# Carbon Neutrality by 2050

*November 2022*

## Executive Summary

On November 12, 2021, the COP26 Joint Declaration (or Glasgow Climate Pact) established the goal of achieving carbon neutrality by 2050. OICA and its member associations – representing the global automotive industry – appreciate the importance of this goal and are working diligently to contribute to the decarbonization of road transport in support of this broader objective. We also recognize no single government policy or industry commitment alone will achieve this ambitious goal. We must work collaboratively – at all levels of government and across all economic sectors – to identify the range of approaches necessary to establish sustainable pathways to carbon neutrality across sectors and the unique circumstances of individual nations around the world.

The auto industry understands the important role it plays in decarbonizing road transport as a way to help achieve this broader goal. According to the International Energy Agency[1], transport as a whole contributed in 2020 to 37 percent of the global CO2 emissions from end-use sectors. It is also generally recognized that road transport (cars, trucks and buses) accounts for about 75 percent of the total transport sector.

To that end, the automotive industry is planning to invest more than $1 trillion globally by 2030[2] to help facilitate the transition to an electrified future (including battery, plug-in hybrid and fuel cell electric vehicles), while simultaneously continuing to innovate on the broad array of powertrain technologies necessary to meet the broad and diverse needs of a global market. This includes, for example, internal combustion engines (ICE) with low carbon or carbon neutral fuels, such as hydrogen, bioethanol, biomethane, biodiesel, HVO (Hydrotreated Vegetable Oil), and synthetic fuels. This is valid for all vehicle segments.

While the long-term trajectory certainly embraces a shift toward electrification, the industry recognizes, at present, no single technology is capable of achieving carbon neutrality across the global automotive industry. Individual nations need the flexibility to adopt multiple technologies and policies best suited to their unique realities, including geography, socioeconomic, and geopolitical considerations. Technology neutral and multiple approaches provide more practical and sustainable pathways to carbon neutrality for all nations.

[1] International Energy Agency - https://www.iea.org/topics/transport
[2] https://www.reuters.com/technology/exclusive-automakers-double-spending-evs-batteries-12-trillion-by-2030-2022-10-21/

**The auto industry as represented by OICA, therefore, encourages a collective embrace of the following principles:**

- As we work toward carbon neutrality and rapid reduction of carbon emissions, electrification will play a leading role especially for the developed countries. This transition to electrification, however, will require a comprehensive plan that takes the present market realities, the carbon neutrality of electricity generation, consumers' optimal choices into consideration, as well as the on-going investment and innovation in ICE technologies and low carbon fuels including for the existing vehicles in the field.

- Individual countries should proceed toward the achievement of carbon neutrality by implementing practical and sustainable technological and policy measures tailored to their specific circumstances.

- Essential to achieving automotive carbon neutrality are comprehensive national industrial and energy policies with multiple pathways for energy security that effectively promote the competitiveness of the automobile industry.

