JAMA's Guidelines on Carbon Footprint of Automobile Products

2024 Version

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Life Cycle Assessment (LCA) Sectional Committee
Environmental Policy Subcommittee, Environmental Technology & Policy Committee
Japan Automobile Manufacturers Association, Inc. (JAMA)

Revision History

Edition	Date Issued	Revision Details
First edition	May 17, 2024	Issuance of the first edition
Second edition	September 11, 2024	Corrected errors and such regarding GHG emission intensity of materials and CFF parameters

Contents

1. Purpose and Scope of Application

1.1 Purpose

1.1.1 Background and intent of the Guidelines

Toward achieving carbon neutrality, the Japan Automobile Manufacturers Association, Inc. (JAMA) has a policy to conduct life cycle assessment (LCA) for greenhouse gases emitted by automobiles and utilize the assessment results.
With the aim of creating a virtuous cycle of the economy and the environment, JAMA will prepare guidelines on carbon footprint of automobile products ("the Guidelines") so that each automobile manufacturer can properly and fairly assess the initiatives toward realizing carbon neutrality in the automobile industry as well as for the purpose of recommending such evaluation methods both at home and abroad.

1.1.2 Purpose of the Guidelines and normative references

The purpose of the Guidelines is to specify rules, requirements and instructions regarding the calculation of carbon footprint of products (CFP) for automobiles.

The following standards are normative references of the Guidelines.

- ISO 14040:2006 (Environmental management - Life cycle assessment - Principles and framework)
- ISO 14044:2006 (Environmental management - Life cycle assessment - Requirements and guidelines)
- ISO 14067:2018 (Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification)

1.1.3 Intended use and reasons for investigation of the CFP calculation performed using the Guidelines

Intended use and reasons for investigation of the CFP calculation performed using the Guidelines are outlines as (1) to (3) below.

(1) To clarify challenges to be addressed by the industry by developing standardized assessment methods in the industry.

(2) For the challenges to be tackled which are clarified in (1) above that cannot be resolved by a single company, to allow JAMA to help realize carbon neutrality in the industry through the provision of opinions and requests to concerned industry groups and relevant ministries and agencies.
(It is believed that the Guidelines can be used for the government's environment strategy because they are prepared by clarifying common challenges in the industry.)

(3) To provide products that are excellent in environmental performance, which are improved through the process in (2) above.

The Guidelines are not intended to be used for comparison and assertion for the purpose of disclosure to third parties.
(The reason why comparison and assertion are not intended is that carbon neutrality is required to be achieved globally and that it is meaningless if it is only achieved by one company.)

1.1.4 Intended recipients of CFP calculations performed using the Guidelines

JAMA (internally), relevant industry groups, relevant ministries and agencies, and general customers

1.2 Definitions of product types subject to the Guidelines

Product types subject to the Guidelines are vehicles which are defined in the classification of Table 1-1. This classification considers differences in lifetime mileage and the number of years used.
Since a heavy vehicle's classification is diverse, the typical vehicle types in Appended table 1 are assumed.

Table 1-1 Automobile type classification

Vehicle type classification		Details
Small-sized vehicle	Passenger car / Small truck	Passenger car: Car with a seating capacity of nine persons or less Small truck: GVW≦3.5t
Heavy vehicle	Truck	T1 to T11, TT1 to TT2 Typical vehicle type: Refer to Appendix 1
	Bus	B1 to B7, BR1 to BR5 Typical vehicle type: Refer to Appendix 1
Motorcycle	Small-sized motorcycle	ICE: Below 250cc / EV: Rating of less than 1kW * Assumption: Motorcycle for daily and business use such as a scooter
	Large motorcycle	ICE: 250cc or more / EV: Rating of 1kW or more * Assumption: Motorcycle used for recreational purposes such as a road sport motorcycle

In addition, the Guidelines are not applied to the following vehicles.

- Vehicles which are used and disposed of outside Japan
- Vehicles using future fuels such as e-fuel, biofuel and hydrogen
- Vehicles with two-stroke internal combustion engines

1.3 Component elements subject to the Guidelines

Products (automobiles) subject to the Guidelines must include the following elements.

- Vehicle body (including fuels for automobiles with internal combustion engines)
- Maintenance parts (parts which are defined in Table 4-1 List of replacement parts)
- Other accessories (spare tires, spare disc wheels, tools, warning triangle signs, floor mats, etc.)

1.4 Functional unit and reference flow

The Guidelines define automobile's functions, functional units and reference flows as follows, and calculations shall comply with these definitions.

- Automobile's function: To transfer persons or persons and goods on land using engines (as per Article 2 of the Act on Vehicles for Road Transportation)
- Functional unit: Run for the annual mileage and number of years used indicated in Table 1-2 by predetermined certified fuel economy or electricity consumption (Refer to 4.5.2)
- Reference flow: "One automobile" which can satisfy the functional unit (unit of freight weight, unit of the number of passengers, etc.)

Table 1-2 Annual mileage and the number of years used according to vehicle type classification

<table>
<tr><th colspan="3">Vehicle type classification</th><th>Annual mileage</th><th>Number of years used</th><th>Reference</th></tr>
<tr><td rowspan="2">Small-sized vehicle</td><td colspan="2">Passenger car</td><td>8,500 km</td><td>16 years</td><td></td></tr>
<tr><td colspan="2">Small truck</td><td>10,000 km</td><td>15 years</td><td></td></tr>
<tr><td rowspan="8">Heavy vehicle</td><td rowspan="3">Truck</td><td>Small</td><td>30,000 km</td><td>10 years</td><td>Typical vehicle type: T2</td></tr>
<tr><td>Medium</td><td>60,000 km</td><td>11 years</td><td>Typical vehicle type: T5</td></tr>
<tr><td>Large</td><td>99,000 km</td><td>11 years</td><td>Typical vehicle type: T11</td></tr>
<tr><td rowspan="3">Tourist bus</td><td>Small</td><td>26,000 km</td><td>15 years</td><td>Typical vehicle type: B1</td></tr>
<tr><td>Medium</td><td>70,000 km</td><td>11 years</td><td>Typical vehicle type: B3</td></tr>
<tr><td>Large</td><td>120,000 km</td><td>12 years</td><td>Typical vehicle type: B6</td></tr>
<tr><td rowspan="2">Route bus</td><td>Medium</td><td>33,000 km</td><td>11 years</td><td>Typical vehicle type: BR3</td></tr>
<tr><td>Large</td><td>48,000 km</td><td>13 years</td><td>Typical vehicle type: BR4, BR5</td></tr>
<tr><td rowspan="2">Motorcycle</td><td colspan="2">Small-sized motorcycle</td><td>2,500 km</td><td>13 years</td><td></td></tr>
<tr><td colspan="2">Large motorcycle</td><td>4,500 km</td><td>13 years</td><td></td></tr>
</table>

* Values have been set by referencing the following information and actual performance of member companies of JAMA

- Automobile Inspection & Registration Information Association “Table of the (detailed) number of vehicles owned according to vehicle type”
- Ministry of Land, Infrastructure, Transport and Tourism “Monthly statistical report on automobile transportation: Appendix Table 1 - Fuel consumption, kilometrage, etc.”
- Japan Automobile Recycling Promotion Center “Status of operations based on the Act on Recycling of End-of-Life Automobiles”
- Japan Automobile Recycling Promotion Center “Automobile Recycling Data Book”

1.5 System boundary

The Guidelines cover the following life cycle stages in the product system.

- Material production stage
- Parts and vehicles production stage
- Transport stage
- Use stage
- Disposal and recycling stage

The life cycle flow and system boundary are shown in Figure 1-1.

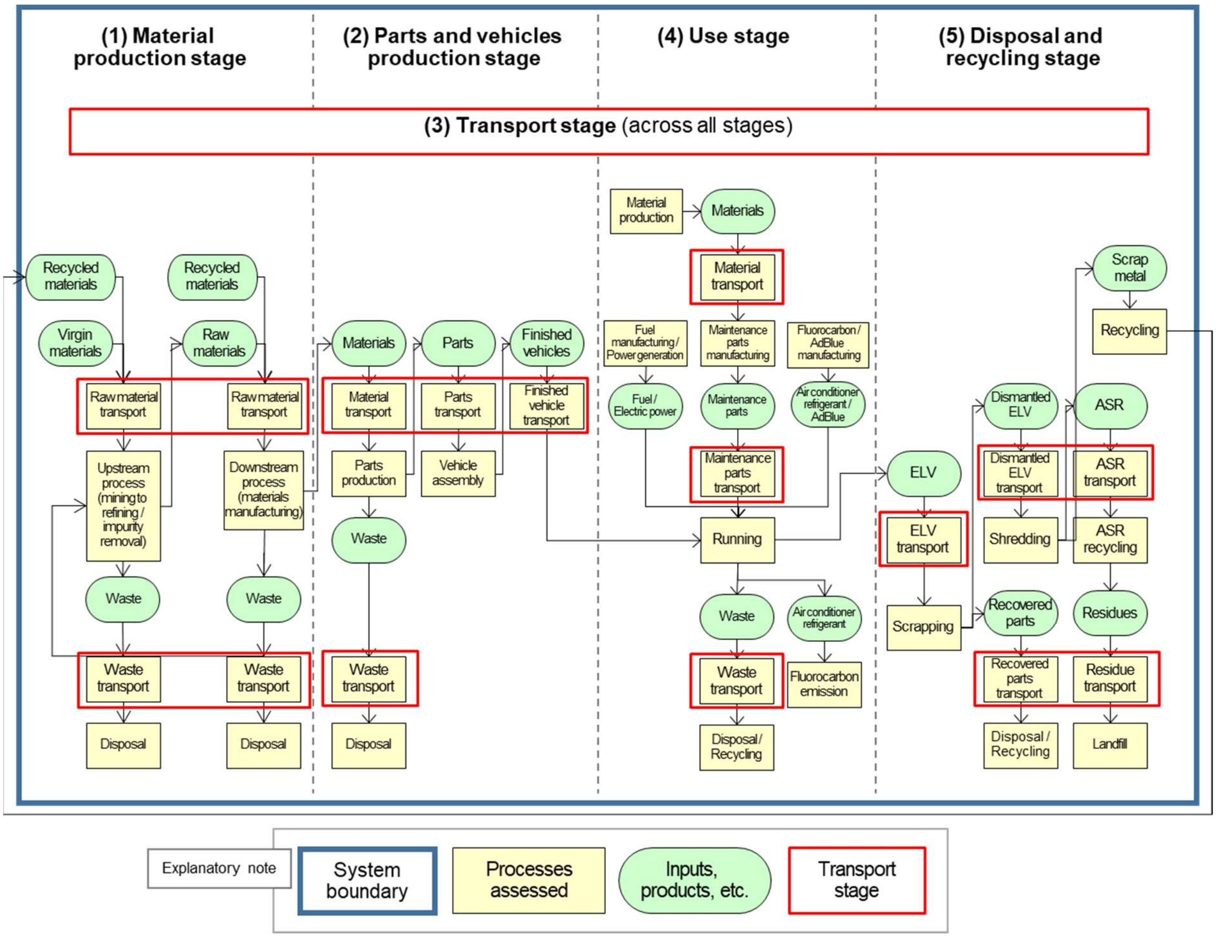


Figure 1-1 Life cycle flow and system boundary

1.6 Impact category

The Guidelines describe the calculation of CFP, so they only cover climate change in theimpact category.

In calculating CFP using the Guidelines, the characterization model regarding climate change, as a general rule, shall use the Global Warming Potential (GWP) 100-year values of the IPCC Fifth Report or the Sixth Report. Among the greenhouse gas (GHG) emission intensities which are referred to in the Guidelines, for GHG emission intensities which do not correspond to the above characterization model as an exception, the appropriate characterization model is described separately.

1.7 Updating the Guidelines

If required, JAMA reviews the calculation method or data used and referred to in the Guidelines and updates the Guidelines, taking into consideration social trends, technological developments, state of adoption of technologies, etc.

2. Normative References and Informative References

2.1 Normative references

The following documents are normative references of the Guidelines.

<Overall>

- International Organization for Standardization (ISO) (2006): ISO 14040:2006 Environmental management — Life cycle assessment — Principles and framework
- International Organization for Standardization (ISO) (2006): ISO 14044:2006, Environmental management — Life cycle assessment — Requirements and guidelines
- International Organization for Standardization (ISO) (2018): ISO 14067:2018, Greenhouse gases — Carbon footprint of products — Requirements and guidelines for quantification

<Disposal area>

- European Commission (2021): Commission Recommendation (EU) 2021/2279 on the use of the environmental footprint methods to measure and communicate the life cycle environmental performance of products and organisations.
- Ministry of the Environment (2003): Regarding the present effective recycling rate for end-of-life vehicles
- Ministry of Economy, Trade and Industry (2020): List of calculation methods and emission factors

2.2 Informative references

The following documents are informative references of the Guidelines.

<Overall>

- Sustainable Management Promotion Organization (SuMPO) (2023): SuMPO Environmental Labeling Program - Quantification and Declaration Rules (General Rules and Requirements) revision No. 06
  https://ecoleaf-label.jp/wp-content/uploads/2024/05/JR-07-06_QuantificationAndDeclarationRules_1.pdf
- International Organization for Standardization (ISO) (2016): ISO 14021:2016, Environmental labels and declarations — Self-declared environmental claims (Type II environmental labelling)
- Zampori, L. and Pant, R. (2019): Suggestions for updating the Product Environmental Footprint (PEF) method, EUR 29682 EN, Publications Office of the European Union, Luxembourg
  https://publications.jrc.ec.europa.eu/repository/handle/JRC115959
- World Resources Institute, World Business Council for Sustainable Development (2011): GHG Protocol Product Life Cycle Accounting and Reporting Standard, USA, ISBN 978-1-56973-773-6
  https://ghgprotocol.org/sites/default/files/standards/Product-Life-Cycle-Accounting-Reporting-Standard_041613.pdf

<Intensity>

- National Institute of Advanced Industrial Science and Technology (2023): JAMA report "Setting of the material intensity in vehicle LCA"
- National Institute of Advanced Industrial Science and Technology (2023): Second JAMA report "Report on technology consulting regarding setting of the material intensity in vehicle LCA"

<Iron & steel>

- International Organization for Standardization (ISO) (2018): ISO 20915:2018 Life cycle inventory calculation methodology for steel products
- World Steel Association (2011): LCA methodology report.
- Junxi Liu, Ichiro Daigo, Daryna Panasiuk, Pasan Dunuwila, Ko Hamada, Takeo Hoshino (2022): Impact of recycling effect in comparative life cycle assessment for materials selection - A case study of light-weighting vehicles. Journal of Cleaner Production. 349, 131317
  https://www.sciencedirect.com/science/article/pii/S0959652622009465
- RMI (2023): Steel GHG Emissions Reporting Guidance

<Aluminum>

- International Aluminium Institute (2021): Aluminium Carbon Footprint Methodology. v2.0
- European Aluminium (2023): Methodological Guidance for the Environmental Assessment of Aluminium

Intermediate and Semi-finished Products. rev.8

<Copper>
- International Copper Association (2023): Copper Environmental Profile
  Copper Environmental Profile - Copper Alliance

<Resin>
- International Council of Chemical Associations
  https://icca-chem.org/
- Plastics Europe (2023): Eco-profiles set
  https://plasticseurope.org/sustainability/circularity/life-cycle-thinking/eco-profiles-set/

<Wood>
- KS Gan, AR Zairul, R Geetha and M Khairul (2021): LIFE CYCLE ASSESSMENT ON LOG HARVESTING FROM NATURAL FOREST IN PENINSULAR MALAYSIA, Journal of Tropical Forest Science. 33 (2), 213-223
  https://www.jstor.org/stable/27007569
- Yusuke Nambu, Toshiharu Ikaga, Hiroki Hondo, Kensuke Kobayashi, Yuko Tsunetsugu (2012): Developing a LCA database of wood materials - Architectural Institute of Japan (AIJ) Journal of Technology and Design, 18(38), 269-274
  https://www.jstage.jst.go.jp/article/aijt/18/38/18_38_269/_pdf/-char/ja
- FAO, ITTO and United Nations (2020): Forest product conversion factors
  https://www.itto.int/direct/topics/topics_pdf_download/topics_id=6402&no=1&disp=inline
- Sustainable Management Promotion Organization (SuMPO) (2023): SuMPO Environmental Labeling Program Product Category Rule (PCR) - Wood, Wood Materials
  https://ecoleaf-label.jp/pcr/download/72

<Battery materials>
- Joint Research Centre (2023): JRC Science for Policy Report, Rules for the calculation of the Carbon Footprint of Electric Vehicle Batteries (CFB-EV), Final draft
- Argonne National Laboratory (2023) R&D GREET Excel Model Platform GREET2_2023.xlsm, Battery_Sum sheet, EV: Conventional Material.
  https://greet.anl.gov/greet_excel_model.models

<Electricity>
- International Energy Agency (2023): World Energy Outlook 2023 Free Dataset
  World Energy Outlook 2023 Free Dataset - Data product - IEA
- International Energy Agency (2023): Life cycle Upstream Emission Factors 2023 (Pilot Edition)
  IEA_UpstreamLifeCycleEmissionFactors_Documentation.pdf (windows.net)

<Transport>
- Ministry of Economy, Trade and Industry (2023): March 28, 2023, Public Notice No. 23 of the Ministry of Economy, Trade and Industry “Calculation method of energy usage concerning transport of goods performed by freight carriers”

<Disposal area>
- Japan Foundation for Advanced Auto Recycling (J-FAR), NTT DATA Japan Corporation (2022): Report on project for the visualization of CO2 emissions across automobile recycling
- The Japan Automobiles Tyre Manufacturers Association, Inc. (2021): Tyre LCCO$_2$ Calculation Guidelines Ver. 3.0.1
- Ministry of the Environment (2022): Fiscal 2021 report for a survey and study on the measures to be taken in the automotive recycling field toward achieving carbon neutrality by 2050
- Japan Auto Recycling Partnership (JARP) (2022): Demonstration project for the sophistication of information management systems for vehicle lithium-ion battery collection
- Automobile Shredder Residue Recycling Promotion Team (2023): Ratio of recovery (utilization) over ASR input in a facility in fiscal year 2023
  https://www.asrrt.jp/asr/place/index.html

3. Terms and Definitions

3.1 Terms related to automobiles

(1) Passenger car

A motor vehicle which, on account of its design and appointments, is intended mainly for carrying persons and their luggage and/or goods, and which has available a maximum of nine seating places, including the driving seat. [ISO 3833:1977 Paragraph 3.1]

(2) Bus

A motor vehicle which, on account of its design and appointments, is intended for carrying persons and luggage, and which has more than nine seating places, including the driving seat. [ISO 3833:1977 Paragraph 3.1]

(3) Truck

A motor vehicle which, on account of its design and appointments, is intended mainly for carrying goods. [ISO 3833:1977 Paragraph 3.1]

(4) Hybrid-electric vehicle, HEV

A vehicle with both a rechargeable energy storage system and a fueled power source for vehicle propulsion. [ISO/TR 8713:2019 Paragraph 3.79]

(5) Plug-in hybrid-electric vehicle, PHEV

A hybrid-electric vehicle with a rechargeable energy storage system that is intended to be charged from an external electric energy source. [ISO/TR 8713:2019 Paragraph 3.62]

(6) Electrically propelled vehicle, EV

A vehicle with one or more electric drive(s) for vehicle propulsion. [ISO/TR 8713:2019 Paragraph 3.46]

(7) Fuel cell vehicle

An electrically propelled vehicle with a fuel cell system as the power source for vehicle propulsion. [ISO/TR 8713:2019 Paragraph 3.71]

(8) OEM (original equipment manufacturer)

A vehicle manufacturer.

(9) Complete vehicle kerb mass

This is the complete vehicle shipping mass plus the mass of accessories (such as tools). [ISO 1176:1990 Paragraph 4.6]

(10) ELV

End-of-life vehicle

(11) ASR

Automobile shredder residue

(12) Hybrid fuel economy

A fuel consumption rate when a hybrid-electric vehicle or a plug-in hybrid-electric vehicle runs in hybrid mode (running without using electric power from external charging). [Ministry of Land, Infrastructure, Transport and Tourism: Regarding the method for measuring emission gas and fuel consumption of a plug-in hybrid-electric vehicle]

(13) Plug-in fuel economy

A fuel consumption rate when a plug-in hybrid-electric vehicle runs in plug-in mode (running using electric power from external charging). [Ministry of Land, Infrastructure, Transport and Tourism: Regarding the method for measuring emission gas and fuel consumption of a plug-in hybrid-electric vehicle]

(14) Utility factor, UF

This is the contribution percentage of running in plug-in mode to entire running of a plug-in hybrid-electric vehicle. [Ministry of Land, Infrastructure, Transport and Tourism: Regarding the method for measuring emission gas and fuel economy of a plug-in hybrid-electric vehicle]

(15) Retreaded tire

A tire which is reused by re-covering worn tread rubber due to running (portion which contacts the road surface) and reviving the function of the tire. [Japan Retreaders' Association: Website]

(16) HFC-134a

1,1,1,2-Tetrafluoroethane; a type of air conditioner refrigerant.

(17) HFO-1234yf

2,3,3,3-Tetrafluoro-1-propene; a type of air conditioner refrigerant.

(18) V2X (vehicle-to-everything)

A technology in which vehicles are used as power sources or electric load is leveled by connecting vehicles to the grid power, buildings or other applications. [International Energy Agency, V2X Roadmap 2019][Renewable Energy Institute: Trends and prospects of penetration of EV, 2018]

(19) IMDS (international material data system)

A material data system for the automobile industry. [IMDS website]

(20) BOM

Bill of materials

(21) CCS (Carbon dioxide capture and storage)

A technology in which CO_2, which is emitted from a factory or an electric power plant, is separated and captured, transported to the place suitable for underground storage, and stably stored over an extended period of time.

(22) CCU (Carbon dioxide Capture and Utilization)

A technology in which CO_2 emitted from a factory or an electric power plant is separated and captured, and converted to fossil fuel-derived fuel or products such as chemicals.

3.2 Terms related to carbon footprint of products

(1) Carbon footprint of products (CFP)

This is the sum of greenhouse gas emissions and greenhouse gas removals in a product system. It is expressed as CO_2 equivalents. [ISO 14067:2018 Paragraph 3.1.1.1]

3.3 Terms related to greenhouse gases

(1) Greenhouse gas (GHG)

This is the gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds. GHG includes carbon dioxide (CO_2), methane (CH_4), nitrogen monoxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). [ISO 14064-1:2018 Paragraph 3.1.1]

(2) Greenhouse gas source

This is a physical unit or process that releases a GHG into the atmosphere. [ISO 14064-1:2018 Paragraph 3.1.2]

(3) Greenhouse gas emission

This is the sum of greenhouse gas mass released into the atmosphere within a specific time period. [ISO 14064-1:2018 Paragraph 3.1.5]

(4) Greenhouse gas emission factor

A coefficient which converts activity data to greenhouse gas emissions. [ISO 14064-1:2018 Paragraph 3.1.7]
Note: In the Guidelines, this shall refer to emissions which do not trace back to upstream GHG emissions of subject activities (so-called gate-to-gate).

(5) Greenhouse gas emission intensity

A numerical value which converts activity data to greenhouse gas emissions.
Note: In the Guidelines, this shall refer to a value which traces back to upstream GHG emissions of subject activities (so-called cradle-to-gate).

