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CERTIFICAÇÃO
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TERO.005 - REDUCTION OF GHG EMISSIONS VIA ELECTRIC VEHICLES

VERSION 1.0

METHODOLOGY, TRANSPORTATION, FUEL SWITCH

TERO CARBON AVALIAÇÕES E CERTIFICAÇÕES S.A.

IDENTIFICATION

METHODOLOGY	REDUCTION OF GHG EMISSIONS VIA ELECTRIC VEHICLES
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AUTHOR	BVM12 - Fundraising Platform for Startups Ltd
PROGRAM	Technology-Based Solution (TBS)
SECTOR	Transportation
TYPE	Fuel Switch
GENERATED ASSET	Carbon Credit (tCO_2e)
PROJECT ACTIVITIES	Replacement of the fleet's internal combustion vehicles with electric vehicles
GHG MITIGATION	Reduction of GHG emissions

ACRONYMS

AC	Alternating current
DC	Direct current
EV	Electric Vehicle
FENABRAVE	National Federation of Motor Vehicle Distribution
GHG	Greenhouse gasses (English)
ICT	Information & Communication Technology
INMETRO	National Institute of Metrology, Quality, and Technology
MRV	Measurement, Reporting, and Verification
ONS	National Electric System Operator
PDD	Project Design Document
SDGs	Sustainable Development Goals
SIN	National Interconnected System
TBS	Technology-Based Solutions
tCO_2e	Carbon Dioxide Equivalent

DEFINITIONS

Developer	Entrepreneur legal entity, plurality permitted, that implements, based on the methodology, through funding, provision of technical assistance, or otherwise, projects to generate carbon credits, in association with a Generator.
Generator	Individual or legal entity, indigenous peoples, or traditional peoples and communities that own or enjoy property that constitutes the basis for projects to reduce emissions or remove GHGs.
Implementer	Organization responsible for project governance during the execution period. It is up to the Implementer to execute and/or coordinate the activities provided for in the methodology.

SUMMARY

1. OBJECTIVE

The purpose of this methodology is to provide a clear and comprehensive framework for the submission of projects aimed at reducing Greenhouse Gas (GHG) emissions by replacing the internal combustion vehicles of a land fleet with electric vehicles. It establishes precise and careful guidelines, ensuring the issuance of carbon credits in an integral and transparent manner, following internationally accepted criteria for the carbon market.

2. METHODOLOGY PROGRAM AND GENERATED ASSETS

This methodology is part of the Technology-Based Solutions Program (TBS). The assets generated are Carbon Credits for reduced emissions.

3. METHODOLOGY SCOPE

This methodology involves incentivizing the reduction of Greenhouse Gas (GHG) emissions by replacing the internal combustion vehicles of land fleets with electric vehicles.

3.1 Applicability

The methodology applies to companies that have a fleet of land vehicles, and companies with mobile applications for logistics or mobility.

3.2 Project Activities

The Proponent must promote the fuel switch by replacing combustion vehicles in their fleet with Electric Vehicles (EVs).

Eligible and applicable activities and actions to guarantee and ensure the reduction of GHG emissions may include, but are not limited to:

- Implementation of a policy to replace combustion vehicles with EVs;
- Implementation of a policy to increase the fleet through the acquisition of EVs;
- Implementation of actions to engage autonomous app drivers/deliverers to use EVs.

3.3. Technological Scope

The applicable technology is the use of electric vehicles instead of combustion vehicles. In the case of electric vehicles with replaceable and chargeable batteries, charging point and battery replacement technology must be available to users.

4. ELIGIBILITY CRITERIA

The carbon projects covered by this methodology must meet minimum criteria, such as:

4.1. Proponent

The proposing company must be a legal entity located in Brazil with a fleet of vehicles or with an application for logistics or mobility.

4.2. Land Vehicle Fleet

Electric vehicles must be owned by the proposing company or proven through rental or leasing contracts.

