

2030 Brazil Roadmap

Multiplying the Transition:
Market-based solutions for catalyzing clean
energy investment in emerging economies

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About

BloombergNEF is working with the Climate Investment Funds to identify how financial intermediaries can mobilize clean energy investment in emerging markets. In the context of post-pandemic sustainable recoveries and the need to meet international climate commitments such as the Nationally Determined Contributions (NDCs), accelerating the global energy transition is now more pressing than ever. BNEF sees electrification through clean power and transport as the basis of decarbonization, and therefore, as the backbone of the energy transition. With investors' appetite for ESG products at an all-time high and capital needs for clean energy investment in many emerging markets often unmet, this project looks at how to better match this supply and demand. This slide deck serves to support the dialog with stakeholders on this topic.

About Climate Investment Funds (CIF)

The [Climate Investment Funds \(CIF\)](#) is one of the world's largest and most ambitious climate finance mechanisms. Founded in 2008, it represents one of the first global efforts to invest in a dedicated climate finance vehicle. The CIF emerged from recognition by world leaders that climate change and development are inextricably intertwined. The CIF's creation also recognized a need to fill a gap in the international climate finance architecture—to deliver climate-smart investment at scale. The CIF supports developing and emerging economies in shifting to low carbon and climate resilient development.



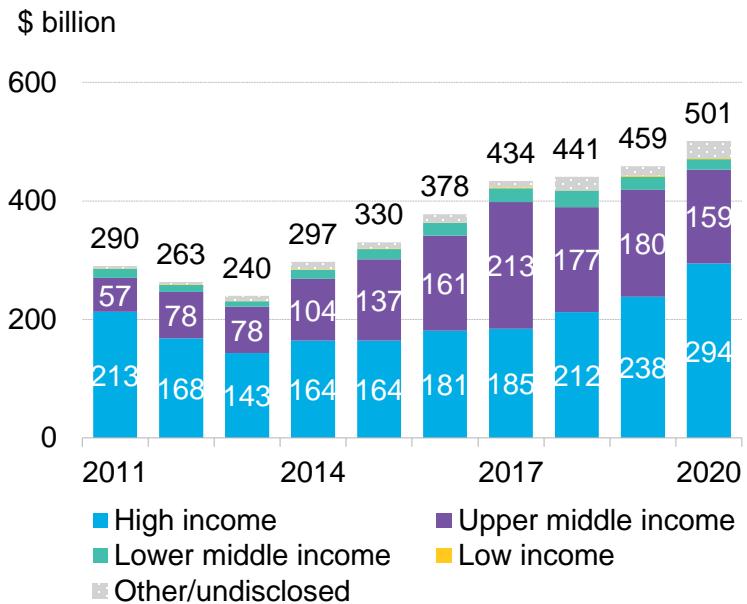
About BloombergNEF (BNEF)

[BloombergNEF \(BNEF\)](#) is a strategic research provider covering global commodity markets and the disruptive technologies driving the transition to a low-carbon economy. Our expert coverage assesses pathways for the power, transport, industry, buildings and agriculture sectors to adapt to the energy transition. We help commodity trading, corporate strategy, finance and policy professionals navigate change and generate opportunities.

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BNEF Take: Emerging markets and the energy transition

Global energy transition investment



- Despite reaching a record-high in 2020, at \$501 billion, global energy transition investment has become even more concentrated in high income countries as a result of the Covid-19 pandemic. Emerging markets are, however, key to achieving the global energy transition, as they will produce the bulk of global emissions until 2050. In the context of delivering sustainable post-pandemic recoveries, accelerating economy-wide decarbonization is therefore more important than ever to keep global temperatures well below 2°C to deliver on the goals set under the Paris Agreement.
- BNEF sees electrification through clean power as the basis of decarbonization, and therefore, as the backbone of the energy transition. The power sector is a major contributor to overall emissions, with coal still the largest source of generation. Clean power generation technologies are the most readily available, scalable decarbonization solutions. To enable zero-carbon electrification of further sectors, renewable energy capacity needs to be expanded through utility-scale projects and distributed assets.
- At \$307 billion in 2020, investment volumes in renewable energy and storage are, however, far from the necessary levels to achieve this: BNEF estimates that expanding and decarbonizing the power system to stay on track for warming of as much as 1.75 degrees Celsius would require over \$2 trillion globally in power generation assets and batteries per year until 2050. There is therefore an urgent need to mobilize and accelerate clean power investment, particularly in emerging markets.

Source: BloombergNEF. Note: Numbers include renewable energy, electrified transport, electrified heat, energy storage, carbon capture and storage and hydrogen.

Project overview

- **Focus: Scaling up clean energy investment through financial intermediaries in emerging markets**
 - Global energy transition investment and sustainable debt issuance reached a record high in 2020, but flows continue to be concentrated in the world's wealthiest countries and a select group of trail-blazing emerging markets.
 - The 2020s are the decade where lessons learned need to be replicated and scaled across emerging markets to ensure that their economies can grow sustainably, and help meet the objectives of the Paris Agreement.
 - Through fund-deployment and fund-raising activities, financial intermediation has an important role to play in activating more players in the investment chain, mobilizing more capital and ensuring more liquidity for the energy transition.
- **The “Roadmaps”: Exploring country-level clean energy finance to 2030**
 - Focus: The short- to mid-term opportunities for intermediation in mobilizing clean energy investment in emerging markets in order to fulfil the commitments of the Paris Agreement.
 - Countries: India, Indonesia, South Africa, Morocco and Brazil.
- **Final report - structure:**
 - Part 1: “Looking back”: The evolution of financial intermediation in delivering clean energy investment.
 - Part 2: “Present situation”: Current opportunities and constraints to mobilizing investment through intermediaries.
 - Part 3: “Looking forward”: The further potential of leveraging intermediaries to accelerate clean energy investment.

Brazil: Key references and background reading

- Ministry of Mines and Energy, Empresa de Pesquisa Energetica (EPE) [National Energy Plan \(PNE\) 2050](#)
- Ministry of Mines and Energy, Empresa de Pesquisa Energetica (EPE) [Ten-Year Energy Expansion Plan \(PDE 2030\)](#)
- Brazil [Intended Nationally Determined Contribution \(INDC\) 2015](#)
- Empresa de Pesquisa Energetica (EPE) [2020 Analysis of Biofuels \(Análise de Conjuntura dos Biocombustíveis 2020\)](#)
- Ministry of Mines and Energy, [RenovaBio national biofuels policy \(2020\)](#)

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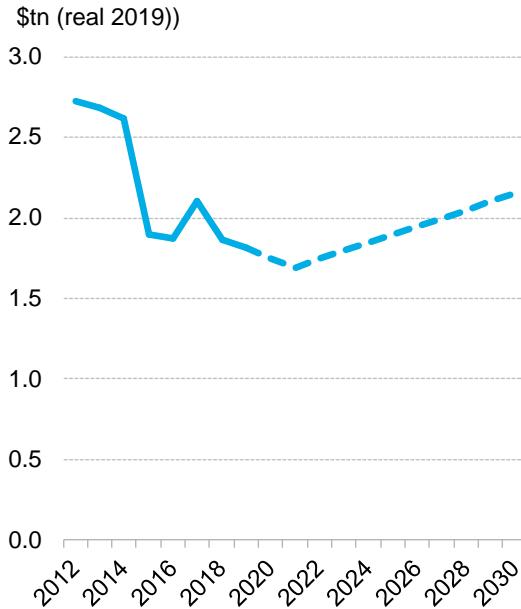
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State of the energy transition

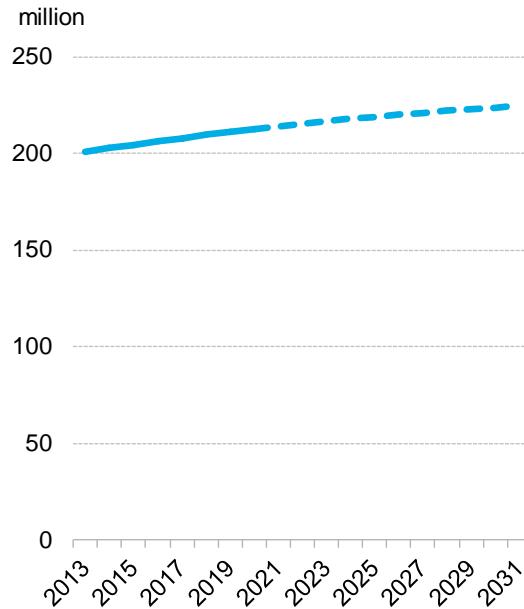
Brazil

Brazil to resume steady economic and population growth

GDP



Population



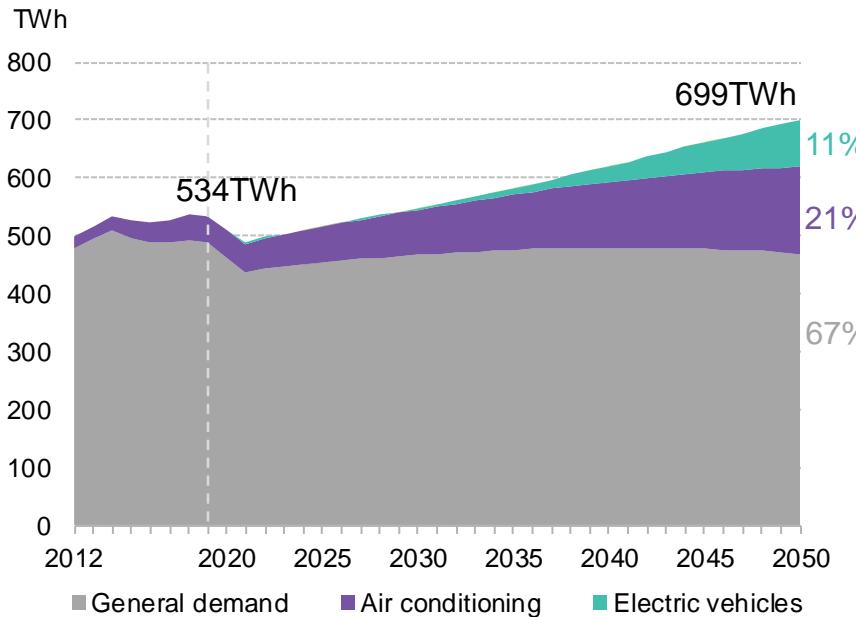
Source: World Bank.

Comments

- With a large and diversified economy, Brazil's GDP was the twelfth largest globally in 2020.
- The pandemic pushed Brazil into a recession in 2020, with GDP shrinking by 4.1%.
- The plunge followed years of middling economic performance with the economy having expanded just 1.5% per year from 2017-19.
- A gradual return to economic growth and steady population growth underpins a long-term forecast for rising electricity demand.

Electricity demand to climb, buoyed by air conditioning and new sources

Brazil electricity demand by source



Source: BloombergNEF. Note: Demand is final consumption.

- After a fall in final electricity demand in 2020, a return to economic growth underpins a rising long-term forecast for electricity demand.
- Long-term growth in demand should average over 1% annually, lifting 2019 demand of 534 terawatt-hours (TWh) by more than 30% by 2050, to around 700TWh.
- Air conditioning (AC) is a key driver. Demand associated with AC in Brazil is expected to expand 4% annually to 2050. AC nearly triples as a proportion of the country's electricity demand, rising to account for 21% of the total by 2050, compared with a global average 12.8%.
- AC is generally well-correlated with output from solar PV in the region. In warmer climates, such as Brazil, peak demand is expected to shift to the middle of the day
- Longer term, new sources of demand, primarily electric vehicles (EVs) further support electricity consumption. Demand associated with EVs rises from negligible levels today to account for as much as 11% of total consumption in 2050.

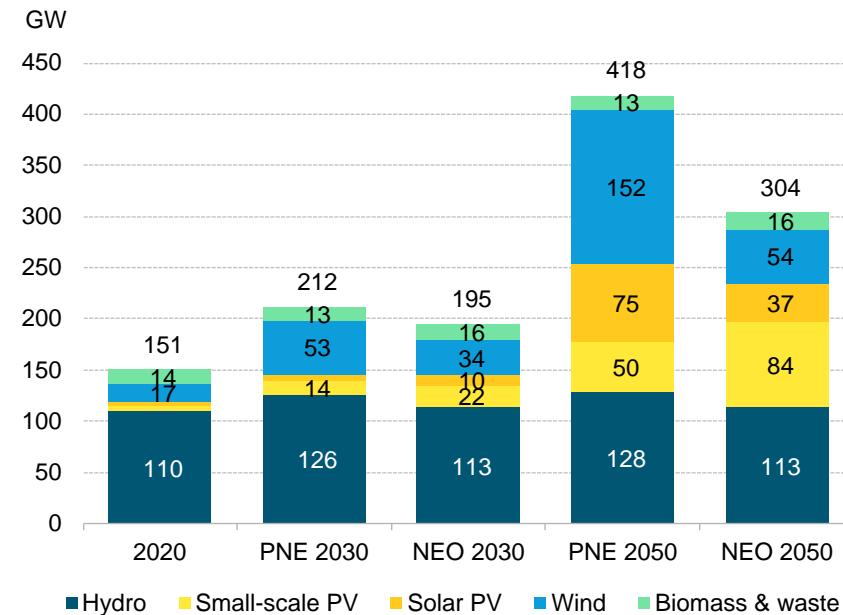
Brazil's targets imply significant growth in renewable energy

Renewable energy targets

Entity	Target	Comments
National Energy Plan (PNE) 2050, Ministry of Mines and Energy, Empresa de Pesquisa Energetica (EPE)	Renewable energy target of 45% of primary energy demand by 2030	Scenario shown implies restriction on expansion of hydro in protected areas, producing growth in non-hydro renewables in addition to thermal sources.
Nationally Determined Contribution	See above, and also expand non-hydro renewables to 28-33% by 2030.	See above
BNEF Outlook	81GW of renewables (ex-hydro) by 2030 and 190GW by 2050	Least-cost outlook shows lower capacity than PNE, tied to differing demand projections.

Note: PNE 2050 Scenario "Exceto UC e TI" Source: BloombergNEF.

