Decarbonizing Transport
The Road to Electrification

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Electrification

The electrification of road passenger and freight transport is an important driver for reducing energy consumption (renewable or not), greenhouse gas (GHG) emissions and air pollutant (AP) emissions locally, with more widespread benefits in cities, where most of the national (global) population is concentrated.

Energy Efficiency

For individual cars, the electric propulsion system is, on average, 3 times more efficient than the conventional one[1] (see Inmetro's Brazilian Vehicle Labeling Program) in terms of energy consumption. Its use in urban traffic (stop-and-go) increases the possibility of kinetic energy regeneration, further increasing the energy efficiency of the whole system. In the case of trucks and buses[2], this benefit tends to be greater (4 to 5 times more efficient), but this can vary greatly depending on the operating regime, driving profile and vehicle capacity.

1- https://www.gov.br/inmetro/pt-br/centrais-de-conteudo/noticias/inmetro-publica-terceira-atualizacao-da-tabela-do-programa-de-etiquetagem-veicular-pbev-de-2024
2- https://plvb.org.br/produtos/guias/ and https://ibts.eco.br/src/uploads/2019/11/relat_ltc_onibusbev.pdf

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Cost

Currently, for most categories, an electric vehicle is still significantly more expensive than a conventional one. In the case of cars, there may even be similarity in some vehicle categories, but electric buses and trucks can be up to twice as expensive as conventional ones. Of this, between 40% and 60% relates to the battery.

Technological Uncertainty

On the other hand, as it is a technology whose replacement curve began recently (less than 10 years ago) and is in the transition between introduction and growth, there is still a lot of uncertainty about the economic useful life of the vehicles, their resale value, operational reliability and savings on maintenance costs.

Intensive Applications

In this context, as it is an asset with a relatively expensive initial investment, the best applications would be for services that require intense and continuous use, such as collective urban public transport (buses) or individual public transport (taxis), apps and urban freight transport.

Urban Strategy

As such, it is understood that a road transport electrification strategy should focus on regular urban operations, with a daily mileage interval compatible with the autonomy offered by a battery pack that guarantees the desired level of service without making the initial investment in the asset excessively expensive. De Abreu et al (2023)[a] suggest using a procedure called Action Plan Focused on Electric Mobility (APOEM), which establishes a sequence of steps with this logic for implementing a fleet of electric vehicles in a medium-sized city in Brazil.

Adopting the logic suggested by APOEM is justified by a number of considerations:

1) The use of relatively more expensive assets in services that require intense and continuous use allows the higher initial investment to be amortized more quickly if you take into account the greater energy efficiency of the electric vehicle given a certain price for the purchase of electricity and the possibility of lower maintenance costs over the course of its economic useful life;

2) Urban buses account for only 1% of the road transport fleet, but are responsible for half (50%) of passenger transport activity and 10% of energy demand;

3) Trucks used in urban freight transport (UFT) represent only 1% of the circulating fleet and around 10% of freight transport activity and energy consumption;

4) Over the last 10 years, the fleet of urban buses and trucks used in UFT have consumed approximately the same amount of energy (diesel);

5) The fleet of urban buses and trucks used in the UFT provide a service that covers a very significant portion of society (compared, for example, to individual transportation - private cars), thus better distributing the benefits of introducing this technology.

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Energy Waste

It should also be noted that the use of individual cars, particularly with the growing trend towards SUVs (sport utility vans), is exacerbating energy waste in transportation. An urban trip in an SUV with just the driver consumes the same amount of energy as an airplane trip (Figure 1).

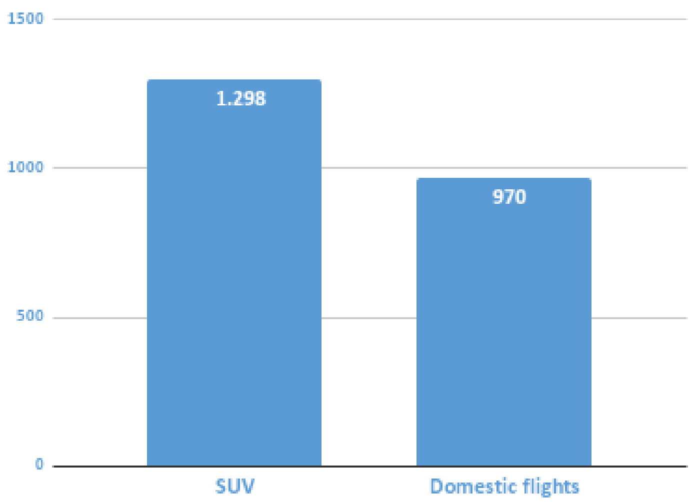

Figure 1. Urban air travel.