4.3. Minimum quantity of vehicles

The company must have at least 5% or at least 50 EVs (owned and/or leased) in its land fleet.

4.4. Voluntary Replacement of the Fleet Fuel Matrix

The proponent must present a voluntary commitment to replace the land fleet's fuel matrix.

4.5. Double Counting

The company cannot have a project to reduce GHG emissions via the replacement of combustion vehicles with electric vehicles registered/certified by another standard/methodology in the same crediting period using the same vehicles.

4.6. Demonstrate MRV Capability

The project must demonstrate MRV (Measurement, Reporting, and Verification) means for collecting data used to quantify the reduction of GHG emissions.

5. PROJECT PARTICIPANTS

Project participants must be clearly identified in the Project Design Document (PDD), among others, including the name of the organization, full address, representative details, and their contacts. This methodology requests that the following participants be identified:

5.1. Generator (Proponent)

The Proponent is the legal entity that owns or uses the land fleet to be used in the project's GHG emissions reduction activities. The project may have:

1. Individual proponent: Only one company is the project proponent and holds the assets; or

2. Consortium: One company is the leader and responsible for the project and must be presented as the main proponent, and the others are presented as secondary proponents.

5.2. Developer

The Developer is the legal entity responsible for project development, registration, and coordination. There must only be 1 Developer for each project.

5.3. Implementer

The Implementer is the legal entity responsible for project governance during the execution period. It is up to the implementer to execute and/or coordinate the activities provided for in the methodology. It is permitted for the same legal entity to be both Developer and Implementer of the project.

6. GOVERNANCE

The project must present how governance will be carried out, aiming to carry out the activities foreseen in this methodology. It is recommended that there be at least:

6.1. Organizational structure

The project must present clear roles for each organization and how they relate to one another.

6.2. Process Structure

The project must define the essential activities, those responsible for the activities and the process flow.

6.3. Technological Infrastructure

The project must disclose which Information & Communication Technology (ICT) will be used, with proven safety and robustness.

6.4. Data Monitoring, Storage, and Protection

The project must minimally present the data collected and its collection frequency, including the format for monitoring, storing, and protecting data. The project must demonstrate how it will guarantee the integrity of this data.

6.5. Avoidance of Double Counting

The project must present a plan to avoid double counting, mitigation actions, and a contingency plan.

6.6. Benefits Transfer

The project must present a benefit transfer plan (carbon credits) and proof formats.

7. TIME LIMITS

7.1. Project Duration Period

The minimum duration of the project is 3 years and must be defined by mutual agreement with the participants, with the possibility of an extension.

7.2. Project Start

The project needs to clearly define the start date.

7.3. Monitoring Period

The monitoring period is from the beginning of the project until its end date, or in the case of extension, until the last scheduled date.

7.4. Retroactivity

The project may request the accounting of reduced GHG emissions generated prior to the project start date, as long as it is possible to prove the authenticity and integrity of the data collected, with all criteria defined in this methodology being respected.

8. BASELINE

The baseline scenario of this methodology assumes that the fleet is composed mainly of internal combustion vehicles. It also assumes that combustion vehicles are comparable to electric vehicles (EVs), providing the same service and belonging to the same category and model, according to FENABRAVE.

8.1. Definition of Combustion Vehicle Models

When preparing the baseline, the project needs to identify which hypothetical combustion vehicles would have been purchased if they were not replaced by EVs. The following must be considered:

- To replace a combustion vehicle, the same model and brand as the previous vehicle should be used, with an updated addendum for the year of manufacture, which must be the same as that of the replacement EV;
- When it is not possible to determine the vehicle being replaced or when the acquisition of the EV is to increase the fleet, a comparison of EVs and combustion vehicles must be made, determining them by category and model according to the FENABRAVE table;
- Assume that the combustion vehicle that would be acquired, if the project did not exist, would have a probability of being

acquired according to the number of vehicles registered in the FENABRAVE table of the same model and registration category in the month and year of that EV's registration.

