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1st IWG on LCA, 26 October – 28 October 2022
Agenda item 5

中国汽车技术研究中心有限公司
China Automotive Technology and Research Center Co ., Ltd.

LCA Research Progress of CATARC

China Automotive Technology and Research Center Co., Ltd
October 2022

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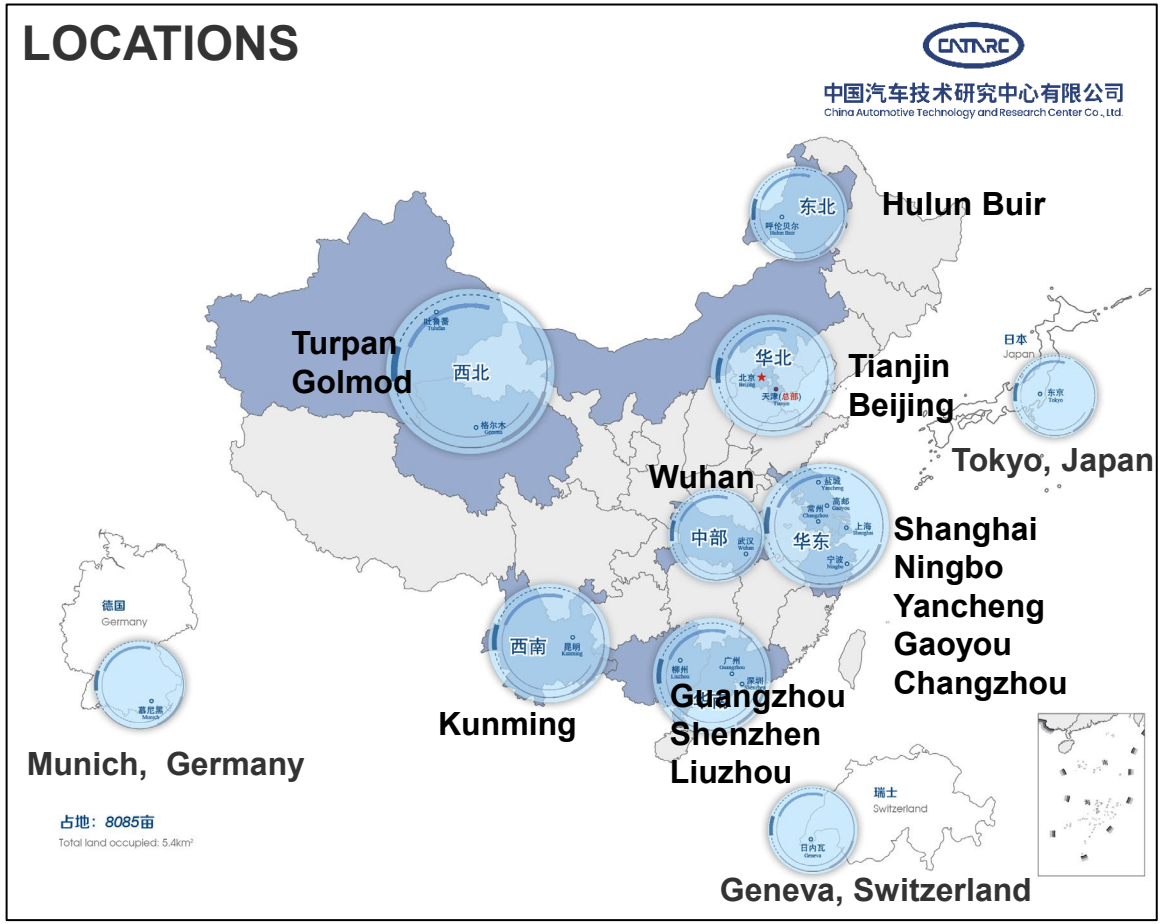
About US