## The Path to Electrification

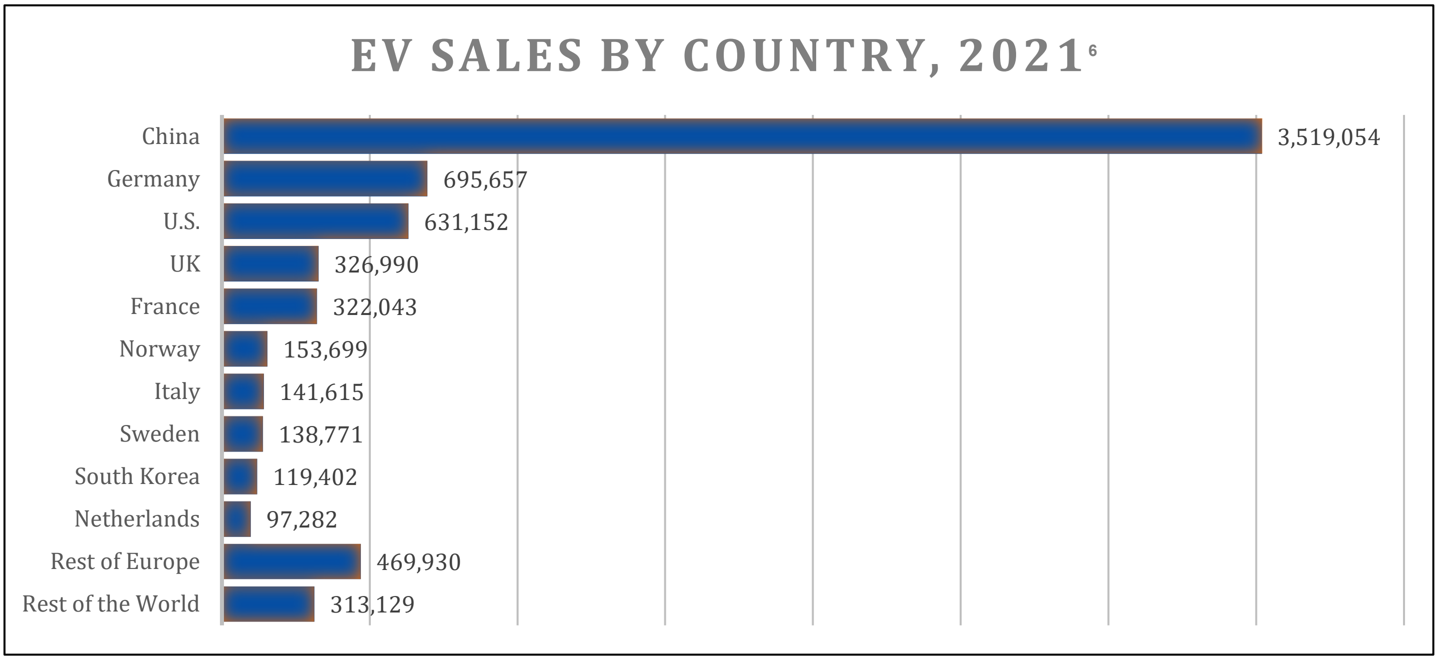
In many of the largest automotive markets, widespread consumer and commercial adoption of EVs[3] is important for achieving goals of long-term carbon neutrality from the transportation sector. To that end, motor vehicle manufacturers are working toward greenhouse gas (GHG) reductions by increasing the number of EVs and alternative fuel vehicles on the road, and with ongoing efficiency improvements for ICE vehicles.