(6) Global warming potential (GWP)

A coefficient which describes the impact of the radiative forcing per unit mass of each GHG by carbon dioxide equivalents for a predetermined period of time. [ISO 14064-1:2018 Paragraph 3.1.12]

(7) Carbon dioxide equivalent (CO_2 e)

A unit for comparing the radiative forcing of a GHG to that of carbon dioxide. The carbon dioxide equivalent is calculated using the mass of a given GHG multiplied by its global warming potential. [ISO 14064-1:2018 Paragraph 3.1.13]

3.4 Terms related to product, product system and process

(1) Process

A set of interrelated or interacting activities that transforms inputs into outputs. [ISO 14044:2006 Paragraph 3.11]

(2) Functional unit

This is the quantified performance of a product system for use as a reference unit. [ISO 14040:2006 Paragraph 3.20]

(3) System boundary

A set of criteria specifying which unit processes are part of a product system. [ISO 14044:2006 Paragraph 3.32]

(4) Reference flow

A quantitative measure of the outputs from processes in a given product system required to fulfil the function expressed by the functional unit. [ISO 14040:2006 Paragraph 3.29]

(5) Elementary flow

A material or energy entering the system being studied that has been drawn from the environment without previous human transformation, or material or energy leaving the system being studied that is released into the environment without subsequent human transformation. [ISO 14044:2006 Paragraph 3.12]

3.5 Terms relating to life cycle assessment

(1) Life cycle

This refers to the consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal. [ISO 14044:2006 Paragraph 3.1]

(2) Life cycle assessment (LCA)

This refers to the compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its entire life cycle. [ISO 14044:2006 Paragraph 3.2]

(3) Life cycle inventory analysis (LCI)

A phase of LCA involving the compilation and quantification of inputs and outputs for a product throughout its entire life cycle. [ISO 14044:2006 Paragraph 3.3]

(4) Life cycle impact assessment (LCIA)

A phase of LCA aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product. [ISO 14044:2006 Paragraph 3.4]

(5) Circular footprint formula (CFF)

A modeling method for calculating and allocating load and credit related to recycled materials and disposal. [European Commission, Annex I of C (2021) 9332 final]

(6) Recycled content method (RCM)

A method for allocating GHG emissions and removals in the recycling process to the life cycle that uses the recycled material. [GHG Protocol, Product Life Cycle Accounting and Reporting Standard]

3.6 Terms related to data and data quality

(1) Primary data

A quantified value of a process or an activity obtained from a direct measurement or a calculation based on direct measurements. [ISO 14067:2018 Paragraph 3.1.6.1]

(2) Site-specific data

This refers to data obtained from a direct measurement or data obtained from a calculation based on a direct measurement in the first information source within the product system. All site-specific data are primary data. (However, not all primary data are site-specific data.) [ISO 14067:2018 Paragraph 3.1.6.2]

(3) Secondary data

This refers to data obtained from information sources other than a direct measurement, or data obtained from sources other than a calculation based on a direct measurement in the first information source within the product system. These information sources can include databases, published literature, national inventories, and other general information sources. [ISO 14067:2018 Paragraph 3.1.6.3]

(4) Default value

A representative value reflecting the industry mainstream level. For example, material component ratio of a passenger car, GHG emission factor of material production, GHG emission factor of finished vehicle production, etc.

3.7 Terms related to biogenic material and land use

(1) Biomass

A material of biological origin, excluding material embedded in geological formations and material transformed to fossilized material. [ISO 14067:2018 Paragraph 3.1.7.1]

(2) Biogenic carbon

This refers to carbon derived from biomass. [ISO 14067:2018 Paragraph 3.1.7.2]

(3) Fossil carbon (biomass)

This refers to carbon that is contained in fossilized material. [ISO 14067:2018 Paragraph 3.1.7.3]

(4) Land use

This refers to human use or management of land within the system boundary. [ISO 14067:2018 Paragraph 3.1.7.4]

(5) Direct land use change (dLUC)

This refers to change in the human use of land within the system boundary.

(6) Indirect land use change (iLUC)

This refers to change in the human use of land outside the system boundary, which occurs as a consequence of direct land use change.

4. Method for Calculating Carbon Footprint

4.1 Items applied across all stages

4.1.1 Data quality standards and data collection methods

4.1.1.1 Standard for setting scope of primary data collection

The scope of primary data collection should be in accordance with 4.2.2.1 , 4.3.2.1 , 4.4.2.1 , 4.5.2.1 , and 4.6.2.1 . Primary data can also be collected for data collection categories outside the scope of primary data collection as necessary.

4.1.1.2 Primary data quality

(1) Standard for temporal scope

The scope should be set as the most recent one year, or a period for which the same appropriateness can be obtained. If there is no data for a period of one year, data shall be collected for the maximum period from the start or until the end of the product's production.

(2) Standard for geographical scope

Calculation should be carried out appropriately based on the data of each region, taking into account differences between regions. However, the differences between regions need not be taken into account if such differences do not exist or are minute.

When several locations fall under the scope of primary data collection, primary data should be collected using methods with little bias so that, cumulatively, the scope covers 50% or more of the production or procurement volume of all locations. Alternatively, the scope should be set to obtain the same appropriateness.

For materials, geographical impact should be taken into account in particular for production processes in the production stage that consume a lot of electricity. 4.2 shows the applicable processes.

(3) Standard for technological scope

The scope should be the production technology of the product in question, or the production technology of similar products for which the same appropriateness as the production technology of the product in question can be obtained.

The process information in question should be collected without gaps, taking into account upstream processes, in accordance with 1.5 System boundary.

For materials, production technologies that are consistent in upstream and downstream process categories should be referenced.

(4) Standard for reproductivity

The evidence for data being used in calculations should be clear.

(5) Special case for primary data quality standards of raw materials when primary data is collected from suppliers

The standard for temporal scope should be set as the most recent one year (calendar year or accounting year), or a period for which the same appropriateness can be obtained.

4.1.1.3 Primary data collection methods

(1) Activity data and factors for obtaining activity volume

a) Data collection using process-based life cycle assessment

When collecting and measuring data, it is preferred to be capable of obtaining data that only covers the product in question. Data covering the product in question should be obtained at the very least.

b) Other matters to note when collecting data

Priority is given to actual measurements when collecting input and output flow data of each process, although design and planned values from product designs, specifications, blending standards, and such as well as estimates from processes of similar products can also be used. However, the primary data quality standards must still be met when using design, planned, or estimated values.

The amount of each input to each process should be calculated taking into account the loss rate of each process. This does not apply when the composition of inputs or processes span a large range and it is not realistic to consider the loss rates.

For the emissions of waste and such, data should be collected based on the inputs and outputs of substances for each process. However, when the composition of inputs or processes span a large range and it is not realistic to collect data based on the inputs and outputs of substances, data can be collected based on the allocation of the amounts of waste and such generated by the factory as a whole.

c) Data collection methods for materials

For material weight, which serves as material activity data, weight information such as from IMDS, BOM, drawings, and such can also be used as primary data instead of the measured values of products.
(However, when the yield rate in the production process is used as primary data, data actually measured for the process must be used.)

(2) Intensity

When using primary data to generate the intensity, besides the burden from inputs, the burden from transporting waste and such as well as waste water generated during production to treatment facilities and processing at such facilities should also be included.

The intensity calculated based on primary data collected by operators or supply chain partners can also be used as primary data. In such cases, the primary data collected by operators or supply chain partners should fulfill the primary data quality standards stated in the previous section.

For materials, the information of upstream and downstream processes should be attached to confirm the technological scope for data quality given in 4.1.1.2 .

4.1.1.4 Secondary data quality

(1) Standard for temporal scope

When using secondary data unique to operators, the temporal scope is to be set as an arbitrary one-year period within the last five years, or a similar period.

For other secondary data, the document or database stating the data being used should be published or announced within the last five years.

(2) Standard for technological scope

The scope should be the production technology of the product in question, or the production technology of similar products for which the same appropriateness as the production technology of the product in question can be obtained.
(For materials, production technologies that are consistent in upstream and downstream process categories should be referenced.)

(3) Standard for reproductivity

The evidence for data being used in calculations should be clear.

4.1.1.5 Secondary data collection methods

Operators shall use the intensity data from databases, documents, and such designated in the evaluation methods for the respective stages in 4.2, 4.3, 4.4, 4.5, and 4.6. When the value of the intensity data is not designated, the

latest data from the same database can also be used.
When secondary data is being used for the intensity of materials, an intensity consistent with the upstream and downstream processes should be used.

4.1.2 Cut-off rules

The cut-off categories stated in this set of guidelines can be excluded. In addition, cut-off categories can be added during calculation in accordance with the cut-off criteria stipulated below.

1) For parts, materials, packaging, and secondary materials used as inputs, cut-off shall be up to a cumulative 1% of the reference flow mass. However, items with small mass that are expected to have a large index in the area of influence should be included in the product system (example: printed circuit boards in electronic devices).

2) For substances, waste, and such being emitted, cut-off shall be up to a cumulative 1% of the reference flow mass. However, items with small mass that are expected to have a large index in the area of influence should be included in the product system. In particular, it is necessary to pay attention to direct emissions into the atmosphere, hydrosphere, and such, and to harmful substances subjected to management (example: air conditioner refrigerant leakage, etc.).

3) For flows and processes that cannot be grasped using mass, cut-off shall be up to a cumulative 1% of the index in the area of influence against the calculation results (example: transport process within a site).

4) The area where information with adequate reliability cannot be obtained and it is difficult to create an appropriate scenario model (example: construction and capital assets of a production factory, indirect departments).

5) In the internal recycling process of materials, it is a recycling process whereby waste is returned to the material production process without processing.

4.1.3 Allocation rules

When a process generates several products as output, allocation should be undertaken in accordance with the following progressive steps as it is necessary to allocate the input and output flows across several products.

1) Step 1: If possible, avoid allocation through any of the following.
   - Further split the unit process subjected to allocation into two or more subprocesses, and collect input and output flow data related to these subprocesses.
   - Expand the product system to include additional functions related to co-products.

2) Step 2: When allocation cannot be avoided, the input and output flows of a system can be divided and allocation using a method that reflects the physical relationship that exists between different products or functions. In other words, it is preferred that the method allocates input and output flows according to changing relationships in line with the quantitative changes of products or functions being provided by the system. For example, allocation can be undertaken between co-products according to the ratio of product mass, amount of heat, quantity, work area, and other such factors.

3) Step 3: When the physical relationship alone cannot be used as evidence for allocation, the input and output flows can be allocated between products and functions using a method that reflects the relationships between products and functions. For example, environmental input and output flow data can be allocated between co-products according to the ratio of product economic values. For example, allocation can be undertaken according to the ratio of prices when there is a mix of lightweight products with high added value, such as precious metals.

4.1.4 Handling of biomass

Regarding biomass being managed using sustainable methods and biomass of waste materials and other reused products, the CO_2 emissions and removals should be calculated respectively and separately shown.
In addition, CO_2 emissions arising from activities introduced for the production, transport, and such of biomass as well as emissions of greenhouse gases such as methane generated during biodegradation should be included in the product system.

4.1.5 Handling of land use and land use change

The evaluation results of GHG emissions and removals arising from direct land use change should be included in CFP calculations.
The evaluation results of GHG emissions and removals arising from land use can be included in CFP calculations. When evaluating GHG emissions and removals from land use and land use change, evaluation should be undertaken in accordance with internationally recognized methods, and GHG emissions and removals should be separately shown when generating reports.

In the evaluation of land use and land use change, database values that take them into account can also be referenced.
However, when procurement from sustainable land can be confirmed, land use and land use change can be exempted from CFP calculations. In addition, cut-off can be carried out in accordance with Cut-off rules in 4.1.2 .

4.1.6 Recycling

The circular footprint formula (CFF) outlined below shall be applied to the evaluation of material/parts recycling. In the material production stage, 1) material production shall be evaluated. In the disposal and recycling stage, both 2) burdens and allowances related to recycled material use and 3) burdens and allowances related to recycled material supply shall be evaluated as the total value of 2) and 3) (CFF effect). Additionally, the CFF effect shall be separately indicated.

$$(1-R_1)E_V + R_1 \times \left(AE_{recycled} + (1-A)E_V \times \frac{Q_{S_{in}}}{Q_P}\right) + (1-A)R_2 \times \left(E_{recyclingEoL} - E_V^* \times \frac{Q_{S_{out}}}{Q_P}\right)$$

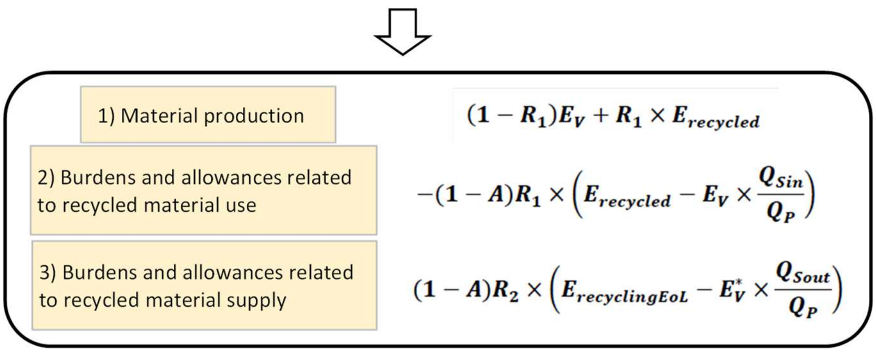


Figure 4-1 Circular footprint formula and its components
(Source: Product Environmental Footprint Category 1 Rules Guidance 2 Version 6.3 – May 2018)

In cases where obtaining appropriate data for CFF parameter setting is difficult, the recycled content method (RCM) may be applied.
The definition of recycled materials and recycled content ratio shall follow ISO 14021.

4.2 Material production stage

The system boundary of the material production stage is outlined below.

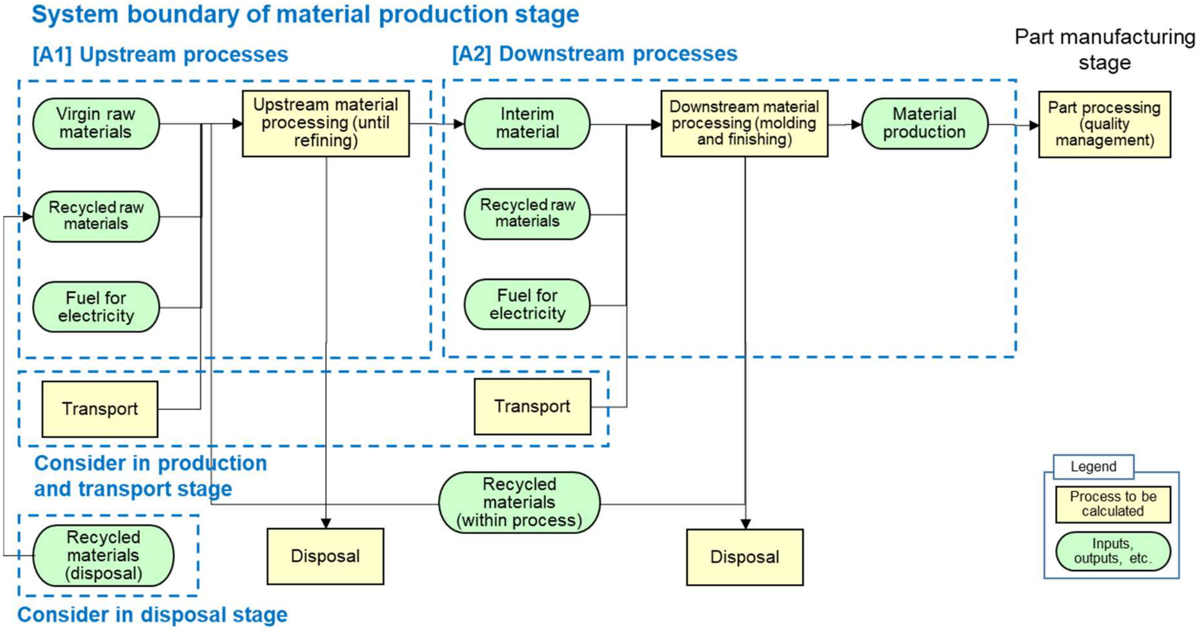


Figure 4-2 System boundary of the material production stage

4.2.1 Processes included in the scope of data collection

Data collection applies to the processes outlined below.

[A1] Processes related to material mining, refining, and impurity removal (defined as upstream processes)
[A2] Processes related to material production (defined as downstream processes)

In the material production stage, material production should be evaluated. In the disposal and recycling stage, both burdens and allowances related to recycled material use and burdens and allowances related to raw material provision of recycled materials should be evaluated as the total value of the two (CFF effect).

4.2.2 Data collection categories

Data shall be collected for the categories outlined below.

[A1] Processes related to material mining, refining, and impurity removal (defined as upstream processes)

- Types of processes defined in Appended figure 1, Appended figure 2, Appended figure 3, and Appended figure 4
- Material input weight and blending ratio (usage rate of recycled materials and bio-derived materials)
- When using recycled raw materials and applying the circular footprint formula (CFF), refer to the CFF parameters (Section 4.6)
- Country of origin, country/region of processing, amount of fuel used for electricity, and rate of renewable energy
- GHG emission factors related to upstream processes

[A2] Processes related to material production (defined as downstream processes)

- Products being used defined in Appended figure 1, Appended figure 2, Appended figure 3, and Appended figure 4 as well as the types of processes related to their production
- Material input weight and blending ratio (usage rate of recycled materials and bio-derived materials)
- When using recycled raw materials and applying the circular footprint formula (CFF), refer to the CFF parameters (Section 4.6)
- Country/region of processing, amount of fuel used for electricity, and rate of renewable energy
- GHG emission factors related to downstream processes

4.2.2.1 Primary data collection categories

Primary data is preferred over secondary data to reflect corporate efforts toward carbon neutrality. In principle, material information in the International Material Data System (IMDS), which is implemented across the automotive industry, should be collected as primary data.

[IMDS material data]
- Material name, VDA classification, material number, applicable amount, material weight, and basic substance information

At the same time, going up the supply chain of the upstream processes in the upper reaches of a material to obtain primary data has a high CO_2 reduction effect and can reflect corporate efforts even though still being in the developmental stage. It is therefore recommended to obtain primary data of the categories in [A1] and [A2] outlined below, and secondary data can also be used.

[A1] Processes related to material mining, refining, and impurity removal (defined as upstream processes)
- Types of processes defined in Appended figure 1, Appended figure 2, Appended figure 3, and Appended figure 4
- Material input weight and blending ratio (usage rate of recycled materials and bio-derived materials)
- Country of origin, country/region of processing, amount of fuel used for electricity, and rate of renewable energy

[A2] Processes related to material production (defined as downstream processes)
- Products being used defined in Appended figure 1, Appended figure 2, Appended figure 3, and Appended figure 4 as well as the types of processes related to their production
- Material input weight and blending ratio (usage rate of recycled materials and bio-derived materials)
- Country/region of processing, amount of fuel used for electricity, and rate of renewable energy

4.2.2.2 Secondary data collection categories

The categories outlined below shall be collected as secondary data.
The default values in the appendices can be used, and data collected independently by the party carrying out the calculation can also be used.

[A1] Processes related to material mining, refining, and impurity removal (defined as upstream processes)
- Weight of each raw material and blending ratio (when using a specific scenario model for calculation)
- When using recycled materials and applying the circular footprint formula (CFF), refer to the CFF parameters (Section 4.6)
- GHG emission factors related to upstream processes

[A2] Processes related to material production (defined as downstream processes)
- Weight of each raw material and blending ratio (when using a specific scenario model for calculation)
- When using recycled materials and applying the circular footprint formula (CFF), refer to the CFF parameters (Section 4.6)
- GHG emission factors related to downstream processes

4.2.3 Scenario

[A1, A2] Processes related to material production
- For material classification, the material classification in Appended table 2 with sensitivity of 1% or higher for per vehicle CO_2 should be used, referencing the IMDS sheet of the representative vehicle.
- Each material should be aggregated under the closest classification in Appended table 2. Separate consideration should be taken if it is found that there are materials not found in Appended table 2 with a sensitivity of 1% or higher.
- For battery materials, state in Appended table 2 the secondary data extracted from Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET), which allows convenient use of a lot of battery material data with high reliability. The values in Appended table 2 can also be used as secondary data of battery materials.
- For other materials and individual materials of parts, cite secondary data from existing databases and documents with high reliability, and state the source in Appended table 2. The values in Appended table 2

can also be used as secondary data of other materials and individual materials of parts.

- Regarding the system boundaries of key materials (iron, aluminum, copper, and plastic) with a high usage ratio, referencing reports from international agencies regarding these materials, upstream mining, refining, and impurity removal with high CO_2 sensitivity have been defined as upstream processes, and downstream material processing as the downstream process.
- For secondary data of key materials, the upstream and downstream processes should be consistent with Appended figure 1, Appended figure 2, Appended figure 3, and Appended figure 4.
- Processes shall have connection to the existing processes in Inventory Database for Environmental Analysis (IDEA), the existing intensity database in Japan, be capable of being used with tools, and have transparency. However, as electricity locality and usage ratio of recycled materials depend on the user, companies can conduct their own modeling calculations.
- The yield rate during material production is set as being included in material intensity. When calculating CO_2 during material production, calculation is carried out by multiplying the material intensity by the product weight for each material and the reciprocal of the yield rate during part processing.

4.3 Parts and vehicles production stage

The system boundary of the parts and vehicles production stage is outlined below.

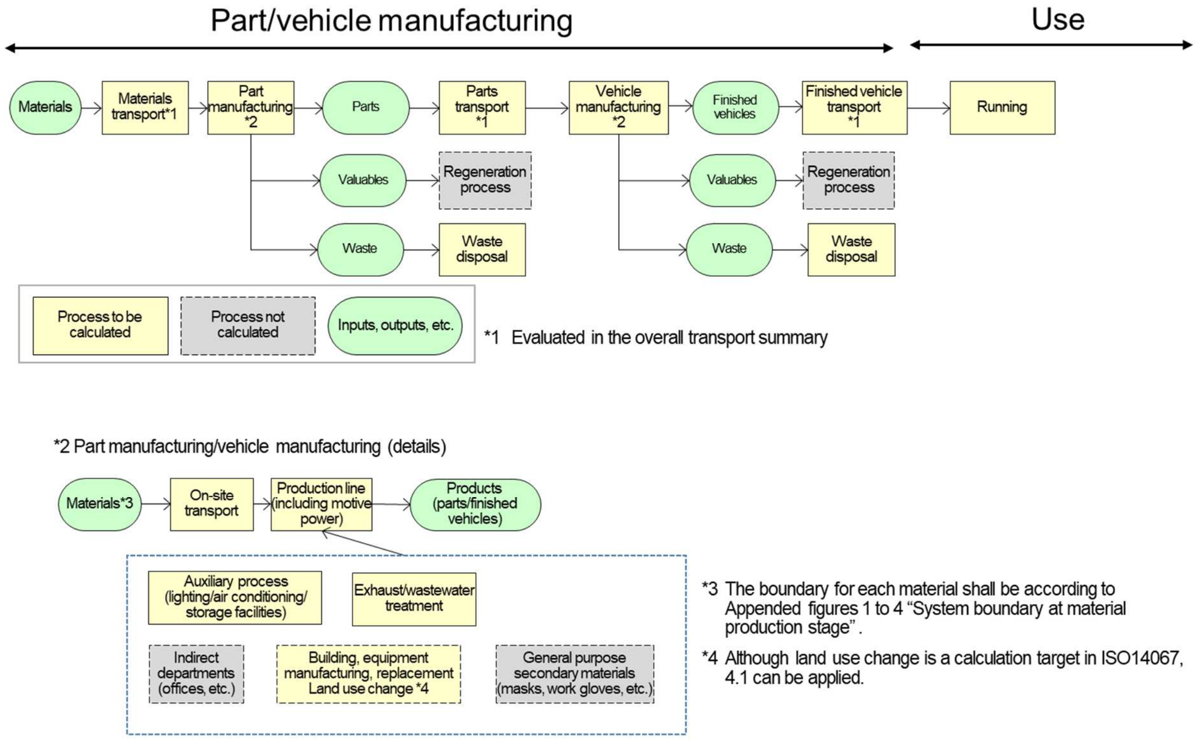


Figure 4-3 System boundary of the parts and vehicles production stage

Calculation methods on an energy basis and on a weight basis are indicated below, and a calculation on the energy basis is recommended in order to promote visualization and reduction activities toward carbon neutrality.