8.2 Fleet Size

The project must define the size of the fleet for building the baseline, taking into account the models defined in the previous item.

8.3 Temporality

The project must define the data collection period to create the baseline.

8.4 Fuel Consumption

The project should define the average consumption of comparative vehicles using data from INMETRO, manufacturers, and other official sources, where:

- For vehicle replacement cases, consumption data must be based on the same model of the vehicle replaced, updating the year of manufacture, which must be the same as the EV;
- When it is not possible to determine the vehicle to be replaced or to increase the fleet, the fuel consumption to be considered is the weighted average consumption of combustion cars according to the FENABRAVE table, which must be that of the same month and year of registration of the EV.

8.5. Baseline Test

The project must compare GHG emission data between combustion vehicles and EVs, using the same distance traveled.

9. ADDITIONALITY

9.1. Additionalities Thesis

The project must present the additionality thesis, considering the following points:

- Legislative (Federal, State, and Municipal Laws): Absence of laws that require the replacement of the internal combustion vehicles of land fleets with electric vehicles;
- Financial: The investment cost for EVs and charging infrastructure must be higher than the price of combustion vehicles;
    - Lack of financial additionality: If the value of the electric vehicle is less than or equal to that of a combustion vehicle, the additionality will still exist when proven according to the additionality test.
- Social: The transfer of carbon credits or the financial value of carbon credits must be an integral part of the project when there are self-employed people who use EVs (delivery drivers, app drivers, and others).

9.2. Additionality Test

The project must demonstrate that it meets the following additionality test:

- Barrier due to prevailing practice: Prevailing practice, regulation, existing policy, or requirements that would have led to the implementation of a technology with higher emissions;
- Financial additionality: Demonstration that there are alternatives to EVs that are more financially attractive and meet the same needs but would lead to higher GHG emissions.
- Technological additionality: A less technologically advanced alternative to the project must be demonstrated, the activity of which involves lower risks due to performance uncertainty or low market share of the new technology adopted for the project activity and thus higher emissions will occur.

10. PERMANENCE

The project needs to demonstrate the ability to ensure that the benefits of reducing Greenhouse Gas (GHG) emissions are sustainable and lasting over time.

11. LEAKAGE

The project needs to present ways to consider and mitigate the risk of GHG emissions leakage during its execution.

12. SOCIAL AND ENVIRONMENTAL SAFEGUARDS

Safeguards are understood as guidelines that aim to enhance the positive impacts and avoid or reduce the negative impacts of the project. Therefore, the project needs to demonstrate compliance with the following safeguards:

- Environmental impact assessment;
- Monitoring and evaluation to quantify GHG reduction;
- Expansion of recharge points or replacement batteries.

The methodology foresees that if there are independent drivers or app delivery people, the following must be foreseen:

- Free, Prior, and Informed Consultation, with guarantee of rights;
- Additional revenue generation through fuel matrix replacement using EVs;
- Social impact assessment.

13. QUANTIFICATION OF GHG EMISSIONS REDUCTION

The estimate of the average reduction in GHG emissions, in tCO_2e, due to the implementation of the project activity, must be calculated by comparing data from compatible combustion vehicles for the same category, model, and year, as explained in the Baseline. To this end, project participants must consider:

- The common data used to compare vehicle models will be the distance traveled, measured in km;
- The average consumption (km/liter) of combustion vehicles will be calculated according to the Baseline.

13.1. Calculation

13.1.1. GHG Emissions for Electric Vehicle

GHG emissions from electric vehicles will be calculated using the Brazilian GHG Protocol. For the calculation using this methodology, it is necessary to identify the source of the region's energy matrix; as the Brazilian energy matrix is integrated, we will use data from the National Electric System Operator (ONS), as per the annex.

$$AND_{electric} = C_{electric} \cdot FE$$

$AND_{electric}$ represents the total emissions of the electric vehicle in $kg.CO_2$.

$C_{electric}$ is the electricity consumption in a period (kW.h).