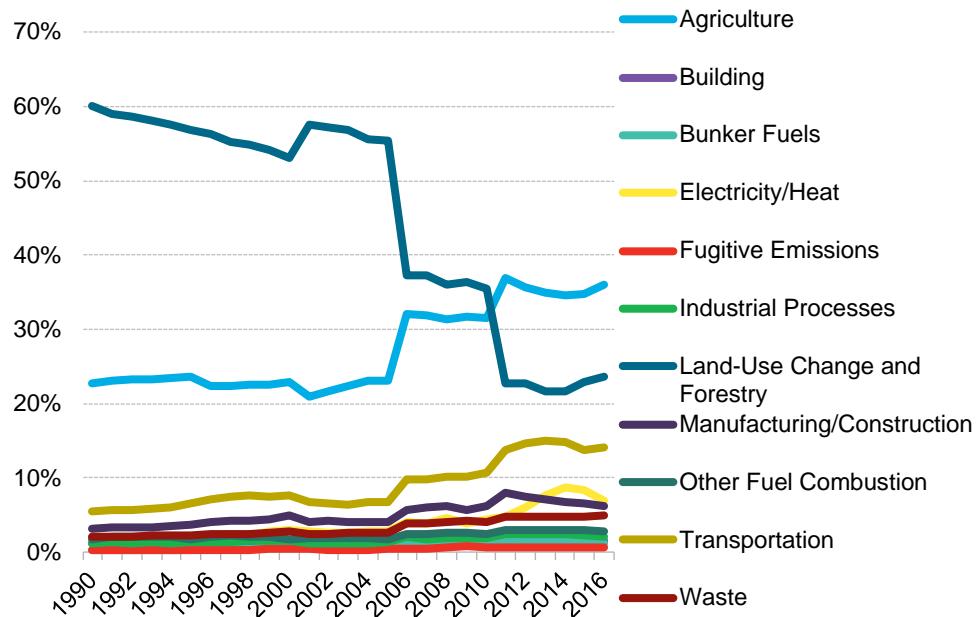
Installed clean power capacity outlook



Source: BloombergNEF

Brazil continues to focus on biofuels in its emission reduction priorities

Emissions by sector



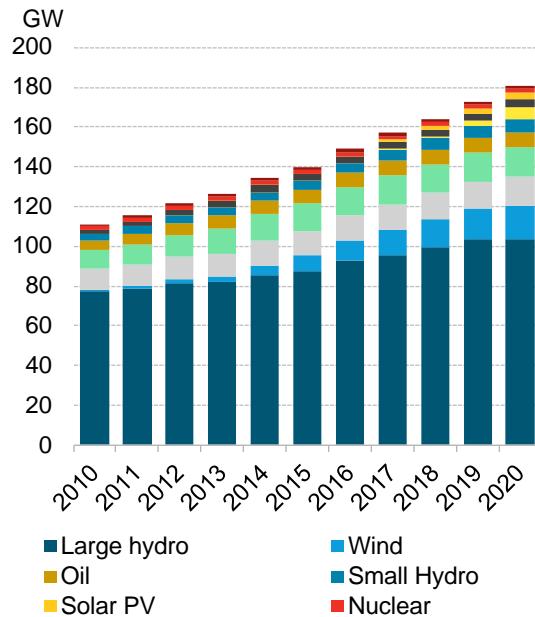
Source: BloombergNEF Emissions Tracker; "Life-Cycle Assessment of Brazilian Transport Biofuel and Electrification Pathways" Glensoar, Muñoz 2019.

Emissions policy

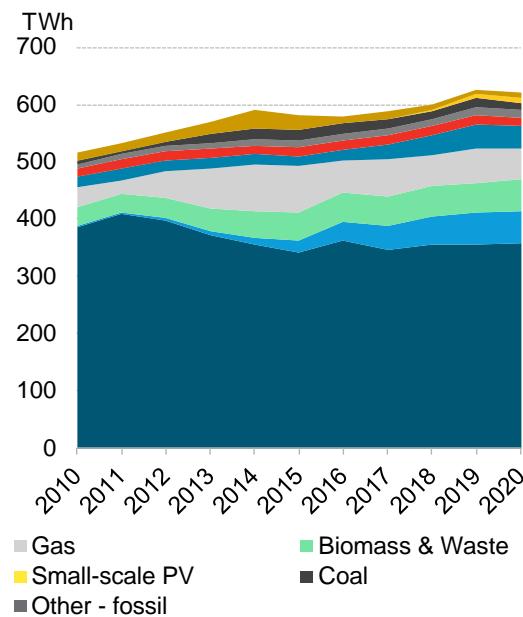
- In 2015, Brazil submitted one of the most ambitious NDC targets among emerging markets. But it has yet to move to a net-zero approach. Due to the significant role of hydropower, the power sector accounts for only ~7% of emissions, around half that of the transport sector (14%). Transport emissions have risen steadily and are the third largest source after 'land use, land-use change, and forestry' (LULUCF) (24%) and agriculture (36%).
- Brazil's NDC includes increasing the share of sustainable biofuels in the energy mix to 18% by 2030, expanding biofuel consumption, increasing ethanol supply, and raising the share of advanced biofuels and biodiesel in the mix.
- RenovaBio, Brazil's national biofuel policy, came into force in 2020. It establishes annual decarbonization targets for fossil fuel suppliers, targeting a 10% reduction in carbon emissions by 2028. It classifies biofuels by their greenhouse gas emissions profiles, and introduces a carbon credit system. The tradeable carbon credits (Cbios) represent the equivalent of a one metric ton reduction of CO₂ versus fossil fuel emissions, and create a cost advantage for biofuels over fossil fuels.
- As major markets embrace net-zero goals, a focus on cutting emissions via biofuels won't be sufficient. Some studies suggest that wholesale conversion of car and urban bus fleets to 100% biofuels results in similar or higher transport emissions than a business as usual (BAU) scenario due to land-use change emissions.

Brazil's power mix is relatively clean today

Installed capacity



Power generation mix



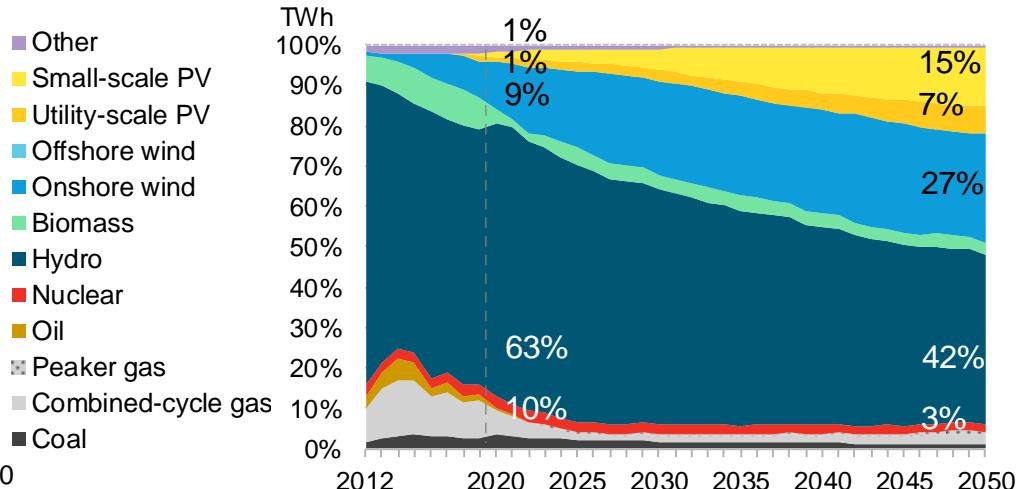
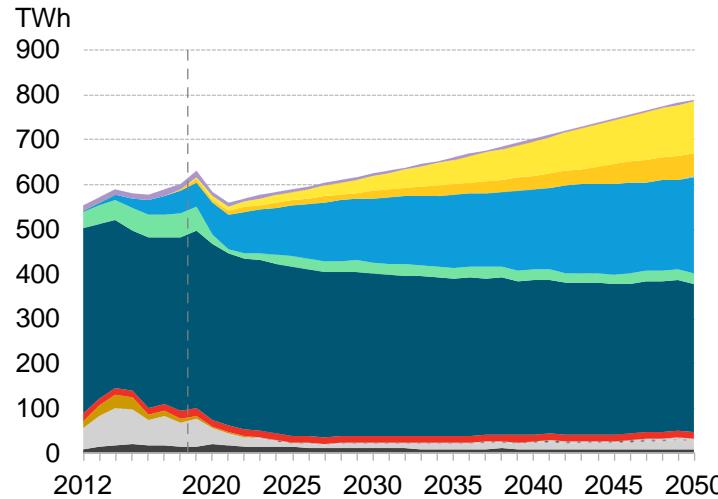
Comments

- Brazil's power mix today is relatively clean. Heavy reliance on hydropower, which accounts for nearly two-thirds of capacity, means overall renewable energy stands at 82% of generation, including large hydro.
- Excluding large hydro, renewables account for 23% of generation capacity.
- The country's clean power matrix has positive implications for electrifying transport.

Source: BloombergNEF

Source: BloombergNEF

...and it is poised to become one of the cleanest major power markets worldwide

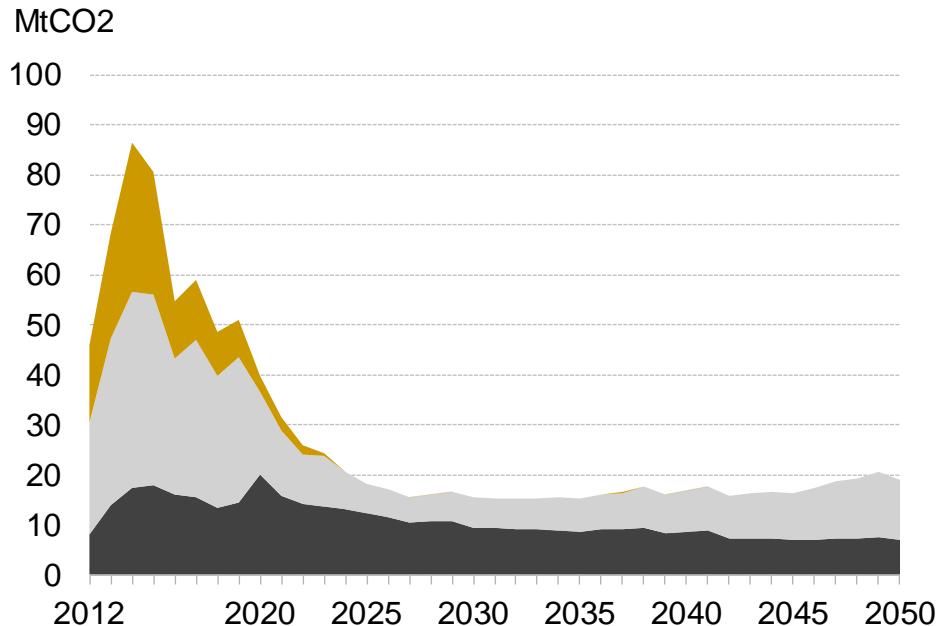


- Renewable energy – and wind and solar in particular – is poised to continue to grow in importance on Brazil's grid. Renewables represent over 60% of the 11GW of generation capacity under construction. According to BNEF's least-cost outlook, swiftly rising renewables generation will sharply lower the country's reliance on thermal generation from the early 2020s.
- Gas, oil, and coal are projected to fall from 13% of generation today to 4% in 2050. Renewables grow to comprise 93% in 2050. Brazil's power generation is 95% zero-carbon by that year, making it one of the cleanest major markets in the world.

Source: BloombergNEF

Brazil power sector emissions are expected to drop (from already low levels)

Power sector CO2 emissions

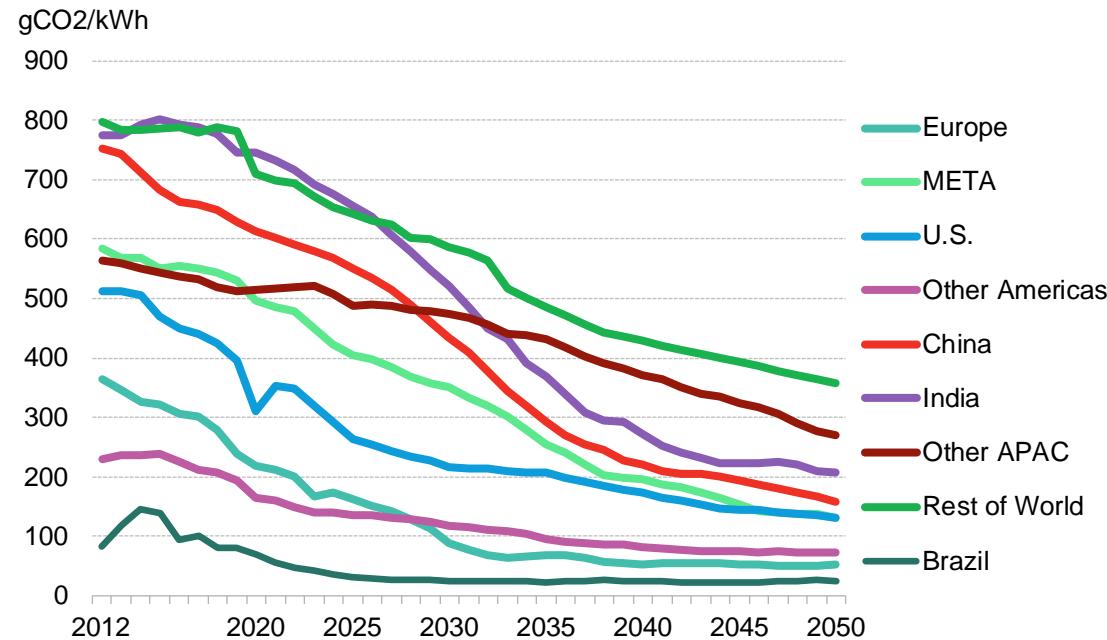


Source: BloombergNEF, World Resources Institute (WRI)

- The power sector today accounts for a small share of Brazil's overall CO2 emissions, and further reductions are expected as renewables generation rises and fossil generation falls.
- According to BNEF's least-cost outlook, power sector emissions sink from 51MtCO2e in 2019 to 19MtCO2e by 2050 – a more than 60% reduction from today's level.
- Oil gets pushed from Brazil's generation mix by the mid-2020s, taking an important source of emissions with it. Emissions from burning coal drop by a third by 2030.
- As the role of natural gas in Brazil's grid shifts from baseload to providing back-up and meeting peak demand, its emissions retreat to one fifth of current levels by 2030, before steadily rising again to nearly half current levels.

Brazil's grid emissions intensity to decrease even further

Carbon intensity of electricity, by region



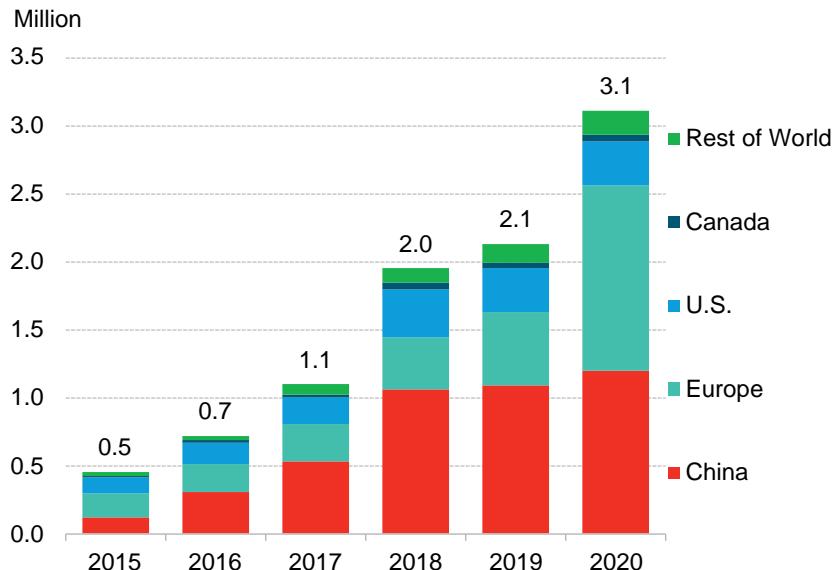
Source: BloombergNEF

- Due to the significant role hydropower plays, the carbon intensity of Brazil's electricity is already among the lowest of any major market.
- As the share of zero-carbon generation increases from 85% today to 96% in 2040, Brazil's grid emissions intensity is set to decrease from 81g of CO2 per kilowatt-hour to 24gCO2/kWh across the same time period.
- Annual emissions from EV use will decrease as renewable energy generation rises. EVs will charge (and eventually be manufactured) with clean power, lowering their lifecycle CO2 emissions and leading to a growing emissions gap with internal combustion engine (ICE) vehicles.