■ **China Automotive Technology and Research Center Co., Ltd. (CATARC)**

Founded in 1985，Headquartered in Tianjin，affiliated to State-Owned Assets Supervision and Administration Commission of the State Council (SASAC)，is a comprehensive technology enterprise group with extensive influence in domestic and foreign automobile industry

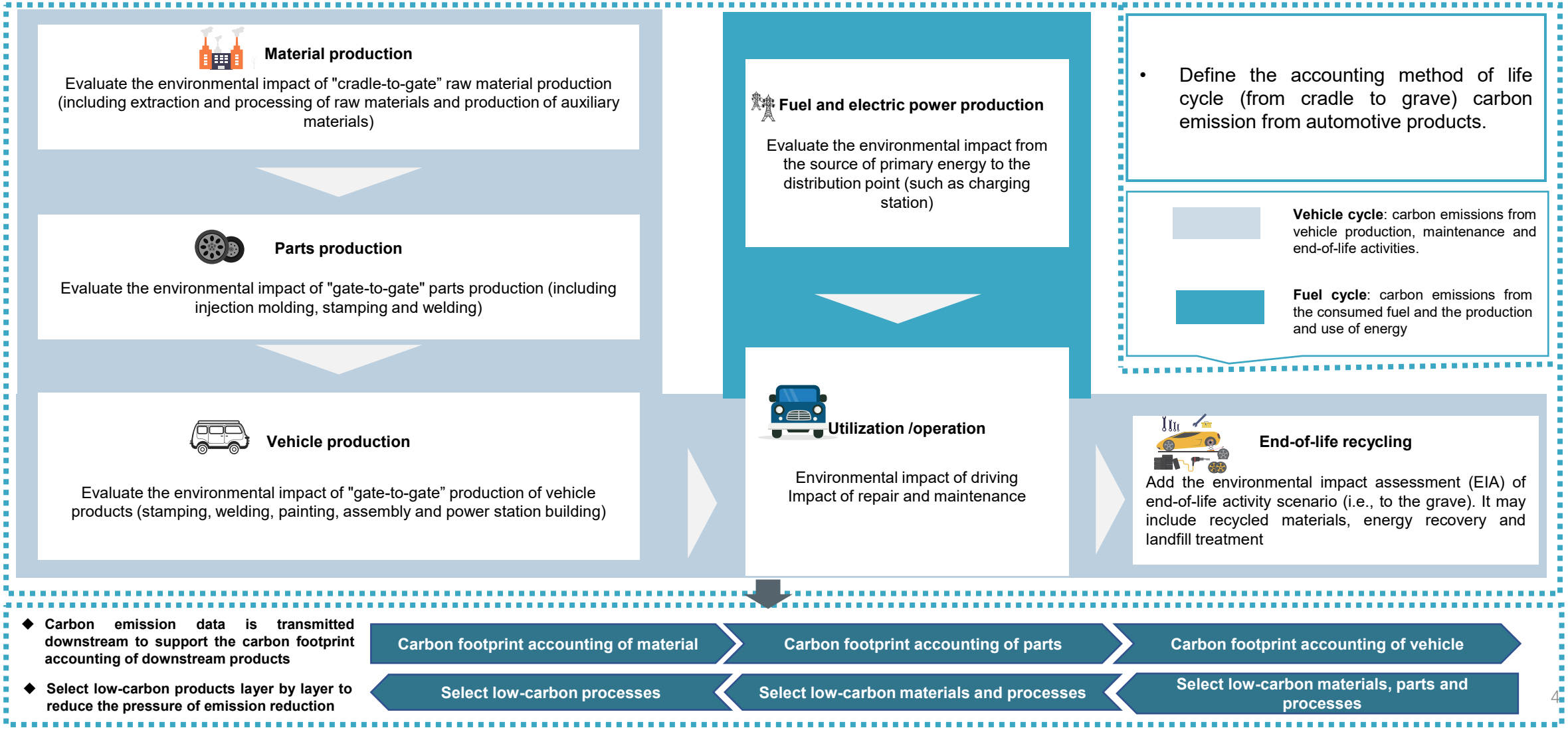
Positioning	Object	Main Business
Independent	To G Think tank	Industry service
Fair	To B Service	Standard business
Third Party	To C Consumption guidance	Policy research
		Testing
		R&D
		Big data
		Engineering Design
		Consulting
		New energy
		Certification
		Industrialization
		Emerging business



1.1 Fundamental Research

■ Carbon Footprint Methodology for Automotive Products - how to calculate the carbon footprint?