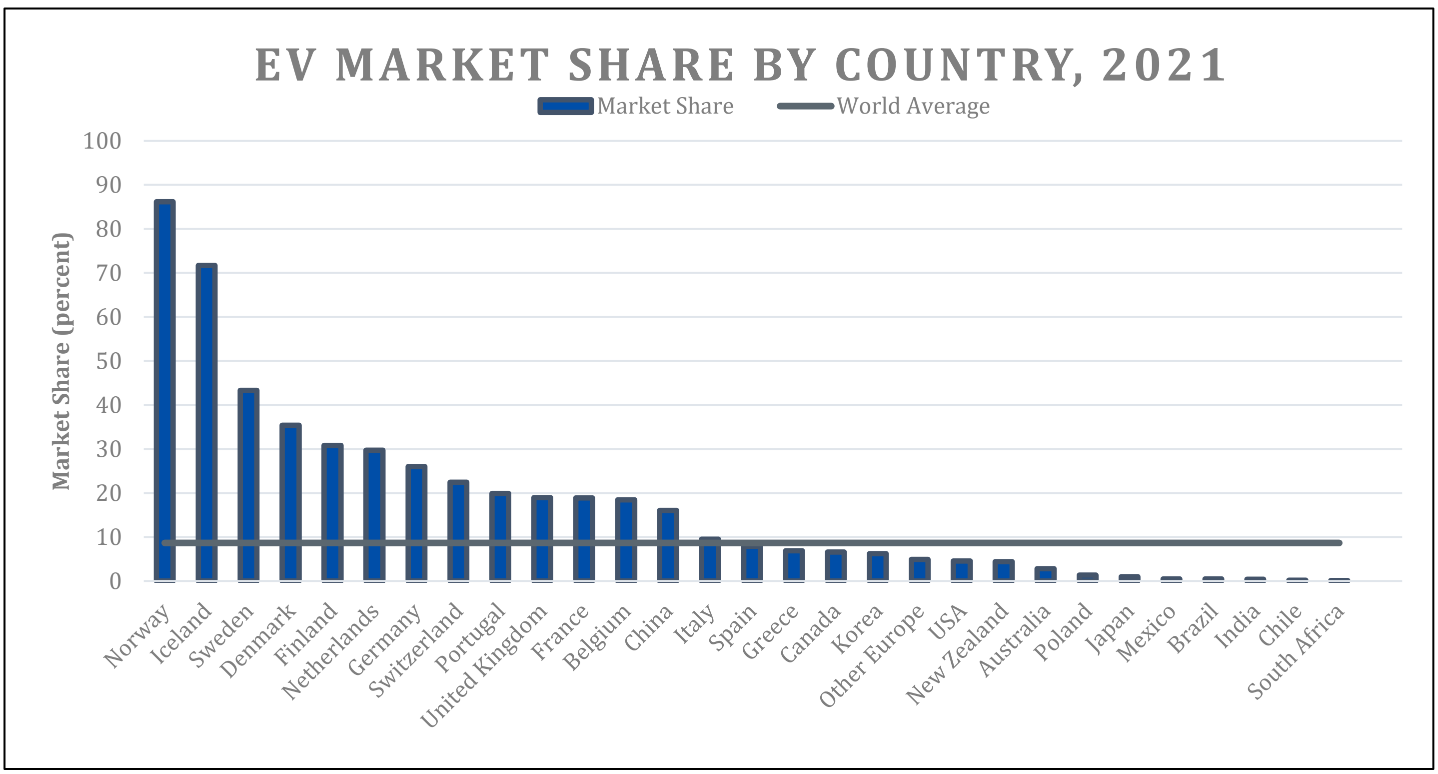
As a result, the world is on the cusp of achieving a remarkable milestone of 20 million EVs on the road, up from just one million in 2016. To further illustrate the pace of this transition, sales of electric cars (including fully electric and plug-in hybrids) doubled in 2021 to a new record of 6.6 million. Despite global supply chain challenges, "sales kept rising into 2022, with 2 million electric cars sold worldwide in the first quarter, up by three-quarters from the same period a year earlier. The number of electric cars on the world's roads by the end of 2021 was about 16.5 million, triple the amount in 2018."[4]

[3] For the purposes of this document, all references to EVs include battery, plug-in hybrid, and fuel cell electric vehicles unless otherwise specified

[4] International Energy Agency, Press Release, "Global electric car sales have continued their strong growth in 2022 after breaking records last year," 2022-05-23

Despite this tremendous progress and building momentum, EVs still represent only a fraction of the more than 1.4 billion vehicles on the road worldwide.[5] Likewise, the increasing pace of EV sales are not the same in every country around the world.




[5] Colin McKerracher, "The World's Electric Vehicle Fleet Will Soon Surpass 20 Million," *Bloomberg*, 2022-04-08
[6] Govind Bhutada, "Visualizing 10 Years of Global EV Sales by Country," 2022-08-08

In order to maximize EV acceptance and adoption, policymakers and industry investments must focus on improving vehicle affordability, increasing consumer awareness and confidence, developing vital charging and refueling infrastructure, accelerate decarbonization of the electric grid, and building reliable and resilient supply chains to support the manufacture of EVs.