Electrified transport in Brazil

Globally, EVs are booming, but not yet everywhere

Global passenger EV sales outlook by market



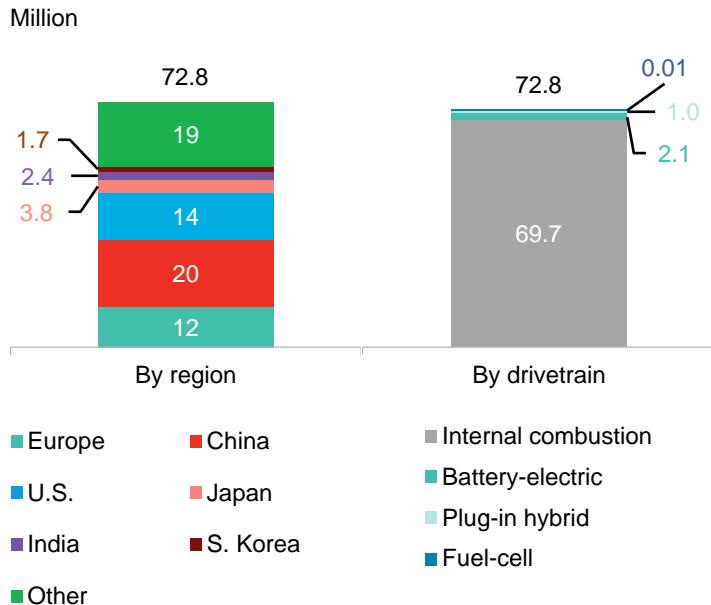
Comments

- There are now 12 million passenger EVs globally, up from just 1 million in 2015. This means that EVs accounts for 1% of all cars on the road, a significant milestone.
- However, progress is not evenly distributed. Nearly all EVs (96%) are found in just three major automotive markets: over 44% of all EVs are in China, about 35% are in Europe and North America is home to 17%. The remaining 4% are spread across numerous other markets.
- Sales of new EVs present a similar picture. Together, China, Europe and North America accounted for 94% of the 3.1 million passenger EVs sold in 2020, while many other markets are in their infancy.

Source: BloombergNEF Long-Term Electric Vehicle Outlook 2021 (EVO)

There remains a huge gap in the rest of the world for electrifying transport

Global passenger vehicle sales, 2020



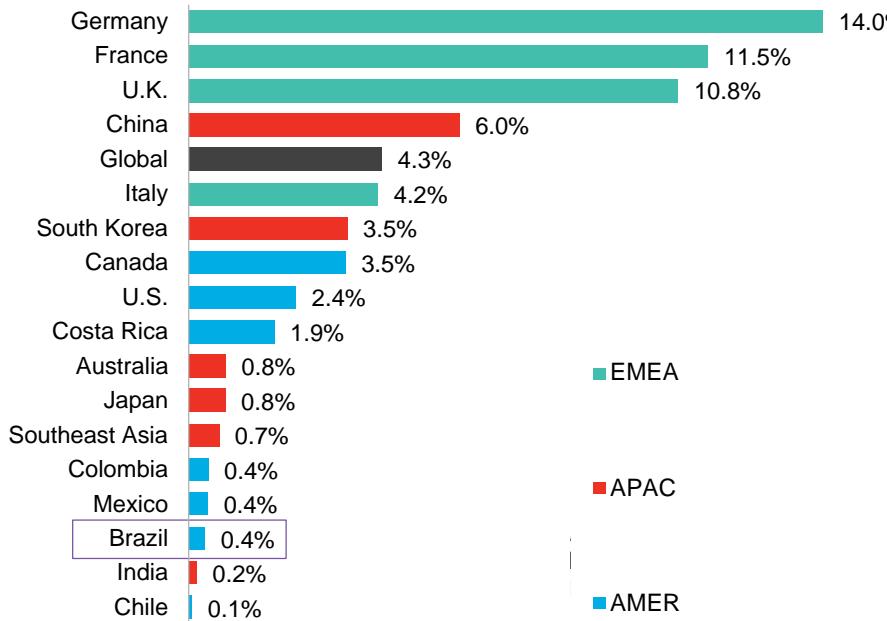
Comments

- The rest of the world (everywhere outside of China, Europe and North America) accounts for just 6% of new EV sales, or some 172,000 vehicles. Latin America's share of global EV sales in 2020 was 0.36%.
- However, while small in terms of EVs, the rest of the world accounts for over a third of total passenger vehicle sales, or some 27 million vehicles, nearly all of which are internal combustion engine (ICE) vehicles.
- Therefore, the pace of global EV adoption will greatly affect the pace of global decarbonization.

Source: BloombergNEF Long-Term Electric Vehicle Outlook 2021 (EVO)

Most EV markets (not just emerging ones) are in their infancy

2020 EV share of passenger vehicle sales



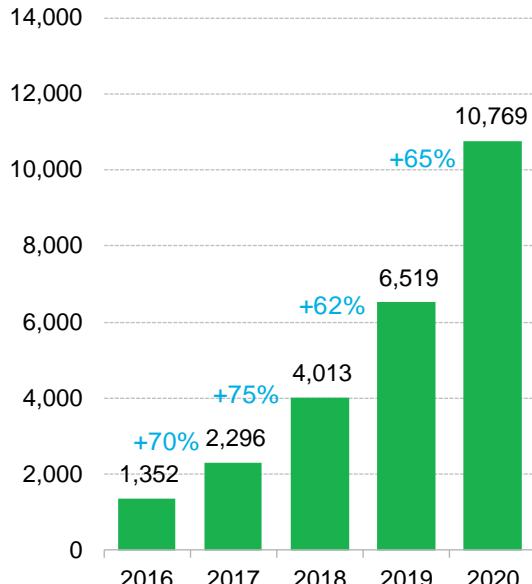
Source: BloombergNEF. Note: Includes battery electrics and plug-in hybrids.

Comments

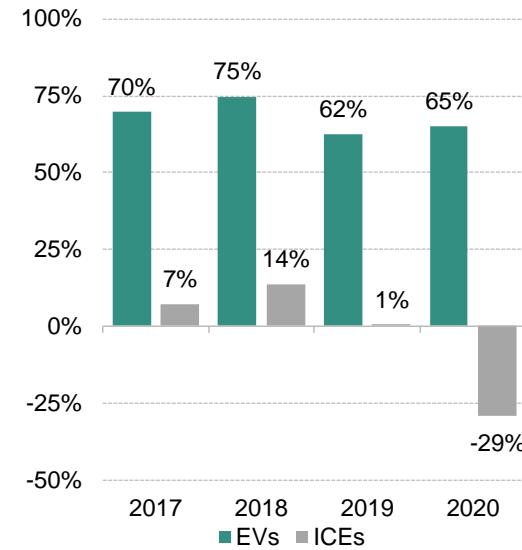
- While most emerging markets are only beginning to adopt EVs, both Australia and Japan lag their developed-market peers with under 1% of new sales.
- The average across the top five markets in Latin America is 0.68%. Costa Rica is the only country in the region to have introduced strong incentives.
- Emerging markets are price-sensitive, and ICE vehicles remain the lowest-cost option. Policy support is, in general, limited. Fuel subsidies and, in some markets, the presence of alternatives like ethanol and natural gas vehicles, present further hurdles.
- The scale being driven by today's leading markets will push down battery and infrastructure costs for emerging markets, reducing required investment and bringing forward price parity with ICE vehicles.

EV sales in Latin America remain small, but growth is strong

Latin America annual EV sales



Latin America passenger vehicle sales YoY change by drivetrain



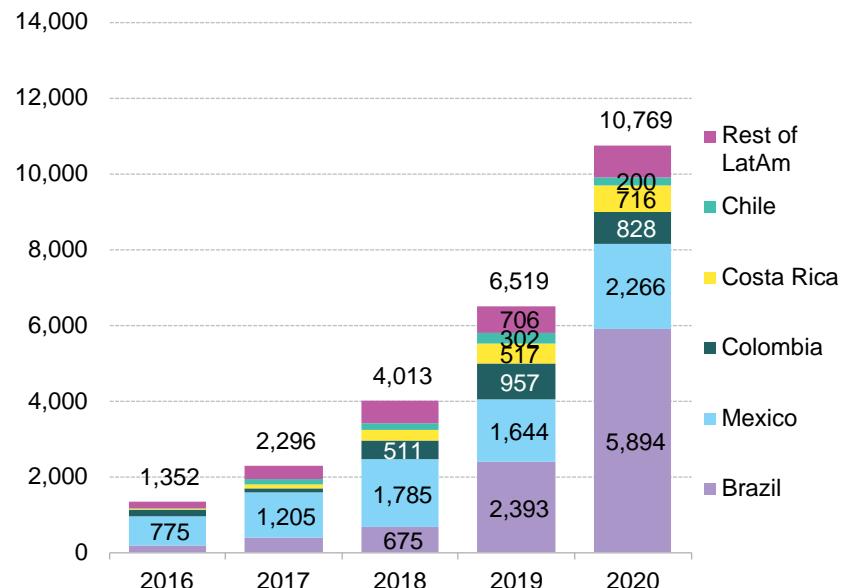
Source: BloombergNEF. Note: EVs include battery-electric and plug-in hybrid electric vehicles.

Comments

- EV sales in Latin America remain tiny, but sales growth of around 70% per year since 2016 has outstripped that of ICE vehicles.
- Global passenger EV sales rose 48% in 2020, even as total passenger vehicle sales fell 13%. This trend was mirrored in Latin America, which saw a 65% increase in EV sales alongside a 29% decline in total passenger vehicle sales.
- With meaningful policy support absent in much of the region, gains to date are almost entirely driven by fundamentals: improvements in cost and technology, compelling new models and growing commitment from automakers and consumers alike.

Brazil leads the region in EV sales, but market concentrated in luxury models

Latin America annual EV sales, by country



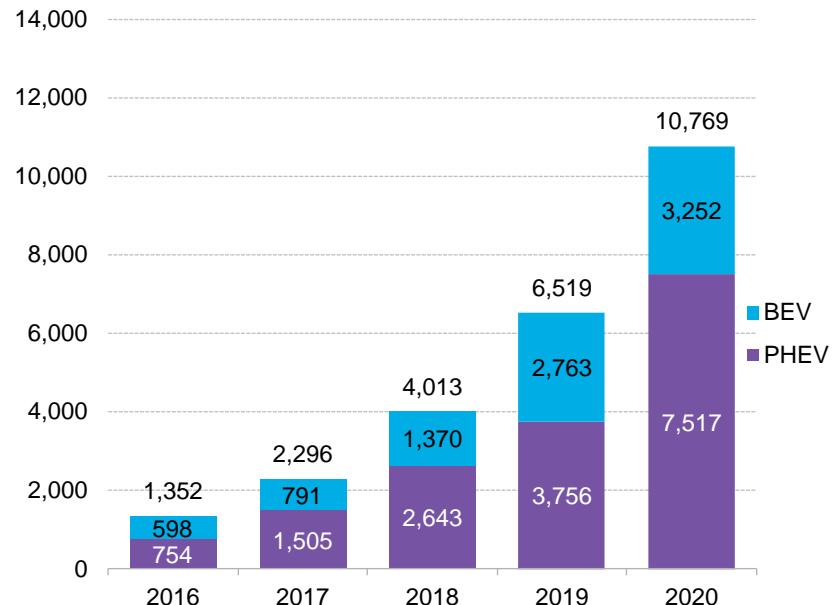
Source: BloombergNEF. Note: "Rest of LatAm" includes Argentina, Dom Rep, Ecuador, Panama, Peru and Uruguay. EVs include battery-electric and plug-in hybrid electric vehicles.

Comments

- Brazil is the leader in Latin America for EV sales, with 5,894 sold in 2020, a position it only assumed in 2019. Growth has been driven by rising plug-in hybrid electric vehicle (PHEV) sales, concentrated in luxury brands such as Volvo, BMW and Porsche. Luxury vehicles accounted for 89% of Brazil's EV sales in 2020.
- We expect Brazil to continue to lead in the next five years due to the size of its market and continued growth in luxury PHEV sales, even as adoption remains low as a share of new passenger vehicle sales (0.36% in 2020). Competition from ethanol, import taxes and flex-fuel vehicle (FFV) incentives will hinder growth of battery electric vehicles (BEVs).
- Mexico, Colombia and Costa Rica are expected to remain regionally important markets in the next five to 10 years. Incremental improvements to the policy environment, improving economics, new models and better availability of charging will support growing sales across the region, even in the absence of bold policy support.

Plug-in hybrids lead in Latin America

Latin America annual EV sales, by type



Comments

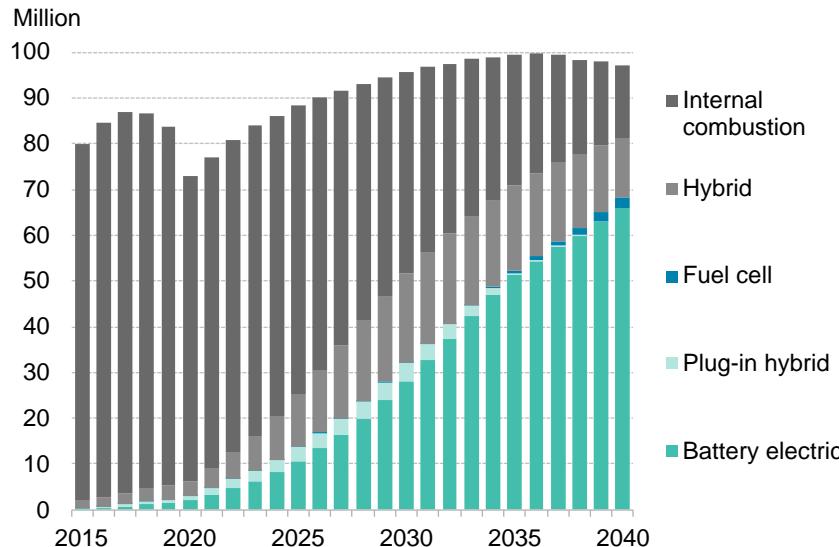
- PHEVs are popular in Latin America, in contrast to much of the rest of the world where BEVs are displacing them. Availability of charging infrastructure is likely the key factor and this is particularly true in Brazil, where PHEVs were 86% of EV sales in 2020.
- PHEVs are an important part of automakers' CO2 compliance strategies in Europe, but we expect them to fade quickly after this decade as battery prices continue to fall and automakers shift their efforts towards dedicated BEV platforms. In China and North America, most upcoming EV model launches are BEVs and automakers show limited interest in PHEVs.
- In BNEF's Electric Vehicle Outlook 2021 (EVO), PHEV sales cease by 2035. Nevertheless, in some markets, such as Japan, they remain a part of the mix for longer due to the priorities of Japanese automakers like Toyota and Honda. The same could occur in other markets. For example, automakers in Brazil such as VW, Toyota and Nissan are taking steps to develop 'flex-fuel engine EVs' for the local market, or PHEVs that run on a combination of ethanol and petrol.

Snapshot: The waning role of plug-in hybrids. Unlike BEVs, there is no route for PHEVs to ever become cheaper on an up-front basis than traditional ICEs. Over the last year, several studies have found that PHEVs are charged very infrequently. This means their CO2 reduction benefits may be overstated and that their regulatory treatment may change, which could further reduce their appeal to automakers and consumers.

Source: BloombergNEF

Electrification is inevitable

Global passenger vehicle sales outlook by drivetrain



Source: BNEF Long-Term Electric Vehicle Outlook 2021 (EVO). Note: EVs include battery-electric and plug-in hybrid electric vehicles. Battery-electric vehicles represent 88% of total electric vehicle sales in 2030.