The carbon footprint methodology for materials, components and vehicles has been established, which lays a foundation for the carbon footprint accounting. Currently, there are two major problems to be figured out: one is to solve the uncertainty of existing ISO standards, and the other is to solve the problem of inconsistent accounting methods.



1.1 Fundamental Research

■ **China Automotive Life Cycle Database (CALCD)- Carbon emission factor database**

The database covers the industry average carbon emission factors ranging from the automotive material manufacturing, components and vehicle manufacturing, driving to end-of-life recycling, supporting the industry to carry out product carbon footprint accounting and research.

Material Manufacturing

- Inventory data for ***over 50*** vehicle materials, fuels/energy, fluids, etc.
- Power battery material composition data
- Weight and material composition data of ***nearly 100*** kinds of parts
- Weight and material composition data of ***more than 100*** vehicle models

End-of-life Recycling

- Power battery recycling data
- Vehicle end-of-life recycling data
- Incineration and landfill treatment process data

Vehicle Usage

- Fuel (gasoline, diesel, electricity, etc.) consumption data of ***more than 10,000*** vehicle models in the using stage
- Emission data of ***more than 10,000*** vehicle models in the using stage

Components manufacturing

- Energy consumption and emission data of ***nearly 1,000*** parts manufacturing and processing processes
- Energy consumption and emission data of power battery manufacturing and processing process

Vehicle Manufacturing

- Production energy consumption and emission data of ***over 100*** OEMs

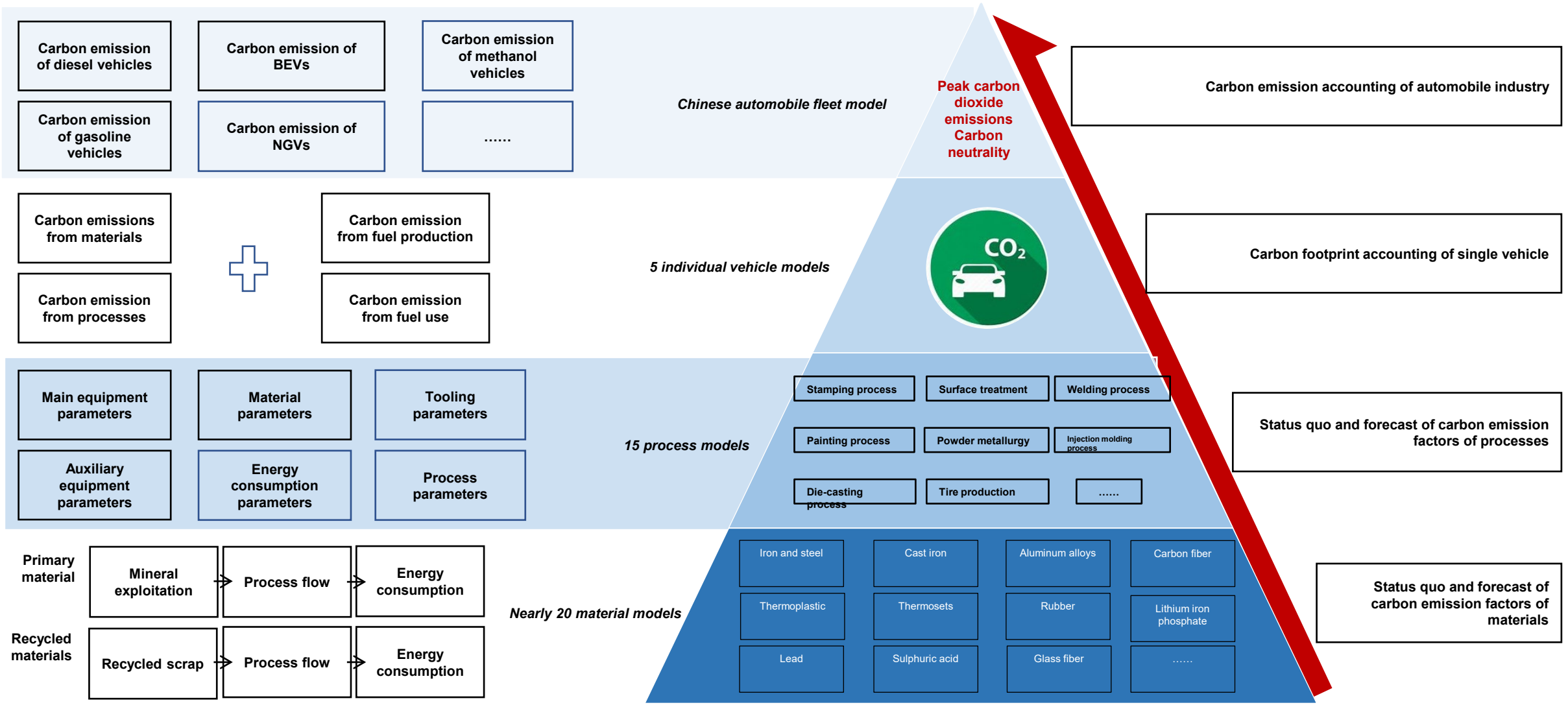
Each piece of data considers the functional unit, data source, inventory data and other information, ensuring high quality of the data