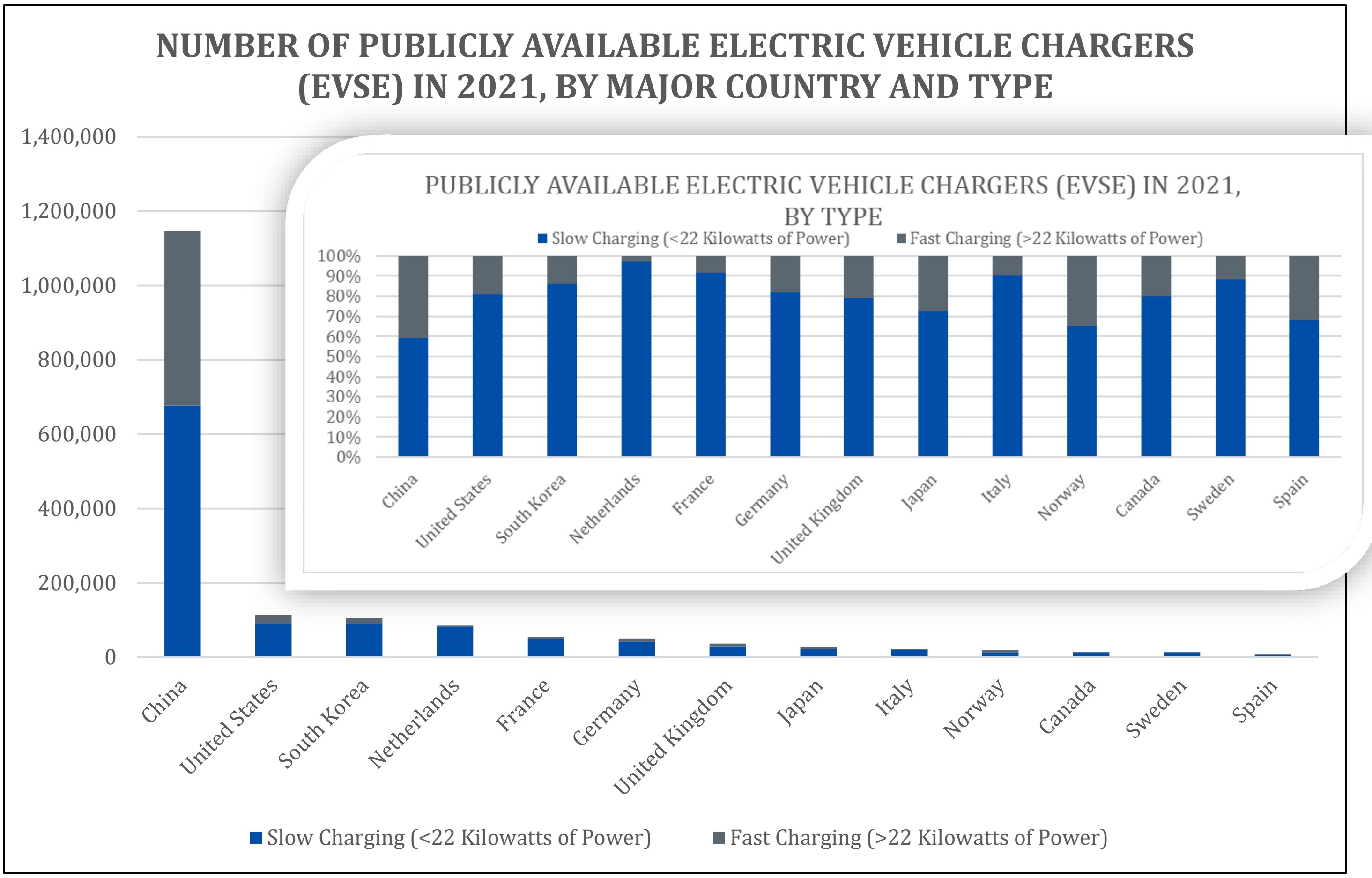
**Electrical charging and hydrogen fueling infrastructure:** All stakeholders must work together on public policy efforts, such as incentives, grants, rebates and other mechanisms, along with private investment, to spur significant electric charging and hydrogen refueling infrastructure development to support three key areas: homes (especially multi-unit dwellings and areas with higher residential densities), workplaces and highway and other public locations, with an emphasis on those lacking public transport.

Existing research shows charging needs will vary substantially by country and region, housing stock, average distance travelled, population density and EV mix.[7] For example, home charging is currently the most important charging option in most countries for the current type of EV customers and will remain a critical option where conditions support home charging. Other countries, regions, and customer segments are seeing an increasing importance of public and workplace charging. Further, individual countries will have different demands for DC fast charging depending on geography, demographics and other factors. In short, there is no set playbook for optimizing charging infrastructure and individual nations must make decisions based on their national interests and needs."[8]

Regardless, achieving the right charging infrastructure mix will require a massive and coordinated investment between the public and private sectors. For example, according to Alix Partners, it is estimated that around a $300 billion infrastructure investment would be required by 2030 to support automaker-projected growth in EV parc globally.[9] According to IEA, globally there were nearly 1.8 million publicly accessible charging points in 2021, a third of which were fast chargers. In addition, the number of fast chargers installed in 2021 (500,000) was greater than the total number of global chargers available in 2017.[10] In other words, while progress has been made over the last five years, there is still significant investment necessary to meet the needs of a diverse set of EV drivers.