Note:

Values in kJ/pass.km, considering the PBEV for SUVs and the weighted average sales of the 5 best-selling SUVs in 2022 (Tracker, T-cross, Compass, Creta and oRenegage). Air transport data was taken from Gonçalves (2022)b as an average for the period 2015 to 2019 for domestic flights.

Infrastructure Risks

In addition to the uncertainties already presented regarding the introduction of electric vehicles into the national car fleet, it is understood that there are additional risks, particularly if this happens at an accelerated rate. These risks are associated with the supply-demand relationship for electricity and the availability of recharging infrastructure (grid). The risk of infrastructural inadequacy is exacerbated if there is an intense acceleration in the introduction of electric cars, which would require the spread and capillarity of the recharging infrastructure, with potentially high costs and the risk of underutilization. On the other hand, this risk does not seem to be so great if the strategy is to prioritize the electrification of urban bus and truck fleets, since it would be possible to plan the expansion of the energy distribution network to well-defined locations (fleet garages), reducing the spread of recharging points, but inducing service capillarity.

Energy Viability

Studies carried out by COPPE/UFRJ to evaluate bold decarbonization scenarios for national economic activities, including transport, and to help Brazil meet its NDCs, show that the supply/demand ratio for electricity to meet a planned projection for the introduction of electric vehicles does not seem to compromise the supply of electricity.

Sustainable Projection

Projections for 2050 that consider a 40% share of hybrid electric and battery electric cars in the national fleet and 10% of the fleet of heavy vehicles (urban buses and semi-light, light and part of medium trucks) powered by batteries (Figure 2), would lead to a 10% share of energy consumption by transportation (industrial, commercial and residential uses would each account for 20%, double the demand for transportation) (Figure 3). In total, this energy could be supplied without compromising protected areas (Figure 4).

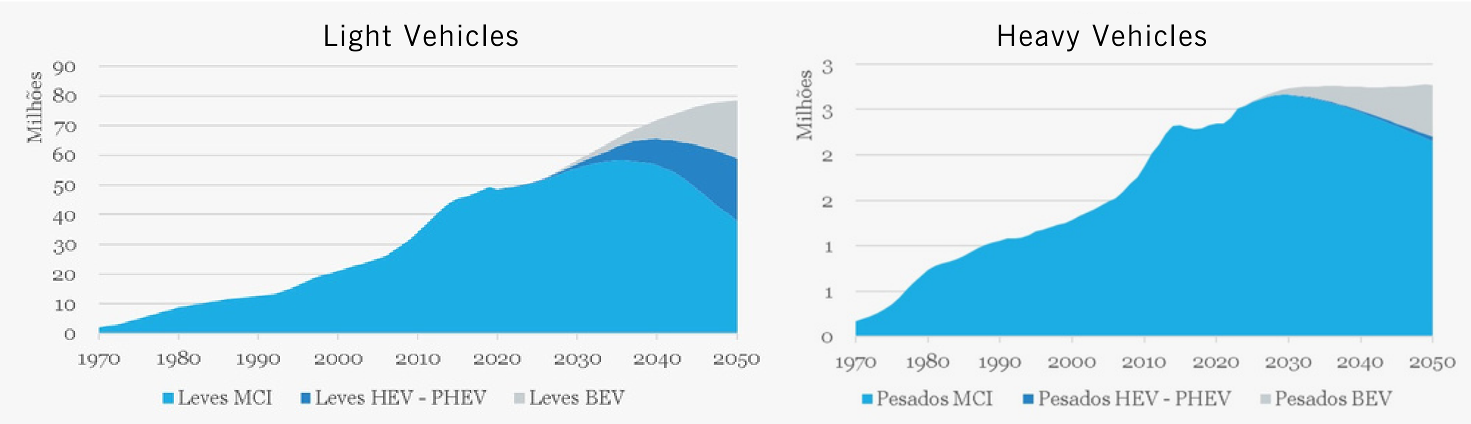

Figure 2. Fleet composition in a bold decarbonization scenario.