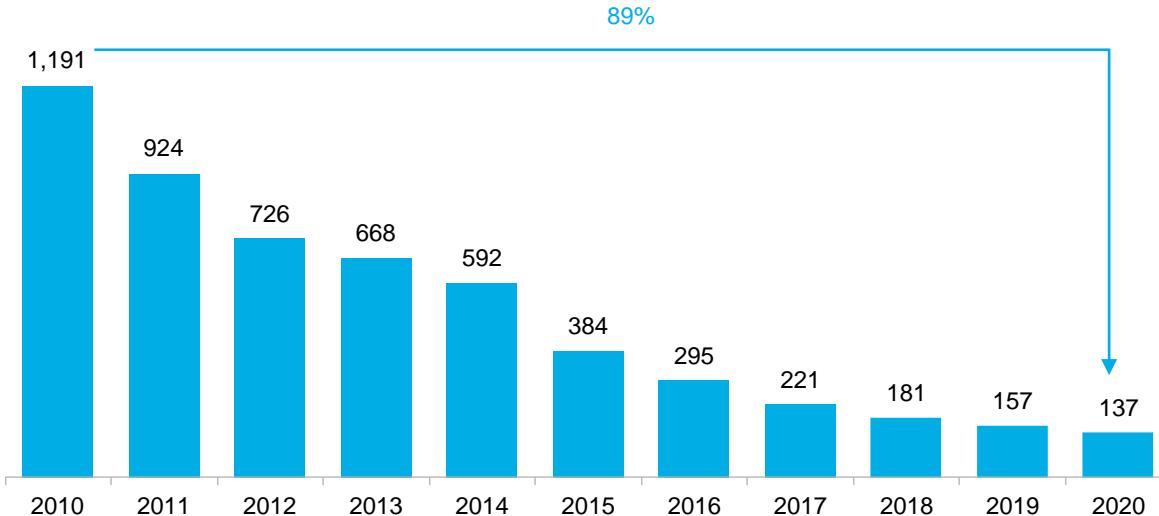
Comments

- Long-term technological, economic and policy trends are at the core of the transition in mobility that will see significant changes to the sector over the next 20 years.
- In our outlook (EVO), global passenger EV sales continue to rise quickly as battery prices fall, and sales of ICE vehicles peaked in 2017. Unsubsidized price parity between EVs and ICE vehicles is achieved in most segments and countries by the late 2020s, and some reach this point much sooner.
- EV sales rise from 3.1 million in 2020 to 13.7 million in 2025 (16% of sales), 32 million in 2030 (34% of sales) and 66 million in 2040 (68% of sales). The global fleet of passenger EVs grows from 10 million on the road at the end of 2020 to 169 million in 2030 (12% of the fleet) and 619 million by 2040 (40% of the fleet).
- However, EVs will take longer to spread in emerging markets. Sales are forecasted to grow rapidly in the 2030s as the economics improve in these price-sensitive markets, but different start times for the steep part of the s-curve in different countries draws out the global adoption curve.

Electrification is inevitable

Lithium-ion battery price survey results: volume-weighted average

Real 2020 \$/kWh



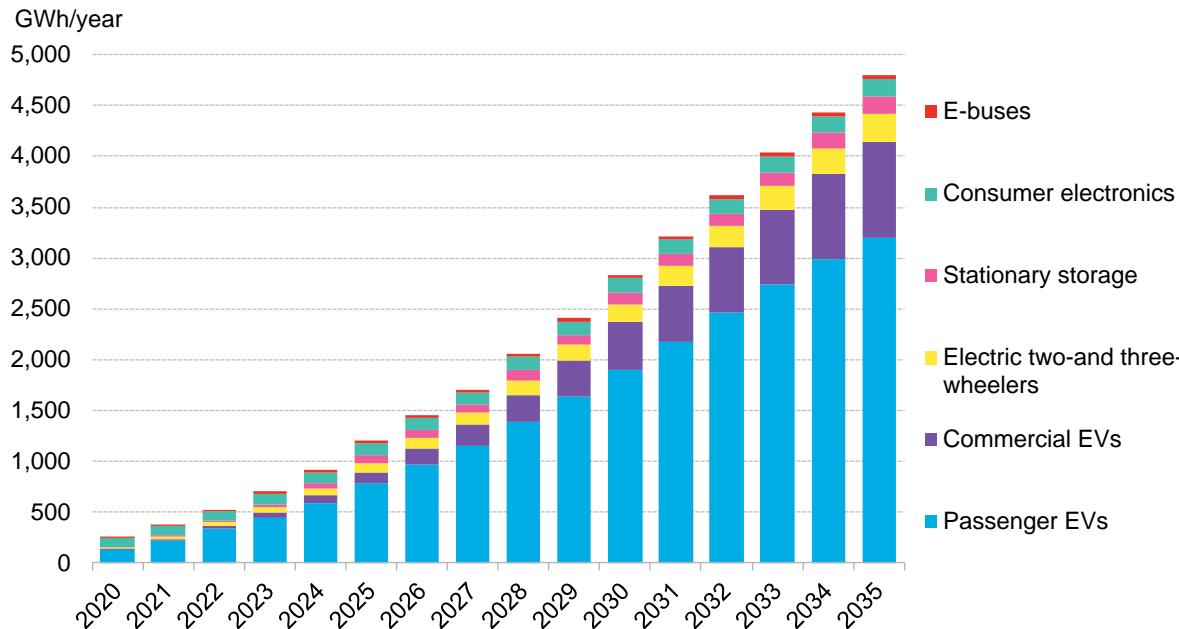
Comments

- Battery prices are nearing levels where the upfront costs of EVs can start to be competitive with ICE vehicles without subsidies.
- Battery prices fell again in 2020, dropping 13% year-over-year to \$137/kWh, due to growing order sizes from manufacturers, higher BEV sales and the introduction of new cell and pack designs.
- In 2020, the cheapest packs delivered on a volume-weighted average basis were in China, coming in at \$111/kWh, a 13% fall on the average price in 2019.

Snapshot: Falling lithium-ion battery prices. This trend is the most important factor in our EV adoption outlook. Pack prices have declined 89% since 2010, while annual battery demand has increased more than 264 times over the same period. This relationship between price and volume is crucial. From observed historical values, we estimate that the learning rate is ~18%, or for every doubling of cumulative volume, we see an 18% reduction in price.

Electrification is inevitable

Lithium-ion battery demand outlook



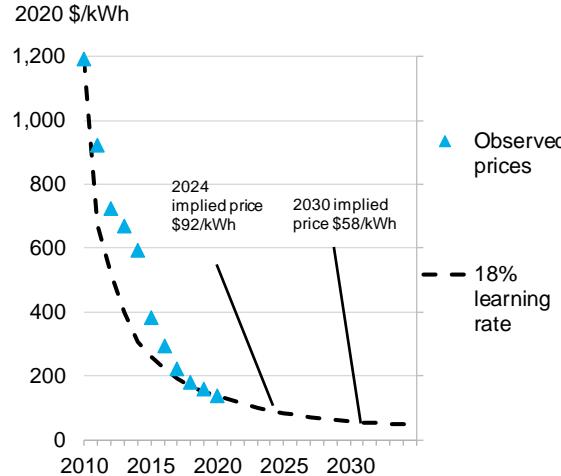
Source: BNEF, Bloomberg, ACEA, China Automotive Information Network.

Comments

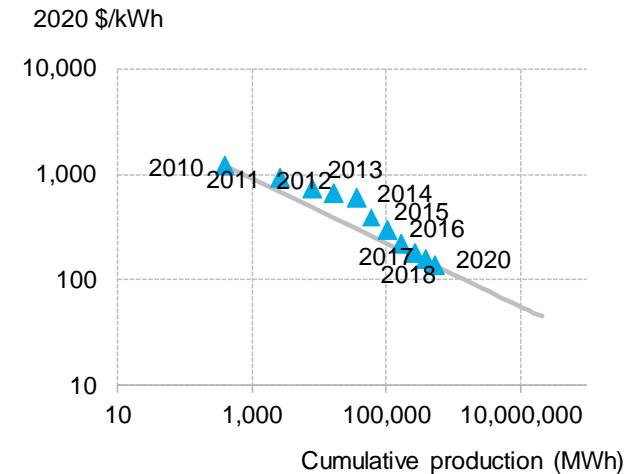
- Demand for lithium-ion batteries in passenger EVs was 133 gigawatt-hours (GWh) in 2020, up from 79GWh in 2019. BEVs accounted for 89% of total passenger EV battery demand in 2020.
- Annual lithium-battery demand grows rapidly in our outlook (EVO). By 2030, annual demand for lithium-ion batteries passes 2.7TWh per year. Passenger EVs account for 72% of the market compared to 11% for the next largest sector, commercial vehicles.
- By 2035, battery demand approaches 4.5TWh.

Electrification is inevitable

Lithium-ion battery-pack price outlook



Log-log battery pack price outlook

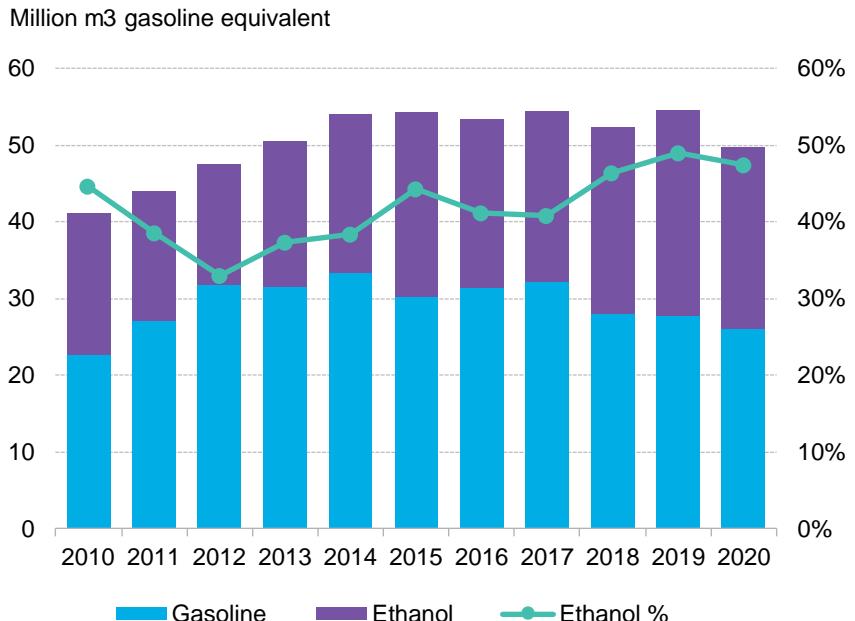


- We expect the volume-weighted average price of battery packs to drop below \$100/kWh in 2024. Cost reductions will come from reduced cell and pack material costs, improvements in energy density that lower capital and operating costs, and more efficient production processes. The introduction of new pack designs for pure BEV platforms will further drive down prices.
- By 2030, the observed learning rate of 18% suggests average prices will fall as low as \$58/kWh. Reaching this requires further technological advances. These include the adoption of technologies such as high-voltage cathodes and solid electrolytes, plus changing manufacturing processes and the introduction of solid-state cells. By 2035, average pack prices could be as low as \$45/kWh.

Source: BNEF. Note: The data in this chart has been adjusted to be in real 2020 dollars.

...but everything is local. In Brazil, biofuels dominate.

Brazil total light vehicle energy demand and ethanol share of total



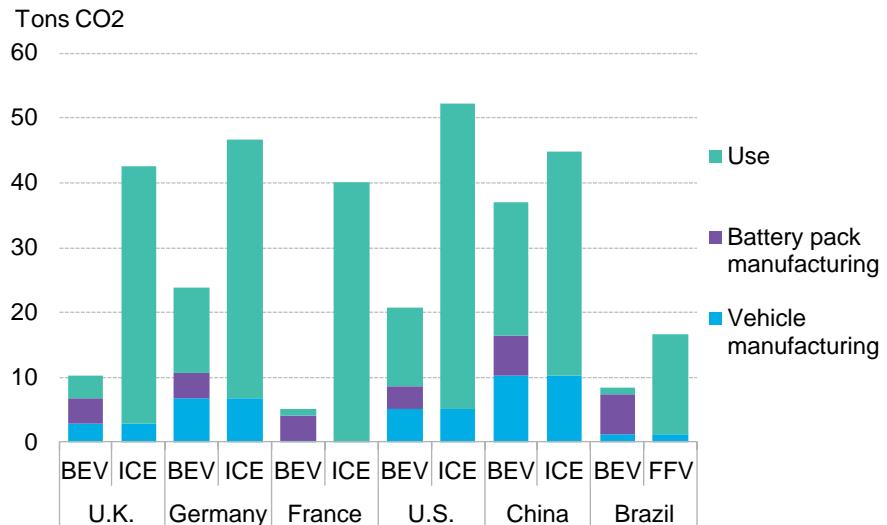
Source: BloombergNEF, EPE Análise de Conjuntura dos Biocombustíveis 2020

Comments

- Brazil's transport sector highlights how everything is local, even when enduring global policy and technology trends are at work. EVs will ultimately tend to be dominant everywhere as automakers have a strong financial incentive to push electrified models across their entire global footprint. Given its size, Brazil's car market will eventually be important for EV adoption globally. But, local characteristics mean Brazil's auto market could diverge from the global market for a long period of time.
- Specifically, the dominance of biofuels in Brazil is relatively unique. Brazil is the second largest producer of biofuels after the U.S. Around 85% of all new light vehicles sold run on a combination of ethanol and petrol (flex-fuel engines), two-thirds of its light passenger fleet is flex-fuel, standard gasoline is 27% blended, and ethanol's share of light vehicle total energy demand hovers near 50%. Diesel has a mandated 10% biodiesel blend.
- Additionally, electrification has been hampered to date by a lack of government commitment, high import taxes and opposition from a large and powerful biofuels lobby. Among the top 10 auto producers globally, Brazil also has a strong domestic auto manufacturing industry that makes FFVs for the national market. Several are pursuing development of 'flex-fuel engine EVs' that would integrate biofuels, a relatively unique path globally.

Brazil EV emissions are half those of flex-fuel vehicles

Lifecycle CO₂ emissions of ICE, FFV and BEV produced in 2020 and used for 250,000 km



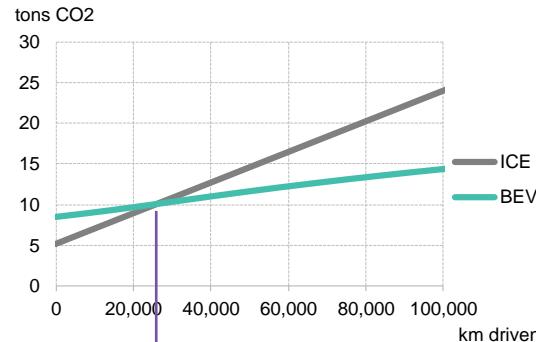
Source: BloombergNEF, ICCT. Note: FFV is flex-fuel vehicle. The tailpipe emissions of ethanol are considered to be zero gCO₂/km as this carbon is considered to have been sequestered in the production phase. Share of ethanol in fuel is 48%. Not considered are land-use change emissions, considered a major contributor to the overall CO₂ emissions of biofuel growth scenarios, particularly where additional land used to grow biofuel feedstocks has high stored carbon.