FE is the emission factor for the source.

13.1.2. GHG emissions for combustion vehicles

GHG emissions from combustion vehicles will be calculated using the Brazilian GHG Protocol. To calculate using this methodology, it is necessary to identify the amount of fuel consumed, as per the annex.

$$AND_{combustion} = C_{fuel} \cdot FE$$

$AND_{combustion}$ represents the vehicle's total emissions at combustion in $kg.CO_2$

C_{fuel} represents the consumption of fuel in liters (L).

FE is the emission factor for the source.

13.1.3. GHG Emissions Reduced via Electric Vehicles

The calculation of GHG emissions reduced by replacing combustion vehicles with electric vehicles is given by the difference between emissions from combustion vehicles and emissions from electric vehicles.

$$AND_{reduced} = AND_{combustion} - AND_{electric}$$

$AND_{reduced}$ are reduced emissions.

$AND_{combustion}$ s are the emissions from combustion vehicles.

$AND_{electric}$ are the emissions from electric vehicles.

14. CREDITING PERIOD

The crediting period will always be retroactive based on data collected for a predetermined period in the Monitoring Plan, as the reduction calculation depends on the distances covered by electric vehicles within a given period.

15. CONTRIBUTION TO SUSTAINABLE DEVELOPMENT GOALS

The project must contribute to at least 3 Sustainable Development Goals (SDGs), with adherence to SDG 13 - Action Against Global Climate Change, being mandatory. In this sense, the project needs to present the direct contributions of the benefit (SDG-13) and at least two more co-benefits (other SDGs) through indicators that have MRV characteristics (Measurement, Reporting, and Verification).

16. MONITORING PLAN

The monitoring plan is particular to each project. It must be simple enough to guarantee implementation and continuity throughout execution, but robust enough to guarantee the veracity and credibility of the information. In this sense, the monitoring plan must contain, at a minimum, the following items:

- Monitoring Objective: Detail the objective of monitoring;
- Responsibilities and duties: Present the responsibilities and activities of each legal entity that is participating in the implementation and monitoring of the project;
- Raw data for quantifying GHG emissions reduction: Data for calculating the quantification of GHG reductions must include at least: (a) distance traveled; (b) energy consumption (KW.h) for the distance covered by each vehicle; (c) number of vehicles; (d) CO_2 emission factors for electricity and combustible fuel;
- Data collection procedures: Define the procedures and protocols to be followed to collect, record, and store monitoring data;
- Monitoring frequency and locations: Define a data collection and monitoring frequency as well as the collection location;
- SDG indicators: Present the indicators that will be collected to show the benefit and co-benefits of the project;
- Monitoring Reports: Reports must be periodic and address the aforementioned items, in addition to, but not limited to, discussing project performance, emissions reductions achieved, and any challenges or deviations from the original plan.

Based on monitoring results, make necessary project adjustments to ensure continued effectiveness and compliance.

ANNEX I

1. Methodological basis for determining the energy consumption (kW.h) of electric vehicles

1.1. Operation of electric motors

The operating principle of electric motors is based on the interaction between magnetic fields. A stator, made up of coils of conducting wire, creates a rotating magnetic field when energized by electrical current. This magnetic field interacts with the rotor, which is also composed of permanent magnets or electromagnets, generating torque and rotational movement.

There are two main types of electric motors used in electric vehicles:

- **Direct Current (DC) Motors:** They are simpler and more robust, but have lower efficiency and torque at low speeds.

- **Alternating Current (AC) Motors:** They are more efficient and offer greater torque at low speeds, but they are more complex and require an inverter to convert the battery's direct current into an alternating current.

To operate the engines, electric vehicles incorporate at least 3 components into their system:

- **Electronic Controller**: Controls the speed and torque of the motor, managing the flow of electrical current.

- **Investor:** Converts direct current from the battery to alternating current to power the AC motor.

- **Reducer:** Adapts engine speed to wheel speed.