Functional unit	Procedure description	Data source	Geographical coverage	Time range	Calculation model and other conventions	Total energy consumption and environmental emission inventory

1.1 Fundamental Research

■ **China Automotive Life Cycle Assessment Model- standardization of carbon footprint accounting**

This model serves as the packaging methodology and database to standardize and streamlining the carbon footprint accounting of vehicle products



1.1 Fundamental Research

■ Vehicle Life Cycle Assessment Tool (OBS) - digitalization of carbon footprint accounting

Automobiles are complicated products, so their carbon footprint accounting is of great complexity. As a professional accounting tool, OBS will assist industrial enterprises in quickly and accurately accounting the carbon footprint of products.

One-click generation of vehicle model

- One-click BOM import to generate models
- Clear presentation of model hierarchy

Real-time maintenance of model data

- Linked update of CICES data and OBS
- Rich content of CALCD database

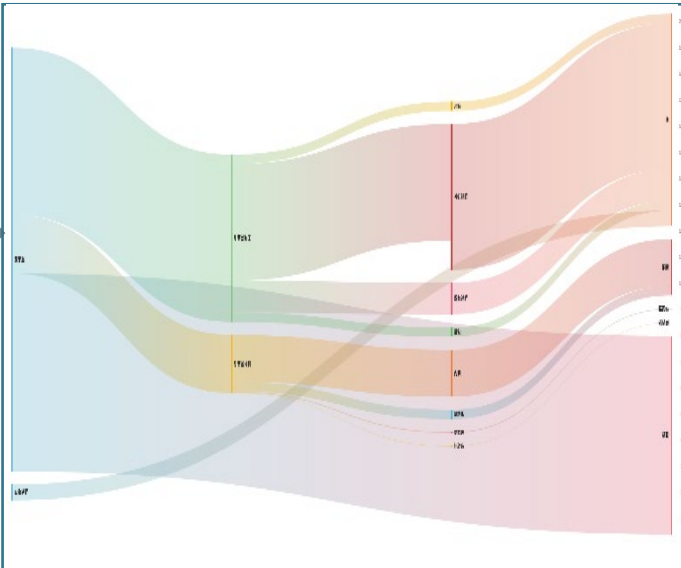
Detailed and vivid analysis results

- Automatic generation of analysis tables and export support
- Automatic generation of analysis images and export support

