1.72	1.55	1.32	1.12	0.89	0.72	0.43
Diesel	1.95	1.48	0.92	0.88	0.80	0.72	0.64	0.58	0.52	0.42	0.33	0.27	0.21	0.17	0.14	0.11	0.08	0.05
HEV	0.25	0.25	0.36	0.43	0.50	0.56	0.62	0.68	0.73	0.78	0.81	0.86	0.86	0.77	0.69	0.55	0.39	0.19
PHEV	0.10	0.20	0.15	0.19	0.21	0.22	0.23	0.22	0.21	0.20	0.19	0.18	0.17	0.17	0.15	0.14	0.11	0.09
EV	0.20	0.29	0.36	0.72	0.87	1.00	1.12	1.25	1.41	1.57	1.76	1.97	2.21	2.54	2.92	3.36	3.87	4.45
NGV	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
FCEV	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.04	0.05	0.07	0.08	0.10	0.12	0.14	0.17

Source: VDA, Automotive from Ultima Media

- **Germany:** production will be 83% EVs by 2035 - because ICE production not banned and continues beyond 2035 for export
- New German coalition government, under auto industry lobbying is pushing for synthetic / e-fuels to replace ICE.
- However, Germany is still bound by the same EU rules of 95g CO2/km target for 2021 and “Fit for 55” proposal banning ICE sales by 2035
- Hydrogen FCEV will also be promoted more than other EU countries