The advantages of using electric motors are:

- **Efficiency:** Electric motors are more efficient than internal combustion engines, converting more energy into motion, approximately 90% rather than 30% overall.

- **Zero Emissions:** They do not generate polluting gas emissions during operation.
    - Despite no emissions during its operation, energy consumed during production results in GHG emissions in most cases.
- **Less Noise:** They are quieter than internal combustion engines.
- **Instantaneous Torque:** Provides maximum torque instantly, providing better acceleration.
- **Reduced Maintenance:** They have fewer moving parts and require less maintenance than internal combustion engines.

1.2. Quantifying energy consumption

Quantifying energy consumption during the period of EV use can be calculated in two ways.

1.2.1. Direct Form

Energy consumption by electric vehicles can be measured directly through telemetry, checking the output current curve (Ampere) of the batteries or through electronic meters (kW.h) installed at the battery output.

$$CE = U.I.t$$

CE is the energy consumed during a certain period of time (kW.h).
U is the output voltage of the batteries (Volts).
I is the electrical current at the output of the batteries (Ampere).
t is the consumption time (Hour).

1.2.2. Indirect Form

Consumption can be calculated indirectly using an estimate based on consumption data from a sample group.

This second way makes it possible, even without telemetry present to measure battery data in all vehicles, to estimate consumption with a statistical degree of precision based on data on distance traveled.

In this method, the average energy consumption per km driven is estimated from a sample group, with a level of uncertainty calculated through the average confidence interval.

Stratification by vehicle models for Indirect Form

The stratification of models serves to reduce variance within the strata. It is important that electric vehicles are grouped by their classes:

Vehicle model (car, motorcycle, truck, etc.); and

Types of vehicles.

If more than 2 classes are identified, even if the characterization shows evidence that the stratifications are different, a statistical test will not be applied to prove the difference in consumption between them. This is because these classes must be used to compare electric vehicles with combustion vehicles of the same class that would have been used.

Stratified random sampling system for indirect cases

For each class of vehicles previously identified, a random sampling will be done to capture telemetry data involving the distance traveled and the energy consumption of electric vehicles.

To calculate the energy efficiency of electric vehicles:

$$Ef = \frac{DP}{CE}$$

Ef represents energy efficiency (km/kWh).

DP is the distance traveled (km).

CE is the energy consumption (kW.h).

Calculation for indirect quantification

From the efficiency calculation of each vehicle in the sample, it will be necessary to calculate the confidence interval of this sample group according to inferential statistics. We will always use the confidence level to be 95%.

Once we have the confidence interval, we will always use the floor of the result for estimation calculations for vehicles that only provide the distance covered; in this way, we will always have the lowest calculated energy efficiency as a basis.

The energy consumption of each vehicle will be calculated as:

$$CE = \frac{DP}{Ef_{floor}}$$

Where Ef_{floor} represents the lowest energy efficiency within the confidence interval.

$$Ef_{floor} = \; = \overline{Ef} - EP.Z$$

Where Z is the confidence level based on the population standard deviation, range of variation of the estimated mean, with a probability of 95%.

2. Statistic

Parameter	Description	Formula
Average	The sum of a set of values divided by the number of values. It represents the central tendency of the data.	$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$
Weighted average	The sum of the values multiplied by the contribution (weight) of each term, with its sum divided by the sum of all weights	$\bar{x} = \frac{\sum_{i=1}^{n} x_i . p_i}{\sum_{i=1}^{n} p_i}$
Variance	Measures the dispersion of data in relation to the mean. It is the average of the squares of the differences between each value and the mean.	$\sigma^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}$
Standard deviation	The square root of the variance. It indicates the average distance between the data and the mean.	$\sigma = \pm\sqrt{\sigma^2}$
Standard Error	The standard deviation of the mean of a sample of data. It indicates the accuracy of the estimate of the population mean.	$EP = \frac{\sigma}{\sqrt{n}}$
Confidence interval	An interval that has a certain probability of containing the true population mean.	$\bar{x} \pm Z.\frac{\sigma}{\sqrt{n}}$

Note: Z is the critical value of the standard normal distribution corresponding to the desired confidence level (for example, 1.96 for a 95% CI).