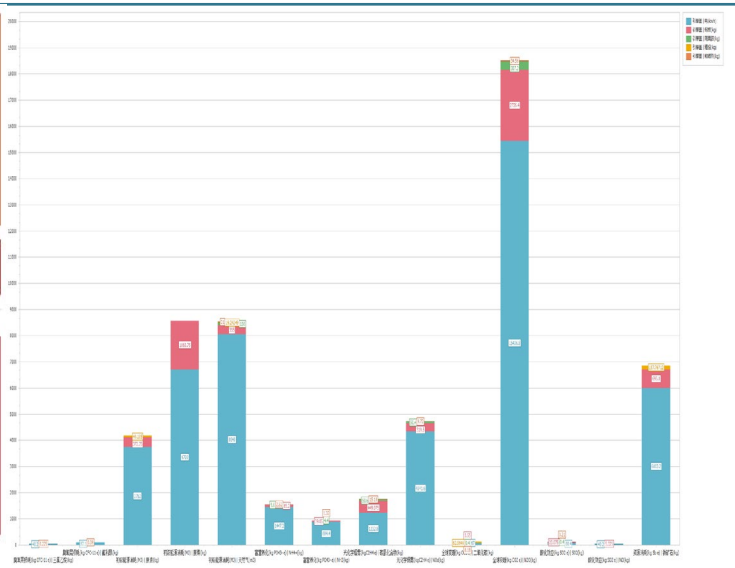
Rapid growth of users

- Application scenarios gradually expanding
- Rapid growth of active users

Results display



- Data flow presented in Sankey diagram
- Data display content can be adjusted and exported



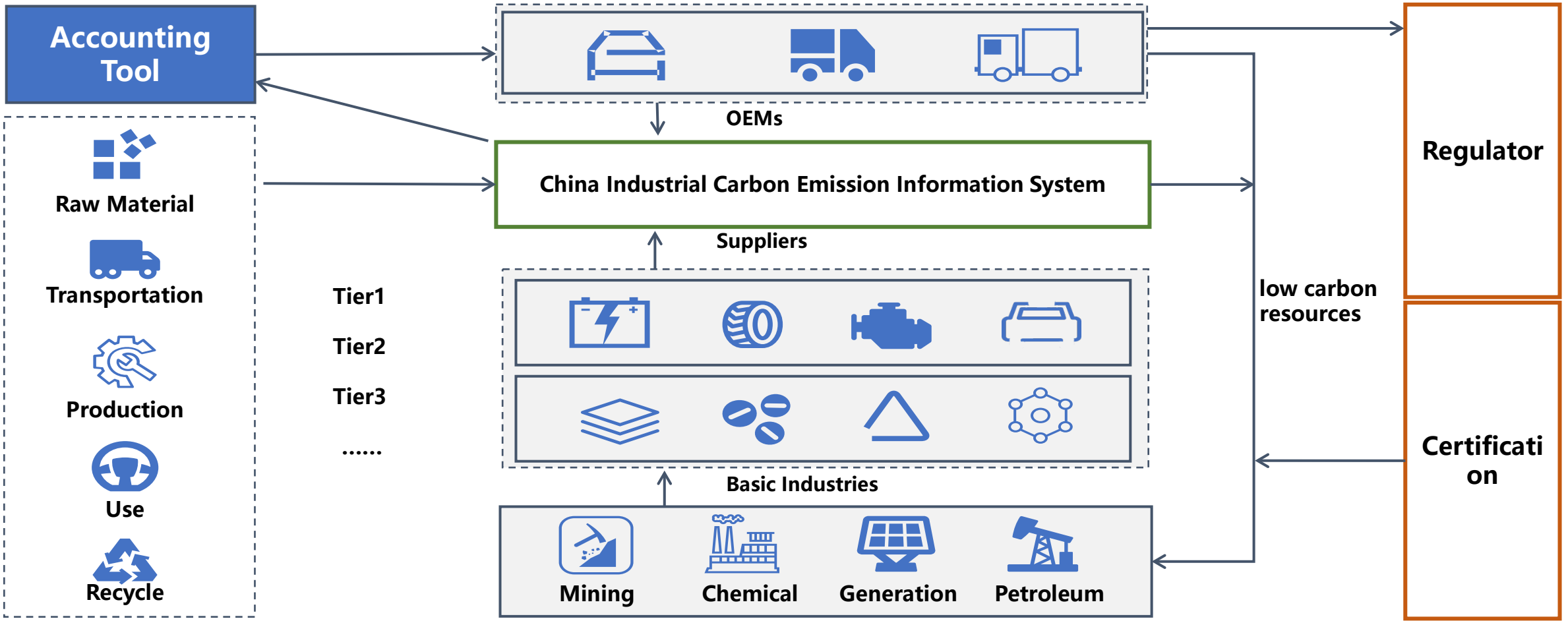
- Contribution of each part presented in histogram
- Data display content can be adjusted and exported