Comments

- Biofuels and electrification are both potential ways to reduce CO₂ emissions from the transport sector. Given their dominance in Brazil, biofuels are likely to stick around in Brazil's transport mix, where they can be considered both a path to lower emissions and a barrier to electrification. This stems from the fact that FFVs compare favorably with ICEs in other markets in terms of emissions, but fare much worse in comparison with EVs in their home market.
- Given the low emissions intensity of Brazil's grid, EV charging there is much lower emitting than ICE vehicles burning fossil fuels. We estimate the lifecycle CO₂ emissions of a medium-segment BEV produced in 2020 and used for 250,000 km to be between 38-85% lower than those of equivalent ICE vehicles in the six countries shown here. For Brazil, the BEV emissions are around half those of an FFV.
- There is already a clear advantage present to incentivize EV charging versus ICE vehicle use from a carbon mitigation perspective. It is unlikely that any molecule-fueled vehicle (gasoline or ethanol, for example) could compete with EVs in lifecycle emissions with a clean grid, such as Brazil's. Further, ethanol's share of light vehicle energy demand was 48% in 2020, meaning that around half of fuel use remained gasoline.

Lifecycle CO₂ emissions of ICE and BEV produced in 2020 and used thereafter

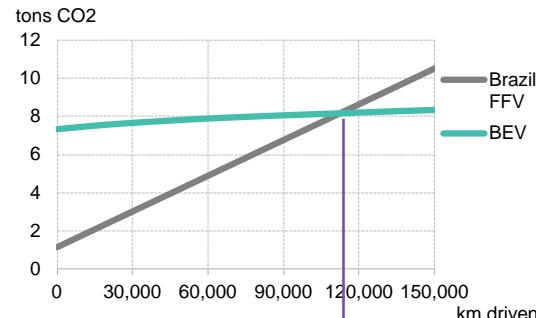
U.S.



- 1.5 years
- 27,000 km

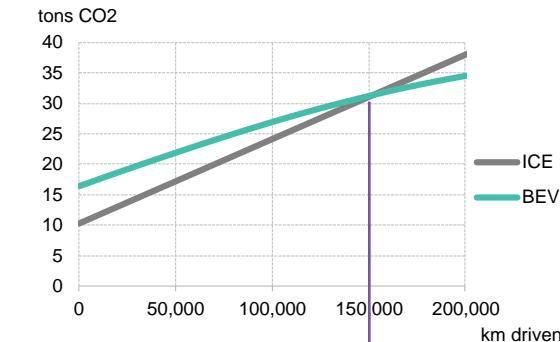
- Due to the low emissions intensity of Brazil's grid, BEVs are cleaner than in most other markets. However, the fact that ICEs are also cleaner in Brazil than elsewhere due to their substantial use of ethanol pushes back the point at which a BEV's lifecycle CO₂ emissions fall below that of an ICE vehicle. In Brazil, this point is reached after 108,000 km of driving, or 8.4 years.

Brazil



- 8.4 years
- 108,000 km

China

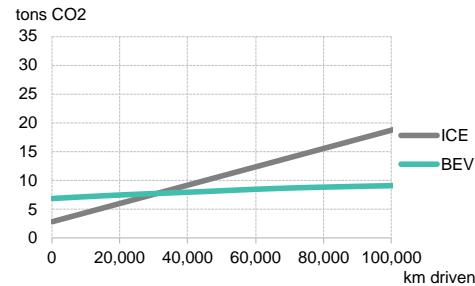


- 11.6 years
- 153,000 km

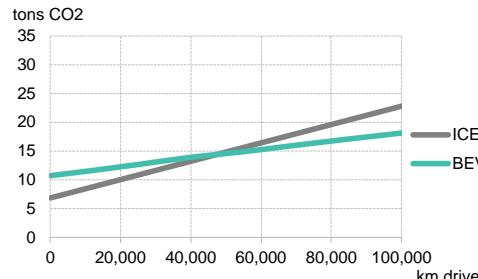
Source: BloombergNEF Note: we assume that cars are driven for some average annual distance (which differs between countries) and adjust the emissions factors to take into account grid decarbonisation; for Brazil we assume that the raw materials and the battery cells and pack are manufactured in China; for the U.S. and China the materials, cells and pack are manufactured domestically; the battery size of medium BEV is 71 kWh.

Lifecycle CO₂ emissions of medium segment ICE and BEV produced in 2020

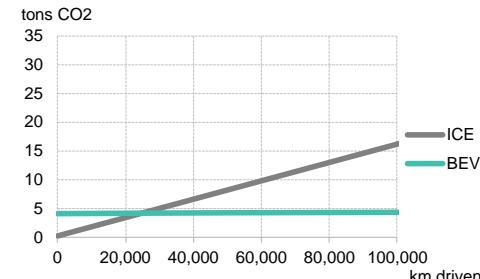
U.K.



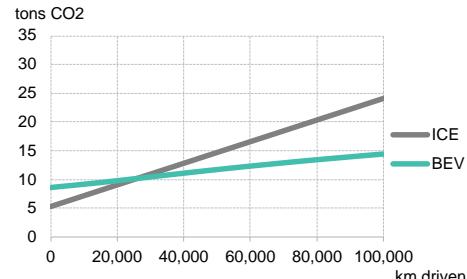
Germany



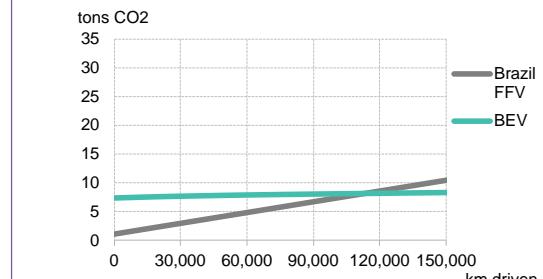
France



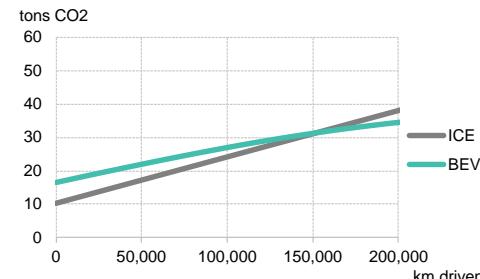
U.S.



Brazil



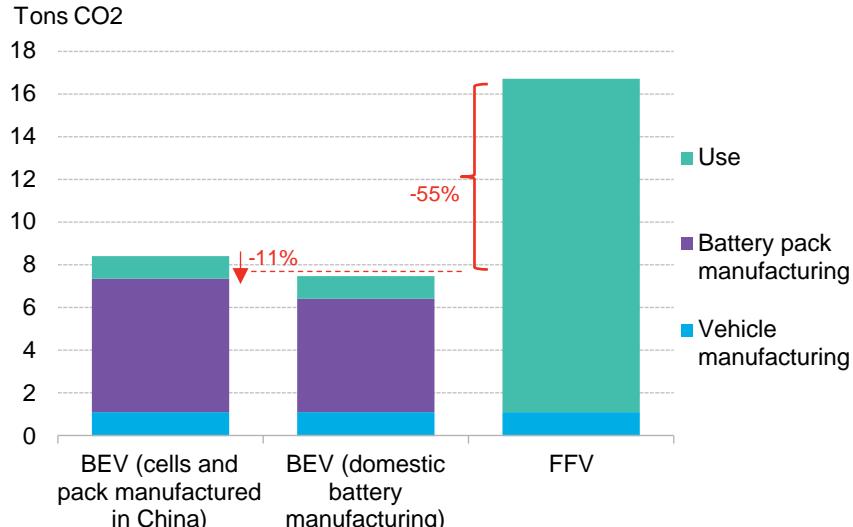
China



Source: BloombergNEF Note: we assume that cars are driven for some average annual distance (which differs between countries) and adjust the emissions factors to take into account grid decarbonization; for the European countries we assume that the raw materials and the battery cells are manufactured in Germany, while the pack is manufactured in the country where the vehicle is used; for the U.S. and China the materials, cells and pack are manufactured domestically; for Brazil the materials, cells and pack are manufactured in China; battery size of medium BEV is 71 kWh.

Domestic battery manufacturing could lower emissions even further

Lifecycle CO2 emissions of Brazil FFV and BEV produced in 2020 and used for 250,000 km



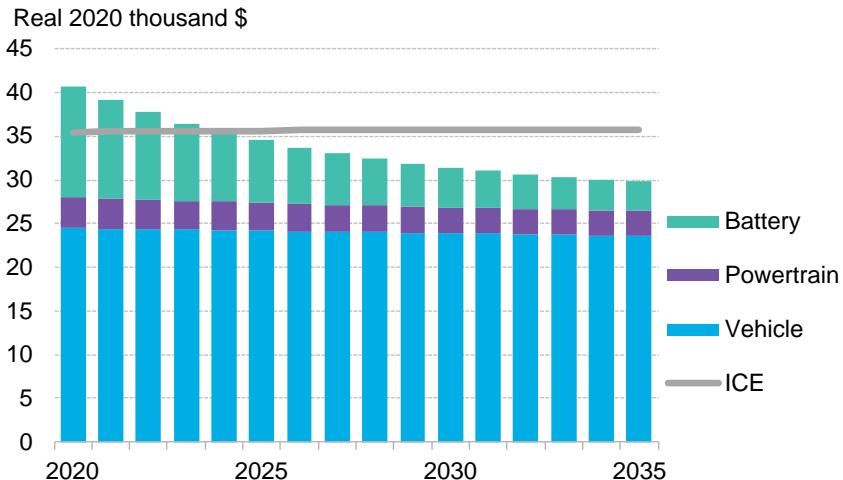
Comments

- As passenger EVs are imported in Brazil, the entire battery is also imported. With no large-scale plans to manufacture batteries domestically, our estimate of lifecycle CO2 emissions reflects an assumption that cell and pack manufacturing are done in China.
- However, producing batteries locally could lower the lifecycle CO2 emissions of a BEV. Given the low carbon intensity of Brazil's electricity, emissions from vehicle manufacturing and use of an EV are relatively minor. Battery pack manufacturing accounts for as much as 70% of the lifecycle emissions of a BEV imported from China and used in Brazil.
- We estimate that producing batteries locally could lower the overall CO2 emissions of an EV in Brazil by 11%, even if processing and refining of battery materials happens in China. This would bring the lifecycle CO2 emissions of a Brazilian BEV down to 7.5 tons of CO2, from 8.4 tons. A locally produced BEV would then have lifecycle CO2 emissions 55% below the 16.7 tons of CO2 generated by a local FFV, underscoring the importance of developing domestic EV manufacturing capacity and finding alternative applications for biofuels in Brazil.

Source: BloombergNEF, ICCT. Note: FFV is flex-fuel vehicle. The tailpipe emissions of ethanol are considered to be zero gCO2/km as this carbon is considered to have been sequestered in the production phase. Share of ethanol in fuel is 48%. Not considered are land-use change emissions, considered a major contributor to the overall CO2 emissions of biofuel growth scenarios, particularly where additional land used to grow biofuel feedstocks has high stored carbon. Battery manufacturing is for NMC (622) with cell and pack manufactured in Brazil (domestic) and in China.

Price parity is a long way off

SUV segment BEV and ICE pre-tax prices and share of battery cost in Europe



Comments

- Price parity between EVs and ICEs is the most important factor for mass market EV adoption. Falling battery prices allow EVs to reach up-front price parity with comparable ICEs without subsidies. Until EVs reach price parity, we expect their adoption to be limited in any given market.
- Globally, price parity is reached by the end of the decade in most segments and geographies. But there is a wide variation between geographies and segments. While BEVs in Europe and the U.S. will start achieving price parity for some segments as early as 2022, smaller vehicles in India do not hit parity until after 2030 due to very low average purchase prices in these segments.
- In Brazil's passenger vehicle market, price parity is likely a long way off. In emerging markets in Asia (India, Southeast Asia), we do not expect EVs to achieve upfront price parity with ICE vehicles in mass-market segments until around 2030.
- Brazil could follow a similar trajectory. The most-sold passenger vehicle in the country today, the Chevrolet Onix, a locally made FFV, retails for R\$63,430 (\$12,396), while the imported, entry-level all-electric Chevrolet Bolt has a price tag of 275,100 Brazilian reals (\$53,757), approximately 4.3 times more expensive.

- Availability of such low-cost ICEs, high import taxes, fossil fuel subsidies and the presence of alternatives like ethanol all ensure parity will not be achieved in the next few years. With limited national-level support for EVs in Brazil, automakers are unlikely to direct their new electric models there in the next few years. At the same time, domestic manufacturing of EVs, a likely route for automakers to eventually take in Brazil in order to circumvent high import taxes, is some years off.

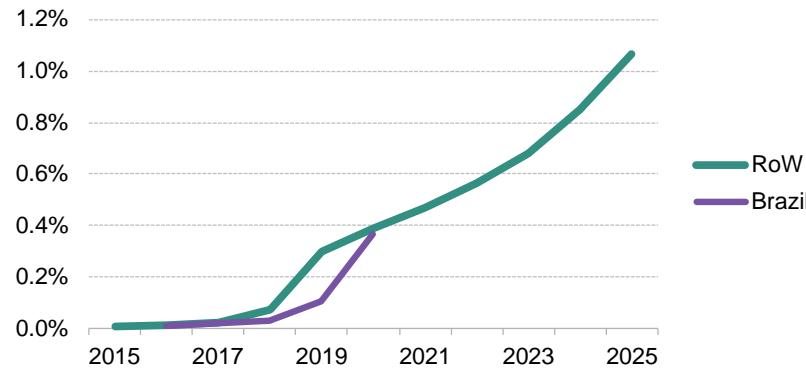
Source: BloombergNEF. Note: USDBRL 5.12 on July 30, 2021.