[7] International Energy Agency, Global EV Outlook 2022, 2022
[8] Simon Árpád Funkea, Frances Spreib, Till Gnanna, Patrick Plötza, "How much charging infrastructure do electric vehicles need?," Transportation Research Part D: Transport and Environment, 2019
[9] Michael Wayland, "Biden wants to build a national EV charging system under $2 trillion infrastructure plan, but it won't be easy," CNBC, 2021-03-31
[10] International Energy Agency, Global EV Outlook 2022, 2022

**Consumer Acceptance and Adoption:** In regions where electrification will play a dominant role in achieving carbon neutrality, sustained government incentives will be essential to encourage consumers to replace their vehicles with EV models. Traditionally, the complete replacement of the existing fleets of vehicles takes decades, if not longer (a minimum of 15 to 20 years if not more). In order to accelerate this process – especially as new, more expensive technologies scale and mature – incentives will be necessary in order to at least partly offset the additional cost to the consumer. Otherwise, if consumers are forced to keep their older vehicles longer than they should, the net effect of electrification will be negative.




While the auto sector has made significant progress driving down battery and fuel cell costs, further research and development (R&D) investments will be needed to realize “cost, utility, and convenience parity” between EVs and their internal combustion counterparts. EVs currently cost significantly more to produce than equivalent gasoline cars or trucks. This divide grows when considering “convenience and utility parity,” which requires larger batteries to support longer EV ranges commensurate with consumer expectations and needs in certain nations.

In sum, both industry and government have a role to play in increasing the availability and affordability of new vehicle technologies.

**R&D:** To increase EV market share, the focus should not be simply on strengthening fuel-efficiency and other regulations. These must be complemented by additional government policies that facilitate the transition to an electric future, including support for critical R&D. Automakers have committed $255 billion to EV R&D activities in 2023.[11]

In order to increase EV penetration and provide EV owners the same cost benefits as those provided by internal combustion engines, governments must continue to work proactively with industry to identify and support critical R&D opportunities, programs and initiatives. Despite tremendous progress in advancing EV technologies, R&D remains essential to addressing challenges from EV battery-pack prices to secure stable access to critical components and supply chains.

**Fuel Cell:** In addition to battery and plug-in EVs, hydrogen fuel cell EVs represent an important technology on the path to decarbonizing road transportation. This is particularly important for heavy duty vehicles, where battery technology may present challenges related to weight, cost and charging.

Hydrogen should be priced at affordable levels, and hydrogen fuels made more conveniently available to users. Accordingly, government support measures are needed in the areas of fuel cell and hydrogen storage R&D, and hydrogen production and station infrastructure development. For example, in South Korea the government has committed substantial resources to both hydrogen energy projects, as well as the establishment of a public-private hydrogen-powered FCEV market.[12] This type of public and private sector collaboration and investment reflects the type of national strategy and technology flexibility necessary to achieve broader decarbonization goals.

**Mineral Extraction and Supply Chain:** Realizing widescale adoption of EVs will require a substantial increase in the identification and responsible extraction of resources critical to the battery supply chain, as well as battery end-of-life policies that minimize environmental harm and support robust and resilient supply chains for battery materials.