<Energy basis>
Production process = Fuel consumption by type [L] × GHG emission intensity [kg-CO_2e/L] (Fuel manufacturing + Fuel combustion)
Generated materials = material mass [kg] × GHG emission intensity [kg-CO_2e/L] concerning material production
Waste disposal = Waste weight [kg] × GHG emission intensity [kg-CO_2e/L] concerning waste disposal

<Weight basis>
Production process = Weight of materials or parts [kg] × Energy coefficient concerning processing by material or part [L/kg] × GHG emission intensity [kg-CO_2e/L] (Fuel manufacturing + Fuel combustion)

4.3.1 Processes included in the scope of data collection

Data collection applies to the processes outlined below.

[B1] Processes concerning parts and vehicles production

4.3.2 Data collection categories

Data shall be collected for the categories outlined below.

[B1] Processes concerning parts and vehicles production
<Energy basis>

- Fuel consumption by type in the parts and vehicles production [L]
- GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing in the parts and vehicles production [Appended table 5]
- GHG emission intensity [kg-CO_2e/L] concerning fuel combustion in the parts and vehicles production [Appended table 5]
- Weight by material [kg]
- GHG emission intensity [kg-CO_2e/L] concerning manufacturing by material (Appended table 6)
- Weight by waste [kg]
- GHG emission intensity [kg-CO_2e/L] concerning disposal by waste (Appended table 7)

<Weight basis>
- Weight of materials or parts in the parts and vehicles production [kg]
- Energy coefficient concerning processing of materials and parts, respectively (Appended table 8, Appended table 9 and Appended table 10)
- GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing in the parts and vehicles production [Appended table 5]
- GHG emission intensity [kg-CO_2e/L] concerning fuel combustion in the parts and vehicles production [Appended table 5]

4.3.2.1 Primary data collection categories

The categories outlined below shall be collected as primary data.

[B1] Processes concerning parts and vehicles production
<Energy basis>
- Fuel consumption by type in the parts and vehicles production [L]
- Weight by material [kg]
- Weight by waste [kg]

<Weight basis>
- Weight of materials or parts in the parts and vehicles production [kg]

4.3.2.2 Secondary data collection categories

The categories outlined below shall be collected as secondary data. The default values in the appendices can be used, and data collected independently by the party carrying out the calculation can also be used.

[B1] Processes concerning parts and vehicles production
<Energy basis>
- GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing in the parts and vehicles production [Appended table 5]
- GHG emission intensity [kg-CO_2e/L] concerning fuel combustion in the parts and vehicles production [Appended table 5]
- GHG emission intensity [kg-CO_2e/L] concerning manufacturing by material (Appended table 6)
- GHG emission intensity [kg-CO_2e/L] concerning disposal by waste (Appended table 7)

<Weight basis>
- Energy coefficient and yield rate concerning processing of materials and parts, respectively (Appended table 8, Appended table 9 and Appended table 10)
- GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing in the parts and vehicles production [Appended table 5]
- GHG emission intensity [kg-CO_2e/L] concerning fuel combustion in the parts and vehicles production [Appended table 5]

4.3.3 Scenario

[B1] Processes concerning parts and vehicles production
<Weight basis>
- Regarding the processing intensity in the parts and vehicles production, each material shall go through a

certain processing process (Appended table 8) by reference to the “Japan Auto Parts Industries Association (Second Edition).

- Regarding the coefficient of each processing process, the typical survey values of processing processes by the Japan Automobile Manufacturers Association, the Japan Auto Parts Industries Association, and the Japan Auto-Body Industries Association are indicated in Appended table 9.
- With regard to tires, lead batteries, lithium-ion (Li-ion) batteries and nickel-metal hydride (Ni-MH) batteries, the coefficients of processing processes from the existing database and highly reliable literature are indicated in Appended table 10.

4.3.4 Others

- Offset by carbon credits or contribution to reduction shall not be included in the CFP calculation.
- In the CFP calculation, a renewable energy certificate may be used for electricity purchased from outside.
- When a renewable energy certificate (*1) is included in the CFP calculation, the amount of electricity consumed for the product and the renewable energy certificate shall be retained as grounds for the calculation. In addition, the renewable energy certificate may not be used exceeding the amount of electricity consumed.
- If a renewable energy certificate is purchased and it is applied to the product, the emission factor at the time of generating electricity is zero, but the emission factor in the upstream side (fuel manufacturing and procurement, equipment manufacturing, etc.) shall be added (*2).
- Regarding use of CCS (*3), if carbon dioxide is captured before it is emitted from the company’s own plant to the atmosphere, it may be included in the CFP calculation. In such a case, the net balance of GHG, which is stored by separation and capture during the relevant process of the plant (product) that is capturing GHG, must be demonstrated. Furthermore, for the CFP calculation of the product manufactured by a plant other than the pertinent plant which is capturing GHG, the effect of CSS shall not be used.

*1: A usable renewable energy certificate must satisfy the Scope 2 Quality Criteria in the Scope 2 Guidance of the GHG protocol.

*2: When calculating using a renewable energy certificate, it is recommended that a consistent calculation method be used also for other procurement methods of electricity. Such calculation methods are summarized as follows.

- If an emission factor for an supplier can be obtained, an emission factor in the upstream side is added to the supplier’s emission factor.
- If an emission factor for an supplier cannot be obtained, an emission factor in the upstream side is added to the emission factor which is an average of countries and regions using secondary data.

*3: GHG emissions related to CCS shall be considered in accordance with ISO/TR27915 or equivalent international standards, etc.

4.4 Transport stage

The system boundary of the transport stage is outlined below.

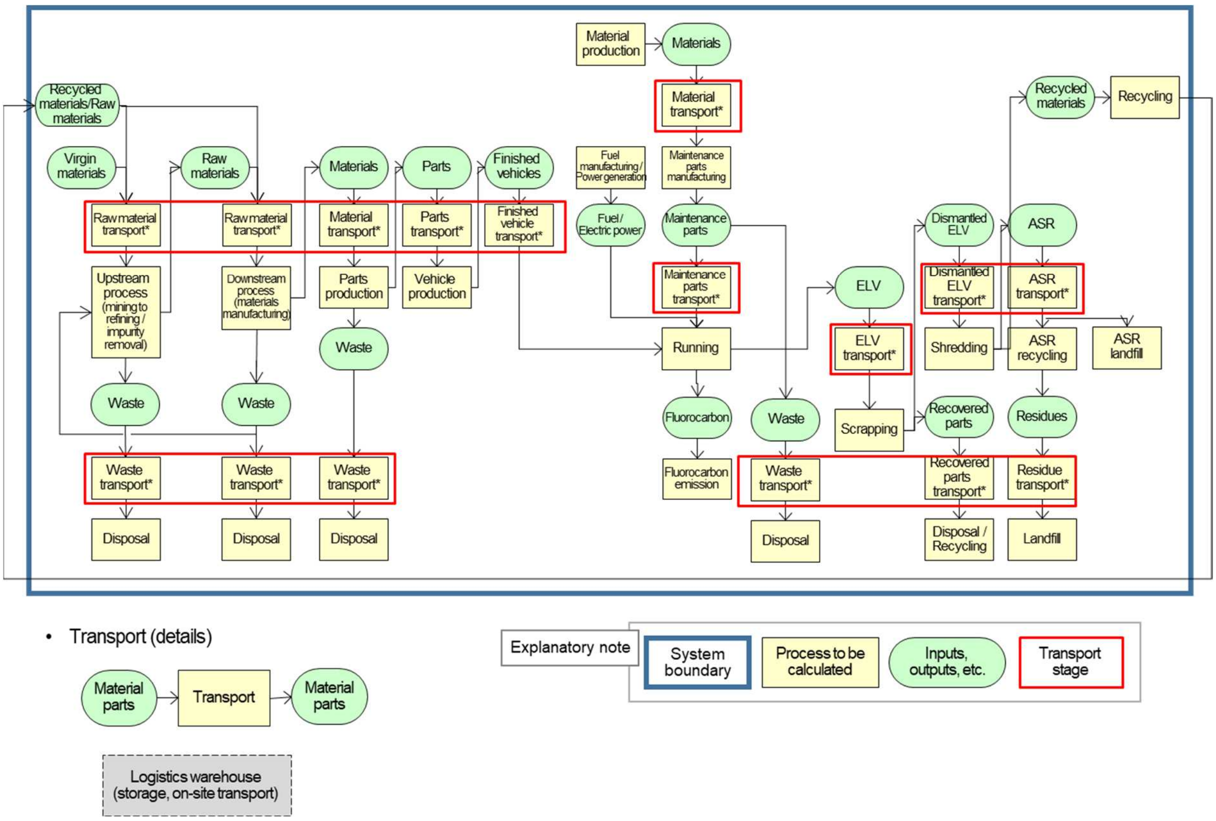


Figure 4-4 System boundary of the transport stage

Calculation methods on an energy basis and on a weight basis are indicated below, and a calculation on the energy basis is recommended in order to promote visualization and reduction activities toward carbon neutrality.

<Energy basis>

Fuel method = Fuel or electricity consumption [L] × GHG emission intensity for transport [kg-CO_2e/L] (Fuel manufacturing + Fuel combustion)

Fuel consumption method = Transport distance [km] × 1 / Fuel consumption [km/L] × GHG emission intensity for transport [kg-CO_2e/L] (Fuel manufacturing + Fuel combustion)

Improved ton-kilometer method = Transport weight [kg] × Transport distance [km] × Improved ton-kilometer method fuel usage intensity [L/kg・km] × GHG emission intensity for transport [kg-CO_2e/L] (Fuel manufacturing + Fuel combustion)

Conventional ton-kilometer method = Transport weight [kg] × Conventional ton-kilometer method CO_2 intensity [g-CO_2/kg・km]

<Weight basis>

= Transport weight [kg] × GHG emission factor [kg-CO_2e/kg]

4.4.1 Processes included in the scope of data collection

Data collection applies to the processes outlined below.

[C1] Processes related to material transport
[C2] Processes related to parts transport
[C3] Processes related to finished vehicle transport
[C4] Processes related to scrapped vehicle transport
[C5] Processes related to maintenance parts transport

4.4.2 Data collection categories

Data shall be collected for the categories outlined below.

Processes related to [C1] material transport, [C2] parts transport, [C3] finished vehicle transport, [C4] scrapped vehicle transport, [C5] maintenance parts transport

<Energy basis>

a) Fuel method
- Fuel [L] or electricity consumption [kWh] by transported item
- GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing (Appended table 5)
- GHG emission intensity [kg-CO_2e/L] concerning fuel combustion (Appended table 5)

b) Fuel consumption method
- Transport distance [km] by transported item
- Fuel consumption [km/L] by transported item
- GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing (Appended table 5)
- GHG emission intensity [kg-CO_2e/L] concerning fuel combustion (Appended table 5)

c) Improved ton-kilometer method (trucks)
- Transport weight [kg] by transported item
- Transport distance [km] by transported item
- Improved ton-kilometer method fuel usage intensity [L/kg・km]
- GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing (Appended table 5)
- GHG emission intensity [kg-CO_2e/L] concerning fuel combustion (Appended table 5)

d) Conventional ton-kilometer method (railways, ships, aircraft)
- Transport weight [kg] by transported item
- Conventional ton-kilometer method CO_2 intensity [g-CO_2/kg・km]

<Weight basis>
- Transport weight [kg] by transported item
- GHG emission intensity [kg-CO_2e/kg] (Appended table 11)

4.4.2.1 Primary data collection categories

The categories outlined below shall be collected as primary data.

Processes related to [C1] material transport, [C2] parts transport, [C3] finished vehicle transport, [C4] scrapped vehicle transport, [C5] maintenance parts transport

<Energy basis>

a) Fuel method
- Fuel [L] or electricity consumption [kWh] by transported item

b) Fuel consumption method
- Transport distance [km] by transported item
- Fuel consumption [km/L] by transported item

c) Improved ton-kilometer method (trucks)
- Transport weight [kg] by transported item
- Transport distance [km] by transported item

d) Conventional ton-kilometer method (railways, ships, aircraft)
- Transport weight [kg] by transported item

<Weight basis>
- Transport weight [kg] by transported item

4.4.2.2 Secondary data collection categories

The categories outlined below shall be collected as secondary data. If secondary data collection is difficult, the values in Appended table 11 may be adopted.

<Energy basis>

a) Fuel method
- GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing (Appended table 5)
- GHG emission intensity [kg-CO_2e/L] concerning fuel combustion (Appended table 5)

b) Fuel consumption method
   - GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing (Appended table 5)
   - GHG emission intensity [kg-CO_2e/L] concerning fuel combustion (Appended table 5)

c) Improved ton-kilometer method (trucks)
   - Improved ton-kilometer method fuel usage intensity [L/kg・km]
   - GHG emission intensity [kg-CO_2e/L] concerning fuel manufacturing (Appended table 5)
   - GHG emission intensity [kg-CO_2e/L] concerning fuel combustion (Appended table 5)

d) Conventional ton-kilometer method (railways, ships, aircraft)
   - Conventional ton-kilometer method CO_2 emission intensity [g-CO_2/kg・km]

<Weight basis>

- GHG emission intensity [kg-CO_2e/kg] by transported item (Appended table 11)

4.4.3 Scenario

[Collection of data on transport]

If it is difficult to collect primary data on transport volume (or fuel usage volume), each company may set up scenarios. If it is difficult for each company to set up scenarios, however, transport distances on Appended table 12 may be used.

4.5 Use stage

The system boundary and calculation methods of the use stage are outlined below.

The calculation processes must take into account three factors: running, maintenance, and air conditioner refrigerant.

- Running: Process concerning energy use and emissions after-treatment system using AdBlue
- Maintenance parts: Materials, production/transport, and disposal of parts that are replaced during the lifetime use of a vehicle from new to scrapped
- Air conditioner refrigerant: Refrigerant leakage from air conditioning systems and production of replenishment refrigerant

*Evaporation emissions and V2X will be reflected as soon as the calculation method is established and must not be considered in this guideline.

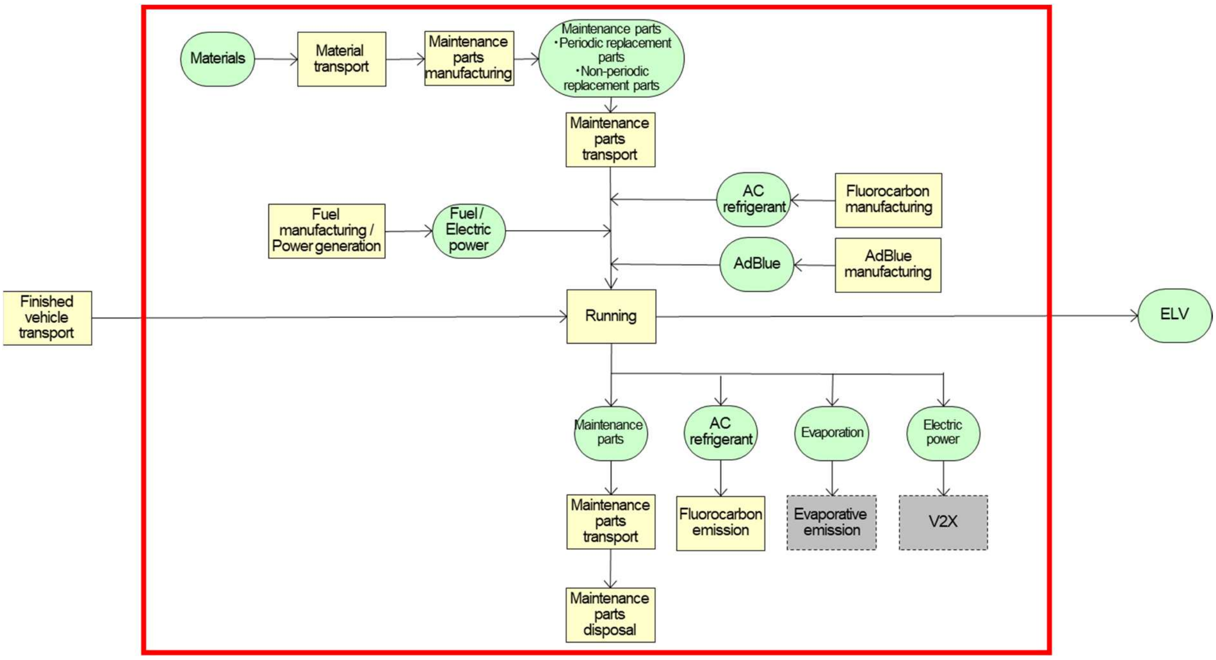


Figure 4-5 System boundary of the use stage (red box above)

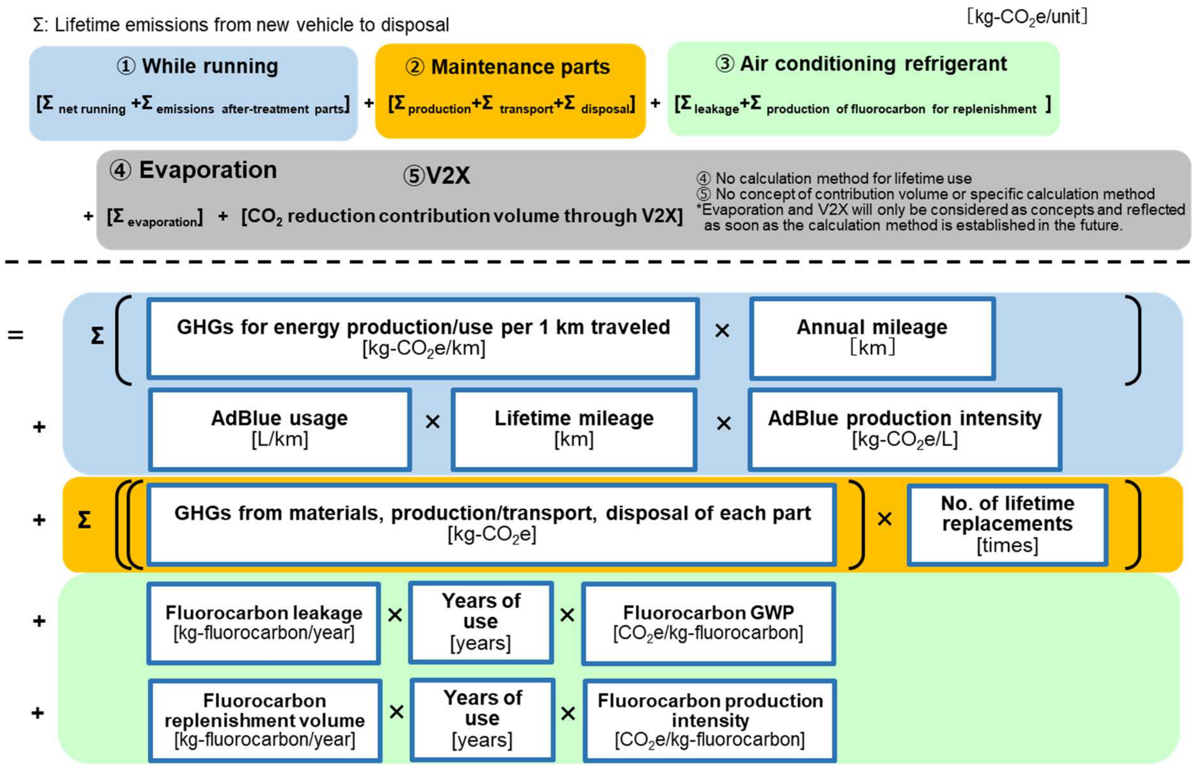


Figure 4-6 Use stage formula

4.5.1 Processes included in the scope of data collection

Data collection applies to the processes outlined below.

[D1] Processes concerning running
[D2] Processes concerning maintenance
[D3] Processes concerning air conditioner refrigerant

4.5.2 Data collection categories

Data shall be collected for the categories outlined below.

[D1] Processes concerning running

a) Net running
- At the time of application for product type approval:
  - Fuel consumption [L/km] (ICE, HEV)
  - Electricity consumption [kWh/km] (EV, PHEV)
  - Hybrid fuel consumption [L/km], plug-in fuel consumption [L/km] (PHEV)
- Plug-in range [km] (PHEV)
- Lifetime mileage [km] or annual mileage [km], years of use [years]
- Fuel production/combustion intensity for the year [kg-CO_2e/L]
- Electricity production intensity for the year [kg-CO_2/kWh]

b) Emissions after-treatment system (Assumed system: a system that uses AdBlue for NOx reduction)
- Fuel consumption [km/L] of models equipped with emissions after-treatment system *Same as data described in a)
- AdBlue tank capacity [L], fuel tank capacity [L]、No. of fuel replenishments [times/1 AdBlue replenishment] or AdBlue replenishment distance [km/1L of AdBlue]

[D2] Processes concerning maintenance
- Target parts (Table 4-1)
- Parts replacement distance [km] or parts replacement period [years]
- Lifetime mileage [km] or annual mileage [km], years of use [years] *Same as data described in a)
- No. of lifetime replacements [times]

- New tire production intensity [kg-CO_2e/kg], retreaded tire production intensity [kg-CO_2e/kg], retreaded ratio

[D3] Processes concerning air conditioner use
- Air conditioner refrigerant leakage volume [kg/year]
- Fluorocarbon GWP
- Fluorocarbon production intensity [kg-CO_2e/kg-fluorocarbon]
- Years of use [years] *Same as data described in a)

4.5.2.1 Primary data collection categories

The categories outlined below shall be collected as primary data.

[D1] Processes concerning running
a) Net running
- At the time of application for product type approval:
  - Fuel consumption [L/km] (ICE, HEV)
  - Electricity consumption [kWh/km] (EV, PHEV)
  - Hybrid fuel consumption [L/km], plug-in fuel consumption [L/km] (PHEV)
- Plug-in range [km] (PHEV)

b) Emissions after-treatment system (Assumed system: a system that uses AdBlue for NOx reduction)
- Fuel consumption [km/L] of models equipped with emissions after-treatment system *Same as data described in a)
- AdBlue tank capacity [L], fuel tank capacity [L]、No. of fuel replenishments [times/1 AdBlue replenishment]
  or AdBlue replenishment distance [km/1L of AdBlue]

[D2] Processes concerning maintenance
*Not applicable

[D3] Processes concerning air conditioner use
*Not applicable

4.5.2.2 Secondary data collection categories

The categories outlined below shall be collected as secondary data. The default values in the appendices can be used, and data collected independently by the party carrying out the calculation can also be used.