ASIA PACIFIC PRODUCTION FORECAST BY POWERTRAIN

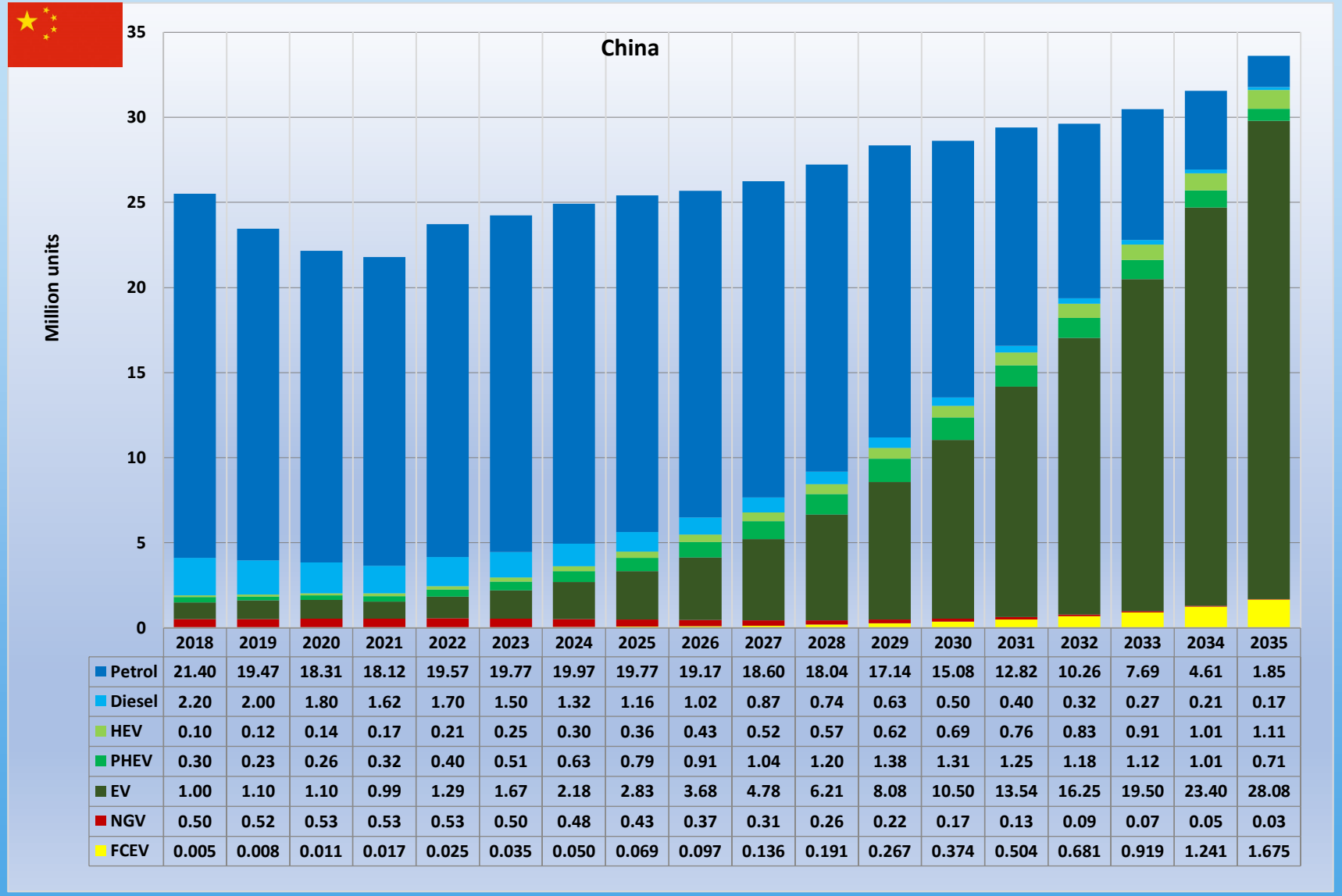


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	38.67	35.94	31.23	31.74	34.43	34.98	35.26	34.93	34.00	32.75	31.07	29.09	25.98	22.85	19.49	16.25	12.18	8.32
Diesel	5.40	4.93	3.99	3.80	3.65	3.24	2.88	2.55	2.27	1.98	1.74	1.52	1.30	1.12	0.97	0.86	0.76	0.67
HEV	1.17	1.32	1.34	1.61	1.93	2.31	2.77	3.33	3.99	4.79	5.70	6.29	6.94	6.98	7.04	6.82	6.62	6.19
PHEV	0.57	0.53	0.61	0.72	0.86	1.03	1.24	1.49	1.71	1.96	2.24	2.57	2.67	2.79	2.95	3.07	3.00	2.74
EV	1.37	1.44	1.40	1.33	1.72	2.21	2.86	3.69	4.78	6.20	8.04	10.42	13.52	17.28	20.89	25.24	30.51	36.91
NGV	0.80	0.83	0.87	0.88	0.88	0.87	0.84	0.80	0.71	0.63	0.55	0.49	0.41	0.33	0.27	0.22	0.18	0.13
FCEV	0.013	0.018	0.026	0.036	0.052	0.072	0.100	0.135	0.183	0.248	0.336	0.458	0.624	0.832	1.110	1.483	1.981	2.647

Source: CAAM, JAMA, KAMA, Automotive from Ultima Media

- **Asia Pacific** EV production to be 64.7% by 2035 which is above the global average
- Most Asian countries have fuel economy regulations – but less so for smaller ones
- **China:** Corporate Average Fuel Consumption (CAFC) of 4 litres / 100km by 2025.
- **Japan** OEMs must reduce their fleet emissions 32% by 2030 compared to 2016
- **India** 4.77 litres / 100km target for 2022-23
- **South Korea** aligns standards with California for petrol, and Euro 6 for diesel