3. Methodological basis for estimating fuel consumption of combustion vehicles

3.1. Operation of combustion engines

Most vehicle combustion engines operate on a four-stroke cycle:

- **Admission:** The intake valve opens and the piston moves downward, allowing the air-fuel mixture to enter the cylinder.
- **Compression:** The intake and exhaust valves close and the piston moves upward, compressing the air-fuel mixture.
- **Combustion:** A spark from the spark plug (gasoline engines) or heat from compression (diesel engines) ignites the air-fuel mixture, generating an explosion that pushes the piston down.
- **Escape:** The exhaust valve opens and the piston moves upward, expelling exhaust gasses from the cylinder.

These four strokes repeat continuously as long as the engine is running. The main components of an engine are:

- **Cylinder:** Space where the piston moves up and down.
- **Piston:** Component that moves up and down inside the cylinder, compressing and expanding the air-fuel mixture.
- **Valves:** Control the entry and exit of air from combustion and exhaust gasses from the cylinder.
- **Spark plug:** Generates the spark that ignites the air-fuel mixture in gasoline engines.
- **Combustion chamber:** Space where the air-fuel mixture is burned.
- **Connecting rod:** Connects the piston to the crankshaft.
- **Crankshaft:** Converts the linear movement of the piston into rotary movement.

Furthermore, we can find 5 types of combustion engines on the market:

- **Gasoline engines:** Use gasoline as fuel and ignition is created by a spark plug.
- **Alcohol engines:** Use alcohol as fuel and ignition is created by a spark plug
- **Flex engines:** Use gasoline or alcohol as fuel and ignition is created by a spark plug. As the engine is designed to serve two types of fuel, its efficiency is lower compared to the other engines mentioned above.
- **Diesel engines:** Use diesel as fuel and ignition is created by air compression.
- **Gas engines:** Use natural gas or liquefied petroleum gas (CNG or LPG) as fuel.

3.2. Calculation of consumption indirectly: The estimation of fuel consumption will be carried out indirectly, since it is not possible to directly account for the consumption of something that has been replaced. In this way, we will use data on distance traveled and classes of electric vehicles to calculate the GHG emission potential.

Obs 1: If the electric vehicle has replaced another combustion vehicle, the consumption data of the replaced combustion vehicle that will be used for calculation must be those provided by the manufacturer, INMETRO (Brazil) or another conformity assessment body (outside of Brazil).

Obs 2: If the electric vehicle is an acquisition/lease to increase the vehicle fleet, we must stratify the combustion model.

3.2.1. Stratification by combustion vehicle models

Starting from the stratification of electric vehicles, it will be necessary to find vehicles of the same class and category that are compatible with those previously stratified by the same criteria.

- Vehicle model (car, motorcycle, truck, etc.)

- Types of vehicles (hatch, SUV, sedan, minivan, minibus, etc.)

Obs: 1: If there are vehicles of the same class compatible with EVs in the Proponent's fleet, these will be the models used for calculation, taking into account the number of vehicles of the same category, brand, and consumption according to the manufacturer's data, INMETRO (Brazil) or another conformity assessment body (outside of Brazil).

Obs 2: If there are no compatible vehicles in the fleet, the comparison must be made using as a basis the number of combustion vehicles of the same model and category sold in the month and year in which the electric vehicle was registered. This information can be found at FENABRAVE (Brazil) https://www.fenabrave.org.br/Portal/conteudo/emplacamentos.

Below we have an example for small sedans registered in March 2023.