[D1] Processes concerning running
a) Net running
- Lifetime mileage [km] or annual mileage [km], years of use [years] (Table 1-2)
- Fuel production/combustion intensity for the year [kg-CO_2e/L] (Appended table 13)
- Electricity production intensity for the year [kg-CO_2/kWh] (Appended table 14)

b) Emissions after-treatment system (Assumed system: a system that uses AdBlue for NOx reduction)
- Fuel consumption [km/L] of models equipped with emissions after-treatment system *Same as data described in a)

[D2] Processes concerning maintenance
- Target parts (Table 4-1)
- Parts replacement distance [km] or parts replacement period [years] (Appended table 16)
- Lifetime mileage [km] or annual mileage [km], years of use [years] *Same as data described in a)
- No. of lifetime replacements [times]
  *GHG calculations for production, transport, and disposal of target parts must be in accordance with the respective sections.

- New tire production intensity [kg-CO_2e/kg], retreaded tire production intensity [kg-CO_2e/kg], retreaded ratio (

- Appended table 17)

[D3] Processes concerning air conditioner use
- Air conditioner refrigerant leakage volume [kg/year] (Appended table 18)
- Fluorocarbon GWP (Appended table 18)
- Fluorocarbon production intensity [kg-CO_2e/kg-fluorocarbon] (Appended table 2)
- Years of use [years] *Same as data described in a)

4.5.3 Scenario

[D1] Processes concerning running
- GHGs must be calculated by multiplying the "GHGs emitted during production/use" of energy used per 1 km traveled by the annual mileage while considering the years of use.
- For vehicles equipped with emissions after-treatment systems that use AdBlue, the GHGs for the production of AdBlue must also be considered.

- The "GHGs for the production/use of energy used per 1 km traveled" must be calculated based on the formula for each powertrain of ICE, HEV, EV, and PHEV.
- Type-approved values (fuel economy, electricity consumption, hybrid fuel economy, plug-in fuel economy), which are the results of measurement using objective evaluation methods, must be used for fuel consumption and electricity consumption.
- "Fuel production/combustion intensity for the year" or "electricity production intensity for the year" that considers the technological advancement from year to year must be used. However, this does not apply if the value of technological advancement cannot be ascertained.

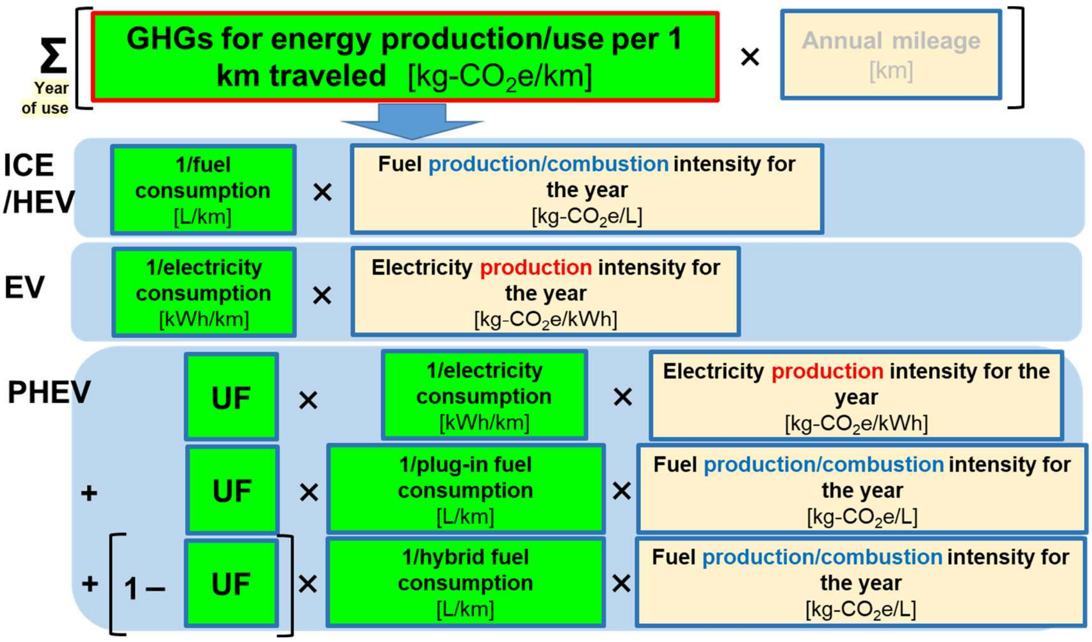


Figure 4-7 Formula for calculating GHGs for the production/use of energy used per 1 km traveled

*Calculation of UF (plug-in running ratio, utility factor)
Refer to the calculation formula in "Judgment Standards for Manufacturers, etc. of Energy-Consuming Equipment Concerning the Enhancement of the Energy Consumption Efficiency for Transformers" (Notification No. 2 of the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure and Tourism, March 1, 2013).

- In emissions after-treatment systems that use AdBlue, each product has a specific AdBlue replenishment time. The calculation methods for the case where AdBlue is replenished according to the number of fuel replenishments and the case where AdBlue is replenished according to mileage are outlined below.

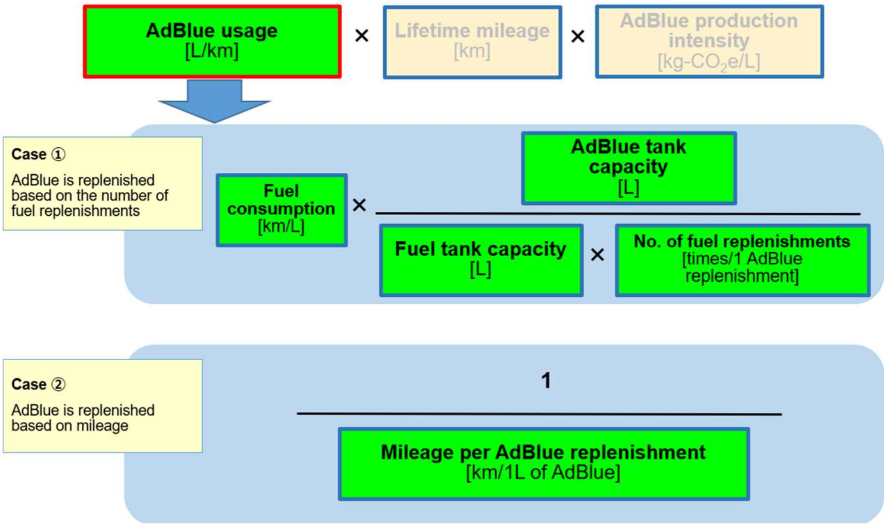


Figure 4-8 Formula for calculating GHG emissions associated with the use of AdBlue

[D2] Processes concerning maintenance

- The target includes not only periodic replacement parts recommended for the product, but also replacement parts other than periodic replacement that are replaced according to the hours of use, etc. (Refer to Table 4-1)
- The number of replacements is based on publicly available information. (Appended table 16 Parts replacement distance, parts replacement period)
- CFP calculations for individual parts in each process of materials, production/transport, and disposal are based on the calculation methods of each process.
- In reality, retreaded tires are used as replacement tires for large motor vehicles. Therefore, retreaded tires must be considered for replacement tires.

Table 4-1 List of replacement parts

	Small-sized vehicle	Heavy vehicle	Motorcycle
Periodic replacement parts			
Oil filter	○	○	○
Air cleaner element	○	○	○
Fuel filter	○	○	○
Timing belt	○	○	○
Spark plug	○	-	○
Disc pad (front wheels)	○	○	○
Brake shoe (rear wheels)	○	○	○
MT clutch plate	-	○	-
Starter motor	-	○	-
Drive chain on chassis side	-	-	○
Drive belt on chassis side	-	-	○
Engine oil	○	○	○
Brake fluid	○	○	○
Long life coolant	○	○	○
Replacement parts other than periodic replacement			
Tires	○	○*Retreaded tires	○
Auxiliary battery (lead-acid battery)	○	○	○

MT mission oil	-	○	-
AT oil	-	○	-
Differential oil	-	○	-

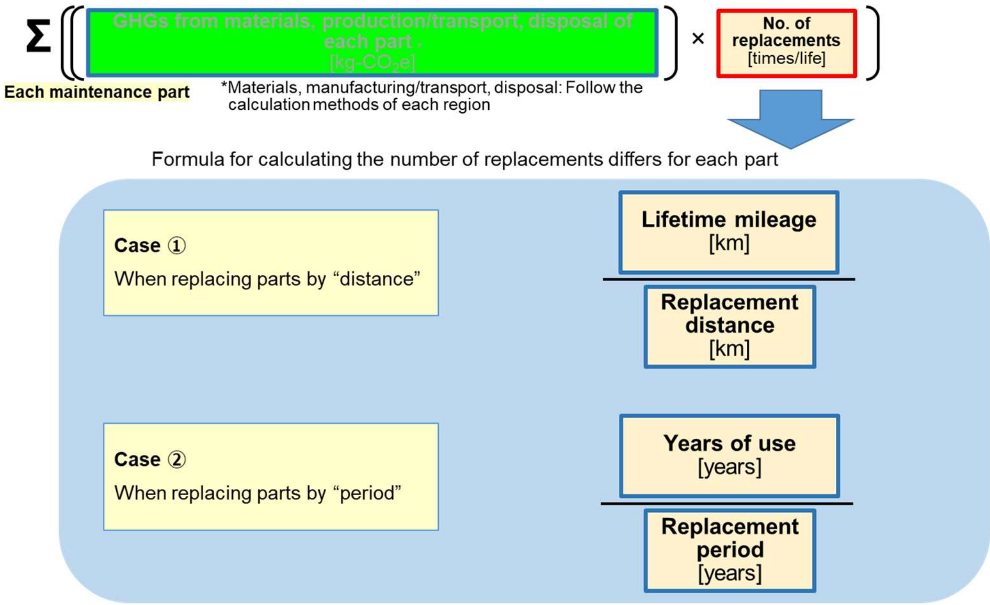


Figure4-9 Formula for calculating number of replacements

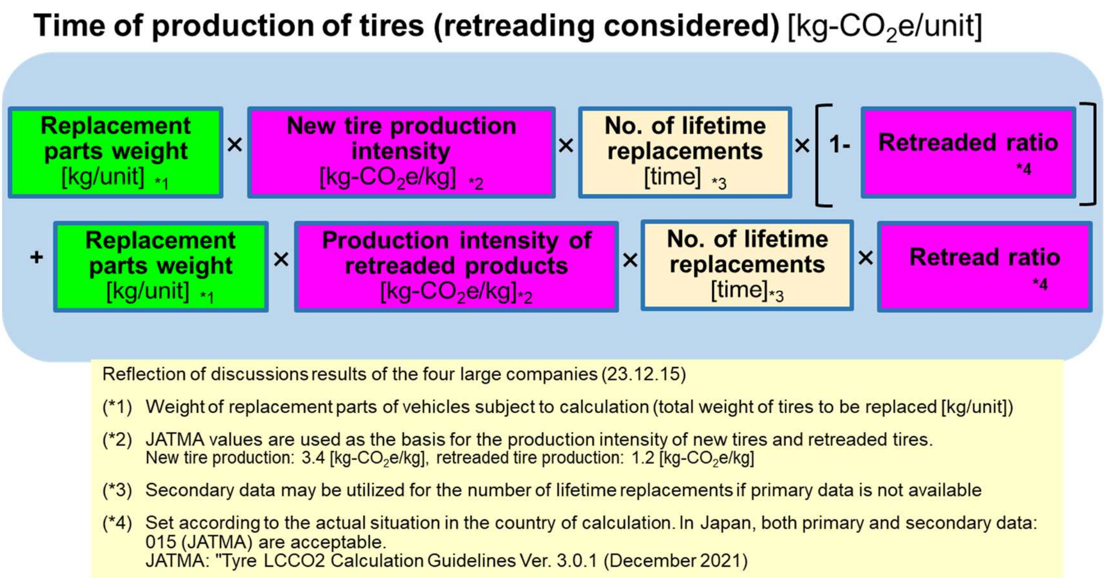


Figure 4-10 Formula for calculating GHGs associated with tire production/replacement (retreading considered)

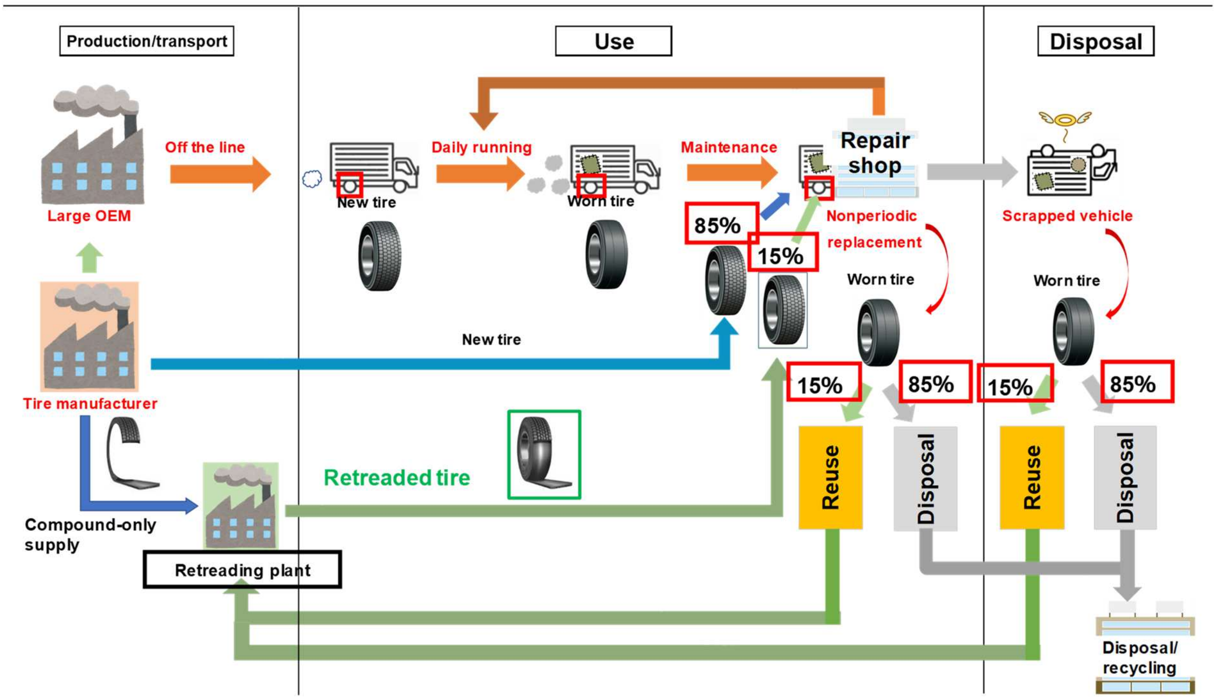


Figure 4-11 Process diagram of production/use/disposal of retreaded tires

[D3] Processes concerning air conditioner use

- Assuming the leakage and replenishment (not the replacement) of the air conditioner refrigerant
- The replenishment volume is equal to the leakage volume.
- The refrigerant used shall be HFO-1234yf (GWP: 1) for small-sized vehicles and HFC-134a (GWP: 1300) for large motor vehicles.

4.6 Disposal and recycling stage

The system boundary of the disposal and recycling stage as well as its calculation method are outlined below.

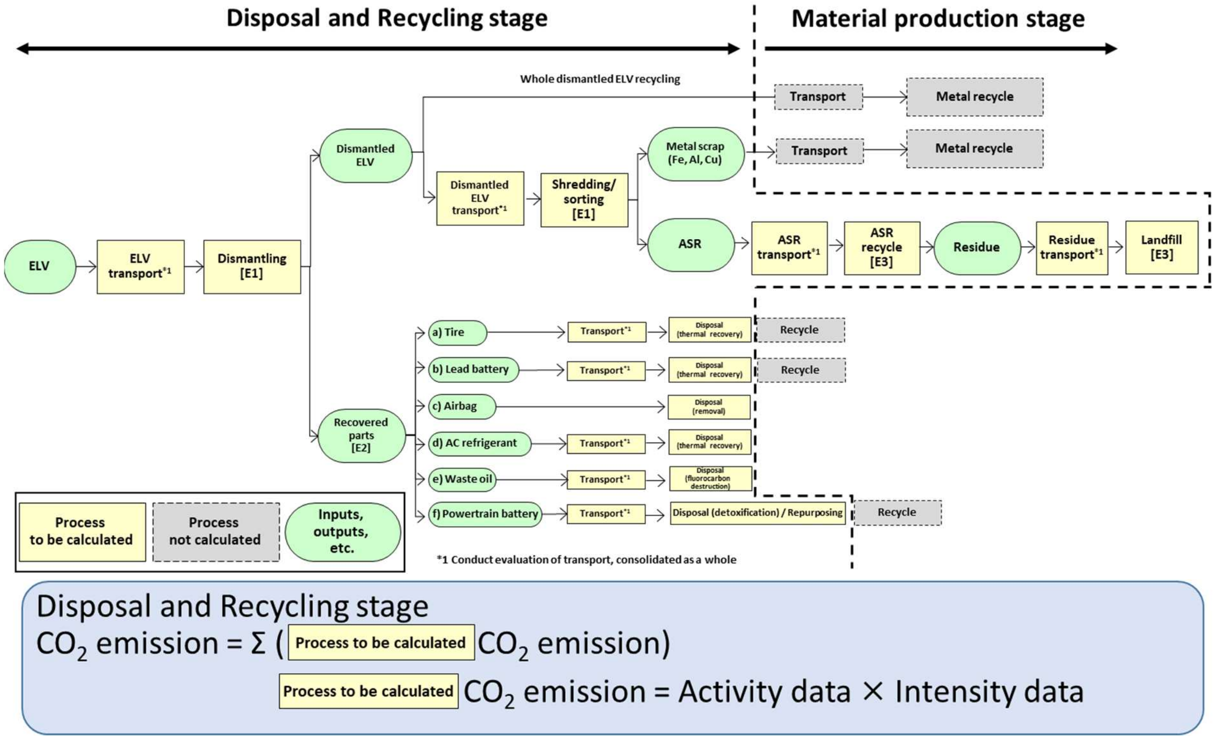


Figure 4-12 System boundary of the disposal and recycling stage

The evaluation of material/parts recycling, repurposing, and energy recovery in the disposal and recycling stage shall use the circular footprint formula (CFF) outlined below.
Reference: European Commission Recommendation (EU) 2021/2279 on the use of the environmental footprint methods to measure and communicate the life cycle environmental performance of products and organisations.

$$\text{Material}\ (1-R_1)E_V + R_1 \times \left(AE_{recycled} + (1-A)E_V \times \frac{Q_{Sin}}{Q_P}\right) + (1-A)R_2 \times \left(E_{recyclingEoL} - E_V^{*} \times \frac{Q_{Sout}}{Q_P}\right)$$

$$\text{Energy}\ (1-B)R_3 \times (E_{ER} - LHV \times X_{ER,heat} \times E_{SE,heat} - LHV \times X_{ER,elec} \times E_{SE,elec})$$

$$\text{Disposal}\ (1-R_2-R_3) \times E_D$$

In cases where obtaining appropriate data for CFF parameter setting is difficult (recycling of materials other than iron, steel, aluminum, and copper, as well as recycling of parts other than the repurposing of powertrain batteries), the recycled content method (RCM) may be applied.
Regarding plastic and powertrain battery materials, the setting of CFF parameters toward application of the CFF method will be carried out after their recycling technologies have been implemented in the future.
The intensities and CFF parameters of the various disposal processes should be set taking into account the future disposal processes and recycling technologies approximately 13 years after the vehicle reaches end of life. If such prediction is difficult, they may be set using scenarios based on current disposal processes and recycling technologies.

4.6.1 Processes included in the scope of data collection

Data collection applies to the processes outlined below.

[E1] Processes in the dismantling and shredding/sorting of end-of-life vehicles (ELVs)
[E2] Processes in the proper processing of specific parts
[E3] Processes in the processing of automobile shredder residue (ASR)
[E4] Processes in the recycling of materials

4.6.2 Data collection categories

Data shall be collected for the categories outlined below.

[E1] Processes in the dismantling and shredding/sorting of end-of-life vehicles (ELVs)

- ELV weight [kg]
- GHG emission intensity for ELV dismantling and shredding/sorting [kg CO_2e/kg]

[E2] Processes in the proper processing of specific parts

a) Tire

- Tire weight [kg]
- Wear rate [%]
- GHG emission intensity for tire incineration, including CFF allowance from thermal recovery [kg CO_2e/kg]

b) Lead battery

- Lead battery weight [kg]
- GHG emission intensity for proper processing of lead batteries, including plastic part (PP) incineration, lead scrap processing, and electrolyte neutralization [kg CO_2e/kg]

c) Airbag

- Airbag weight [kg]
- GHG emission intensity for proper processing of airbags [kg CO_2e/kg]

d) Air conditioner refrigerant

- Weight of air conditioner (AC) refrigerant introduced at the time of new vehicle production [kg]
- GHG emission intensity generated when destroying fluorocarbons during fluorocarbon destruction [kg CO_2e/kg]

e) Waste oil

- Waste oil weight [kg]
- GHG emission intensity for waste oil incineration, including CFF allowance from thermal recovery [kg CO_2e/kg]

f) Powertrain battery

f-1) Detoxification

- Waste battery pack weight [kg]
- Combustibles in waste battery pack [kg]
- GHG emission intensity for detoxification [kg CO_2e/kg]

f-2) Reuse (repurposing)

- Emission factor that allocates the environmental burden of repurposed parts and their reduction effects between the supplier and the user (A)
- Proportion of parts that will be repurposed during disposal [%] (R2)
- Quality of repurposed parts during disposal / quality of virgin parts (Qsout/Qp)
- GHG emission intensity for the production of virgin parts that can be replaced by repurposed parts [kg CO_2e/kg] (E*v)
- GHG emission intensity during disposal and repurposed part production, including transport of waste batteries [kg CO_2e/kg] (ErecEoL)

[E3] Processes in the processing of automobile shredder residue (ASR)

- Weight of ASR thermal recovery materials [kg]
- Weight of wooden materials [kg] (for trucks and buses only)
- GHG emission intensity for the incineration and residue landfill of non-wood ASR, including CFF allowance generated by heat/electricity recovered through thermal recovery [kg CO_2e/kg]
- GHG emission intensity for the incineration of wooden materials, including CFF allowance generated by heat/electricity recovered through thermal recovery of wooden materials [kg CO_2e/kg]

[E4] Processes in the recycling of materials

- Respective weights of iron, steel, aluminum, and copper materials [kg]
- Allocation factor that allocates the environmental burden of recycled materials and their reduction effects between the supplier and the user (A)
- Quality of recycled materials during raw material procurement stage / quality of virgin materials (Qsin/Qp)
- Quality of recycled materials during the processing stage after use / quality of virgin materials (Qsout/Qp)
- Proportion of recycled materials introduced in the raw material procurement stage [%] (R1)
- Proportion of materials being recycled in the processing stage after use; includes both the recovery rate of

the materials in question and the yield rate of the recycled material generation process [%] (R2)

- GHG emission intensity for the process of generating the recycled materials introduced in the raw material procurement stage; includes GHG emissions for recovery, sorting, and transport [kg CO_2e/kg] (Erec)
- GHG emission intensity for the process of generating the recycled materials introduced in the processing stage after use; includes GHG emissions for recovery, sorting, and transport [kg CO_2e/kg] (ErecEoL)
- GHG emission intensity for the production of virgin materials [kg CO_2e/kg] (Ev)
- GHG emission intensity for the production of virgin parts that can be replaced by recycled materials [kg CO_2e/kg] (E*v)

4.6.2.1 Primary data collection categories

The categories outlined below shall be collected as primary data.