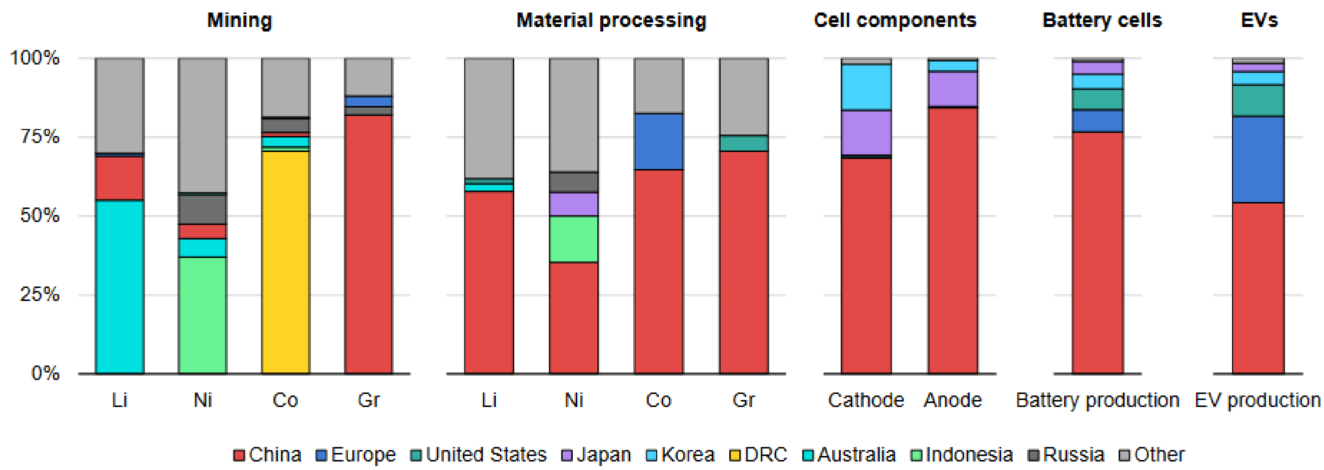
According to the IEA, "demand for EV batteries will increase from around 340 GWh today, to over 3500 GWh by 2030."[13] Others place this estimate higher – up to 9,300 GWh by 2030, a more than 1600 percent increase from 2020 levels.[14] This will apply tremendous pressure on existing supply

[11] Alix Partners, "Betting Big in Electrification and Autonomous," AlixPartners Global Automotive Outlook 2018
[12] https://www.macquarie.com/au/en/perspectives/a-clean-start-south-korea-embraces-its-hydrogen-future.htm
[13] International Energy Agency, "Global Supply Chains of EV Batteries," 7/22
[14] Govind Bhutada, "Mapped: EV Battery Manufacturing Capacity, by Region," Visual Capitalist, 2022-02-28

chains for critical minerals, components and materials. For example, some estimates suggest that global demand for lithium from battery factories "could hit 3 million tonnes by 2030, requiring a massive increase over the 82,000 tonnes produced in 2020.[15] Benchmark Minerals Intelligence estimates that over 300 new mines for graphite, lithium, nickel and cobalt will need to be built over the next decade to meet EV and energy storage battery demands.[16]

As a result of surging demand and tight supply chains, "[p]rices of raw materials such as cobalt, lithium and nickel have surged. In May 2022, lithium prices were over seven times higher than at the start of 2021."[17]

Geographical distribution of the global EV battery supply chain [18]






Notes: Li = lithium; Ni = nickel; Co = cobalt; Gr = graphite; DRC = Democratic Republic of Congo. Geographical breakdown refers to the country where the production occurs. Mining is based on production data. Material processing is based on refining production capacity data. Cell component production is based on cathode and anode material production capacity data. Battery cell production is based on battery cell production capacity data. EV production is based on EV production data. Although Indonesia produces around 40% of total nickel, little of this is currently used in the EV battery supply chain. The largest Class 1 battery-grade nickel producers are Russia, Canada and Australia.
Sources: IEA analysis based on: EV Volumes; US Geological Survey (2022); Benchmark Mineral Intelligence; Bloomberg NEF.

**Grid Reliability/Decarbonizing:** Decarbonization of road transport is firmly linked to decarbonization of the electric grid (both for BEVs as well as FCEVs). Thus, realizing the full potential of EVs and their charging infrastructure will require careful but urgent consideration and evaluation of upgrades to electric grid infrastructure, as well as the accelerated transition to clean and renewable sources of energy. A critical factor in the widescale adoption of EVs is ensuring the grid infrastructure is clean, reliable, resilient, affordable and able to accommodate various charging needs (not limited only to light-duty vehicles). We must work collaboratively to understand how widespread adoption of EVs will

[15] Govind Bhutada, "Mapped: EV Battery Manufacturing Capacity, by Region," Visual Capitalist, 2022-02-28
[16] Benchmark Mineral Intelligence, "More Than 300 New Mines Required To Meet Battery Demand by 2035," 9/22
[17] International Energy Agency, Press Release, "Global Electric Car Sales Have Continued Their Strong Growth In 2022 After Breaking Records Last Year," 2022-05-23
[18] International Energy Agency, "Global Supply Chains of EV Batteries," 7/22

increase demand on existing infrastructure and plan for the necessary investments required to maintain grid reliability.