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Modelos mais emplacados acumulado até Março/2023

Sedans Pequenos

	Modelo	2023 Fev	2023 Mar		2023 Acumulado	Part.
1°	FIAT/CRONOS	1.653	3.442	▲	7.576	50,36%
2°	HYUNDAI/HB20S	1.098	2.025	▲	4.807	31,96%
3°	VW/VOYAGE	57	1	▼	2.062	13,71%
4°	RENAULT/LOGAN	54	240	▲	580	3,86%
5°	FIAT/SIENA	2	3	▲	12	0,08%
6°	TOYOTA/ETIOS SEDAN	0	2	▲	2	0,01%
7°	FORD/FIESTA SEDAN	0	1	▲	1	0,01%
8°	FORD/KA SEDAN	0	1	▲	1	0,01%
9°	GM/CLASSIC	0	0	=	1	0,01%
10°	GM/CORSA SEDAN	0	1	▲	1	0,01%
	Total	2.864	5.716	▲	15.043	100%

Figure 1 - license plate table - FENABRAVE.

To calculate the average consumption of a supposed combustion vehicle, we will use the manufacturer's efficiency data (km/liter) and the registration numbers of combustion vehicles to find the average and the confidence interval.

Obs: It is always important to observe the month and year of registration of the electric vehicle as a reference, as this data reflects a hypothetical purchase of one of these combustion vehicles listed in the table at that time.

3.2.2. Stratified Random Sampling System

According to the class of electric vehicle identified previously, we will use data from the FENABRAVA tables to calculate the average consumption and its confidence interval. We will use as a basis the number of vehicles registered in the reference month and year and the consumption data provided by the manufacturers, INMETRO (Brazil) or another conformity assessment body (outside of Brazil).

To determine the fuel consumption that will be used in inferential statistics, we will calculate the ceiling of the confidence interval for the average consumption of combustion vehicles. The ceiling reflects the greater efficiency of combustion engines, which means that the vehicle will travel a greater distance for 1 liter of fuel. To do this, we need to calculate the average based on the efficiency of each car and the number of cars registered in the same period of EV registration, calculate the standard error, and then the confidence interval.

$$MC_{ceiling} = \overline{MC} + EP.Z$$

$MC_{ceiling}$ is the highest possible consumption within the confidence interval

$\overline{MC}$ is the average consumption (km/liter)

The value of **Z,** as in the previous case, will be the amplitude of variation of the estimated average, with a probability of 95%.

In this way, fuel consumption can be calculated using the formula below:

$$C_{fuel} = \frac{DP}{MC_{ceiling}}$$

C_{fuel} is the fuel consumption

DP is the same value as the distance traveled by the electric vehicle we are comparing.

4. Definition of electrical energy sources

The sources of electrical energy are diverse in Brazil (hydroelectric, thermoelectric, photovoltaic, wind, among others), and the system has become interconnected over time (98% of the Brazilian population is interconnected, only the remote regions of the Amazon are not). This interconnection is called the National Interconnected System (SIN) and integrates the 5 regions of the country. In this way, it is possible that a customer from one state is consuming energy generated from another region of the country, meeting local needs and avoiding blackouts.

Therefore, it becomes difficult to determine exactly whether the EV charging point used energy generated by a wind or by a hydroelectric source at a given time, for example. In this way, as the systems are interconnected, we can infer that a consumer unit uses proportionally the energy coming from different energy sources.

To determine the % consumption of each energy source, we will use the National Electric System Operator database, accessing the operation history in relation to energy generation for a given period. https://www.ons.org.br/paginas/resultados-da-operacao/historico-da-operacao/dados-gerais

Figure 2 - Energy generation graph - ONS

5. Fuel definition for GHG emission reduction calculations

In Brazil, we have varied fuel consumption (diesel, alcohol, gasoline) that is difficult to measure for each location. The choice of fuel for calculation must be made according to the category and class of the vehicle. If the vehicle is flexible, we will use the least polluting fuel in the calculations to guarantee the lowest possible GHG reduction, ensuring that there is no room for questioning the possibility of using estimated fuel consumption data and generating non-existent carbon credits.

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