[E1] Processes in the dismantling and shredding/sorting of end-of-life vehicles (ELVs)
- ELV weight [kg]

[E2] Processes in the proper processing of specific parts
a) Tire
- Tire weight [kg]

b) Lead battery
- Lead battery weight [kg]

c) Airbag
- Airbag weight [kg]

d) Air conditioner refrigerant
- Air conditioner (AC) refrigerant introduced at the time of new vehicle production [kg]

e) Waste oil
- Waste oil weight [kg]

f) Powertrain battery

f-1) Detoxification
- Waste battery pack weight [kg]
- Combustibles in waste battery pack [kg]

f-2) Reuse (repurposing)
- Factor that allocates the environmental burden of repurposed parts and their reduction effects between the supplier and the user (A)
- Proportion of parts that will be repurposed during disposal [%] (R2)
- Quality of repurposed parts during disposal / quality of virgin parts (Qsout/Qp)
- GHG emissions for the production of virgin parts that can be replaced by repurposed parts [kg CO_2/kg] (E*v)
- GHG emissions during disposal and repurposed part production, including transport of waste batteries [kg CO_2/kg] (ErecEoL)

[E3] Processes in the processing of automobile shredder residue (ASR)
- Weight of ASR thermal recovery materials [kg]
- Weight of wooden materials [kg] (for trucks and buses only)

[E4] Processes in the recycling of materials
- Respective weights of iron, steel, aluminum, and copper materials [kg]

4.6.2.2 Secondary data collection categories

The categories outlined below shall be collected as secondary data. The scenario established for the collection of secondary data shall state in detail the scenario with notes such as the source report and fiscal year of issue. When it is difficult to collect secondary data, the values from the appendices calculated based on the scenarios for the respective processes in 4.6.3 may be used.

[E1] Processes in the dismantling and shredding/sorting of end-of-life vehicles (ELVs)
- GHG emission factor for ELV dismantling and shredding/sorting [kg CO_2e/kg]

[E2] Processes in the proper processing of specific parts
a) Tire

- Wear rate [%]
- GHG emission intensity for tire incineration, including CFF allowance from thermal recovery [kg CO_2e/kg]

b) Lead battery
- GHG emission intensity for proper processing of lead batteries, including plastic part (PP) incineration, lead scrap processing, and electrolyte neutralization [kg CO_2e/kg]

c) Airbag
- GHG emission intensity for proper processing of airbags [kg CO_2e/kg]

d) Air conditioner refrigerant
- GHG emission intensity generated when destroying fluorocarbons during fluorocarbon destruction [kg CO_2e/kg]

e) Waste oil
- GHG emission intensity for waste oil incineration, including CFF allowance from thermal recovery [kg CO_2e/kg]

f) Powertrain battery

f-1) Detoxification
- GHG emission intensity for detoxification [kg CO_2e/kg]

f-2) Reuse (repurposing)
- None

[E3] Processes in the processing of automobile shredder residue (ASR)
- GHG emission intensity for the incineration and residue landfill of non-wood ASR, including CFF allowance generated by heat/electricity recovered through thermal recovery [kg CO_2e/kg]
- GHG emission intensity for the incineration of wooden materials, including CFF allowance generated by heat/electricity recovered through thermal recovery of wooden materials [kg CO_2e/kg]

[E4] Processes in the recycling of materials
- Allocation factor that allocates the environmental burden of recycled materials and their reduction effects between the supplier and the user (A)
- Quality of recycled materials during raw material procurement stage / quality of virgin materials (Qsin/Qp)
- Quality of recycled materials during the processing stage after use / quality of virgin materials (Qsout/Qp)
- Proportion of recycled materials introduced in the raw material procurement stage [%] (R1)
- Proportion of materials being recycled in the processing stage after use; includes both the recovery rate of the materials in question and the yield rate of the recycled material generation process [%] (R2)
- GHG emission intensity for the process of generating the recycled materials introduced in the raw material procurement stage; includes GHG emissions for recovery, sorting, and transport [kg CO_2e/kg] (Erec)
- GHG emission intensity for the process of generating the recycled materials introduced in the processing stage after use; includes GHG emissions for recovery, sorting, and transport [kg CO_2e/kg] (ErecEoL)
- GHG emission intensity for the production of virgin materials [kg CO_2e/kg] (Ev)
- GHG emission intensity for the production of virgin parts that can be replaced by recycled materials [kg CO_2e/kg] (E*v)

4.6.3 Scenario

[E1] Processes in the dismantling and shredding/sorting of end-of-life vehicles (ELVs)
- Based on data from the 2022 demonstration project by Japan Foundation for Advanced Auto Recycling (J-FAR) and NTT DATA for the visualization of CO2 emissions across automobile recycling and interviews with the three recycling companies that supported this project, the detailed processes and energy use (electricity and diesel) for dismantling, shredding, sorting, and whole dismantled ELV recycling were investigated, the ELV disposal process was standardized, and the average value of GHG emissions per unit ELV weight was calculated.
- The vehicles considered ranged from motorcycles to buses and trucks.
- GHG emissions in ELV dismantling and shredding/sorting = ELV weight [kg] × GHG emission intensity for ELV dismantling and shredding/sorting [kg CO_2e/kg]
- Refer to Appended table 19 for the intensity.

[E2] Processes in the proper processing of specific parts

a) Tire
- Referencing "Tyre LCCO$_2$ Calculation Guidelines Ver. 3.0.1" by the Japan Automobile Tyre Manufacturers Association, Inc. (JATMA), for the disposal of tires recovered from ELVs, CFF was used to evaluate GHG

emissions, including allowance from thermal recovery of tires.

- Regarding the allowance from retreading, evaluation was conducted in the area of use, and due to material recycling allowance being 1% or lower, it was excluded from the scope.

- The wear rate is set as 15% for passenger cars and motorcycles, and 18% for heavy vehicles.

- GHG emissions from tire disposal = tire weight [kg] × (1 - wear rate [%]) × GHG emission factor for tire disposal [kg CO_2e/kg]

- Refer to Appended table 20 for the intensity.

- Evaluation of heat energy allowance in thermal recovery was conducted using the CFF formula outlined below.

    - **R3 × (1-B) × (E_{ER}– LHV × X_{ER},heat × E_{SE},heat – LHV × X_{ER},elec × E_{SE},elec)**

  B: Allocation factor that allocates the environmental burden of energy recovery and their reduction effects between the supplier and the user; always set as 0 in the framework of environmental footprint
  R3: Proportion of materials used for energy recovery in the processing stage after use
  E_{ER}: Intensity for energy recovery process [kg CO_2e/kg]
  LHV: Lower heating value of the materials in the energy recovery process [MJ/kg]
  X_{ER},heat, X_{ER},elec: Efficiency of energy recovery process (heat and electricity) [%]
  E_{SE},heat, E_{SE},elec: Intensity for the supply of energy (heat and electricity) that can be replaced by recovered energy [kg-CO_2e/MJ]

- Refer to Appended table 21 for heat energy allowance in thermal recovery.

b) Lead battery

- Referencing the fiscal 2021 report from the Ministry of the Environment for a survey and study on the measures to be taken in the automotive recycling field toward achieving carbon neutrality by 2050, the GHG emissions for plastic parts (PP) incineration, lead scrapping, and electrolyte neutralization were evaluated.
  Note) Evaluation of lead battery material recycling using CFF was not undertaken due to being unable to obtain adequate data.

- GHG emissions for lead battery disposal = lead battery weight [kg] × GHG emission factor for lead battery disposal [kg CO_2e/kg]

- Refer to Appended table 22 for the intensity.

c) Airbag

- GHG emissions for removal of airbags after deployment were evaluated as airbag disposal.
- The metals and plastics found in airbags were evaluated as dismantled ELVs under [E3] processing of ASR and [E4] recycling of materials.

- GHG emissions for airbag disposal = airbags weight [kg] × GHG emission intensity for airbag disposal [kg CO_2e/kg]

- Refer to Appended table 23 for the intensity.

d) Air conditioner refrigerant

- Referencing the fiscal 2021 report from the Ministry of the Environment for a survey and study on the measures to be taken in the automotive recycling field toward achieving carbon neutrality by 2050, the GHG emissions for fluorocarbon destruction and CO_2 generated during such destruction were evaluated.
- Approach to fluorocarbons: Chlorofluorocarbons (CFCs; production fully discontinued in 1995) make up approximately 2% of all fluorocarbons as of 2021. They are excluded as the proportion will not increase in the future (HFO1234yf: outside the scope of calculating GWP = 1).

- GHG emissions for AC refrigerant disposal = weight of AC refrigerant [kg] × GHG emission factor for AC refrigerant disposal [kg CO_2e/kg]

- Refer to Appended table 24 for the intensity.

e) Waste oil

- Referencing the fiscal 2021 report from the Ministry of the Environment for a survey and study on the measures to be taken in the automotive recycling field toward achieving carbon neutrality by 2050, the GHG emissions for disposal of waste oil recovered from ELVs were evaluated, including allowance from thermal recovery of waste oil due to the adoption of CFF.

- GHG emissions for waste oil processing = waste oil weight [kg] × GHG emission intensity for waste oil processing [kg CO_2e/kg]

- Refer to Appended table 25 for the intensity.

- Heat energy allowance for waste oil thermal recovery was evaluated using the CFF formula stated in [E2] a) Tire.

- Refer to Appended table 21 for heat and electricity allowances in thermal recovery.

f) Powertrain battery

f-1) Detoxification

- Referencing the demonstration project for the sophistication of information management systems for vehicle lithium-ion battery collection by the Japan Auto Recycling Partnership (JARP), GHG emissions arising from the detoxification (energy source; dismantling, transport, disassembly, interim processing, and landfill disposal) and incineration (non-energy source; carbon incineration) of powertrain batteries recovered from ELVs were evaluated.

- GHG emissions for detoxification of powertrain batteries = (waste battery pack weight [kg] × GHG emission intensity for detoxification [kg- CO_2e/kg]) + (weight of combustibles [kg] × carbon ratio of combustible incineration × 44 / 12)

  Multiple by (1 - repurposing ratio [%]) if a portion of the waste battery is being repurposed.
  In addition, the iron, steel, aluminum, and copper contained in the battery pack shall be evaluated for recycling using CFF according to [E4] recycling of materials.

- Refer to Appended table 26 for the intensity.

f-2) Reuse (repurposing)

- The circular footprint formula (CFF) should be used for evaluating the reuse (repurposing) of powertrain batteries recovered from ELVs in other industries.
- In the disposal and recycling stage, the burden and allowance from the provision of recycled parts is evaluated with the formula outlined below as CFF effect.
- The CFF parameters shall be collected as primary data.

- CFF formula for battery reuse

  R2 × (1-A) × (ErecEoL – E*v × Qsout/Qp)

  A: Factor that allocates the environmental burden of repurposed parts and their reduction effects between the supplier and the user; the default value is 0.5
  R2: Proportion of parts that will be repurposed during disposal [%]
  Qsout/Qp: Quality of repurposed parts during disposal / quality of virgin parts
  E*v: GHG emission intensity for the production of virgin parts that can be replaced by repurposed parts [kg CO_2e/kg]
  ErecEoL: GHG emission intensity during disposal and repurposed part production, including transport of waste batteries [kg CO_2e/kg]
  In addition, the iron, steel, aluminum, and copper contained in the battery pack not being repurposed shall be evaluated for recycling using CFF according to [E4] recycling of materials.

[E3] Processes in the processing of automobile shredder residue (ASR)

- GHG emissions for the processing of non-wood ASR, including incineration and residue landfill, as well as the allowance generated by heat/electricity recovered through thermal recovery using CFF, was evaluated. The scope of materials for thermal recovery of ASR shall be combustible materials. Refer to Table 4-2 ASR thermal recovery materials for details.

- GHG emissions for wooden materials, including incineration as well as allowance generated by heat/electricity recovered through thermal recovery of ASR using CFF, was evaluated. In the disposal and recycling stage, the amount of CO_2 absorbed is not evaluated.

- GHG emissions for ASR processing = (weight of ASR thermal recovery materials [kg] × GHG emission intensity for disposal of ASR thermal recovery materials [kg- CO_2e/kg] + (weight of wooden materials [kg] × GHG emission intensity for disposal of wooden materials [kg- CO_2e/kg])

- Refer to Appended table 27 disposal and wooden material disposal for the intensities.

- Allowances generated by heat/electricity recovered through thermal recovery of ASR and wooden materials were evaluated using the CFF formula stated in [E2] a) Tire.

- Refer to Appended table 21 for heat and electricity allowances in thermal recovery.

Table 4-2 ASR thermal recovery materials

ASR thermal recovery materials			
Plastic	PP	Plastic	TPO
Plastic	PE	Plastic	TPV
Plastic	PVC	Plastic	SBR
Plastic	ABS	Plastic	EPDM
Plastic	PA	Plastic	Other thermoplastic
Plastic	PC	Plastic	Other thermoset
Plastic	PET	Other organic material	Natural rubber
Plastic	PBT	Other organic material	Synthetic rubber
Plastic	PUR	Other organic material	CFRP
Plastic	POM	Other organic material	Anti-rust oil
Plastic	ASA	Other organic material	Adhesive
Plastic	PMMA	Other organic material	Other organic material
Plastic	EP	Other	Paint
Plastic	PPS		

[E4] Processes in the recycling of materials

- The circular footprint formula (CFF) should be used for evaluating the recycling of materials recovered from ELVs.
  In the disposal and recycling stage, the formula outlined below should be used to evaluate both burdens and allowances related to recycled material use and burdens and allowances related to recycled material supply as the total value (CFF effect).

- GHG emissions including CFF effect of material recycling = Σ (weight of each material [kg] × CFF effect of each material [kg CO_2e/kg])

- Formula for calculating CFF effect

  - (1-A) R1 × (Erec - Ev × Qsin/Qp) + (1-A) R2 × (ErecEoL - E*v × Qsout/Qp)

  A: Allocation factor that allocates the environmental burden of recycled materials and their reduction effects between the supplier and the user; a value between 0.2 to 0.8, in which a value smaller than 0.5 refers to a case where the demand for recycled materials exceed the supply, and a value larger than 0.5 refers to a case where the supply exceeds demand
  Qsin/Qp: Quality of recycled materials during raw material procurement stage / quality of virgin materials
  Qsout/Qp: Quality of recycled materials during the processing stage after use / quality of virgin materials
  R1: Proportion of recycled materials introduced in the raw material procurement stage [%]
  R2: Proportion of materials being recycled in the processing stage after use; includes both the recovery

rate of the materials in question and the yield rate of the recycled material generation process [%]
Erec: GHG emission intensity for the process of generating the recycled materials introduced in the raw material procurement stage; includes GHG emissions for recovery, sorting, and transport [kg CO_2e/kg]
ErecEoL: GHG emission intensity for the process of generating the recycled materials introduced in the processing stage after use; includes GHG emissions for recovery, sorting, and transport [kg CO_2e/kg]
Ev: GHG emission intensity for the production of virgin materials [kg CO_2e/kg]
E*v: GHG emission intensity for the production of virgin parts that can be replaced by recycled materials [kg CO_2e/kg]

・Refer to Appended table 28 for the parameters by material

5. Reports

A survey report should be generated when conveying LCA survey results obtained using this set of guidelines to a third party.

When generating the survey report, it is necessary to ensure transparency showing that the survey was conducted in accordance with this set of guidelines, and consistency of the survey results in regard to the purpose and scope of the LCA.
In particular, the primary data, secondary data, and scenario selected for calculation based on this set of guidelines should be stated. In addition, to ensure transparency and consistency, interpretation of the survey results in accordance with ISO 14044 should be stated.
However, reports to a third party need not include confidential information.

As an example, ISO 14044:2006 requires items a) to g) of Annex B be included in reports to a third party.

6. Verification

Verification can be conducted to ensure that the survey results are obtained in accordance with this set of guidelines, or to ensure that the transparency and consistency of the contents of the report are ensured when generating the report. Verification can be undertaken by different persons from the same organization as the persons conducting the survey (internal verification), or by persons from a different organization (third-party verification). Third-party verification can be chosen to ensure greater objectivity.
The international standards stated in 1.1.2 serve as the normative references for this set of guidelines. Critical reviews based on the respective standards should be conducted to ensure that the results calculated using this set of guidelines comply with the international standards in 1.1.2.

Appendix A. Reference: Numerical data, etc. used in calculations

Appended table 1 Representative types of heavy vehicle

			Japan					
			Vehicle name Hino	Vehicle name Isuzu	Vehicle name UD	Vehicle name Mitsubishi	Total vehicle weight (t)	Category (Fuel consumption standards for heavy-duty vehicles)
Truck	Large	Motorcycle	PROFIA	GIGA	Quon	Super Great	20＜	T11
		Tractor	PROFIA	GIGA	Quon	Super Great	≦20	TT1
	Medium	Motorcycle	RANGER	FORWARD	Condor (⇐)	Fighter	7.5＜ & ≦8	T5
	Small	Motorcycle	DUTRO	ELF	Kazet (⇒)	Canter	3.5＜ & ≦7.5	T2
tour bus	Large	-	SELEGA	GALA	—	Aero	14＜ & ≦16	B6
	Medium	-	MELPHA	GALAmio	—	—	8＜ & ≦10	B3
	Small	-	LIÉSSE II	—	—	Rosa	3.5＜ & ≦6	B1
Route bus	Large	-	Blue Ribbon	ERGA	—	Aero Star	12＜ & ≦14, 14＜	BR4、BR5
	Medium	-	Rainbow	ERGAmio	—	—	10＜ & ≦12	BR3

Appended table 2 Default values of GHG emissions intensity for materials and designated parts materials

Material or part name		GHG intensity ($kg\text{-}CO_2e/kg$)	(Upstream process)	Source/IDEA product code
Iron	Cast iron*1	Undisclosed		Upper: 221115201pJPN, 221115202pJPN
Iron	Cast steel*1			Upper: 221115201pJPN, 221115202pJPN
Iron	Hot-rolled steel sheet			Upper: 221115201pJPN Lower: 222118201pJPN
Iron	Cold-rolled steel sheet			Upper: 221115201pJPN Lower: 222212201pJPN
Iron	Electromagnetic steel sheet			Upper: 221115201pJPN Lower: 222213201pJPN
Iron	Hot-rolled hot-dip steel sheet			Upper: 221115201pJPN Lower: 222118201pJPN, 232914000pJPN, 171115801pJPN
Iron	Hot-rolled electroplating steel sheet			Upper: 221115201pJPN Lower: 222118201pJPN, 231211000pJPN, 232914000pJPN, 171115801pJPN
Iron	Cold-rolled hot-dip steel sheet			Upper: 221115201pJPN Lower: 224111211pJPN
Iron	Cold-rolled electroplating steel sheet			Upper: 221115201pJPN Lower: 224111221pJPN
Iron	Carbon steel bar/wire rod			Upper: 221115201pJPN Lower: 222116201pJPN
Iron	Special steel bars			Upper: 221115201pJPN Lower: 223112221pJPN
Iron	Special steel wire rod/spring steel			Upper: 221115201pJPN Lower: 223113211pJPN
Iron	Stainless steel sheet/bar			Upper: 221115201pJPN Lower: 223113221pJPN
Iron	Sintered steel			Upper: 221115201pJPN Lower: 229919000pJPN
Aluminum	Aluminum casting material*1 (wheels)			Upper: 232211000pJPN
Aluminum	Aluminum casting material*1 (excluding wheels)			Upper: 231313000mJPN

Material or part name		GHG intensity ($kg-CO_2e/kg$)	(Upstream process)	Source/IDEA product code
Aluminum	Aluminum die-casting material*1 (powertrain system)	Undisclosed		Upper: 232211000pJPN
Aluminum	Aluminum die-casting material*1 (chassis system)			Upper: 231313000mJPN
Aluminum	Aluminum expanded material (sheet)			Upper: 231313000mJPN Lower: 233211000pJPN
Aluminum	Aluminum extrusion material			Upper: 231313000mJPN Lower: 233212000pJPN
Copper	Copper strip (TPC)			Upper: 231112000pJPN Lower: 233111000pJPN
Copper	Copper wire (TPC)			Upper: 234111000pJPN Lower: 234112000pJPN
Copper	Copper strip (OFC)			Upper: 231112000pJPN Lower: 2.2 Reference List (JAMA Report 2023)
Copper	Copper wire (OFC)			Upper: 231112000pJPN Lower: 2.2 Reference List (JAMA Report 2023)
Non-ferrous metals	Magnesium			231919229mGLO
Non-ferrous metals	Other metals			231112000pJPN
Non-ferrous metals	Zinc alloy			233912000pJPN
Non-ferrous metals	Lead			233911000pJPN
Non-ferrous metals	Platinum/rhodium			233915000pJPN
Resin	PP			Upper: 163112000pJPN Lower: 2.2 Reference List (JAMA Report 2023 Part 2)
Resin	PE			Upper: 163111000pJPN Lower: 2.2 Reference List (JAMA Report 2023 Part 2)
Resin	PVC			Upper: 163521000pJPN Lower: 2.2 Reference List (JAMA Report 2023 Part 2)
Resin	ABS			Upper: 163114101pJPN, 163611100pJPN, 163225000pJPN Lower: 2.2 Reference List (JAMA Report 2023 Part 2)
Resin	PA			Upper: 163414000pJPN Lower: 163524100pJPN
Resin	PC			Upper: 162949107pJPN, 163429130pJPN Lower: 2.2 Reference List (JAMA Report 2023 Part 2)
Resin	PET			Upper: 163411103pJPN Lower: 2.2 Reference List (JAMA Report 2023 Part 2)
Resin	PBT			Upper: 163239104mJPN, 163411101pJPN Lower: 163529106pJPN
Resin	PUR			184111100pJPN

Material or part name		GHG intensity (kg-CO_2e/kg)	(Upstream process)	Source/IDEA product code
Resin	POM			163529119pJPN
Resin	ASA			163517106pJPN
Resin	PMMA			163522000pJPN
Resin	EP			163527000pJPN
Resin	PPS			163529116pJPN
Resin	TPO			163600000mJPN
Resin	TPV			163600000mJPN
Other organic materials	SBR			163611104pJPN
Other organic materials	EPDM	Undisclosed		163611102pJPN
Other organic materials	Other thermoplastic resins			163518000pJPN
Other organic materials	Other thermosetting resins			184111100pJPN
Other organic materials	Natural rubber			016911210pVNM
Other organic materials	Synthetic rubber			163611000pJPN
Other organic materials	CFRP			163611000pJPN
Other organic materials	Anti-rust oil			171119000pJPN
Other organic materials	Wood (apitong wood, lumber)	0.44	-	2.2 Reference List (wood)
Other organic materials	Adhesives			169412200pJPN
Other organic materials	Other organic materials			171119000pJPN
Others	Glass			211211000pJPN
Others	Other inorganic materials			214419200pJPN
Others	Paints			-
Others	Electronic parts (silicon)			-
Others	Electronic parts	Undisclosed		-
Others	Engine oil			171119200pJPN
Others	Brake fluid			163239164pJPN
Others	LLC			163216000pJPN
Others*	Air conditioner refrigerant (HFO-1234yf)			JAMA 2011
Part	Tires[*2]			Japan Automobile Tyre Manufacturers Association
Part	Lead-acid battery[*2]			Battery Association of Japan
Part	Ni-MH battery[*2]	8.80	-	2.2 Reference List (battery materials)
NMC811type cell constituent material[*3]		25.71	-	2.2 Reference List (battery materials)
NMC622 type cell constituent material[*3]		22.97	-	
NMC532 type cell constituent material[*3]		22.06	-	
NMC111 type cell constituent material[*3]		21.24	-	
LMO type cell constituent material[*3]		5.39	-	
LFP (Hydrothermal) type cell constituent material[*3]		9.42	-	
LFP (Solid State) type cell constituent material[*3]		4.47		

Material or part name	GHG intensity (kg-CO_2e/kg)	(Upstream process)	Source/IDEA product code
NCA type cell constituent material	27.12	-	

*1 The downstream processes of casting materials are deemed to be included in the parts and vehicles production stage's scope of data collection given in 4.3.1 and the GHG intensity in this appended table shall be taken as the GHG intensity for upstream processes.
*2 The figure given shall be taken as the GHG intensity per weight of part.
*3 The figure given shall be taken as the GHG intensity per cathode material included in the cell constituent material of Li-ion batteries.