Further, realizing the benefits of electric and fuel cell vehicles makes decarbonizing the electric grid increasingly important. In order to truly achieve the bold ambition of COP26, especially decarbonization of road transport, the power used to charge EVs will need to come from clean and renewable sources – while also maintaining the reliability necessary to meet demand.

## A Global Approach – A Path to Decarbonization for All Nations

In the near-to-medium-term, full-scale electrification may not offer a realistic or practical path for many nations around the world.

For example, Brazil is the world's largest producer of sugarcane ethanol and second largest soybean producer. Brazil has pioneered the use of energy crops as biofuel for the transport sector since the 1970's (Barros, 2019; CONAB, 2021).[19] Biofuels have been proven to emit significantly lower greenhouse gas (GHG) emissions than petroleum-based fuels.[20] In 2021, 84 percent of new light vehicles sold in Brazil contained flex fuel engines.[21] In contrast, EVs accounted for only 0.14 percent of vehicles sold and remain limited due to concerns around affordability, infrastructure and other factors.[22] Due to the long distances to be travelled in Brazil and the limited size of its electrical recharging grid, the electrification solution for the heavy-duty vehicles segment is a complex endeavor, bringing the use of biofuels (biodiesel, biomethane and HVO) to the center of the country's decarbonization strategy.

For example, according to a scenario analysis contracted by the Japanese Automobile Manufacturers Association[23], as shown in the graph below, it will be possible for CO2 emissions reduction in the global road transport sector to be in line with the IPCC's 1.5℃ climate scenarios for 2050, if electrification of powertrains (including BEVs, PHEVs, HEVs and FCEVs), is combined with the supply by 2050 of carbon-neutral automotive fuels (synthetic fuels and biofuels) at a level equivalent to approximately 30 percent of global automotive fuel consumption in 2020. Also, at least some supply of those fuels for in-use vehicles will be essential for advanced economies to achieve 2050 carbon neutrality in the road transport sector.

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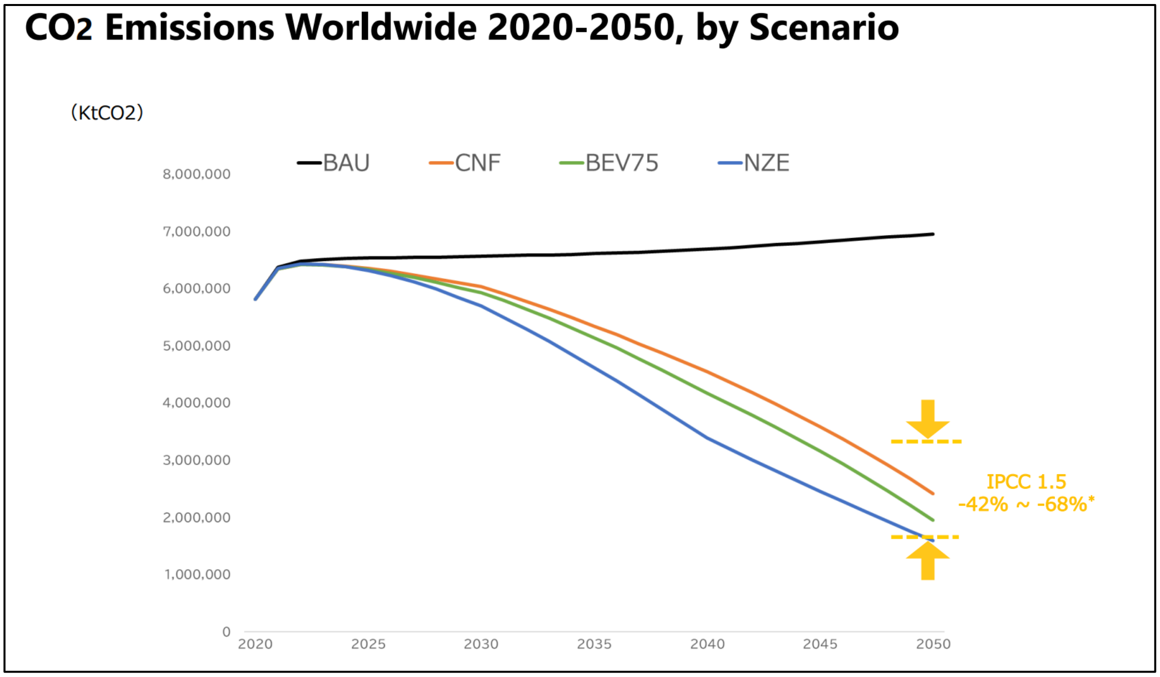
[19] https://www.sciencedirect.com/science/article/pii/S266678942200006X
[20] U.S. Department of Energy, "Ethanol vs. Petroleum-Based Fuel Carbon Emissions," 6/23/22
[21] Electric cars in Brazil - May 2022
[22] Id.
[23] Transitioning to Carbon Neutrality by 2050: A Scenario-Based Analysis