Policy and prices constrain near-term Rest-of-World adoption

Rest-of-World near-term annual passenger EV sales by drivetrain



Rest-of-World and Brazil historical near-term EV share of new passenger vehicle sales

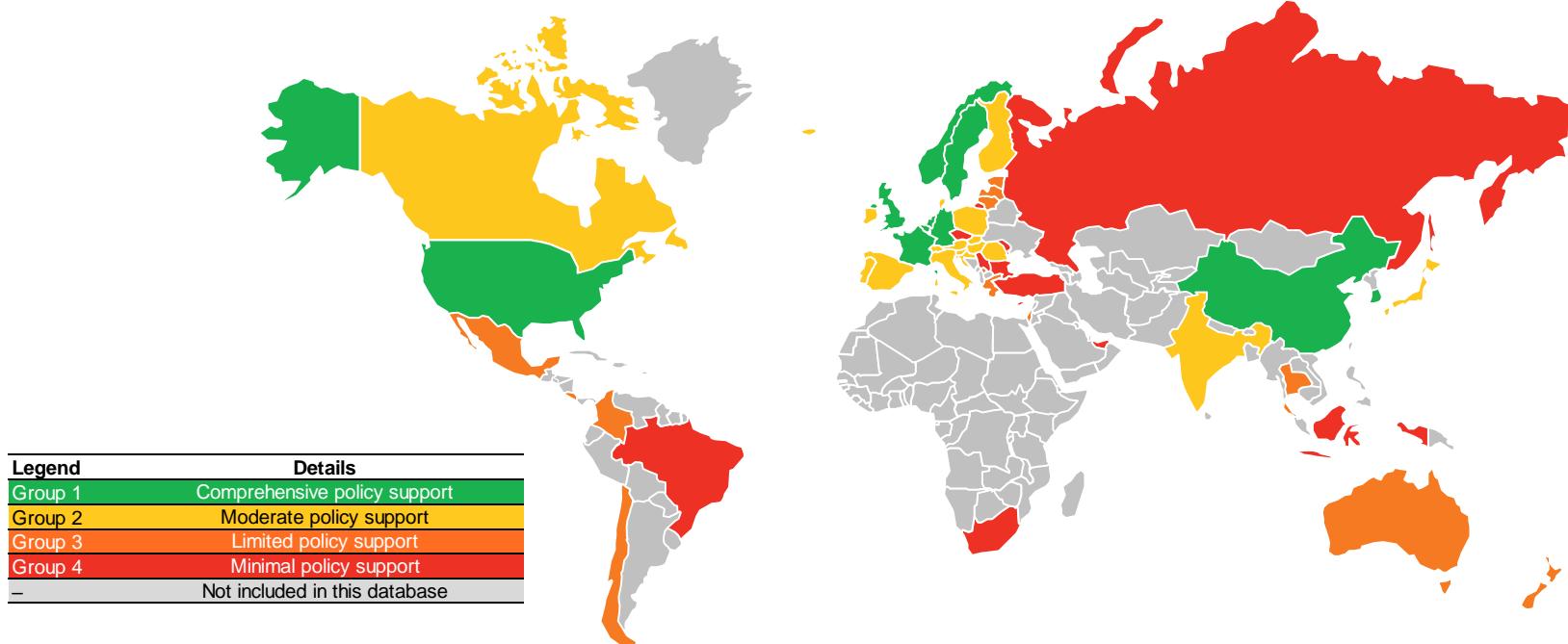


- In our outlook (EVO), markets that fall under our Rest of World (RoW) category – such as Brazil, Mexico, Russia, and Turkey – see some EV adoption, though generally much later and smaller than main EV markets. EV sales in RoW countries are forecasted to increase from just under 58,000 in 2020 to nearly 170,000 by 2025.
- Were Brazil EV sales to follow a similar path, they would grow to 17,200 in 2025, from 5,900 units sold in 2020. However, there are indications that the market is growing faster than this, with 1H 2021 sales in Brazil already equaling the 2020 total.
- EVs are set to surpass 1% of all passenger vehicle sales in these countries for the first time in 2025. At 0.4% in 2020, the share of EVs in new passenger vehicle sales in Brazil is roughly in line with the RoW average.

Source: BNEF Long-Term Electric Vehicle Outlook. Note: Countries included in RoW include markets in Latin America, Russia, Turkey and SE Asia. EV includes battery-electric and plug-in hybrid electric vehicles.

Minimal policy support for EVs

Policy support for EVs and EV charging infrastructure around the world



Source: BloombergNEF Global EV and EV Charging Infrastructure Policy Database

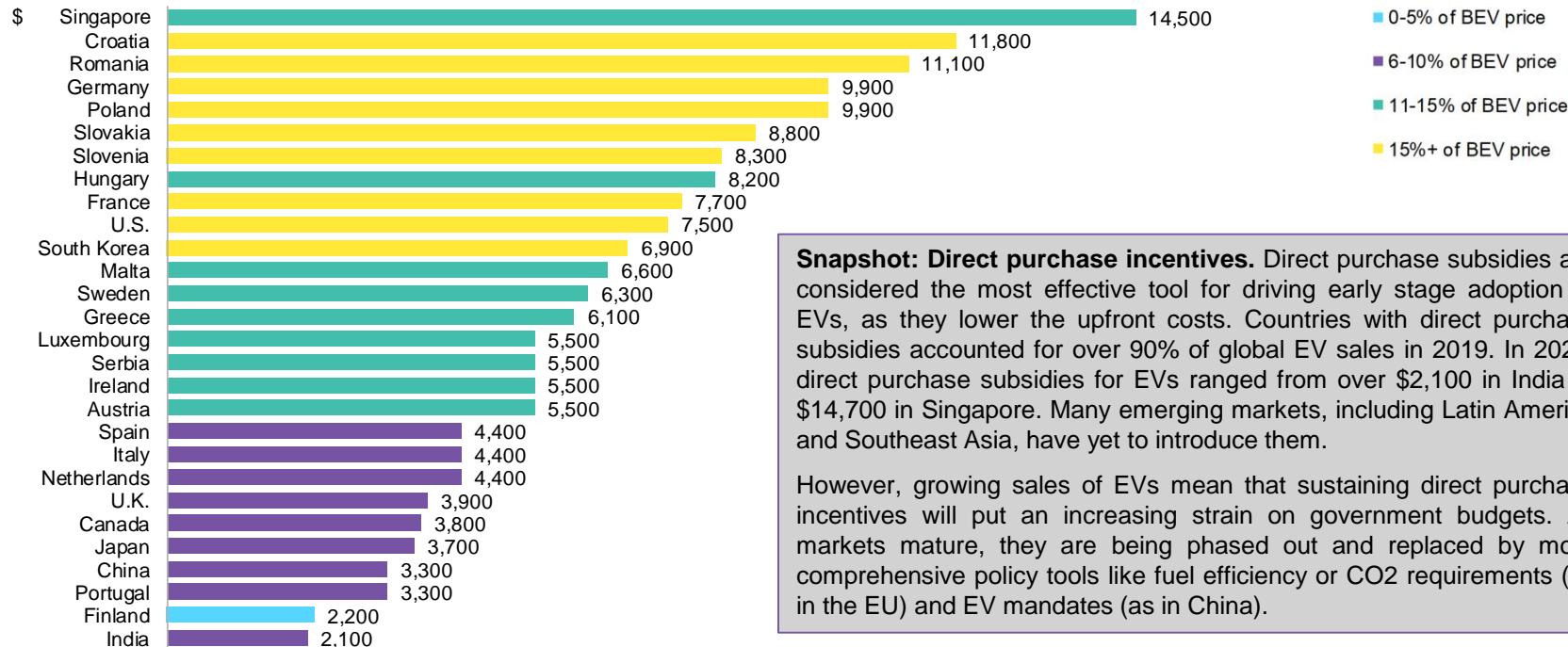
Transport policies

Policy	Status	Start date	Technologies	Details
Rota 2030	● In force	2018	EV, hybrid electric vehicle (HEV), FFV	Approved in late 2018, Rota 2030 provides tax incentives for companies that improve the fuel efficiency of their light-duty vehicles (an energy efficiency program for heavy-duty vehicles was postponed until the 2027-2032 cycle). It also aims to foster innovation and local R&D. Under the scheme, the typical tax applied to industrial products and EVs, HEVs and FFVs was lowered by at least 3%. However, the actual tax paid depends on the vehicle's weight. As a result, EV manufacturers argued taxes on EVs are still higher than for FFVs.
Import tax reduction	● In force	2015	EV, HEV	On October 2015, import tax rates were lowered from 35% to 0% for BEVs, and set at a range of 0-7% for HEVs. However, EVs still pay higher IPI (federal excise tax) and ICMS (state sales tax) taxes.
Annual car ownership tax (IPVA)	● In force	2018	EV	In 2018, the IPVA (annual car ownership tax) was set at 4%. EVs are exempt in seven states (Ceará, Maranhão, Pernambuco, Piauí, Rio Grande do Norte, Rio Grande do Sul and Sergipe) and enjoy a reduced rate in Mato Grosso do Sul, Rio de Janeiro and São Paulo.
Circulation Restriction (Rodízio veicular)	● In force	2014	EV, HEV, FFV	Since 2014 EVs, HEVs and FFVs are exempt from vehicles' circulation restrictions in São Paulo. ICE vehicles are not allowed to enter the city during certain peak hours, depending on the final numbers on their license plates (vehicles with final plate numbers 1 or 2 can not enter the city on Mondays, 3 or 4 on Tuesdays etc.).
BNDES	● In force	2017	EV, HEV, FFV, fuel cell vehicle (FCV), NG	In January 2017, changes in funding lines were announced. As a result, non-polluting buses (EV, HEV, ethanol, FCV, NG) gained priority in access to BNDES funding from 2018.

Transport policies

Policy	Status	Start date	Technologies	Details
Sao Paulo municipal discount on property tax (IPTU)	● In force	2021	EV, HEV	<p>Sao Paulo municipal law that enables buyers of EVs and HEVs to offset a portion of their property taxes (IPTU) with the municipal share of annual car ownership tax (IPVA) paid. The law enables buyers to take advantage of the benefit established by an earlier law in force since 2014. The benefit has a low vehicle price limit of 150,000 Brazilian reals, which must be updated.</p> <p>Law 17,563/2021 reduces bureaucracy in the IPVA discount for EVs established with Law 15.997/2014.</p>
Sao Paulo municipal bus fleet emissions reduction target	● In force	2018	EV, HEV, FFV, fuel cell vehicle (FCV), NG	<p>Sao Paulo municipal law that established a schedule for the conversion of diesel buses into low-emission buses. The law sets 10-year and 20-year targets for fleetwide reductions in tailpipe CO2 and other emissions of 50% and 100%, respectively. It aims to cut emissions by 95% from 2016 levels by January 2038. Law 16.802/2018. The law was temporarily suspended in 2020.</p>
Sao Paulo municipal charging infrastructure	● In force	2020	Charging	<p>Sao Paulo municipal law that provides for the mandatory provision of a solution for charging EVs in new residential and commercial buildings (condominiums) in Sao Paulo city. Law 17.336/2020.</p>

Maximum national direct purchase subsidy available for passenger BEVs, 2020



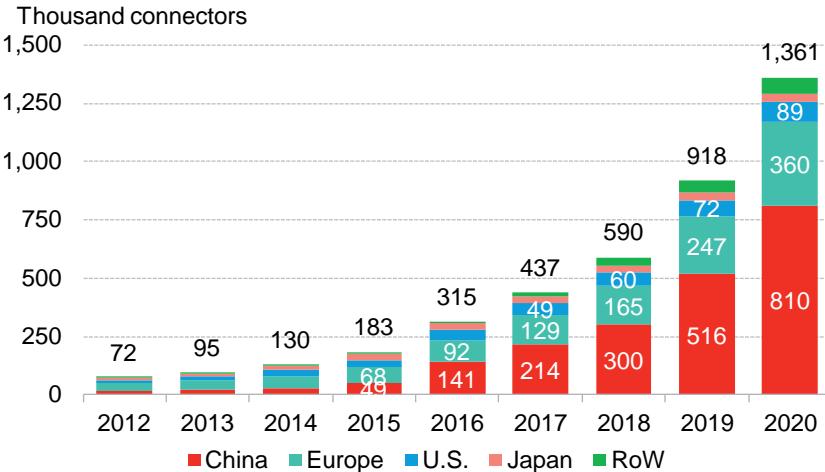
Snapshot: Direct purchase incentives. Direct purchase subsidies are considered the most effective tool for driving early stage adoption of EVs, as they lower the upfront costs. Countries with direct purchase subsidies accounted for over 90% of global EV sales in 2019. In 2020, direct purchase subsidies for EVs ranged from over \$2,100 in India to \$14,700 in Singapore. Many emerging markets, including Latin America and Southeast Asia, have yet to introduce them.

However, growing sales of EVs mean that sustaining direct purchase incentives will put an increasing strain on government budgets. As markets mature, they are being phased out and replaced by more comprehensive policy tools like fuel efficiency or CO₂ requirements (as in the EU) and EV mandates (as in China).

Source: BloombergNEF, respective government agencies. Note: Reference EV is the Tesla Model 3. Where unavailable, we used Hyundai Kona or other EV as a reference. Currencies were calculated using the average exchange rates for 2020

Public charging infrastructure is limited

Global cumulative installed public charging connectors



Snapshot: Public charging. China continues to be the global leader on public charging. China's push for public charging installations is partly driven by a lack of home and workplace charging options. Home and workplace charging dominates in Europe and the U.S., while in China, the adoption of private infrastructure is lower.

Comments

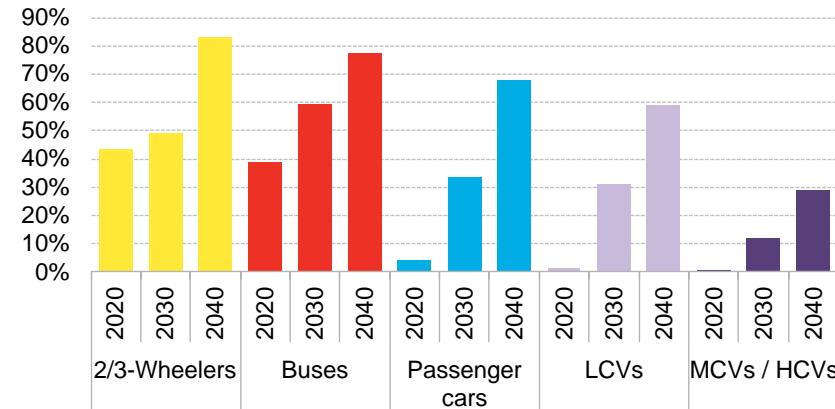
- Globally, there were over 1.36 million public charging connectors at the end of 2020, a 48% increase from 2019.
- Public charging infrastructure is very limited in Brazil, with the number of public chargers estimated to be just 754. This translates into 12.9 EVs per public connector at the end of 2020.
- Globally, there were 7.4 EVs per public connector at the end of 2020. The ratio varies widely across countries, with 5.4 EVs per public connector in China and just 3 EVs per connector in the Netherlands. Norway has the highest ratio of EVs to public chargers, at 25:1.
- Differences can be explained by the prevalence of detached houses, and therefore home charging availability, the power of chargers and utilization of infrastructure, which reduces the need for additional infrastructure as the electric vehicle fleet grows. In Brazil, as an early EV market dominated by luxury vehicles far from price parity, most EV owners likely have installed home charging options, estimated to be around 50%.
- Government-provided financial and legal support for charging infrastructure deployment has proved critical in many markets. A number of governments have announced multi-billion-dollar support packages for the sector while also setting charging deployment targets.

Source: BNEF

Other segments may be the biggest near-term opportunity in emerging economies

- Electrification is spreading to other segments of road transport. There are over 1 million commercial EVs – including buses, delivery vans and trucks – and there are over 260 million electric mopeds, scooters, motorcycles and three-wheelers on the road globally. Other segments of transport are already much further along on EV adoption. Some 44% of global two- and three-wheeler sales and 25% of the existing fleet are already electric.
- The bus market continues to electrify quickly. There are almost 600,000 e-buses on the road globally, representing 39% of new sales and 16% of the global fleet. While China accounted for the vast majority of all e-bus sales in 2020, and continues to account for 98% of the global e-bus fleet, other markets around the world are beginning to scale up the deployment of e-buses.
- Much of this is at the city level. Spurred on by targets in the 2030s and 2040s, big cities and regions are planning to ensure that their fleets make the transition. Over 35 cities have pledged to procure solely e-buses after 2025 as signatories of the C40 Cities Fossil-Fuel-Free Streets Declaration, including Rio de Janeiro, Mexico City, Santiago, Bogota, Medellin and Quito.

Global EV share of new vehicle sales by segment



Snapshot: Long-term EV adoption by segment. Buses and two- and three-wheeled vehicles achieve the highest EV adoption rates globally by 2040 in our outlook (EVO), followed by passenger cars, then light commercial vehicles. By 2040, there are over 600 million passenger EVs on the road and over 750 million electric two-and three-wheelers.