CHINA PRODUCTION FORECAST BY POWERTRAIN

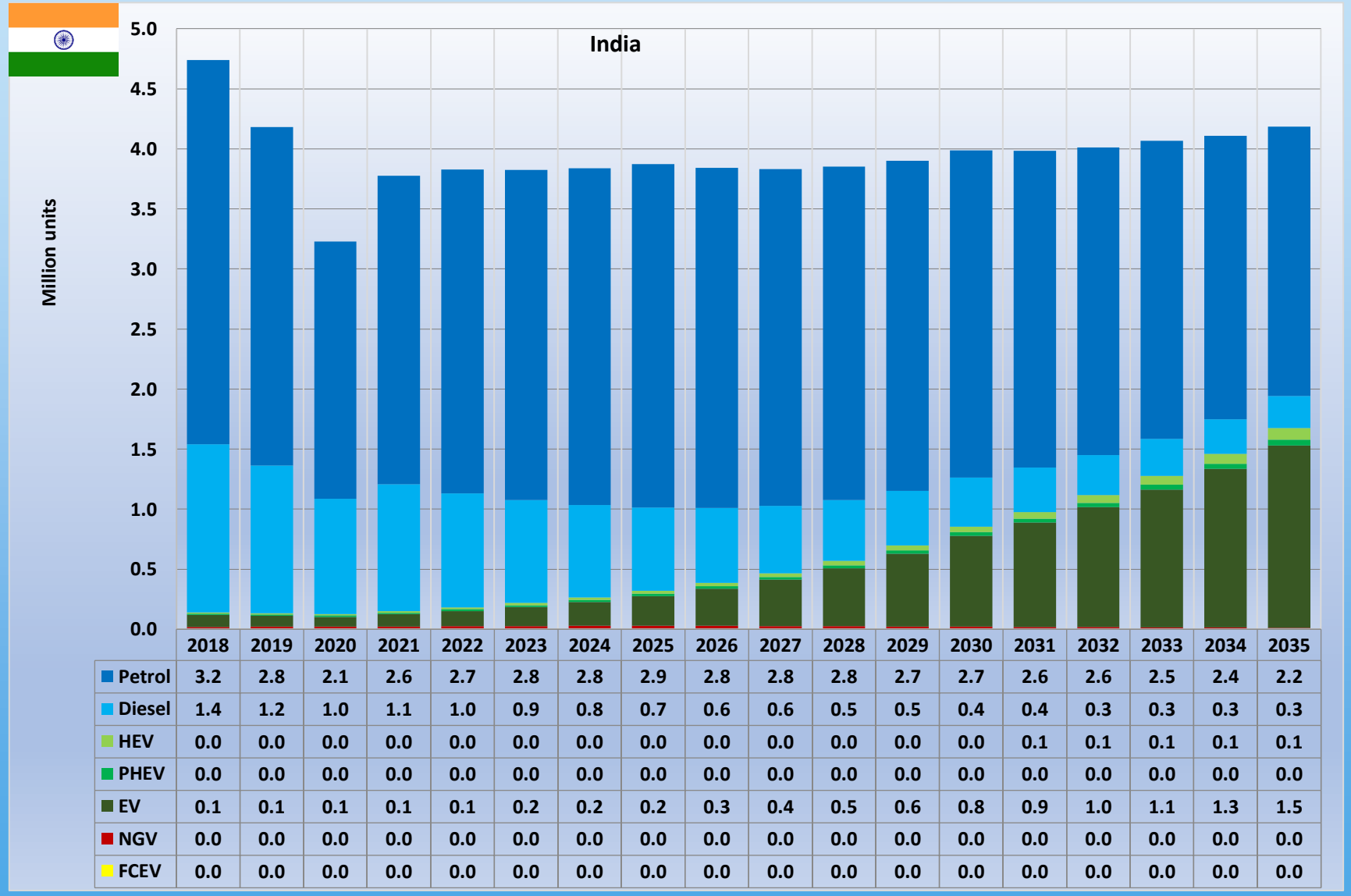


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	21.40	19.47	18.31	18.12	19.57	19.77	19.97	19.77	19.17	18.60	18.04	17.14	15.08	12.82	10.26	7.69	4.61	1.85
Diesel	2.20	2.00	1.80	1.62	1.70	1.50	1.32	1.16	1.02	0.87	0.74	0.63	0.50	0.40	0.32	0.27	0.21	0.17
HEV	0.10	0.12	0.14	0.17	0.21	0.25	0.30	0.36	0.43	0.52	0.57	0.62	0.69	0.76	0.83	0.91	1.01	1.11
PHEV	0.30	0.23	0.26	0.32	0.40	0.51	0.63	0.79	0.91	1.04	1.20	1.38	1.31	1.25	1.18	1.12	1.01	0.71
EV	1.00	1.10	1.10	0.99	1.29	1.67	2.18	2.83	3.68	4.78	6.21	8.08	10.50	13.54	16.25	19.50	23.40	28.08
NGV	0.50	0.52	0.53	0.53	0.53	0.50	0.48	0.43	0.37	0.31	0.26	0.22	0.17	0.13	0.09	0.07	0.05	0.03
FCEV	0.005	0.008	0.011	0.017	0.025	0.035	0.050	0.069	0.097	0.136	0.191	0.267	0.374	0.504	0.681	0.919	1.241	1.675

- **China:** currently exports only a small share of output (~1 million units), so production tracks very closely with demand
- Corporate Average Fuel Consumption (CAFC) of 4 litres / 100km by 2025
- New Energy Vehicles (NEV) credits system may be replaced with an ETS
- Government and OEMs aim to expand EV exports
- Hydrogen being pushed strongly and so FCEV likely to develop fastest in China (& Japan)