Appended table 2-1 Battery cell specifications (2.2 Reference List Battery Materials）

Battery cell	Capacity (kWh)	Weight (kg)	Cruising range (mile)
Ni-MH	84	1294	300
NMC811	84	428	300
MC622	84	452	300
NMC532	84	458	300
NMC111	84	476	300
LMO	84	570	300
LFP (HydroThermal)	84	584	300
LFP (SolidState)	84	584	300
NCA	84	439	300

Appended table 3 Reference values of GHG emissions intensity for manufacturing method using recycled materials
(Steel: electric furnace method; aluminum: use of recycled ingots; copper: use of scrap materials)

Material or part name		GHG intensity (kg-CO_2e/kg)	(Upstream process)	Source/IDEA product code
Iron	Cast iron*1	Undisclosed		Upper: 221115201pJPN, 221115202pJPN
Iron	Cast steel*1			Upper: 221115201pJPN, 221115202pJPN
Iron	Hot-rolled steel sheet			Upper: 221115201pJPN, 221115202pJPN Lower: 222118201pJPN
Iron	Cold-rolled steel sheet			Upper: 221115201pJPN, 221115202pJPN Lower: 222212201pJPN
Iron	Electromagnetic steel sheet			Upper: 221115201pJPN, 221115202pJPN Lower: 222213201pJPN
Iron	Hot-rolled hot-dip steel sheet			Upper: 221115201pJPN, 221115202pJPN Lower: 222118201pJPN, 232914000pJPN, 171115801pJPN
Iron	Hot-rolled electroplating steel sheet			Upper: 221115201pJPN, 221115202pJPN Lower: 222118201pJPN, 231211000pJPN, 232914000pJPN, 171115801pJPN
Iron	Cold-rolled hot-dip steel sheet			Upper: 221115201pJPN, 221115202pJPN Lower: 224111211pJPN
Iron	Cold-rolled electroplating steel sheet			Upper: 221115201pJPN, 221115202pJPN Lower: 224111221pJPN
Iron	Carbon steel bar/wire rod			Upper: 221115201pJPN, 221115202pJPN Lower: 222116201pJPN

Material or part name		GHG intensity (kg-CO_2e/kg)	(Upstream process)	Source/IDEA product code
Iron	Special steel bars			Upper: 221115201pJPN, 221115202pJPN Lower: 223112221pJPN
Iron	Special steel wire rod/spring steel			Upper: 221115201pJPN, 221115202pJPN Lower: 223113211pJPN
Iron	Stainless steel sheet/bar			Upper: 221115201pJPN, 221115202pJPN Lower: 223113221pJPN
Iron	Sintered steel			Upper: 221115201pJPN, 221115202pJPN Lower: 229919000pJPN
Aluminum	Aluminum casting material (wheels)*1			Upper: 232211000pJPN
Aluminum	Aluminum casting material (excluding wheels)*1			Upper: 232211000pJPN
Aluminum	Aluminum die-casting material□ (powertrain system)*1	Undisclosed		Upper: 232211000pJPN
Aluminum	Aluminum die-casting material (chassis system)*1			Upper: 232211000pJPN
Aluminum	Aluminum expanded material (sheet)			Upper: 232211000pJPN Lower: 233211000pJPN
Aluminum	Aluminum extrusion material			Upper: 232211000pJPN Lower: 233212000pJPN
Copper	Copper strip (TPC)			Upper: 231112000pJPN Lower: 233111000pJPN
Copper	Copper wire (TPC)			Upper: 234111000pJPN Lower: 234112000pJPN
Copper	Copper strip (OFC)			Upper: 231112000pJPN Lower: 2.2 Reference List (JAMA Report 2023)
Copper	Copper wire (OFC)			Upper: 231112000pJPN Lower: 2.2 Reference List (JAMA Report 2023)

*1 The downstream processes of casting materials are deemed to be included in the parts and vehicles production stage's scope of data collection given in 4.3.1 and the GHG intensity in this appended table shall be taken as the GHG intensity for upstream processes.

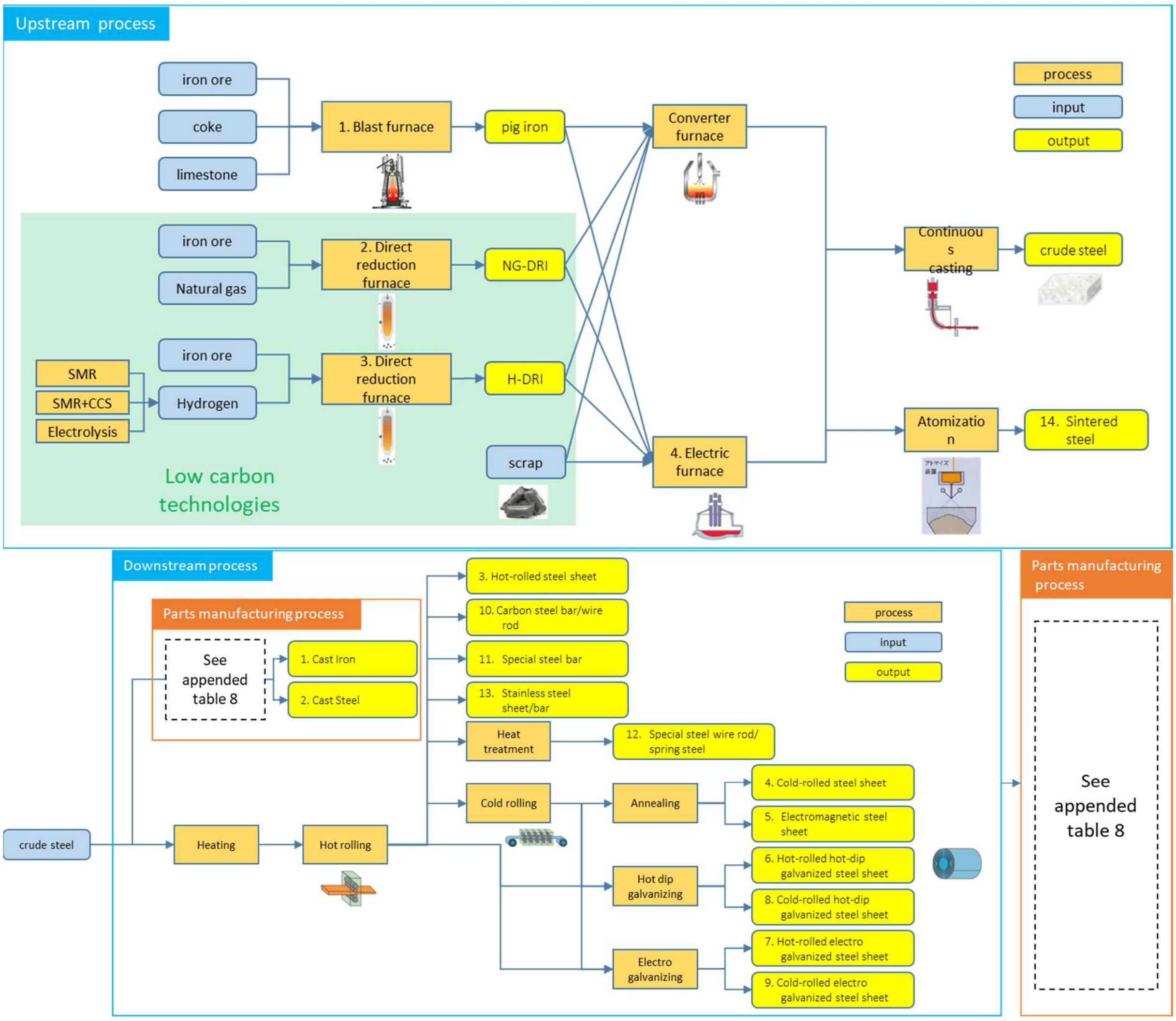
Appended table 4 Reference values of GHG emissions intensity for carbon neutral manufacturing method

Material or part name		GHG intensity (kg-CO_2e/kg)	(Upstream process)	Source/IDEA product code
Iron (methane DRI)	Cast iron*1			Upper: 2.2 Reference List (JAMA Report 2023)
Iron (methane DRI)	Cast steel*1			Upper: 2.2 Reference List (JAMA Report 2023) ¥
Iron (methane DRI)	Hot-rolled steel sheet	Undisclosed		Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222118201pJPN
Iron (methane DRI)	Cold-rolled steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222212201pJPN
Iron (methane DRI)	Electromagnetic steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222213201pJPN
Iron (methane DRI)	Hot-rolled hot-dip steel sheet			Upper: 2.2 Reference List (JAMA Report 2023)

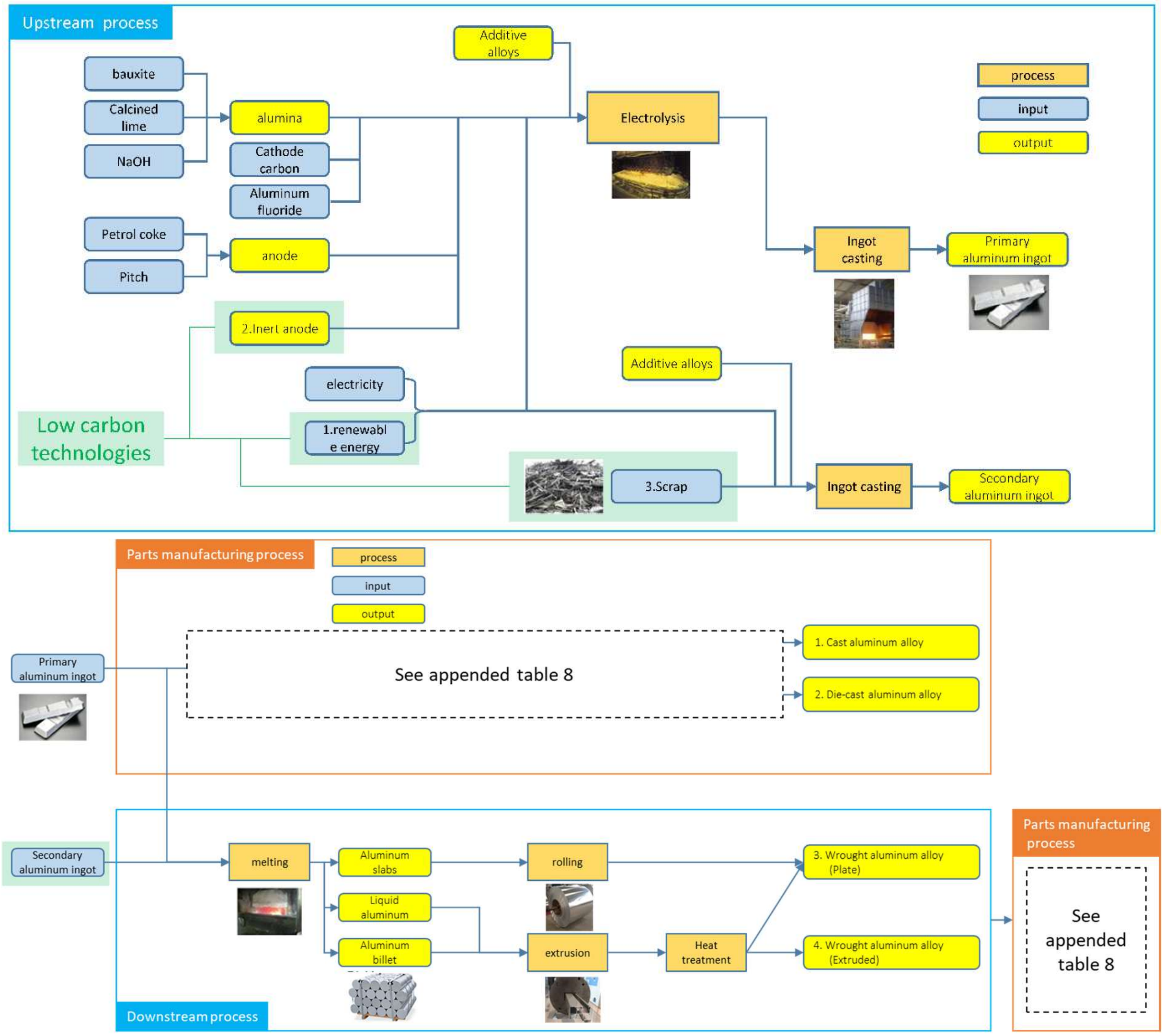
Material or part name		GHG intensity (kg-CO_2e/kg)	(Upstream process)	Source/IDEA product code
				Lower: 222118201pJPN, 232914000pJPN, 171115801pJPN
Iron (methane DRI)	Hot-rolled electroplating steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222118201pJPN, 231211000pJPN, 232914000pJPN, 171115801pJPN
Iron (methane DRI)	Cold-rolled hot-dip steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 224111211pJPN
Iron (methane DRI)	Cold-rolled electroplating steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 224111221pJPN
Iron (methane DRI)	Carbon steel bar/wire rod			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222116201pJPN
Iron (methane DRI)	Special steel bars			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 223112221pJPN
Iron (methane DRI)	Special steel wire rod/spring steel			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 223113211pJPN
Iron (methane DRI)	Stainless steel sheet/bar			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 223113221pJPN
Iron (methane DRI)	Sintered steel			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 229919000pJPN
Iron (hydrogen DRI)	Cast iron[*1]	Undisclosed		Upper: 2.2 Reference List (JAMA Report 2023)
Iron (hydrogen DRI)	Cast steel[*1]			Upper: 2.2 Reference List (JAMA Report 2023)
Iron (hydrogen DRI)	Hot-rolled steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222118201pJPN
Iron (hydrogen DRI)	Cold-rolled steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222212201pJPN
Iron (hydrogen DRI)	Electromagnetic steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222213201pJPN
Iron (hydrogen DRI)	Hot-rolled hot-dip steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222118201pJPN, 232914000pJPN, 171115801pJPN
Iron (hydrogen DRI)	Hot-rolled electroplating steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222118201pJPN, 231211000pJPN, 232914000pJPN, 171115801pJPN
Iron (hydrogen DRI)	Cold-rolled hot-dip steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 224111211pJPN
Iron (hydrogen DRI)	Cold-rolled electroplating steel sheet			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 224111221pJPN
Iron (hydrogen DRI)	Carbon steel bar/wire rod			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 222116201pJPN

Material or part name		GHG intensity (kg-CO_2e/kg)	(Upstream process)	Source/IDEA product code
Iron (hydrogen DRI)	Special steel bars	Undisclosed		Upper: 2.2 Reference List (JAMA Report 2023) Lower: 223112221pJPN
Iron (hydrogen DRI)	Special steel wire rod/spring steel			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 223113211pJPN
Iron (hydrogen DRI)	Stainless steel sheet/bar			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 223113221pJPN
Iron (hydrogen DRI)	Sintered steel			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 229919000pJPN
Aluminum (renewable energy)	Aluminum casting material (wheels)*1			Upper: 231313202pCAN
Aluminum (renewable energy)	Aluminum casting material (excluding wheels)*1			Upper: 231313202pCAN
Aluminum (renewable energy)	Aluminum die-casting material□ (powertrain system)*1			Upper: 231313202pCAN
Aluminum (renewable energy)	Aluminum die-casting material□ (chassis system)*1			Upper: 231313202pCAN
Aluminum (renewable energy)	Aluminum expanded material (sheet)			Upper: 231313202pCAN Lower: 233211000pJPN
Aluminum (renewable energy)	Aluminum extrusion material			Upper: 231313202pCAN Lower: 233212000pJPN
Aluminum (inert electrode)	Aluminum casting material (wheels)*1			Upper: 2.2 Reference List (JAMA Report 2023)
Aluminum (inert electrode)	Aluminum casting material (excluding wheels)*1			Upper: 2.2 Reference List (JAMA Report 2023)
Aluminum (inert electrode)	Aluminum die-casting material□ (powertrain system)*1			Upper: 2.2 Reference List (JAMA Report 2023)
Aluminum (inert electrode)	Aluminum die-casting material□ (chassis system)*1			Upper: 2.2 Reference List (JAMA Report 2023)
Aluminum (inert electrode)	Aluminum expanded material (sheet)			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 233211000pJPN
Aluminum (inert electrode)	Aluminum extrusion material			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 233212000pJPN
Copper (wet type)	Copper strip (TPC)			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 233111000pJPN
Copper (wet type)	Copper wire (TPC)			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 234112000pJPN
Copper (wet type)	Copper strip (OFC)			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 2.2 Reference List (JAMA Report 2023)
Copper (wet type)	Copper wire (OFC)			Upper: 2.2 Reference List (JAMA Report 2023) Lower: 2.2 Reference List (JAMA Report 2023)

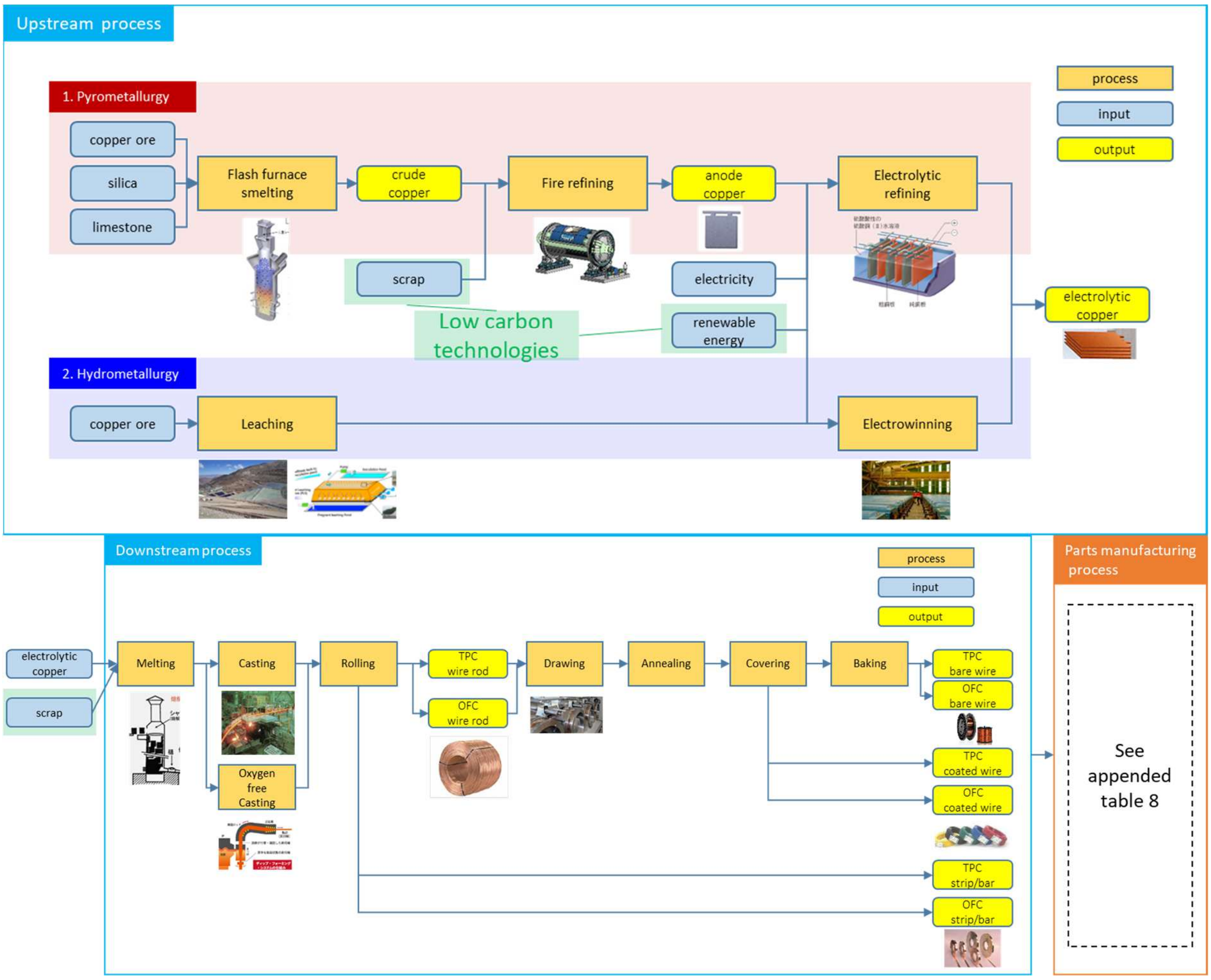
*1 The downstream processes of casting materials are deemed to be included in the parts and vehicles production stage’s scope of data collection given in 4.3.1 and the GHG intensity in this appended table shall be taken as the GHG intensity for upstream processes.