Even in economically advantaged nations, depending on geography or other factors, during a transition phase, more fuel-efficient ICE vehicles, hybrid vehicles and plug-in hybrid vehicles may offer a good alternative. In short, plug-in hybrid vehicles could offer the best of both worlds: a zero-emission driving mode for daily use in urban or semi-urban environments, as well as a good range for longer distances. They also do not necessitate huge charging infrastructure investments.

Fuel carbon neutrality, including the use of low-carbon or even carbon-neutral fuels in ICE-powered vehicles, contributes to reduce CO2 from in-use vehicles, and therefore is a key technology that merits R&D and government support. These clean[er] fuels must be user-friendly in terms of price, quality, and ready availability and coupled with more efficient ICE technologies can provide significant emissions benefits, particularly when an EV may not be an option for a customer.

Hydrogen in ICE vehicles may well offer a viable alternative in some markets, especially for heavy vehicles and other specific use cases. Several manufacturers are actively considering this technology in heavy vehicles and, in some cases, for light vehicles. Whether hydrogen is issued in a fuel cell or in an ICE, the carbon emissions at the tailpipe are zero.

## Additional Considerations

Two key issues for achieving automotive carbon neutrality:

- Although EVs do not emit CO2 while in use, CO2 is emitted during the manufacture, distribution, recycling and disposal process. Carbon neutrality for motor vehicles cannot be achieved without CO2 emissions reductions throughout their life cycle.

- A critical and related issue is that notwithstanding the widely varied energy policies and power-generation mixes existing among countries, a fair and internationally harmonized method of evaluating CO2 emissions based on LCA will need to be adopted.

It should also be noted that carbon neutrality of electricity generation must be achieved by the substitution of thermoelectric plants fueled with coal, oil, and fossil fuels by hydro, solar, wind and other carbon zero plants. No solution will really be effective from the point of view of global warming, if the whole energy chain, from well to wheel is disregarded.

## Conclusion

No single government policy or industry commitment will achieve the ambitious goal of carbon neutrality by 2050. **We must work collaboratively – at all levels of government and across all industries – to identify the suite of approaches necessary to establish sustainable pathways to carbon neutrality across sectors that recognize and take into account the economic, geographic and cultural realities of individual nations around the world.** OICA and its members are committed to supporting this goal. We believe electrification will play a leading role in this transition, however it is currently not the most appropriate technology for all nations.

Electrification requires a sustained commitment and collaboration to adopt supporting policies and infrastructure. Where other technologies or fuels may be more suitable, individual countries should proceed towards the achievement of carbon neutrality by implementing practical and sustainable technological and policy measures tailored to their specific circumstances. Finally, essential to achieving automotive carbon neutrality are comprehensive national industrial and energy policies that effectively promote the competitiveness of the automobile industry and accelerate decarbonization of electric grids as well as ensure reliable infrastructure.