Source: CAAM, Automotive from Ultima Media

INDIA PRODUCTION FORECAST BY POWERTRAIN

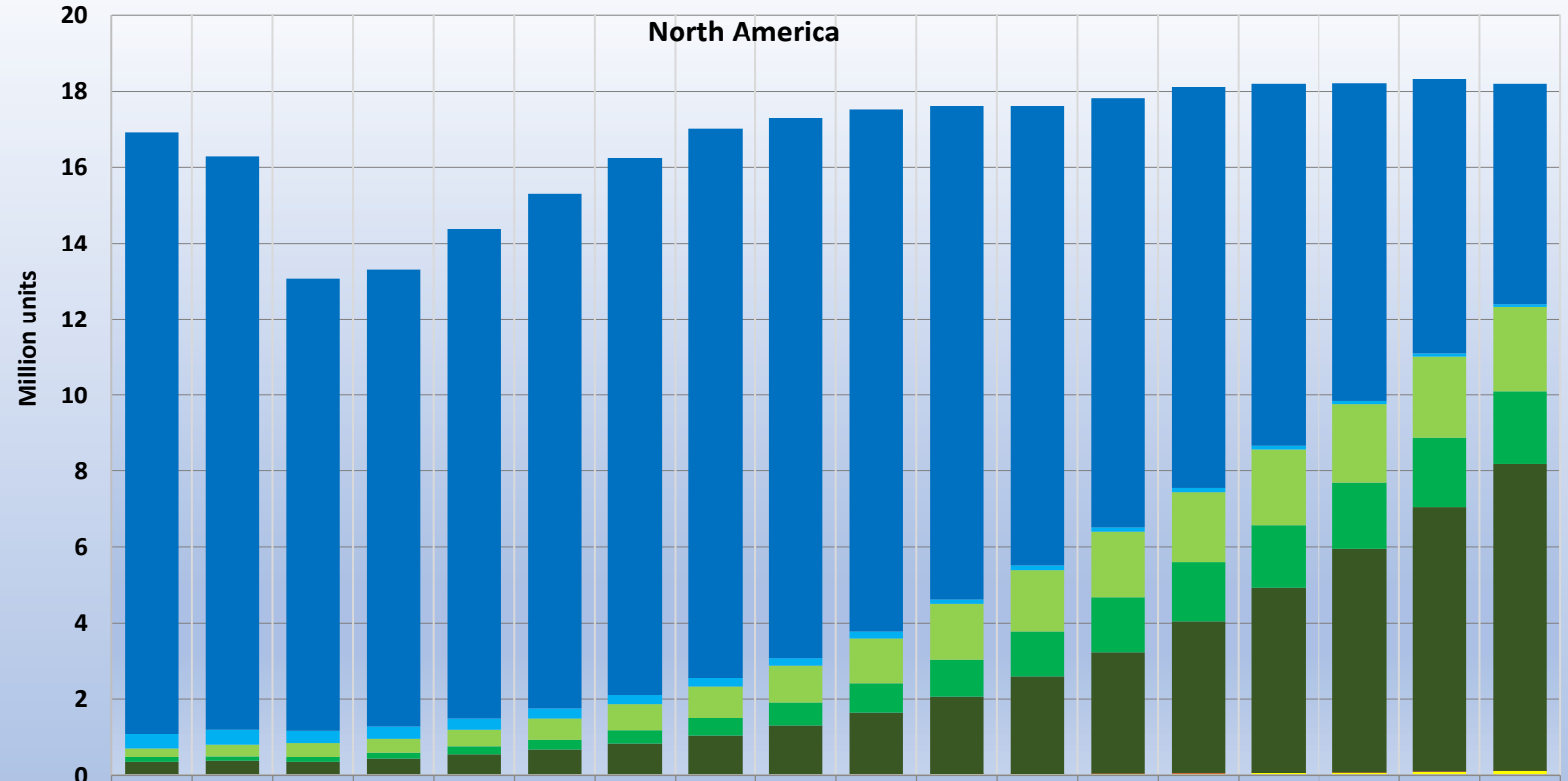


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	3.2	2.8	2.1	2.6	2.7	2.8	2.8	2.9	2.8	2.8	2.8	2.7	2.7	2.6	2.6	2.5	2.4	2.2
Diesel	1.4	1.2	1.0	1.1	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3
HEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
PHEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
EV	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.1	1.3	1.5
NGV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FCEV	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

- **India** has relatively lax emissions regulations, with a target of 4.77 litres per 100km in 2022-23.
- This plus a poor charging infrastructure, indicates electrification will be slow and remain ICE dominated
- India also has a very high level of diesel vehicles
- In 2016, the Indian government announced it would adopt BS VI standards (equivalent to Euro 6) by 2020, but were delayed due to pandemic.

Source: OICA, Automotive from Ultima Media

NORTH AMERICA PRODUCTION FORECAST BY POWERTRAIN



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	15.81	15.08	11.88	12.00	12.88	13.53	14.13	14.46	14.19	13.72	12.95	12.08	11.29	10.56	9.52	8.37	7.22	5.80
Diesel	0.40	0.39	0.33	0.32	0.29	0.26	0.24	0.22	0.20	0.17	0.15	0.13	0.11	0.10	0.09	0.08	0.08	0.07
HEV	0.22	0.32	0.38	0.38	0.46	0.56	0.68	0.82	0.99	1.19	1.44	1.61	1.73	1.85	1.99	2.06	2.14	2.24
PHEV	0.12	0.12	0.12	0.16	0.21	0.27	0.35	0.46	0.59	0.76	0.99	1.20	1.46	1.56	1.65	1.75	1.82	1.91
EV	0.35	0.37	0.35	0.42	0.53	0.66	0.82	1.03	1.29	1.62	2.03	2.55	3.19	3.99	4.88	5.87	6.96	8.06
NGV	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
FCEV	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.08	0.09	0.12

Source: OICA, Automotive from Ultima Media

North America Around 90% of production is for domestic sales so production tracks closely with demand

EV production will be 44.3% by 2035 which is below the global average.