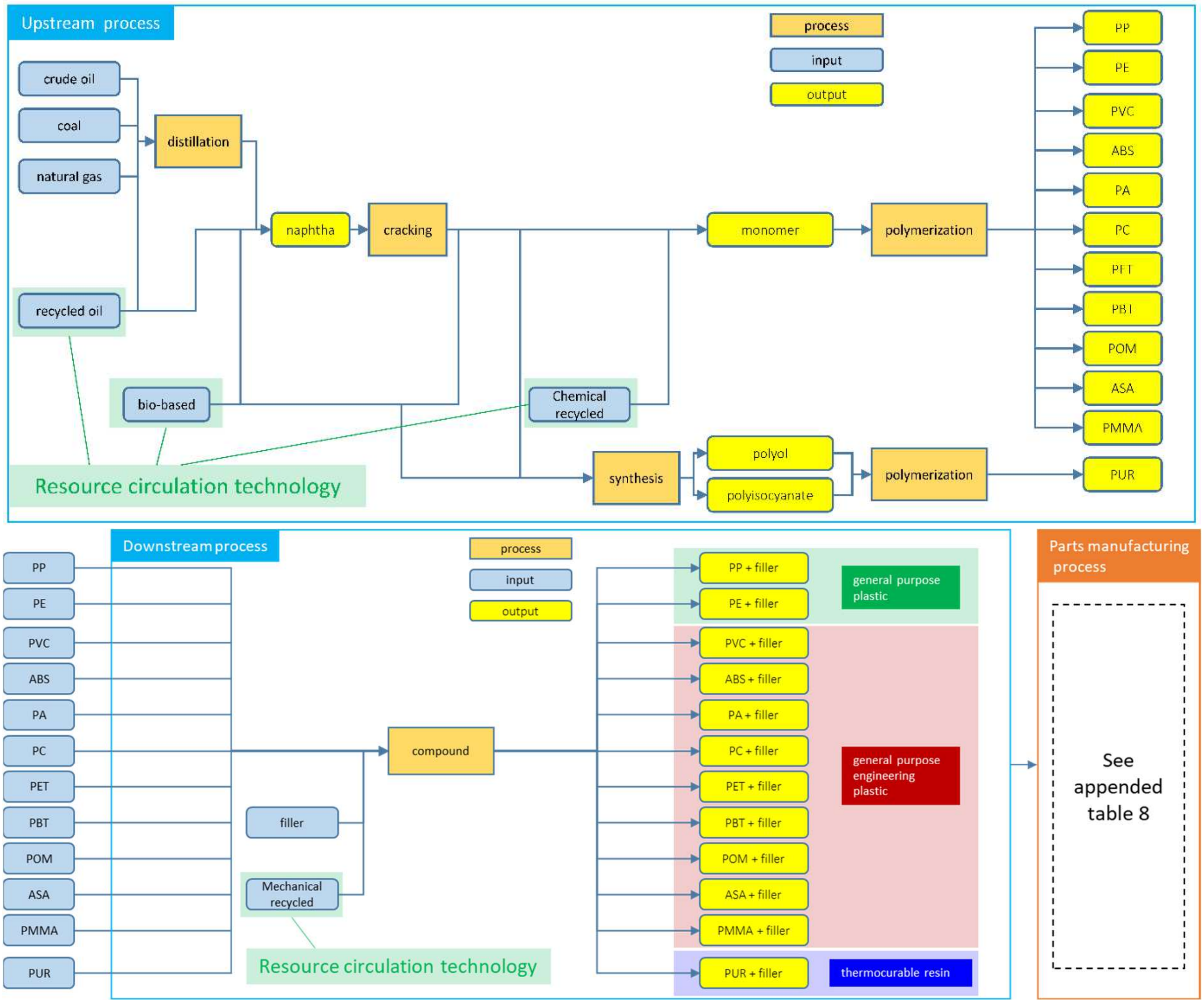
Appended figure 1 System boundary at material production stage (steel)



Appended figure 2 System boundary at material production stage (aluminum)



Appended figure 3 System boundary at material production stage (copper)



Appended figure 4 System boundary at material production stage (resin)

Appended table 5 Fuel production, fuel combustion intensity

	Unit	Production		Combustion	
		Intensity (kg-CO_2 /)	Remarks (IDEA product code)	Intensity (kg-CO_2 /)	Remarks (IDEA product code)
Electricity	kWh	0.58	2.2 Reference List (electricity)	—	—
Gasoline	L	Undisclosed	171111000pJPN	2.32	Automobile Fuel Consumption List Glossary (Ministry of Land, Infrastructure, Transport and Tourism)
Diesel	L		171115000pJPN	2.59	
Heavy oil A	L		171116000pJPN	3.20	Calculation Method Guidelines Related to CO_2 Emissions Volume in the Logistics Sector (Ministry of Economy, Trade and Industry, Ministry of Land, Infrastructure, Transport and Tourism)
Heavy oil C	L		171118000pJPN	2.99	
Liquefied petroleum gas (LPG)	kg		171123000pJPN	3.86	
City gas	m^3		341111000pJPN	2.55	
Kerosene	L		171114000pJPN	Undisclosed	171114801pJPN
Natural gas liquids (NGL)	L		053114000pJPN		053114801pJPN
Liquefied natural gas (LNG)	kg		053113000mJPN		053113801pJPN

Appended table 6 Materials production intensity

Product name	Unit	Intensity (kg-CO_2 /)	IDEA product code
Thinner	kg	Undisclosed	164417000pJPN
Ammonia, natural gas feedstock, 100% NH3 equivalent	kg		161112000pJPN
Nitric acid, 98% equivalent	kg		161113000pJPN
Caustic soda (97% liquid equivalent/solid form)	kg		162111000pJPN
Hydrochloric acid, 35% equivalent	kg		162114000mJPN
Dissolved acetylene	kg		162313000pJPN
Other inorganic chemical products, 4 digits	kg		162900000mJPN
Sulfuric acid (100% equivalent)	kg		162921000mJPN
Chromic anhydride	kg		162949228pJPN
Other organic chemical products, 4 digits	kg		163900000mJPN
Other cleaning/polishing agents	Yen		164619000pJPN
Cellulose-based adhesives, plastic-based adhesives	kg		169412000pJPN
Lubricating oil (including grease)	L		171119000pJPN

Appended table 7 Waste disposal intensity

Product name	Unit	Intensity (kg-CO_2 /)	IDEA product code
Industrial waste disposal, cinder	kg	Undisclosed	882201000mJPN
Industrial waste disposal, inorganic sludge from construction, manufacturing, mining, etc.	kg		882203202mJPN
Industrial waste disposal, organic sludge from manufacturing	kg		882203203mJPN
Industrial waste disposal, waste plastics from manufacturing	kg		882207201mJPN
Industrial waste disposal, scrap metals	kg		882214000mJPN
Industrial waste disposal, glass/concrete/ceramic waste	kg		882215000mJPN
Industrial waste disposal, slag	kg		882216000mJPN
Industrial waste disposal, soot and dust	kg		882220000mJPN
Industrial waste disposal, petroleum-derived waste oil	kg		882204202mJPN
Industrial waste disposal, natural fiber waste	kg		882210000mJPN
Industrial waste disposal, rubber waste	kg		882213000mJPN
Neutralization, industrial waste, waste acid	kg		882205251pJPN
Landfill disposal, industrial waste, waste acid	kg		882205211pJPN
Neutralization, industrial waste, waste alkali	kg		882206252pJPN
Landfill disposal, industrial waste, waste alkali	kg		882206211pJPN

Appended table 8 Definition of the processing flow of materials and parts

Material or part name		Definition of processing flow				Yield rate
		Processing 1	Processing 2	Processing 3	Processing 4	
Iron	Cast iron	Sand casting (iron)	Machining (cast iron)	Heat treatment (cast iron)	Assembly	Undis-closed
Iron	Cast steel	Sand casting (iron)	Machining (cast iron)	Heat treatment (cast iron)	Assembly	
Iron	Hot-rolled steel sheet	Press	Welding	Paints	Assembly	
Iron	Cold-rolled steel sheet	Press	Welding	Paints	Assembly	
Iron	Electromagnetic steel sheet	Press	Welding	Paints	Assembly	
Iron	Hot-rolled hot-dip steel sheet	Press	Welding	Paints	Assembly	
Iron	Hot-rolled electroplating steel sheet	Press	Welding	Paints	Assembly	
Iron	Cold-rolled hot-dip steel sheet	Press	Welding	Paints	Assembly	
Iron	Cold-rolled electroplating steel sheet	Press	Welding	Paints	Assembly	
Iron	Carbon steel bar/wire rod	Cold forging	Machining (steel materials)	Heat treatment (steel materials)	Assembly	
Iron	Special steel bars	Hot forging (steel materials)	Machining (steel materials)	Heat treatment (steel materials)	Assembly	
Iron	Special steel wire rod/spring steel	Cold forging	Machining (steel materials)	Heat treatment (steel materials)	Assembly	
Iron	Stainless steel sheet/bar	Press	Welding	Assembly		

Material or part name		Definition of processing flow				Yield rate
		Processing 1	Processing 2	Processing 3	Processing 4	
Iron	Sintered steel	Cold forging	Machining (steel materials)	Heat treatment (steel materials)	Assembly	Undis-closed
Aluminum	Aluminum casting material (wheels)	Gravity die-casting (aluminum)	Machining (aluminum)	Heat treatment (aluminum)	Assembly	
Aluminum	Aluminum casting material (excluding wheels)	Gravity die-casting (aluminum)	Machining (aluminum)	Heat treatment (aluminum)	Assembly	
Aluminum	Aluminum die-casting material (powertrain system)	Die-casting (aluminum)	Machining (aluminum)	Assembly		
Aluminum	Aluminum die-casting material (chassis system)	Die-casting (aluminum)	Machining (aluminum)	Assembly		
Aluminum	Aluminum expanded material (sheet)	Press	Welding	Assembly		
Aluminum	Aluminum extrusion material	Hot forging (aluminum alloy)	Machining (aluminum)	Heat treatment (aluminum)	Assembly	
Copper	Copper strip (TPC)	Press	Welding	Assembly		
Copper	Copper wire (TPC)	Assembly				
Copper	Copper strip (OFC)	Press	Welding	Assembly		
Copper	Copper wire (OFC)	Assembly				
Non-ferrous metals	Magnesium	Gravity die-casting (zinc, magnesium, etc.)	Machining (zinc, magnesium, etc.)	Heat treatment (zinc, magnesium, etc.)	Assembly	
Non-ferrous metals	Other metals	Gravity die-casting (zinc, magnesium, etc.)	Machining (zinc, magnesium, etc.)	Heat treatment (zinc, magnesium, etc.)	Assembly	
Non-ferrous metals	Zinc alloy	Gravity die-casting (zinc, magnesium, etc.)	Machining (zinc, magnesium, etc.)	Heat treatment (zinc, magnesium, etc.)	Assembly	
Non-ferrous metals	Lead	Gravity die-casting (zinc, magnesium, etc.)	Machining (zinc, magnesium, etc.)	Heat treatment (zinc, magnesium, etc.)	Assembly	
Non-ferrous metals	Platinum/rhodium	Assembly				
Resin	PP	Injection molding (hydraulic machine)	Assembly			
Resin	PE	Injection molding (hydraulic machine)	Assembly			
Resin	PVC	Extrusion molding	Assembly			
Resin	ABS	Blow molding	Assembly			
Resin	PA	Injection molding (hydraulic machine)	Assembly			
Resin	PC	Injection molding (hydraulic machine)	Assembly			
Resin	PET	Stamping molding	Assembly			
Resin	PBT	Stamping molding	Assembly			
Resin	PUR	Transfer molding	Assembly			
Resin	POM	Injection molding (hydraulic machine)	Assembly			
Resin	ASA	Injection molding (hydraulic machine)	Assembly			
Resin	PMMA	Injection molding (hydraulic machine)	Assembly			
Resin	EP	Injection molding (hydraulic machine)	Assembly			
Resin	PPS	Injection molding (hydraulic machine)	Assembly			

Material or part name		Definition of processing flow				Yield rate
		Processing 1	Processing 2	Processing 3	Processing 4	
Resin	TPO	Injection molding (hydraulic machine)	Assembly			Undis-closed
Resin	TPV	Injection molding (hydraulic machine)	Assembly			
Resin	SBR	Synthetic rubber molding (others)	Assembly			
Resin	EPDM	Synthetic rubber molding (others)	Assembly			
Resin	Other thermoplastic resins	Injection molding (hydraulic machine)	Assembly			
Resin	Other thermosetting resins	Transfer molding	Assembly			
Other organic materials	Natural rubber	Natural rubber molding	Assembly			
Other organic materials	Synthetic rubber	Synthetic rubber molding (others)	Assembly			
Other organic materials	CFRP	Assembly				
Other organic materials	Anti-rust oil	Assembly				
Other organic materials	Wood	Wood processing	Assembly			
Other organic materials	Adhesives	Assembly				
Other organic materials	Other organic materials	Assembly				
Others	Glass	Assembly				
Others	Other inorganic materials	Assembly				
Others	Paints	Assembly				
Others	Electronic parts (silicon)	Electronic parts production	Assembly			
Others	Electronic parts	Assembly				
Others	Engine oil	Assembly				
Others	Brake fluid					
Others	LLC	Assembly				
Others	Air conditioner refrigerant (HFO-1234yf)	Assembly				
Part	Tires	Tire production	Assembly			
Part	Lead-acid battery	Lead-acid battery production	Assembly			
Part	Part_Li-ion/Ni-MH battery (weight)	Li-ion/Ni-MH battery production	Assembly			
Part	Part_Li-ion/Ni-MH battery (capacity)	Li-ion/Ni-MH battery production	Assembly			

Appended table 9 Source of energy coefficient concerning processing of materials

	INPUT										Source
	Electricity (kWh)	Heavy oil A (L)	Heavy oil C (L)	Kerosene (L)	Diesel (L)	Gasoline (L)	Natural gas liquids (L)	Liquefied petroleum gas (LPG) (kg)	Natural gas (LNG) (kg)	City gas (m3)	
Assembly											*1
Paints											
Paints (base material + paints)											
Paints (paints only)											
Welding											
Press											
Injection molding (hydraulic machine)											
Injection molding (electric motor)											
Extrusion molding											
Blow molding											
Stamping molding											
Transfer molding											
Reaction injection molding											
Sand casting (iron)											
Gravity die-casting (aluminum)						Undisclosed					
Die-casting (aluminum)											*2
Die-casting (zinc, magnesium, etc.)											
Gravity die-casting (zinc, magnesium, etc.)											
Cold forging											
Hot forging (steel material)											
Hot forging (aluminum alloy)											
Hot forging (titanium alloy)											
Sintering materials/sintering											
Machining (steel material)											
Machining (cast iron)											
Machining (aluminum)											
Machining (zinc, magnesium, etc.)											
Heat treatment (cast iron)											
Heat treatment (malleable cast iron)											

<table>
<tr><th rowspan="2"></th><th colspan="10">INPUT</th><th rowspan="2">Source</th></tr>
<tr><th>Electricity (kWh)</th><th>Heavy oil A (L)</th><th>Heavy oil C (L)</th><th>Kerosene (L)</th><th>Diesel (L)</th><th>Gasoline (L)</th><th>Natural gas liquids (L)</th><th>Liquefied petroleum gas (LPG) (kg)</th><th>Natural gas (LNG) (kg)</th><th>City gas (m3)</th></tr>
<tr><td>Heat treatment (aluminum)</td><td colspan="10" rowspan="12">Undisclosed</td><td rowspan="11"></td></tr>
<tr><td>Heat treatment (steel material)</td></tr>
<tr><td>Heat treatment (zinc, magnesium, etc.)</td></tr>
<tr><td>Surface treatment (plating)</td></tr>
<tr><td>Anodized aluminum</td></tr>
<tr><td>Brazing</td></tr>
<tr><td>Vendor</td></tr>
<tr><td>Natural rubber molding</td></tr>
<tr><td>Synthetic rubber molding (acrylic, fluorine-based)</td></tr>
<tr><td>Synthetic rubber molding (others)</td></tr>
<tr><td>Electronic parts production</td></tr>
<tr><td>Wood processing</td><td>*3</td></tr>
</table>

*1 Japan Automobile Manufacturers Association, Inc.
*2 Japan Auto Parts Industries Association
*3 Japan Auto-Body Industries Association Inc.

Appended table 10 Source of energy coefficient concerning processing of parts

	INPUT										Source
		Electricity (kWh)	Heavy oil A (L)	Heavy oil C (L)	Kerosene (L)	Diesel (L)	Gasoline (L)	Natural gas liquids (L)	Liquefied petroleum gas (LPG) (kg)	Natural gas (LNG) (kg)	City gas (m3)
Tires		Undisclosed									*1
Lead-acid battery											*2
Li-ion battery											
	LMO	1.3									*3
	NMC111	1.6									
	LFP: Hydrothermal	1.3									
	LFP: SolidState	1.3									
	NMC622	1.6									
	NMC811	1.7									
	NCA	1.7									
	NMC532	1.6									
	NMC95	1.8									

*1 Tire $LCCO_2$ Calculation Guidelines Ver. 3.0.1
*2 Battery Association of Japan
*3 2.2 Reference List (battery materials)

Appended table 11 Transport intensity

			Mass (kg)	Transport distance (km)	Intensity			CO_2 emissions volume (kg-CO_2e)	Transport intensity (kg-CO_2e/kg)
					Ton-kilometer (L/t・km)*	Fuel combustion (kg-CO_2e/L)	Fuel production (kg-CO_2e/L)		
From materials to vehicles	Materials		1630	500	0.063	Undisclosed			
	Part		779	500	0.063				
	Finished vehicles	Land transport	1039	500	0.063				
		Ships	1039	500	0.013				
Scrapped vehicles	to dismantlers		1039	50	0.063				
	to shredding & sorting operators		675	50	0.063				
	to ASR facilities		187	100	0.063				
	to landfill		6	100	0.063				
Maintenance parts	From materials to landfill		191	―	―				
Scrapped vehicle parts	to proper disposal operators		48.5	100	0.063				

*2.2 Reference List (transport)

Appended table 12 Transport distance

Target	Transport distance
When it is certain transport will be limited to within the city or between neighboring cities	50 km
When it is certain transport will be limited to within the prefecture	100 km
When there is a possibility of transport between prefectures	500 km
Land transport distance overseas	500 km
Ship distance between ports in Japan	500 km
Ship distance between ports overseas	Refer to IDEA Annex (7) Distance between countries

Appended table 13 Fuel production/combustion intensity for the year

		2022	~	2050
Gasoline	kg-CO_2/L	Undisclosed		〃
Diesel	kg-CO_2/L			〃

*Values for the first fiscal year are cited from the combustion intensity in Appended table 5. In this first version, future values are also assumed to be the same.

Appended table 14 Electricity production intensity for the year

	2022	2023	2024	2025	2026	2027	2028	2029	2030
Electricity	**0.58**	0.54	0.51	0.47	0.43	0.39	0.36	0.32	**0.28**

	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
Electricity	0.26	0.24	0.26	0.25	0.24	0.23	0.22	0.21	0.20	0.19

	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Electricity	0.18	0.17	0.16	0.15	0.14	0.14	0.13	0.12	0.11	**0.10**

*Electricity intensity for the year creation method
For the electricity intensity values (2022, 2030, 2050) in Appended table 15, the intensity for years without future values is supplemented by assuming that the intensity changes linearly.

*Electricity production intensity creation method
Information on power generation [TWh] and CO_2 emissions [MtCO_2] for each country in line with the APS (The Announced Pledges Scenario) from the World Energy Outlook 2023 Free Dataset in the World Energy Outlook 2023 published by the IEA was extracted to create electricity production intensity [gCO_2/kWh]. In addition, the upstream emissions is based on the actual values for 2021 from the IEA Life Cycle Upstream Emission Factors 2023-Pilot Edition and is supplemented with the upstream portion ratio (123% = total / direct emissions) for subsequent years.
*APS: Considers all climate-change-related commitments made by governments, including NDCs and long-term net zero targets, and assumes they will be met in full and on time.

Appended table 15 Electricity production intensity (WEO 2023 Japan) *

<table>
<tr><th colspan="4"></th><th>2021</th><th>2022</th><th>2030</th><th>2050</th></tr>
<tr><td colspan="3">Power sector inputs</td><td>Mt CO_2</td><td>482</td><td>501</td><td>250</td><td>-6</td></tr>
<tr><td colspan="3">Electricity generation</td><td>TWh</td><td>1,040</td><td>1,062</td><td>1,083</td><td>1,358</td></tr>
<tr><td rowspan="4">CO_2 Intensity</td><td colspan="2">Upstream emissions</td><td>kg-CO_2e/kWh</td><td>0.463</td><td>0.472</td><td>0.231</td><td>0.080</td></tr>
<tr><td rowspan="2">Upstream portion</td><td>Fuel-cycle factors</td><td>kg-CO_2e/kWh</td><td>0.079</td><td rowspan="2">0.108</td><td rowspan="2">0.053</td><td rowspan="2">0.018</td></tr>
<tr><td>Life cycle T&D factors</td><td>kg-CO_2e/kWh</td><td>0.027</td></tr>
<tr><td colspan="2">Total</td><td>kg-CO_2e/kWh</td><td>0.570</td><td>0.580</td><td>0.283</td><td>0.098</td></tr>
<tr><td colspan="3"></td><td>%</td><td>123%</td><td></td><td></td><td></td></tr>
</table>

*2.2 Reference List (electricity)

Appended table 16 Parts replacement distance, parts replacement period

Replacement parts	Small-sized vehicle		Heavy vehicle						Motorcycle	
	Passenger car	Small truck	Truck			Bus (tourist bus/route bus)			Small Motorcycle	Large Motorcycle
			Small	Medium	Large	Small	Medium	Large		
Periodic replacement parts										
Oil filter	1 year	1 year	1 year	1 year	1 year	1 year	1 year	1 year	12,000 km	20,000 km
Air cleaner element	50,000 km	50,000 km	1 year	1 year	1 year	1 year	1 year	1 year	20,000 km	40,000 km
Fuel filter	100,000 km	100,000 km	1 year	1 year	1 year	1 year	1 year	1 year	100,000 km	100,000 km
Timing belt	100,000 km	100,000 km	150,000 km	300,000 km	300,000 km	200,000 km	300,000 km	300,000 km	100,000 km	100,000 km
Spark plug	100,000 km	100,000 km	-					-	400,000 km	400,000 km
Disc pad (front wheels)	50,000 km	50,000 km	2 years	2 years	2 years	2 years	2 years	2 years	15,000 km	15,000 km
Brake shoe (rear wheels)	50,000 km	50,000 km	2 years	2 years	2 years	2 years	2 years	2 years	15,000 km	15,000 km
MT clutch plate	-	-	200,000 km	300,000 km	400,000 km	200,000 km	250,000 km	250,000 km	-	-
Starter motor	-	-	150,000 km	300,000 km	540,000 km	200,000 km	370,000 km	300,000 km	-	-
Drive chain on chassis side	-	-	-					-		20,000 (km)
Drive belt on chassis side	-	-	-					-	20,000 km	
Engine oil	0.5 years	0.5 years	1 year	1 year	1 year	1 year	0.5 years	0.5 years	6,000 km	10,000 km
Brake fluid	2 years	2 years	2 years	1 year	1 year	1 year	1 year		2 years	2 years
Long life coolant	4 years	4 years	3 years	3 years	3 years	2 years	3 years	3 years	4 years	4 years
Replacement parts other than periodic replacement										
Tires	40,000 km	40,000 km-	3 years	3 years	1 year	3 years	3 years	2 years	15,000 km	15,000 km
Auxiliary battery (lead-acid battery)	4 years	4 years	3 years	3 years	4 years	3 years	3 years	4 years	3 years	3 years
MT mission oil	-	-	2 years	1 year	1 year	2 years		1 year	-	-
AT oil	-	-	2 years	4 years	1 year	2 years	4 years	1 year	-	-
Differential oil	-	-	2 years	1 year	1 year	2 years	1 year	1 year	-	-

*Values are set based on the owners' manuals of JAMA member companies' products and the actual situation as understood by member companies.