- Details of each part presented in doughnuts
- Data display content can be adjusted and exported

1.2 Industry Efforts

■ **Implementing the Construction of China Industrial Carbon Emission Information System (CICES)**

On December 23, 2021, China Industrial Carbon Emission Information System (CICES) was launched. The CICES provides a solution for OEMs to collect the emission data from their upstream suppliers, in order to facilitate the product carbon footprint accounting.



1.2 Industry Efforts

- **Carbon emission publicity platform.** The objects of platform mainly include passenger vehicle products and key component products. The publicity contents include basic product information, carbon emission information, identification information, etc. The carbon emission publicity platform (CPP) of automobile products is under construction. The draft design of the platform is as follows:
- **Carbon labelling**: specifies the terms and definitions, requirements, marking positions, marking methods and marking requirements of carbon footprint marking of road vehicle products.

Carbon emission publicity platform (**CPP**) of automobile products

Chinese | **English**

Home page | Statistical chart | Standards and regulations | Industry information | Data download | Research library | Emission reduction measures | Cooperation platform | Contact us

Latest models

Model 1
Time to market: 6/5/2022
Last updated: 7/15/2022
Carbon emission per unit mileage: 314.1 gCO_2e/km
Industry average level: 311 gCO_2e/km

Model 2
Time to market: 6/10/2022
Last updated: 7/14/2022
Carbon emission per unit mileage: 221 gCO_2e/km
Industry average level: 200 gCO_2e/km

Model 3
Time to market: 6/8/2022
Last updated: 7/14/2022
Carbon emission per unit mileage: 197 gCO_2e/km
Industry average level: 200 gCO_2e/km

Data publicity Vehicle | Parts | Material

Data download

System ID	Model Name	Model ID	Vehicle Type	Curb Weight	Fuel Tyoe	TTM	Carbon Footprint (gCO_2e/km)	Average Level (gCO_2e/km)	Carbon Label	Lastest Update	History
CEPP.989	**XXX**	XXXXXXX	SUV	2850	**ICEV (Gasoline)**	2022/6/5	314.1	311	**Check**	2022/7/15	**Check**

Vehicle Product Carbon Footprint Label (Sample)

目录 Contents

Principles

■ **Key principles of** *Technical specification of life cycle carbon emission accounting of passenger cars*