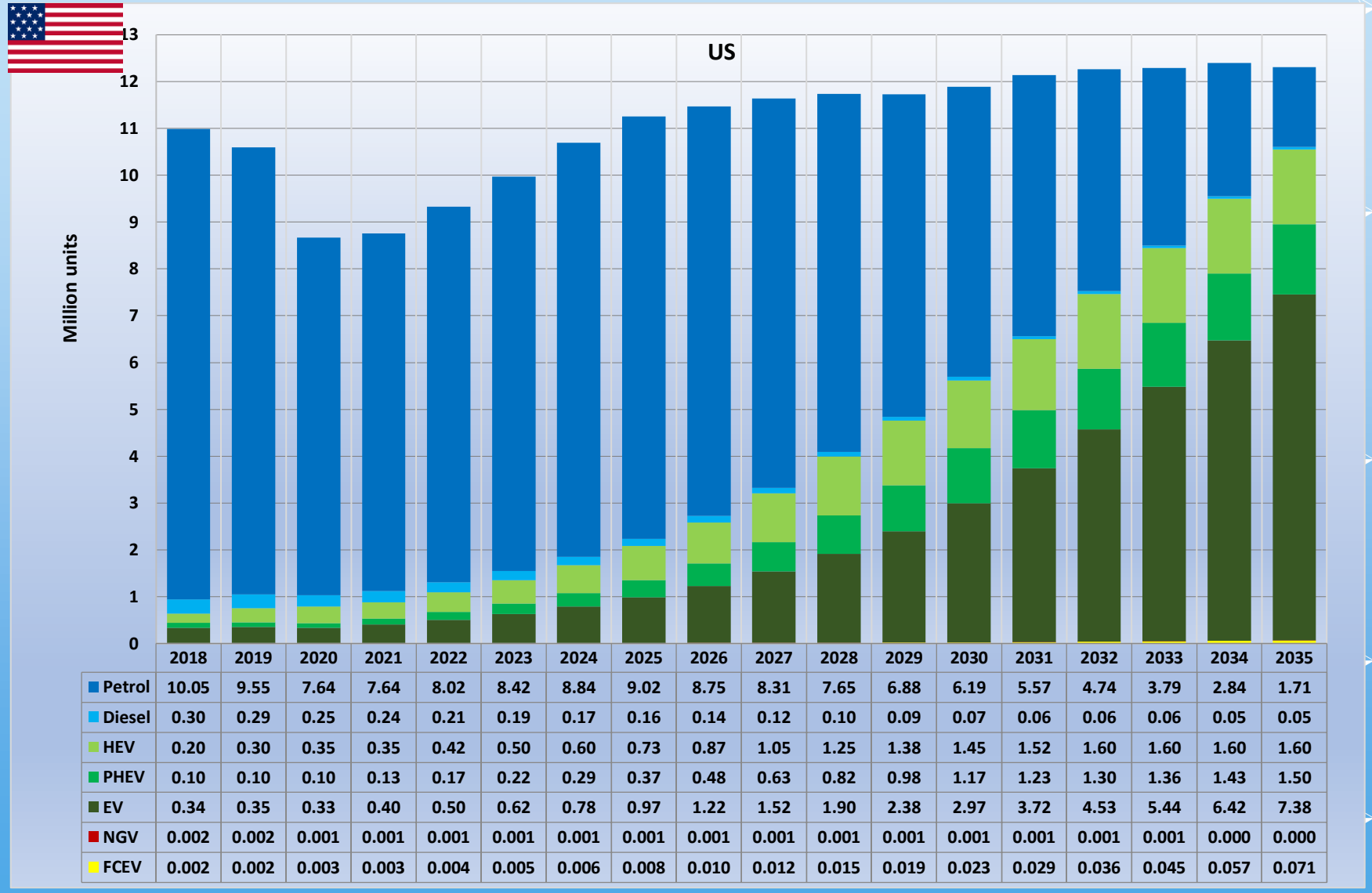
US: Biden's target of 50% 'electrified' vehicle sales by 2030 - not legally binding

CAFE target 52mpg by 2026

Canada banning ICE sales by 2035 – but starting from a very low base, Therefore it will be difficult to reach

Mexico ICE dominated and traditionally follows US emissions standards

US PRODUCTION FORECAST BY POWERTRAIN



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	10.05	9.55	7.64	7.64	8.02	8.42	8.84	9.02	8.75	8.31	7.65	6.88	6.19	5.57	4.74	3.79	2.84	1.71
Diesel	0.30	0.29	0.25	0.24	0.21	0.19	0.17	0.16	0.14	0.12	0.10	0.09	0.07	0.06	0.06	0.06	0.05	0.05
HEV	0.20	0.30	0.35	0.35	0.42	0.50	0.60	0.73	0.87	1.05	1.25	1.38	1.45	1.52	1.60	1.60	1.60	1.60
PHEV	0.10	0.10	0.10	0.13	0.17	0.22	0.29	0.37	0.48	0.63	0.82	0.98	1.17	1.23	1.30	1.36	1.43	1.50
EV	0.34	0.35	0.33	0.40	0.50	0.62	0.78	0.97	1.22	1.52	1.90	2.38	2.97	3.72	4.53	5.44	6.42	7.38
NGV	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000	0.000
FCEV	0.002	0.002	0.003	0.003	0.004	0.005	0.006	0.008	0.010	0.012	0.015	0.019	0.023	0.029	0.036	0.045	0.057	0.071