Legend: Leves MCI - light vehicles with internal combustion engine, Leves HEV - light vehicles hybrid electric, PHEV - plug in hybrid electric vehicle, Leves BEV - light vehicles baterry electric vehicles, Pesados MCI - heavy vehicles with internal combustion engine, Pesados HEV - heavy vehicles hybrid electric, PHEV - plug in hybrid electric vehicle, Pesados BEV - heavy vehicles baterry electric vehicles.

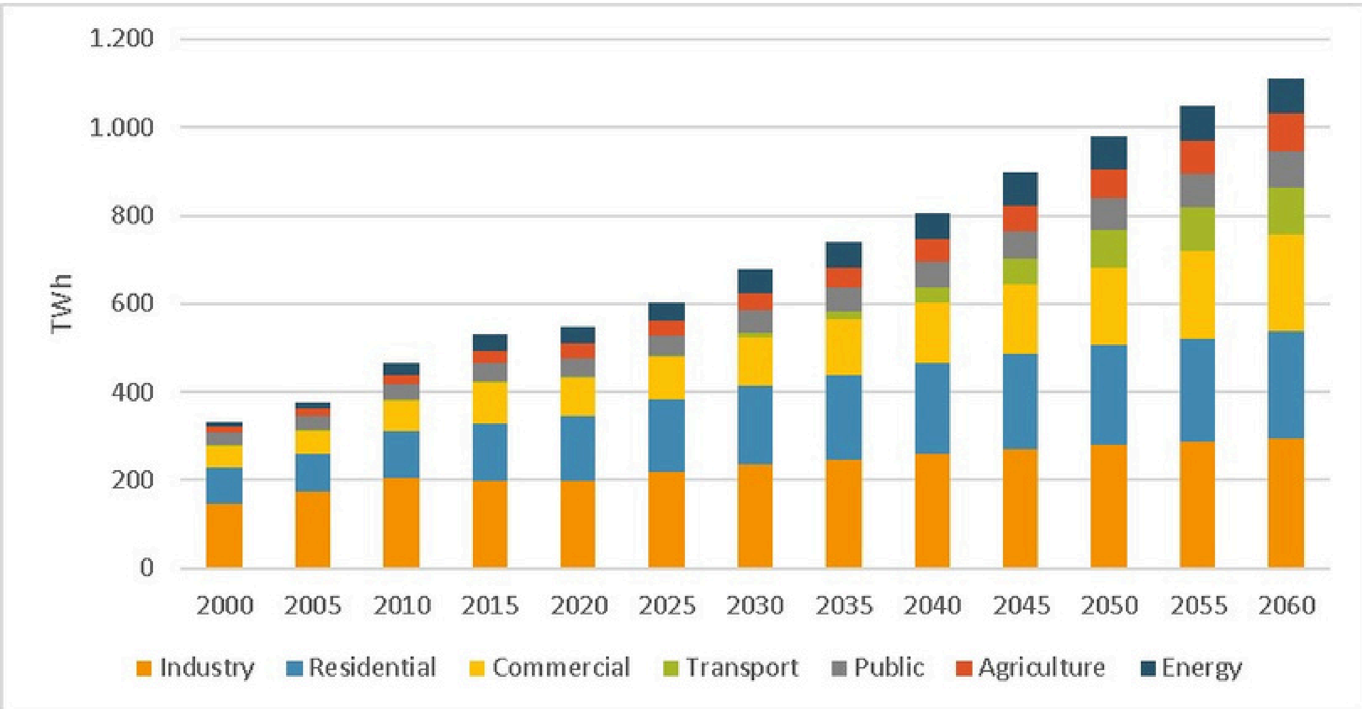

Figure 3. Share of transport in electricity use.