Source: BNEF Long-Term Electric Vehicle Outlook 2021 (EVO)

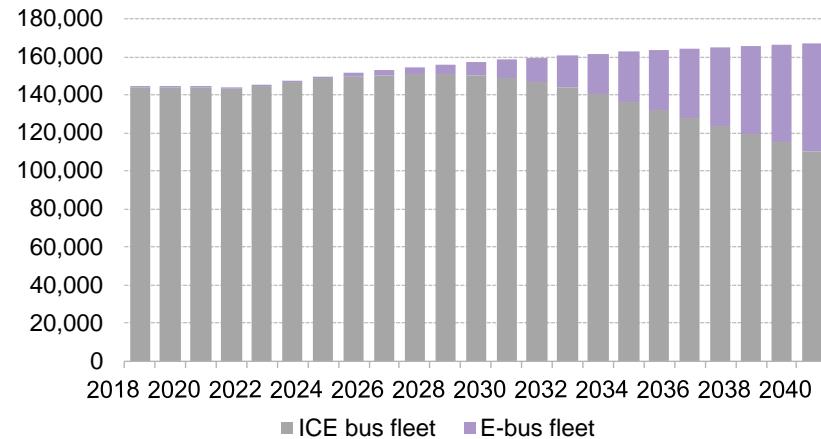
E-buses: large opportunity, but a long way to go

Comments

- In Latin America, e-bus activity shows signs of ramping up. The region's e-bus fleet in 2020 was nearly 2,000 units. The largest markets are Chile (789) and Colombia (588). It is projected to grow to over 11,600 units by 2025 in our outlook (EVO). Key efforts behind this include Chile's call for a 100% electric fleet by 2040 and Colombia's 2019 Electric Mobility law mandating 30% of all purchases or leases for public transport must be electric through 2025.
- Brazil hosts e-bus chassis and battery manufacturing capacity, but e-bus orders in Brazil remain negligible to date, even by regional standards. There are around 48 battery e-buses in operation largely due to municipal pilots in Sao Paulo, Campinas, and Brasilia.

Snapshot: The economics of e-buses. The economics of e-buses will improve steadily over the next 20 years. By the second half of the 2020s, e-buses begin to reach upfront cost parity with their diesel counterparts in some countries, but this takes until the 2030s in many emerging economies where there are very low-cost diesel options available. E-buses on routes requiring larger battery packs also take longer to reach parity. The total cost of ownership, however, is competitive within the next 3-5 years in many markets.

Brazil municipal bus fleet by powertrain



- Brazil's municipal bus fleet numbers over 140,000 units and is primarily diesel. Our long-term e-bus adoption forecast suggests its e-bus fleet could grow to nearly 10,000 units by 2030, or around 6% of the fleet. By 2040, it grows to over 55,000 units, or around one third of the fleet.

Source: BNEF Long-Term Electric Vehicle Outlook 2021 (EVO), E-bus Radar

Summary: Power sector is clean, transport needs attention

Opportunities

Clean power sector and expected to get cleaner

Brazil's power sector is clean, which is favorable for electrifying transport. EVs will charge (and eventually be manufactured) with clean power, lowering lifecycle CO₂ emissions and leading to a growing emissions gap with conventional vehicles (ICEs and FFVs). EV emissions fall further as renewable generation rises.

Established clean power investment and policy environment

A pioneer of renewable auctions, Brazil offers an open investment environment with which domestic and international renewables investors are comfortable and a diverse financial landscape. It has deep experience in support for new industries.

Large potential for impact in transport as costs fall

Emissions from transport are double those from the power sector and are growing. In countries with clean grids, every ICE replaced has a disproportionate impact on emissions. Growing scale will push down battery and infrastructure costs for emerging markets, reducing investment needs and bringing forward price parity with ICEs. Displaced biofuels offer a complementary path for hard-to-abate sectors.

Large, polluting public transport and urban fleets are ripe for disruption

Brazil's large, diesel bus fleet represents an opportunity for impact, as do urban commercial and passenger fleets. E-buses are a segment that is further along on adoption globally and often led at the city level. Brazil hosts e-bus chassis and battery manufacturing, but lags neighbors Chile and Colombia in adoption.

Challenges

Domestic auto manufacturing industry

Brazil has a large auto manufacturing industry and FFVs enjoy more incentives than EVs. Limited support will discourage automakers from focusing on Brazil and high import taxes discourage consumers from purchasing EVs. With no large-scale plans to manufacture EVs or batteries domestically, the market will remain dependent on imports, preserving the price gap with ICEs.

Limited policy support for electrification

Electrification is hampered by a lack of government commitment. Direct subsidies that lower the upfront costs of EVs are unlikely to be adopted. Policies that target the supply side, such as fuel economy standards, EV mandates, or bans on sales of ICEs may eventually be the preferred route, but are not under discussion. Policy may continue to support ethanol as an alternative.

Biofuels are deeply entrenched

Biofuels lower emissions but act as a barrier to electrification. While FFVs beat ICEs on emissions, they compare poorly with EVs. Biofuels are likely to remain in the transport mix for some time. To preserve a role for them, automakers may pursue development of 'flex-fuel engine EVs', a unique path globally. Optimizing the route to net zero could mean electrifying all passenger cars and redirecting biofuels to sectors with no other easy decarbonization pathway.

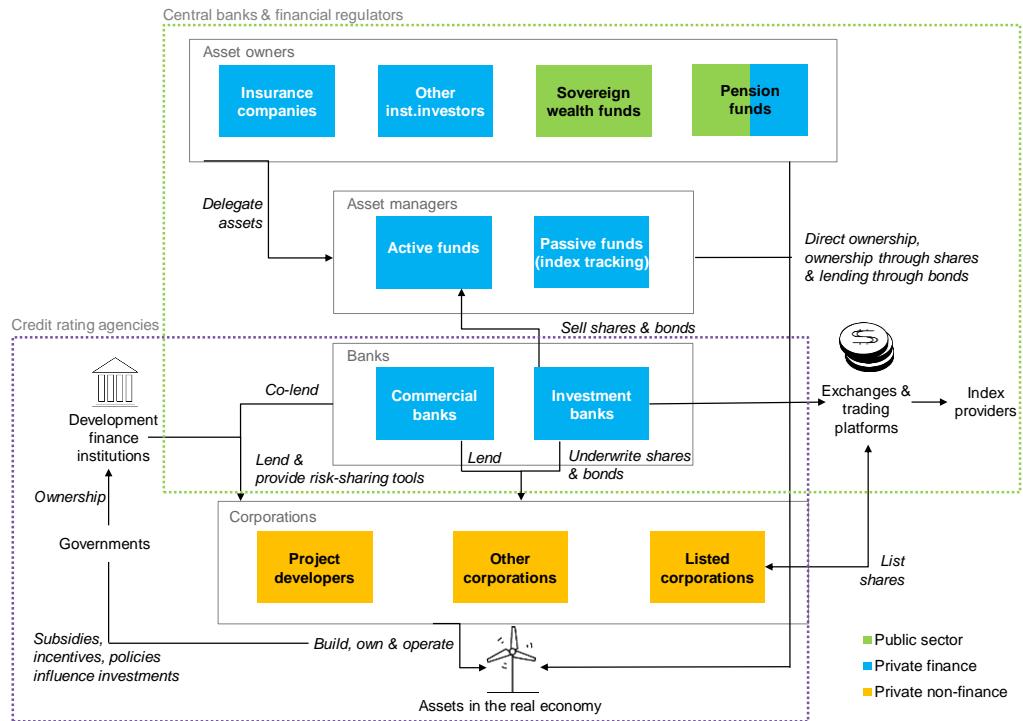
EV market is concentrated in luxury vehicles, price parity is years away

Brazil leads the region in EV sales, but growth has been concentrated in luxury vehicles. Price parity in the passenger vehicle market is likely a long way off. Public charging network will remain limited as most EV owners are likely to have installed home charging.

Financial ecosystem, capacity and financing needs

Brazil

All segments of the investment chain are activated in Brazil



Source: CFLI, BloombergNEF.

Brazil's financial market is deep, diversified and mature

Investment chain representation

Entities	National	International
Asset owners	● Active	● Active
Asset managers	● Active	● Active
Banks	● Active	● Active
Corporations	● Active	● Active

BNEF Take: Intermediation in focus

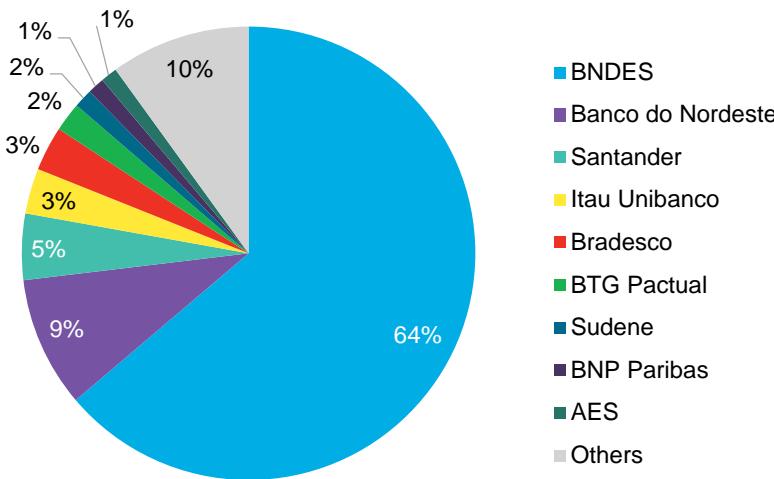
Brazilian and international markets have historically been able to provide most of the energy transition investment required. Brazil's domestic development banks, historically BNDES but more recently Banco do Nordeste, have been the primary sources of long-term funding, but lenders such as the IDB, World Bank and KfW have also played an important role.

Source: BloombergNEF.

- The Brazilian financial sector is mature, with all major actors in the investment chain activated and active in energy transition investment. Brazil's domestic development banks have historically played a dominant role in supplying long-term finance to industry and infrastructure, including clean power projects.
- Investment opportunities are overwhelmingly in the Brazilian real, potentially exposing international investors to exchange rate risk.
- Sustainable debt instruments have grown recently, but there is plenty of room for expansion. Brazil issued less than half the volume issued by Chile, a much smaller market, in 2020.
- The Brazilian bank association FEBRABAN supports domestic players in the adoption of recommendations by the Task Force on Climate-Related Financial Disclosures (TCFD).
- Investors are comfortable with established clean power technologies such as solar PV and wind. For less established technologies, such as energy storage, the private sector tends to be more active in the early stages.

Brazil's lead arrangers in renewable energy are largely development banks

Brazil top clean energy lead finance arrangers, 2011-20



Source: BloombergNEF. Note: BNDES, Banco do Nordeste and Sudene are public development banks or agencies. BNDES stands for Banco Nacional de Desenvolvimento Econômico e Social, Sudene stands for Superintendência do Desenvolvimento do Nordeste. Note: exchange rate on December 31, 2020: 5.19 BRL/USD

- The most active players in financing clean power in Brazil are domestic development banks, with the top lead arrangers being Brazilian public banks BNDES, Banco do Nordeste, Sudene and others. BNDES ranks as the top lender to clean energy globally, having disbursed nearly \$20 billion (excluding large hydro) over 2011-2020, mainly through term loans.
- However, recent changes to BNDES' methodology to calculate interest rates mean these are now slated to increase gradually for new loans through 2023, until they reach par with commercial levels. Accordingly, we expect BNDES' contributions to fade somewhat as other entities assume a more prominent role. Nevertheless, BNDES continues to play an outsized role in the renewables industry and was responsible for 64% of loans over 2011-2020, while Banco do Nordeste and Sudene accounted for 9% and 1%, respectively.
- In 2020, BNDES launched a new credit line aimed at supporting the transport sector, Finame – Low carbon, focused on financing low carbon equipment, including buses and trucks.
- BNDES provides sustainability-linked loans for biofuels producers in the context of national biofuel policy RenovaBio, with benefits linked with reduction of emissions.
- BNDES reports that 11% of its total investments in 2020, or 7.4 billion Brazilian reals (\$1.4 billion), went to the "green economy." The bank reports investing 22% of that in "cargo and public transport."

The local financial sector offers most of the necessary instruments for renewables

Financial sector maturity

Indicator	Value
Domestic banks' credit to private non-financial sector	23.9% of GDP
Domestic credit to private sector	70.2% of GDP
Lending interest rate	29.0%
Stocks traded, total value	95.1% of GDP
Turnover ratio of domestic shares	87.5%*
Depth of credit information index (0=low, 8=high)	8*
Strength of legal rights index (0=weak, 12=strong)	2*

Source: Bloomberg Terminal, World Bank. *Note: 2019 data.

Key characteristics

Debt:

- Debt instruments such as loans are accessible from domestic commercial and public banks. Foreign commercial banks also lend in large volumes. Supply has remained largely stable despite the Covid-19 pandemic.
- Access to public, domestic concessional debt was vital to kick-starting Brazil's renewables market and remains key. Debt available to finance renewable projects has longer tenors and lower interest rates than market instruments, but equipment typically must be produced locally.

Equity:

- Equity funding has been largely unaffected by Covid-19 and comes from a diverse range of domestic and international investors, including conglomerates, developers, institutional investors and private equity.

BNDES plays a key role to finance e-truck value chain

- **Domestic equipment finance**

BNDES Finame – Low carbon, a credit line launched in 2020, is aimed at supporting procurement of low carbon equipment, including in the transport sector (e-buses and e-trucks, hybrids and drivetrains using biofuels exclusively). Eligible goods also include wind and solar generation equipment and other machinery to reduce carbon emissions. Equipment must be produced locally. The program offers longer loan tenors, up to 10 years. Typically, comparable loans for trucks may have tenors of around five years.

- **E-truck national manufacturing**

In December 2019, BNDES approved a loan of 88.6 million Brazilian reals (\$17.1 million) to finance development of Volkswagen's locally manufactured electric truck line, the VWCO e-Delivery, in Resende, Rio de Janeiro state, representing 80% of the total investment made by the company.

Volkswagen starts commercial production of its national e-truck, the e-Delivery, in 2021. The vehicles will be eligible for BNDES Finame Low Carbon credit line as it is produced locally. Ambev, Coca-Cola and JBS have procured units from the company. Volkswagen announced it aims to invest 2 billion Brazilian reals in production of trucks and buses over 2021-25 in the country.

- **Corporate commitments**

AB InBev, the world's largest brewer, aims to procure 1,600 e-trucks in Brazil by 2023. In the near-term, the company plans to kick off with operation of 200 e-trucks, focused on urban distribution. AB InBev started a pilot program in 2018 to test the logistics of e-trucks on shorter routes in São Paulo city. By 2025, it aims to cut emissions across its Brazilian value chain by 25% and procure 100% clean energy. Major retailers in Brazil, such as supermarket chain Pão de Açúcar and retailer Lojas Americanas have also made firm commitments to add electric vehicles to their operations, beginning with urban delivery.