Source: OICA, Automotive from Ultima Media

US: President Biden's target of 50% 'electrified vehicle" sales by 2030 – but not legally binding

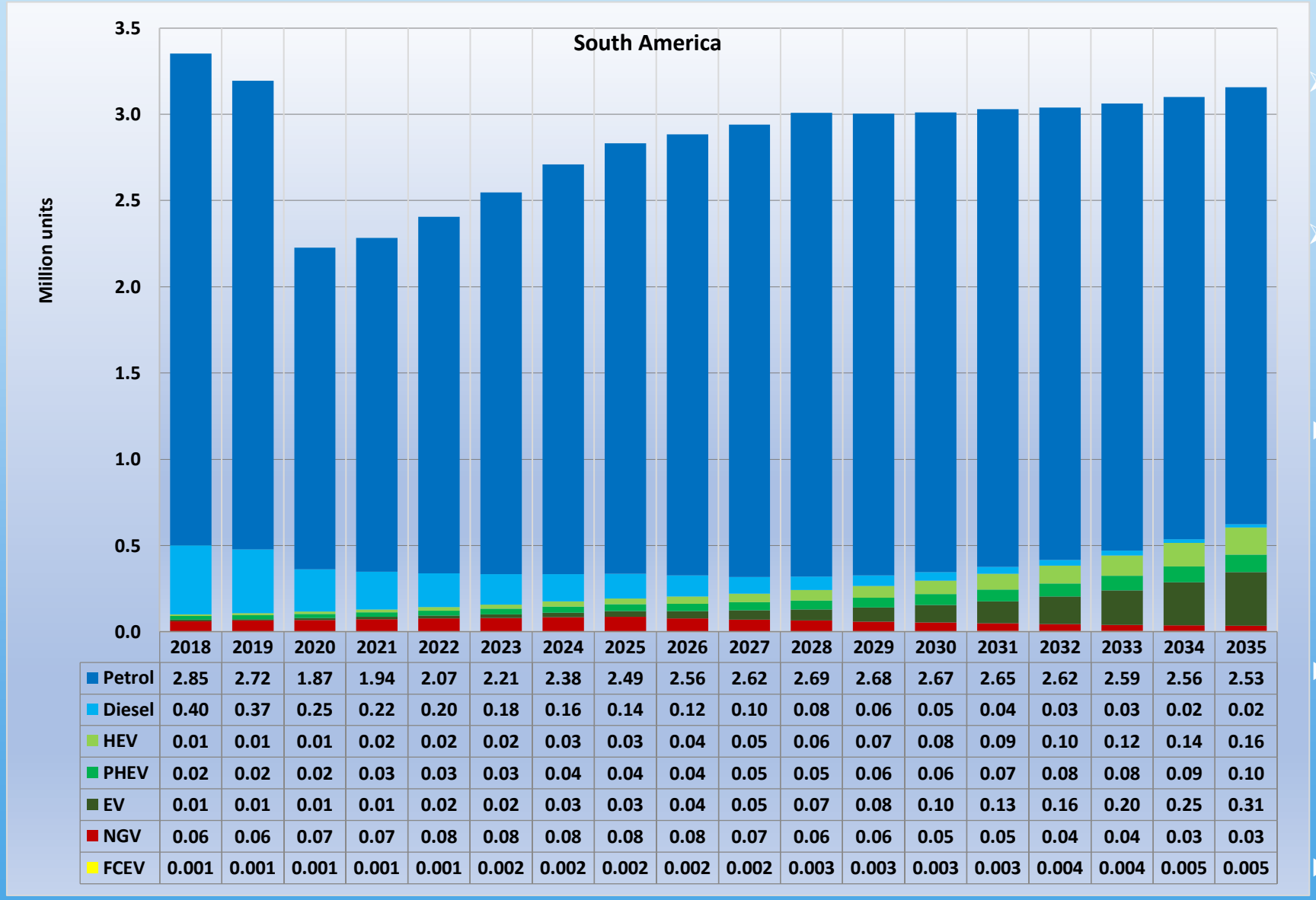
CAFE standards to tighten by 10% in 2023, with a 5% improvement each year from 2024 onwards to reach 52 mpg by 2026

Major infrastructure constraints, lack of a battery supply chain and consumer resistance.