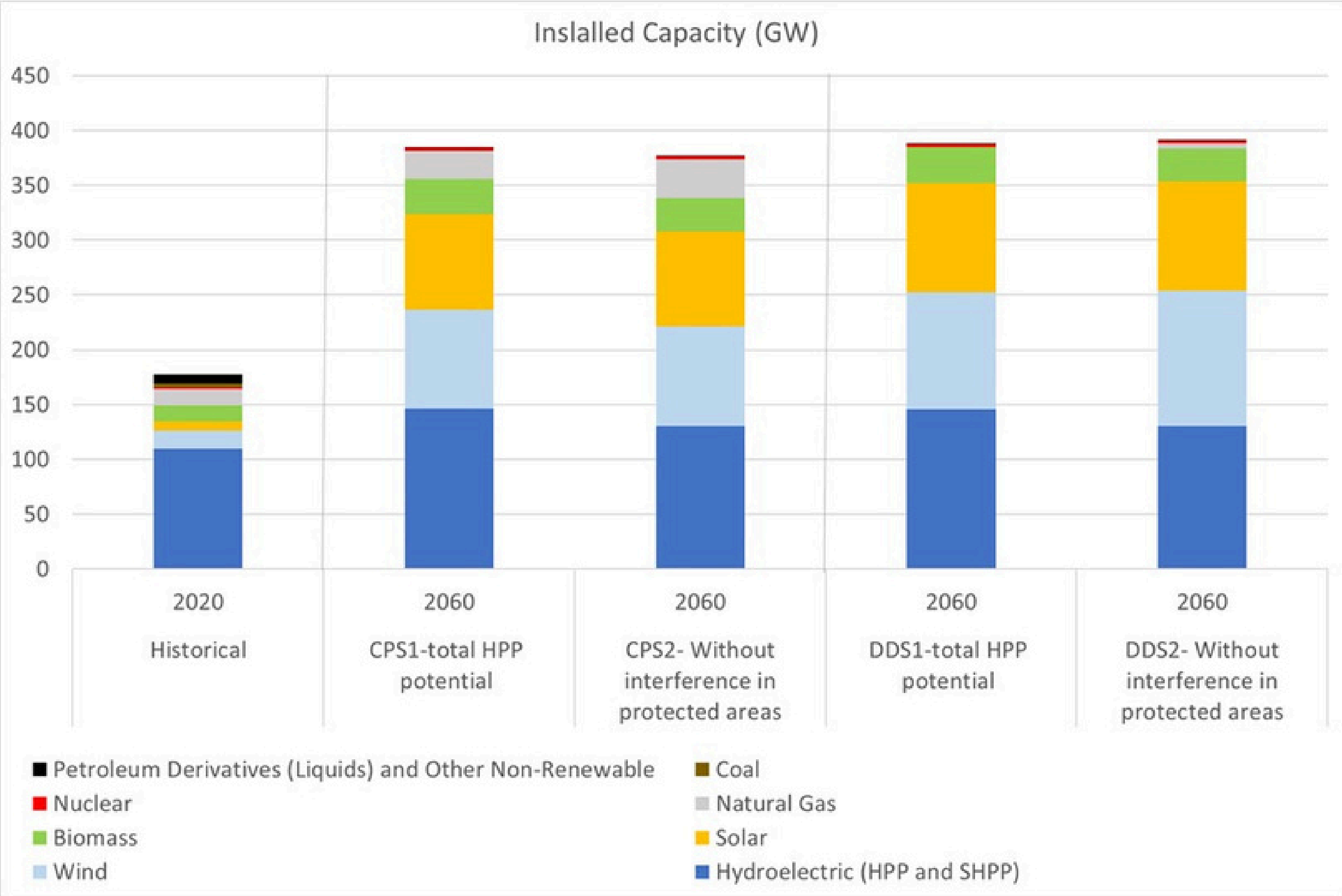

Figure 4: Installed capacity..

Decarbonization Scenario

Everything leads us to believe that even in a bold scenario of decarbonizing transport, with a significant percentage of electric road vehicles being introduced, the main infrastructural risks would not be in energy supply but in distribution, particularly if there is an acceleration in the electrification of individual cars.

References:

Victor Hugo Souza De Abreu, Márcio de Almeida D'Agosto, Ana Carolina Maia Angelo, Lino Guimarães Marujo e Pedro José Pires Carneiro. Action Plan Focused on Electric Mobility (APOEM): A Tool for Assessment of the Potential Environmental Benefits of Urban Mobility. Sustainability 2023, 15, 10218. https://doi.org/10.3390/ su151310218.

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