Cheaper credit lines for EV buyers

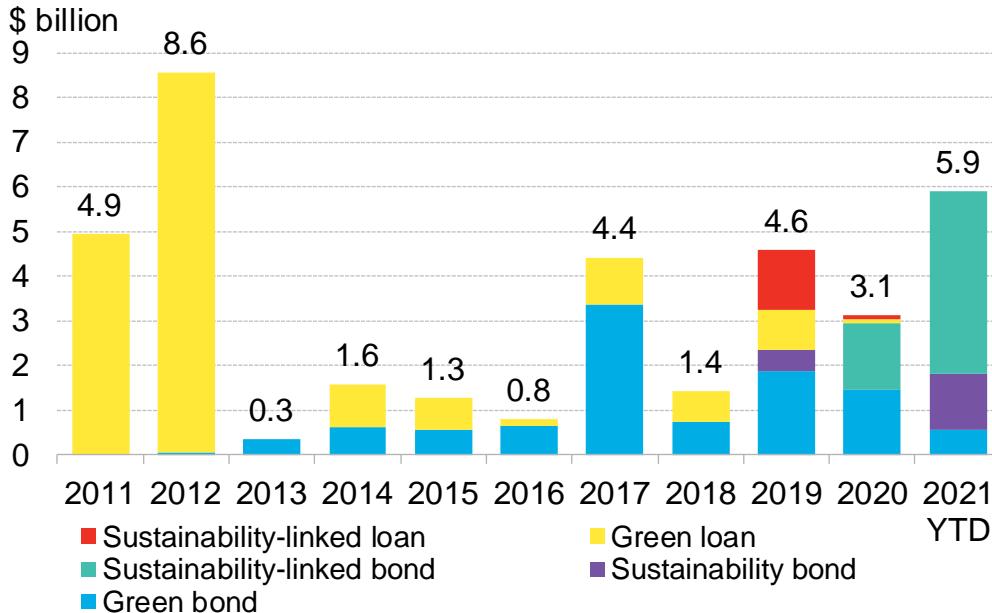
- **Special credit lines for EVs**

Santander and Itaú Unibanco banks have created dedicated credit lines to finance passenger EVs for the end-consumer under more competitive conditions than conventional vehicles. In November 2020, Santander announced a special line starting at 0.77% per month, or 9.64% per year, to be paid in 24 or 60 installments. Prior to that, Itaú Unibanco had announced in July 2019 a credit line starting at 0.79% per month, or 9.9% per year.

For ICE vehicles, Brazilian Central Bank reports interest rates starting at 0.97% per month, or 12.2% per year. Banks can finance ICE vehicles with tenors of up to 72 months.

Brazilian sustainable debt market maturing

Brazil sustainable debt issuance, by instrument

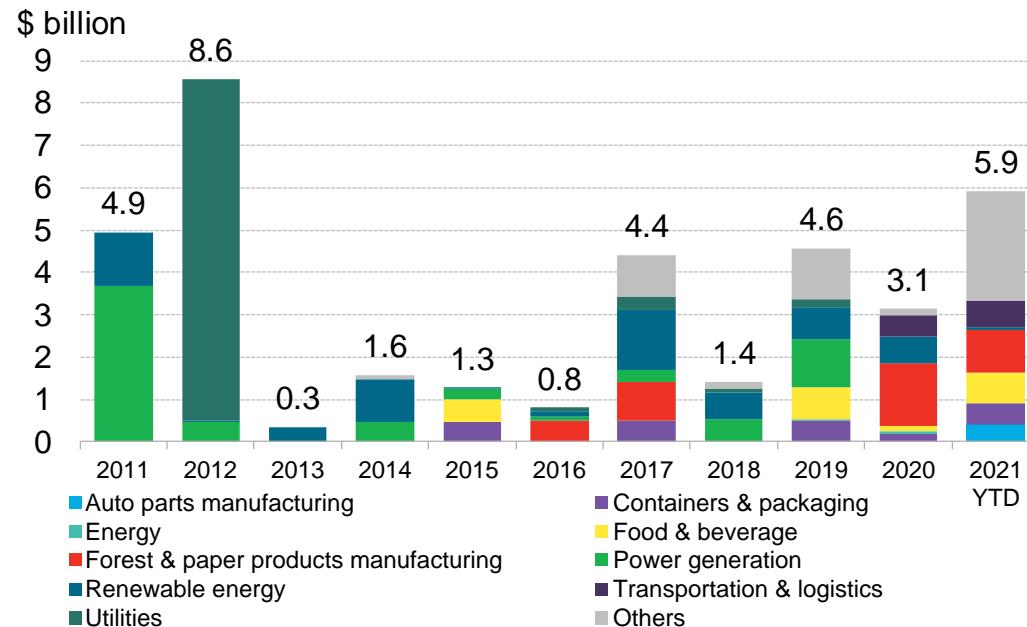


Source: BloombergNEF

- Brazil's sustainable debt issuance is maturing and shows signs of expansion. As of July 2021, the market had issued \$5.9 billion, almost double the volume issued in the previous year.
- Sustainability-linked bonds and sustainability bonds have grown in the past few years and comprise 90% of year-to-date issuance. Meanwhile, green bonds have declined in volume and comprise just 9% of 2021 issuances year-to-date.
- The largest issuances this year include paper manufacturer Suzano and cosmetics producer Natura, both at \$1 billion.
- In 2021, [BNDES launched a Sustainability Bond Framework \(SBF\)](#) with support from IDB, designed to expand funding options established under its Green Bond Framework (2017). Funds will be used to finance and refinance new or existing projects in the BNDES's portfolio across six green and three social categories (including clean transport).

Growing diversification by industry

Brazil sustainable debt issuance, by industry



Source: BloombergNEF

- The growing diversity of issuers by sector is an important trend in evidence since 2018.
- Sustainable debt has expanded from concentration in the power industry a decade ago, to sectors such as forest & paper, food & beverage, consumer products and others in recent years.
- Transportation & logistics and auto parts manufacturing debuted in the market in 2020. Last year, these two sectors accounted for 16% of sustainable debt issuance.
- The first transportation green bond was issued by Cosan for its railway business, Rumo. The capital will be used to procure new locomotives and invest in infrastructure to improve carbon emissions.
- Two other deals were sustainability-linked bonds issued by auto parts manufacturer Iochpe-Maxion and transportation and logistics company Simpar, both in 2021 and linked with carbon emission reduction efforts.

Summary: limited impact on electrifying of transportation to date

Opportunities

Strength of local and international financial sector

Brazil's financial ecosystem is developed and generally well positioned to finance new transportation initiatives via a variety of entities and instruments. Moreover, the ability to tap into international markets opens up further financing opportunities. The Brazilian EV market is still in its infancy and will require substantial and varied resources.

Domestic development banks' vital role to spur new technologies

Brazil's development banks are committed to green funding and played a crucial role in kickstarting the country's renewables market and associated supply chains. Their activity is increasing in the transportation sector, which will support electrification.

Financial sector maturity

Brazil's significant experience in terms of financing renewables, should, in time, benefit energy transition investment in other areas as well, including electrification of transport.

Challenges

Lack of dedicated financing options for electrified transport

The current suite of financial products are almost universally designed for "low carbon" transportation (ie. to include biofuels) and promotion of local industry, rather than to specifically promote electrifying transport. As a well-established segment of the economy, the biofuels industry is better placed to access finance compared to earlier stage EV activity.

Room for growth in sustainable credit

Brazil has substantial room for growth in development of its sustainable credit market compared to other markets in Latin America. Chile, for instance, issued more than double the volume of green bonds issued by Brazil in 2020. There is a lack of sustainable debt linked to EVs. Advanced sustainable debt regulation and a deeper market could increase opportunities to invest in assets that fulfil corporate ESG mandates.

Forex risk hinders access to international goods and capital

Rising costs of goods and capital associated with imported equipment and heavy depreciation of the Brazilian real represents a barrier to planned investments in EVs at the commercial level. At the consumer level, the market is price insensitive and concentrated in luxury vehicles.

Leveraging intermediaries to accelerate the energy transition

Brazil

Brazil has most necessary prerequisites in place to scale intermediation

- The success of Brazil's renewables market underscores the extent to which it has the necessary market fundamentals in order to attract energy transition investment. Brazil has the largest power market in Latin America and its size, resources and conducive policies have made it the region's main renewable energy market and one of the top 10 in the world. In the past decade, Brazil has attracted over \$65 billion of new clean energy investment, nearly half of the regional total and one of the highest volumes among emerging markets. This has been supported by policies such as auctions and net metering.
- The key drivers of clean power investment in Brazil are relevant to transport. As transport rises among Brazil's emission reduction priorities and the current narrow focus on biofuels expands in the coming years, investment in electrification may benefit from similar market fundamentals.
- **Acceleration opportunity:** meeting growing demand for solutions that deliver fleetwide reductions in emissions and the necessary infrastructure offer investment opportunities in the near-, medium- and long-terms. Exploring further capital market options to finance electric buses and urban commercial and passenger fleets, in addition to supporting charging infrastructure and exploring alternative applications for biofuels for hard-to-abate sectors within and outside of transport, offer multiple avenues for new investment.
- In the financial sector, clear investment rules, a diverse setup of public and private banks and non-bank financial companies, and a variety of debt and equity instruments have provided financing for renewables and may do for electrified transport.
 - **Acceleration opportunity:** Activity in electrified transport is early and commercial and technology risk remains an impediment to securing capital. Capital needs for electrification of transport projects may be unmet. Sustainable debt issuance remains below expected levels. Making greater and flexible use of financing instruments such as bonds could offer opportunities to access larger volumes of investment.

Action area 1: Support municipal bus fleet emissions reduction targets

Given Brazil's large diesel-powered municipal bus fleet, e-bus pilot initiatives in several cities, and concrete 10- and 20-year targets for fleetwide emissions reductions in São Paulo, the region's largest metropolis and bus fleet, Brazil must begin scaling up e-buses in the near term. Though Brazil hosts e-bus chassis and battery manufacturing capacity, it lags neighbors Chile and Colombia, which have deployed hundreds of e-buses. Urban air quality concerns and city decarbonization goals will accelerate bus electrification in the coming years.

Investment opportunities

- Domestic and international financial intermediaries can play a role in supporting the acquisition of e-buses, a technology that is proven in the region but at the early stages of ramping up. Latin America's e-bus fleet in 2020 was nearly 2,000 units, but e-bus orders in Brazil remain negligible to date. This may be poised to change. A 2018 São Paulo municipal law established a schedule for the conversion of diesel buses into low-emission buses, setting 10- and 20-year targets for fleetwide reductions in emissions of 50% and 100%, respectively. The city's fleet consists of over 14,000 diesel buses. The law was temporarily suspended in 2020.
- Given the higher upfront cost of e-buses relative to diesel, DFI funds could be valuable to support, or as an alternative to, domestic sources of funding. For example, Brazil hosts e-bus chassis and lithium iron phosphate battery manufacturing capacity, established by Chinese manufacturer, BYD Brasil, and accredited by BNDES' FINAME facility in 2020. FINAME resources are earmarked for financing the purchase of Brazilian equipment and enables finance up to 80% of the value of the bus, for up to 10 years, with a 2-year grace period. Non-accredited equipment would not be eligible for this.

Enabling environment opportunities

- Technical assistance can help strengthen the financial health of public transportation operators. Covid-19 has imposed severe financial difficulties on fleet operators. Reduced ridership, fare losses, higher costs associated with cleaning and sanitization and slashed public budgets have contributed to losses and prompted operational restructurings and cost cutting. Rising costs of e-buses associated with imported equipment and heavy depreciation of the Brazilian real has further deterred planned investments in e-buses and new market entrants.
- Technical assistance around development of new business models could be valuable, including, for example, separation of asset ownership and operation and maintenance, which all lie with the transport operator. The entrance of other players, including from the power market for example, could be encouraged to hold ownership of assets and/or support vehicle finance. This approach has been used elsewhere in the region.
- DFI support could be useful to draw investment to or help domestic intermediaries gain familiarity with lending to supportive areas such as optimizing charging infrastructure, digitalization, and fleet management and operations.

Action area 2: Scaling up commercial EV fleets

High circulation, urban commercial fleets offer an opportunity for near-term impact in Brazil, across delivery, transport and shared mobility vehicles. Though taxi, ride-hailing and car-sharing demand was hit hard by Covid-19, delivery businesses benefited from lockdowns. A recovery in urban passenger services will coincide with rising levels of e-commerce which will support demand for delivery vehicles, including vans and smaller trucks in the light commercial segment.

Investment opportunities

- Financial intermediaries may play an important role in raising and deploying funds for investment in electrification of commercial fleets, with a focus on urban duty cycles. Ride-hailing companies, as well as large commercial fleet owners are pursuing electrification and will be initial adopters in Brazil. According to our total cost of ownership (TCO) analysis, in urban duty cycles, battery electric trucks of any size become the cheapest option for several use cases in the 2020s and for some use cases, such as delivery vans, the TCO of all-electric vehicles is already the lowest.
- DFI funds could be valuable in supporting smaller and mid-size companies to make larger required investments. Larger companies are more likely to have the financial capacity to accommodate the higher upfront cost of electric trucks, vans and cars relative to diesel options. In addition, they can better optimize the deployment of charging infrastructure. Some large corporations have made strong commitments to decarbonize their operations.
- BNDES may become a primary provider of capital to corporations buying vehicles in some segments, but international intermediaries with a focus on ESG can be valuable players in raising funds to support new electrification projects where domestic funding is unavailable or inadequate.

Enabling environment opportunities

- DFI support may be needed for some players in the market to access traditional means of capital where domestic and international intermediaries are not familiar with transport electrification technologies. DFIs could especially assist smaller- to mid-sized owners and operators of commercial fleets in their first bond issuance.
- Foreign exchange risk can be substantial for international procurement, exposing purchasers of imported equipment to volatile costs in local currency. Exploring options such as green hedging instruments could support access to international capital markets.
- Technical assistance could be valuable in designing sound policy incentives to incentivize electrification of urban commercial fleets across delivery, transport and shared mobility. For example, incentives could be introduced at the municipal level around parking, use of bus lanes and exemption from other restrictions. Recently introduced requirements in Sao Paulo for the mandatory provision of EV charging in new residential and commercial buildings could be expanded to other designated points.

Action area 3: Biofuels for hard-to-abate sectors

While biofuels lower emissions in Brazil's transport sector, they also act as a barrier to electrification in the near term. Brazil's FFVs compare unfavorably with EVs on lifecycle emissions, while wholesale fleet conversion to biofuels likely implies unacceptable land-use change emissions. Electrification will eventually displace a large share of biofuels from Brazil's light passenger fleet and its large biofuel resource may need to be redirected to other areas of transport or the economy, where it may offer a decarbonization solution for hard-to-abate sectors. Exploring optimal applications for biofuels in the context of electrification is vital.

Investment opportunities

- Given current market dominance, biofuels are likely to remain in Brazil's transport mix for some time. Policy makers and auto manufacturers may seek to preserve a role for biofuels by, for example, pursuing development of 'flex-fuel engine EVs'. However, optimizing the route to net zero would likely mean electrifying all passenger cars and directing biofuels to sectors with no other easy decarbonization pathway. While this mainly involves enabling environment activities, supporting research and development on alternative applications for biofuels through technical assistance and DFI funds could help clarify their optimal role in Brazil's energy transition.

Enabling environment opportunities

- DFI support would be valuable in terms of policy development. Optimizing the use of biofuels in Brazil's transport sector in the medium and long terms means fully understanding potential applications and tradeoffs associated with their use in other segments of transport and the economy from an emissions, cost and technological points of view.
- Changes to the role of biofuels in Brazil's transport sector will require commitment from the highest political level, and collaboration between a variety of stakeholders across Brazil's large biofuels and auto manufacturing industries. Technical assistance can provide valuable support in this process.
- DFI support for multi-stakeholder evaluation of Brazil's emissions policy, NDCs and the long-term role of biofuels within these may be important. Brazil's NDC includes increasing the share of sustainable biofuels in the energy mix, expanding biofuel consumption, and increasing ethanol supply. Electrification of transport is notably absent, while dramatically increasing biofuels production and usage could potentially have an adverse effect on Brazil's emissions profile due to land-use change emissions.

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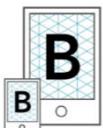
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