Plus the historically low gas prices make ICE vs. EV TCO less attractive for EVs

State level: NY and CA aim to ban ICE by 2035. CA emissions standards are followed by 13 other states

SOUTH AMERICA PRODUCTION FORECAST BY POWERTRAIN

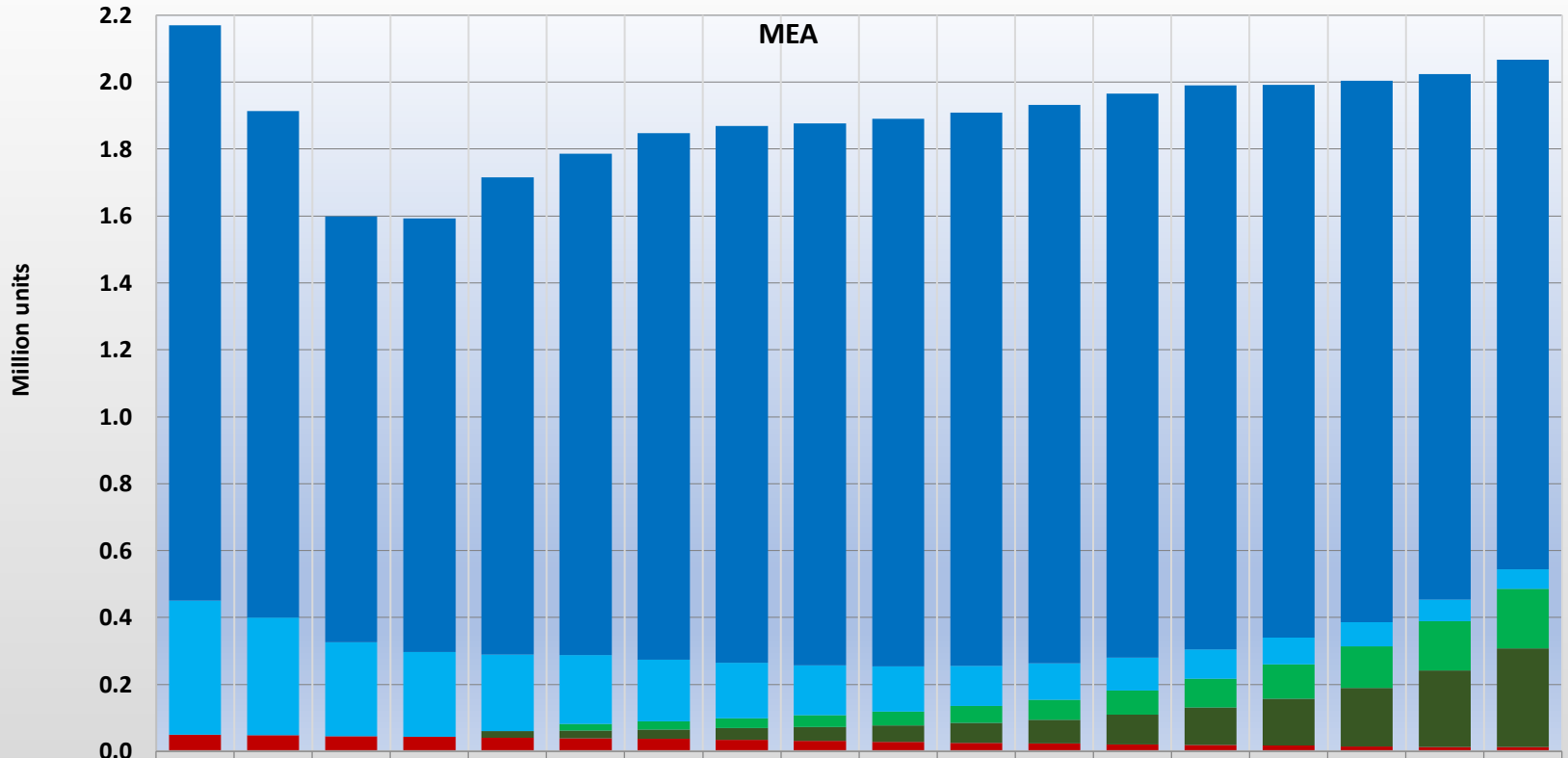


	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	2.85	2.72	1.87	1.94	2.07	2.21	2.38	2.49	2.56	2.62	2.69	2.68	2.67	2.65	2.62	2.59	2.56	2.53
Diesel	0.40	0.37	0.25	0.22	0.20	0.18	0.16	0.14	0.12	0.10	0.08	0.06	0.05	0.04	0.03	0.03	0.02	0.02
HEV	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.12	0.14	0.16
PHEV	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.06	0.06	0.07	0.08	0.08	0.09	0.10
EV	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.05	0.07	0.08	0.10	0.13	0.16	0.20	0.25	0.31
NGV	0.06	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.03	0.03
FCEV	0.001	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.004	0.004	0.005	0.005