Appended table 17 Secondary data related to replacement tires for heavy vehicle

Category	Value	Remarks
New tire production intensity	3.4 kg-CO_2e/kg	Value considered at JATMA/JAMA
Retreaded tire production intensity	1.2 kg-CO_2e/kg	Value considered at JATMA/JAMA
Retreaded tire usage rate	15%	Value considered at JATMA/JAMA

Appended table 18 Air conditioner refrigerant leakage, air conditioner refrigerant GWP

Category	Product category	Product category	Value	Remarks
Air conditioner refrigerant leakage	Small-sized vehicle	Single	8.6 g/year	2011 JAMA method
		Dual	13.3 g/year	2011 JAMA method
	Heavy vehicle	Truck	10.6 g/year	Value considered by JAMA (considering the capacity difference with small vehicles)
		Bus	8.6 g/year 17.2 g/year	Value considered by JAMA (considering the capacity difference with small vehicles) Upper: 1 cycle Lower: 2 cycles
Air conditioner refrigerant GWP	HFO-1234yf		1	Small-sized vehicle
	HFC-134a		1300	Heavy vehicle *Use IPCC 5th Report values in line with industry initiatives

*Fluorocarbon production intensity: Appended table 2

Appended table 19 Dismantling and shredding/sorting of end-of-life vehicles (ELVs)

	Waste disposal [kg-CO_2e/kg]
Scrapped vehicle disposal	0.0359

Appended table 20 Tire disposal

	Waste disposal (including CFF effects) [kg- CO_2e/kg]	Breakdown			(Reference) Disposal/recycling ratio
		Simple incineration [kg- CO_2e/kg]	Thermal recovery deduction (CFF effects) [kg- CO_2e/kg]	Other than recycling (mainly exported overseas, simple incineration) [kg- CO_2e/kg]	
Passenger car and motorcycle tires	Undisclosed	1.530	Undisclosed (See Appended table 21)		Thermal recovery: 0.78 Other than recycling: 0.22
Large motor vehicle tires (trucks, buses, etc.)		0.515			Thermal recovery: 0.42 Other than recycling: 0.22 (material recycling/retreading: 0.36 is not applicable)

Appended table 21 CFF parameters for heat and electricity allowances in thermal recovery

			B	R3	E_{ER}	Heat energy deduction				Electric energy deduction			
						-LHV×$X_{ER,heat}$×$E_{SE,heat}$				-LHV×$X_{ER,elec}$×$E_{SE,elec}$			
							LHV	$X_{ER,heart}$	$E_{SE,heat}$		LHV	$X_{ER,elec}$	$E_{SE,elec}$
Tire	Passenger car use		0	0.78	1.961	Undisclosed	31.4	0.54	Undisclosed	–	–	–	–
		Source	PEFCR		Refer to JATMA Guidelines	–	Waste tire calorific value (Energy Handbook) 39.7 x tire combustible content ratio 0.79	・Nippon Paper Group Cited from the CSR Report *1	・Cited combustion energy of waste tires in IDEA(v3.2) *7				
	Large		0	0.42	1.226	Undisclosed	27.4	0.54	Undisclosed	–	–	–	–
		Source	PEFCR		Refer to JATMA Guidelines	–	・Waste tire calorific value (Energy Handbook) 39.7 x tire combustible content ratio 0.69	・Cited from the Nippon Paper Group CSR Report *1	・Cited combustion energy of waste tires in IDEA(v3.2) *7				
Waste oil			0	0.43	2.63	Undisclosed	40.2	0.48	Undisclosed	–	–	–	–
		Source	PEFCR		・Cited from the Ministry of the Environment website (List of calculation methods/emission factors) *2	–	Cited from the Ministry of the Environment website (List of calculation methods/emission factors) *2	・Calculated based on the cement plants among the reported utilization rates of ASR input facilities in FY23 *3	・Cited combustion energy of waste oil in IDEA(v3.2) *8				
ASR			0	1	2.77	Undisclosed	28.3	0.288	Undisclosed	Undisclosed	28.3	0.044	Undisclosed
		Source	PEFCR		・Calculated from C content of the material, based on the Ministry of the Environment report *4	–	・Cited from the specified values for calculating the ASR input facility utilization rate *3	・Calculated based on the reported utilization rates of ASR input facilities in FY23 *3	・Cited combustion energy of heavy oil in IDEA v3.2 *9	–	・Cited from the specified values for calculating the ASR input facility utilization rate *3	・Calculated based on the reported utilization rates of ASR input facilities in FY23 *3	・Calculated using MJ conversion after adjusting for power generation efficiency from general purchases electricity in IDEA v3.2 *10
Wood			0	1	Undisclosed	Undisclosed	13.9	0.288	Undisclosed	Undisclosed	13.9	0.044	Undisclosed
		Source	PEFCR		・Calculated based on input/output data in IDEA v3.2 *5	–	・Cited from NEDO document *6	・Calculated based on the reported utilization rates of ASR input facilities in FY23 *3	・Cited combustion energy of heavy oil in IDEA v3.2 *9	–	・Cited from NEDO document *6	・Calculated based on the reported utilization rates of ASR input facilities in FY23 *3	・Calculated using MJ conversion after adjusting for power generation efficiency from general purchases electricity in IDEA v3.2 *10

*1: Cited from the Nippon Paper Group CSR Report "The Nippon Paper Group's Environmental Activities" 2011

*2: Calculated with reference to the List of calculation methods and emission factors for greenhouse gas emissions calculation, reporting, and disclosure system on the Ministry of the Environment website

*3: Calculated thermal efficiency/electricity conversion based on data reported by each business from the Ministry of the Environment's FY23 ASR input facility utilization rate

*4: Calculated based on the Ministry of the Environment's fiscal 2013 automobile recycling coordination advancement support project "Research report on material recycling and petrochemistry business of ASR-derived plastics using an optical sorter," 2014, RENOVA, Inc.

*5: CO_2/MJ is calculated by multiplying the CO_2, N_2O, and CH_4 emissions per MJ given in the input/output data from IDEA v3.2 "Waste wood combustion energy" (IDEA product code: 120000801pJPN), with the GHG emission factors (CO_2: 1, N_2O: 265, CH_4: 25) given in the Ministry of the Environment's "List of calculation methods and emission factors"; then, CO_2/kg is calculated using the unit heating value for wooden materials of 14.4 MJ/kg given in the Ministry of the Environment's "Guidelines for Method of Calculating Greenhouse Gas Emissions from Operators"

*6: 25% moisture from NEDO's basic knowledge on woody biomass energy (equivalent to Table 3.1.8 Construction materials (25-30%) in the document)

*7: Cited IDEA v3.2 "Combustion energy of waste tires" (IDEA product code: 882207802pJPN)

*8: Cited IDEA v3.2 "Combustion energy of waste oil" (IDEA product code: 882204801pJPN)
*9: Cited IDEA v3.2 "Combustion energy of heavy oil A" (IDEA product code: 171116801pJPN)
*10: The total of the weight averages for the various generated energy from the input/output data from IDEA v3.2 "Power generation efficiency from electricity, Japan average" (IDEA product code: 331131017pJPN) is used to calculate Japan's average power generation (MJ/kWh), and the CO_2 intensity (CO_2/kWh) of IDEA v3.2 "Power generation efficiency from electricity, Japan average" (IDEA product code: 331131017pJPN) is converted to CO_2/MJ

Appended table 22 Lead battery disposal

	Waste disposal [kg- CO_2e/kg]	Breakdown		
		Plastic parts (PP) Simple incineration [kg- CO_2e/kg]	Lead scrap disposal [kg- CO_2e/kg]	Electrolyte neutralization [kg- CO_2e/kg]
Lead-acid battery	Undisclosed	0.127	Undisclosed *1	Undisclosed *2

*1 Calculated using IDEA v3.2 "Lead scraps" (IDEA product code: 232171101pJPN)
*2 Calculated using IDEA v3.2 "Caustic soda" (IDEA product code: 162111000pJPN)

Appended table 23 Airbag disposal

	Waste disposal [kg- CO_2e/kg]	Breakdown	
		Removal process [kg- CO_2e/kg]	Metal/resin disposal [kg- CO_2e/kg]
Airbag	Undisclosed	Undisclosed *1	– *2

*1 Value obtained by excluding CO2 emissions volume of "General waste" (IDEA product code: 881612000mJPN) from the input/output data of IDEA v3.2 "Incineration/ash melting services, general waste, fluidized bed electric type" (IDEA product code: 881612209pJPN)
(Cited from "Fiscal 2021 report for a survey and study on the measures to be taken in the automotive recycling field toward achieving carbon neutrality in 2050")
*2 Evaluated by [E3] ASR treatment and [E4] Material recycling

Appended table 24 Air conditioner refrigerant disposal

	Waste disposal [kg- CO_2e/kg]	Breakdown	
		Fluorocarbon destruction treatment [kg- CO_2e/kg]	CO_2 produced during fluorocarbon destruction [kg- CO_2e/kg]
Air conditioner refrigerant -Fluorocarbons-	Undisclosed	Undisclosed *1	0.863 *2

*1 Cited from the "LCI database IDEA v3.2 'fluorocarbon destruction treatment' (IDEA product code: 882400102pJPN)" of the LCA Promotion Consortium
*2 Calculated from a chemical reaction formula

Appended table 25 Waste oil disposal

	Waste disposal (including CFF effects) [kg- CO_2e/kg]	Breakdown		
		Simple incineration [kg- CO_2e/kg]	Thermal recovery deduction (CFF effects) [kg- CO_2e/kg]	(Reference) Thermal recovery rate
Waste oil	Undisclosed	2.63 *1	Undisclosed (See Appended table 21)	0.43*2

*1 From the List of calculation methods and emission factors 2020 on the Ministry of Economy, Trade and Industry website
*2 Cited from the "Ministry of the Environment: Fiscal 2021 report for a survey and study on the measures to be taken in the automotive recycling field toward achieving carbon neutrality by 2050"

Appended table 26 Powertrain battery detoxification

	Waste disposal [kg- CO_2e/kg]
Detoxification (energy source)	0.59
Combustion of combustibles (no energy source)	Primary data (carbon ratio of combustibles x 44/12)

Appended table 27 Disposal of ASR thermal recovery materials and disposal of wooden materials

	Waste disposal (including CFF effects) [kg- CO_2e/kg]	Breakdown			
		Simple incineration [kg- CO_2e/kg]	Thermal recovery deduction (CFF effects) [kg- CO_2e/kg]	Electricity recovery deduction (CFF effects) [kg- CO_2e/kg]	Residue landfill *including landfill residue ratio of 0.043 [kg- CO_2e/kg]
ASR thermal recovery materials	Undisclosed	2.77	Undisclosed (See Appended table 21)		0.017
Wood		Undisclosed			0

*Calculated from the "Report on the evaluation and study of the implementation status of the end-of-life vehicle recycling law (2021)"

Appended table 28 CFF parameters by material

Material classification	Classification of downstream process		CFF parameters (based on each of the following sources)								
			PEFCR	IDEA base JAMA data set				JAMA data set			
			A	Ev	E*v	Erec	Erec EoL	R1	Qsin /Qp	R2	Qsout /Qp
Iron	1	Cast iron	0.2	Undisclosed				0.8	0.95	0.98	0.95
	2	Cast steel	0.2					0.8	0.95	0.98	0.95
	3	Hot-rolled steel sheet	0.2					0	-	0.98	0.95
	4	Cold-rolled steel sheet	0.2					0	-	0.98	0.95
	5	Electromagnetic steel sheet	0.2					0	-	0.98	0.95
	6	Hot-rolled hot-dip steel sheet	0.2					0	-	0.98	0.95
	7	Hot-rolled electroplating steel sheet	0.2					0	-	0.98	0.95
	8	Cold-rolled hot-dip steel sheet	0.2					0	-	0.98	0.95
	9	Cold-rolled electroplating steel sheet	0.2					0	-	0.98	0.95
	10	Carbon steel bar/wire rod	0.2					0	-	0.98	0.95
	11	Special steel bars	0.2					0	-	0.98	0.95
	12	Special steel wire rod/spring steel	0.2					0	-	0.98	0.95
	13	Stainless steel sheet/bar	0.2					0	-	0.98	0.95
	14	Sintered steel	0.2					0	-	0.98	0.95
Aluminum	1	Aluminum casting material (wheels)	0.2					0.1	1.0	0.98	1.0
	2	Aluminum casting material (excluding wheels)	0.2					0	-	0.98	0.8
	3	Aluminum die-casting material (powertrain system)	0.2					0.8	0.8	0.98	0.8
	4	Aluminum die-casting material (chassis system)	0.2					0	-	0.98	0.8
	5	Aluminum expanded material (sheet)	0.2					0	-	0.98	0.7
	6	Aluminum extrusion material	0.2					0	-	0.98	0.7
Copper	1	Copper strip (TPC)	0.2					0.15	1.0	0.91	1.0
	2	Copper wire (TPC)	0.2					0.15	1.0	0.91	1.0
	3	Copper strip (OFC)	0.2					0.15	1.0	0.91	1.0
	4	Copper wire (OFC)	0.2					0.15	1.0	0.91	1.0

Appendix B. Reference: Requirements for third-party reports in ISO 14044:2006

a) General aspects
   1) Person responsible for the LCA and person conducting the LCA (internal or external)
   2) Report date
   3) A statement that the survey was conducted in accordance with the requirements of this regulation (mandate)
b) Survey purpose
   1) Reason for survey
   2) Intended use
   3) Target receiver of report
   4) A statement of whether the survey is one that seeks to support comparative claims intended to be disclosed to the public
c) Survey scope
   1) Functions including:
      i) A description of performance characteristics
      ii) Any additional functions omitted in the comparison
   2) Functional units including:
      i) Consistency with the purpose and survey scope
      ii) Definitions
      iii) Results of performance measurements
   3) System boundaries including:
      i) Omitted life cycle stages, processes or data needs
      ii) Quantification of energy and material inputs and outputs
      iii) Assumptions related to power generation
   4) Cut-off standards for initial inclusion of inputs and outputs, including:
      i) A description of cut-off standards and assumptions
      ii) Influence of selection on results
      iii) Inclusion of mass, energy, and environmental cut-off standards
d) LCI
   1) Data collection procedures
   2) Qualitative and quantitative description of unit processes
   3) Sources of published literature
   4) Calculation procedures
   5) Validation of data including:
      i) Evaluation of data quality
      ii) Handling of missing data
   6) Sensitivity analysis for probing system boundaries
   7) Allocation principles and procedures, including:
      i) Documentation of allocation procedures and confirmation of rationale
      ii) Uniform application of allocation procedures
e) LCIA, where applicable
   1) LCIA procedures, calculations, and survey results
   2) Limitations of LCIA results in relation to the stated purpose and survey scope of the LCA
   3) Relationship of LCIA results to the stated purpose and survey scope
   4) Relationship of LCIA results to LCI results
   5) Areas of influence and area indicators considered, including selected rationale and citation of sources
   6) A description or citation of all characterization models, characterization factors, and methods used, including all assumptions and limitations
   7) A description or citation of all value selections used in relation to the areas of influence, characterization models, characterization factors, normalization, grouping, weighting, and other parts of the LCIA, the rationale for their use, and their effect on the results, conclusions, and recommendations

8) Descriptions of LCIA results are relative expressions and do not predict impacts on endpoints within areas of influence, exceedances from threshold values, safety limits, or risks. As part of the LCA, they include:
    i) An explanation and rationale of the definitions and an explanation of any new areas of influence, area indicators, and characterization models used for the LCIA
    ii) A description and rationale of the grouping of areas of influence
    iii) Further steps to transform the resulting indicators and a rationale for selected references, weighting factors, etc.
    iv) For example, a sensitivity and uncertainty analysis, including any implications for the results, or an analysis of the resulting indicators, which is the use of environmental data
    v) The data obtained prior to normalization, grouping or weighting, and the resulting indicators must be made available for use in conjunction with the normalized, grouped, and weighted results.

f) Life cycle interpretation
    1) Results
    2) Assumptions and limitations related to the interpretation of the results with both the methodology and data involved
    3) Evaluation of data quality
    4) Full transparency regarding value selection, logical rationale, and professional judgment

g) Critical review, where applicable
    1) Name and affiliation of the person conducting the review
    2) Critical review report
    3) Response to recommendations

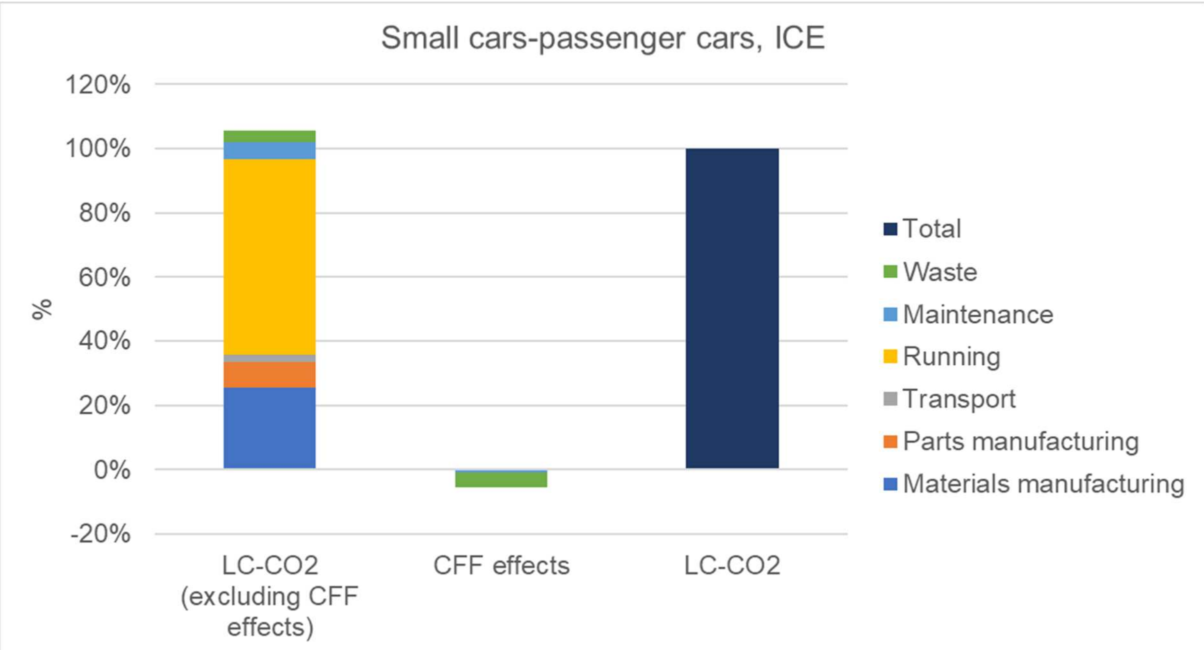
Appendix C. Reference: Examples of trial calculations based on guidelines

To confirm the effectiveness of these guidelines, JAMA conducted a CFP trial calculations for one each of Table 1-1 small vehicles, large motor vehicles, and motorcycles The numerical values for performance, specifications, and weight ratio of materials for each car model used in the trial calculations were set by JAMA based on the assumption of a representative vehicle type, and are not the evaluation results of a specific vehicle type. The evaluation results are expressed as relative values with 100% of GHG emissions over the life cycle, including GHG reduction effects from CFF.

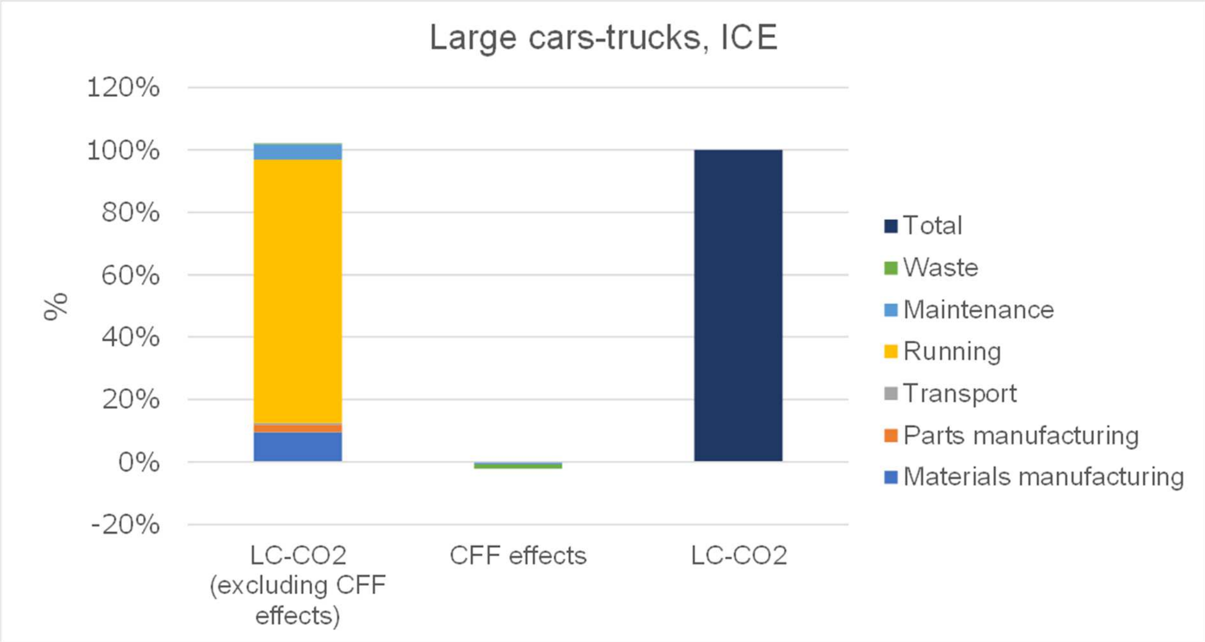
Appended table 29 Vehicle types for trial calculations

Vehicle type classification		Power source	Fuel consumption value [km/L]
Small-sized vehicle	Passenger car	ICE *1 (gasoline)	23.1
Heavy vehicle	Truck-large	ICE *1 (diesel)	3.99
Motorcycle	Small	ICE *1 (gasoline)	45.0

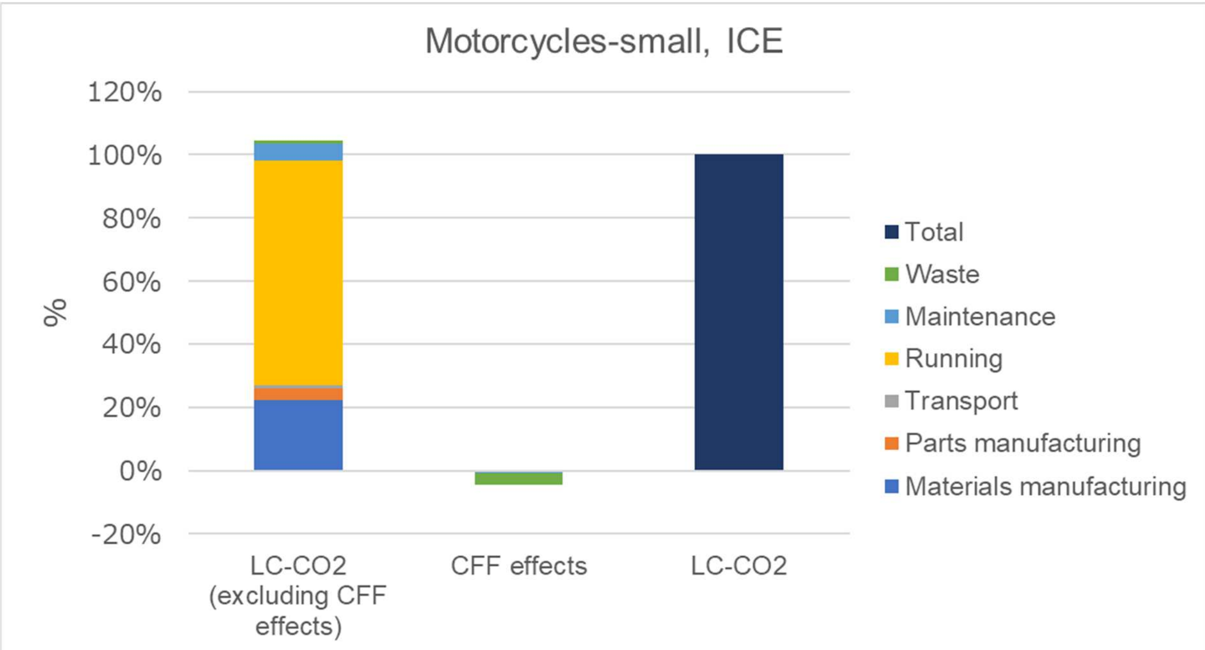
*1 ICE: Non-hybrid internal combustion engine



Appended figure 5 Trial calculation results: Small vehicles (passenger cars, ICE)



Appended figure 6 Trial calculation results: Large motor vehicles (trucks, ICE)



Appended figure 7 Trial calculation results: Motorcycles (small, ICE)