- **South America:** production is highly regionally focused and tracks closely with demand.
- Dominated by ICE production with only 9.9% EVs by 2035 which is well below the global average
- **Brazil:** has adopted the ROTA 30 roadmap e.g. with EV purchase incentives, but are less ambitious than targets in China or Europe.
- Locally produced ethanol powers a large share of 'flex-fuel' vehicles, while NGV levels remain significant
- **Argentina:** no CO2 targets

Source: OICA, Automotive from Ultima Media

MEA PRODUCTION FORECAST BY POWERTRAIN



	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Petrol	1.72	1.51	1.27	1.30	1.43	1.50	1.57	1.60	1.62	1.64	1.65	1.67	1.69	1.69	1.65	1.62	1.57	1.52
Diesel	0.40	0.35	0.28	0.25	0.23	0.21	0.18	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06
HEV	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PHEV	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.09	0.10	0.12	0.15	0.18
EV	0.00	0.00	0.00	0.00	0.02	0.02	0.03	0.03	0.04	0.05	0.06	0.07	0.09	0.11	0.14	0.17	0.23	0.30
NGV	0.050	0.048	0.045	0.043	0.041	0.039	0.037	0.035	0.031	0.028	0.025	0.023	0.021	0.019	0.017	0.015	0.014	0.012
FCEV	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

- **MEA:** ICE dominates and production will be 14.3% EVs by 2035 which is well below the global average.
- **Iran:** heavily ICE based for local demand.
- **Egypt:** heavily ICE based for local demand.
- MEA production is mostly for regional demand -
- **Except for -**
- **Morocco:** ~85% exported to EU, so therefore likely to have a much higher EV %
- **South Africa:** ~70% exported to EU so again likely to have a high EV %

Source: OICA, Automotive from Ultima Media

PRODUCTION STRATEGY IMPLICATIONS

- **Shift from volume to value.** Semiconductor and other materials shortages has forced OEMs to change production strategy and prioritise more profitable SUVs / pickups / premium vehicles
- **However, less profitable EVs are also being prioritised** – but to help meet emissions targets
- **Build to order strategy increasingly being used** instead of building to maintain inventory
- **Hollowing out of ICE value chains** means legacy ICE supply chains are in managed decline
- **New battery supply chain.** Increasing trend to form JVs with battery cell suppliers to reduce risk. Also increasing partnerships with upstream raw material companies. Having to form new relationships with companies outside of the traditional automotive supply chain
- **Regionalisation of battery supply chains** is about resilience, sustainability and reducing costs
- **Shift from single-sourcing to multi-sourcing** for batteries also mitigates against supply disruption
- **Regional variation in pace of electrification** further complicates manufacturing and supply chains

MANUFACTURING LINE IMPLICATIONS

- **The multitude of 6 – 7 powertrain types is multiplying complexity.**
- Having to quickly adapt to changes in regulation & technology leads to variability in producing multiple vehicle types on the same assembly line and drives the need for production flexibility
- **Modular cell-based production & automated logistics adapts more flexibly to this variability.** This allows one station to be retooled while keeping other modules operating allowing OEMs to easily introduce new models, scale-up (or scale-down lines) by duplicating or connecting stations
- **OEMs will use legacy ICE production facilities for EVs as much as possible.** However, some ICE facilities will inevitably be scrapped and new 'greenfield' EV facilities will be required
- **Localisation & battery supplier integration.** Supply disruption and technology change is making OEMs opt for battery module assembly / battery pack integration to be increasingly localised near to or even "super localised" within OEM plants. There is also a shift to "cell to pack" technology
- **Connectivity and big data achieves a holistic approach.** 5G connectivity brings together automation, material flows, tooling, in-plant logistics allowing much better production visibility
- **Future proofing plants** In response to accelerating pace of technological change, OEMs are investing more in plants that are future proofed and can adapt seamlessly to changes in powertrains

EV DESIGN & MANUFACTURING IMPLICATIONS

- **Compressed development cycles** mean that manufacturers must adapt more quickly to product and production changes
- **Vehicle platform consolidation.** The majority of EVs are still produced on platforms that can flexibly accommodate ICE, HEV or EV powertrains
- **Increase in dedicated EV platforms.** e.g. skateboard designs
- **Increasing customisation.** Consumers demand more individualisation marks a shift from batch production to individualised ‘build to order’ production variability which must be adapted to quickly
- **Accelerating pace of technological change.** Technical and production changes need to be made swiftly e.g. OEMs may introduce a different, larger capacity battery from a new supplier in the middle of the vehicle life-cycle or have to integrate solid state batteries or shift to hydrogen fuel cells especially in larger commercial vehicles
- **Holistic design.** To save weight, battery packs & casings are increasingly being made structural elements of the vehicle. In this example, the battery must be designed holistically for the vehicle, and fundamentally changes the sequence of assembly – requiring more partnership between suppliers & OEMs

THANK YOU

Daniel Harrison, Automotive Analyst

AUTOMOTIVE
FROM ULTIMAMEDIA