◆ Product Level

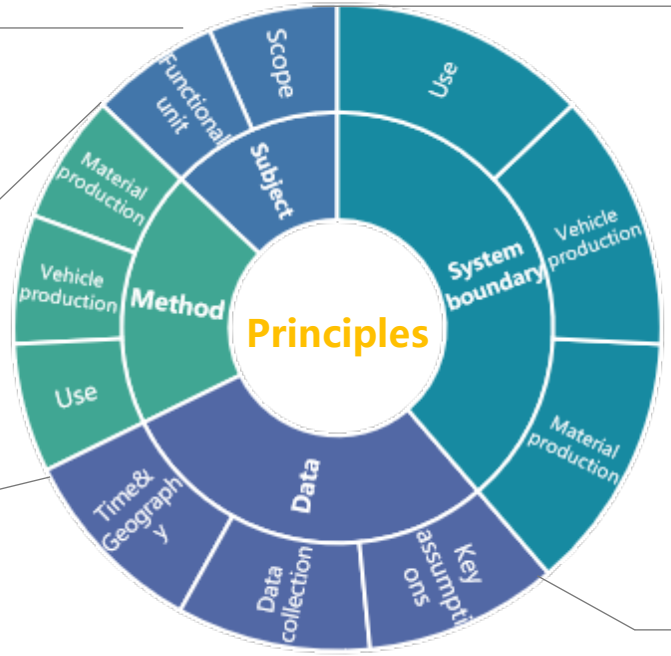
Emissions must be reported at the product level.

◆ Functional unit

The transportation services provided by a passenger car traveling 1km within life cycle, and the life cycle mileage is calculated by (1.5×10^5) km.

◆ Calculation method

According to IPCC and relevant passenger vehicle standards of China, the accounting method of **material production stage, vehicle production stage and use stage** is determined. And **recycled materials** are also considered.



◆ Fixed boundary

- A fixed boundary is defined to enable comparability between different passenger vehicle products
- Boundary defined based on a set of criteria representing which unit processes are a part of the system under study
- This document adds the **material production stage (including raw material and recycled material), vehicle production stage and use stage** into life cycle carbon emission accounting range, excluding carbon emissions from parts processing and transportation.

Time & Geography	Primary Data First	LCI Database	Environmental Influencing Factors	Key Assumptions
Time: 3 months to 1 year; the average data of the most recent continuous production for 1 year should be used preferentially. **Geography**: Data on the actual production geographic area.	**On-site data should be collected and use preferentially.** When specific site data collecting is not feasible, the **default value** should be used. **Secondary data** can only be used when site-specific data is not available and there is no corresponding default value.	**CALCD CICES**	Global Warming Potential (GWP) [gCO_2e/km],	Life cycle mileage

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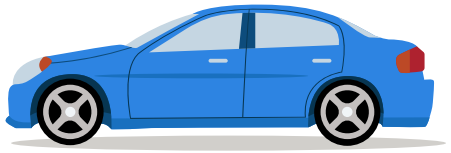
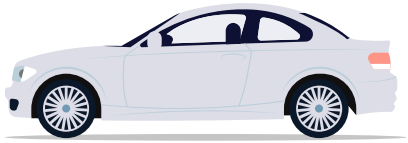
2.1 Definition of Scope

■ **Scope:**

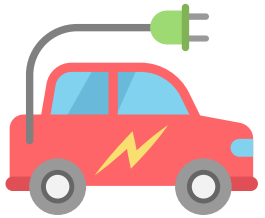
This document applies to M1 vehicles with a maximum design mass not exceeding 3500 kg, including passenger vehicles that only use gasoline or diesel, non-off-vehicle-chargeable hybrid electric passenger vehicle, plug-in hybrid electric passenger vehicle, and battery electric passenger vehicles.
Other M1 vehicles can refer to this document for implementation.



ICEVs (Gasoline/Diesel)



HEVs



PHEVs

BEVs

Other M1 vehicles can also refer to this method

Methanol/ Ethanol

CNG/LNG/LPG

Others

Note：There is no clear definition of passenger BEV. In GB/T 28382-2012, the term is directly cited, refers to intersect of BEV and passenger vehicle

2.1 Definition of Scope

■ **Functional unit**

□ **Definition**: Transportation service provided by a passenger car traveling 1km in its life cycle, where the life cycle mileage is calculated as (1.5×10^5) km.

Life cycle mileage:
13000km/year × 11.5 year=1.5×10^5km

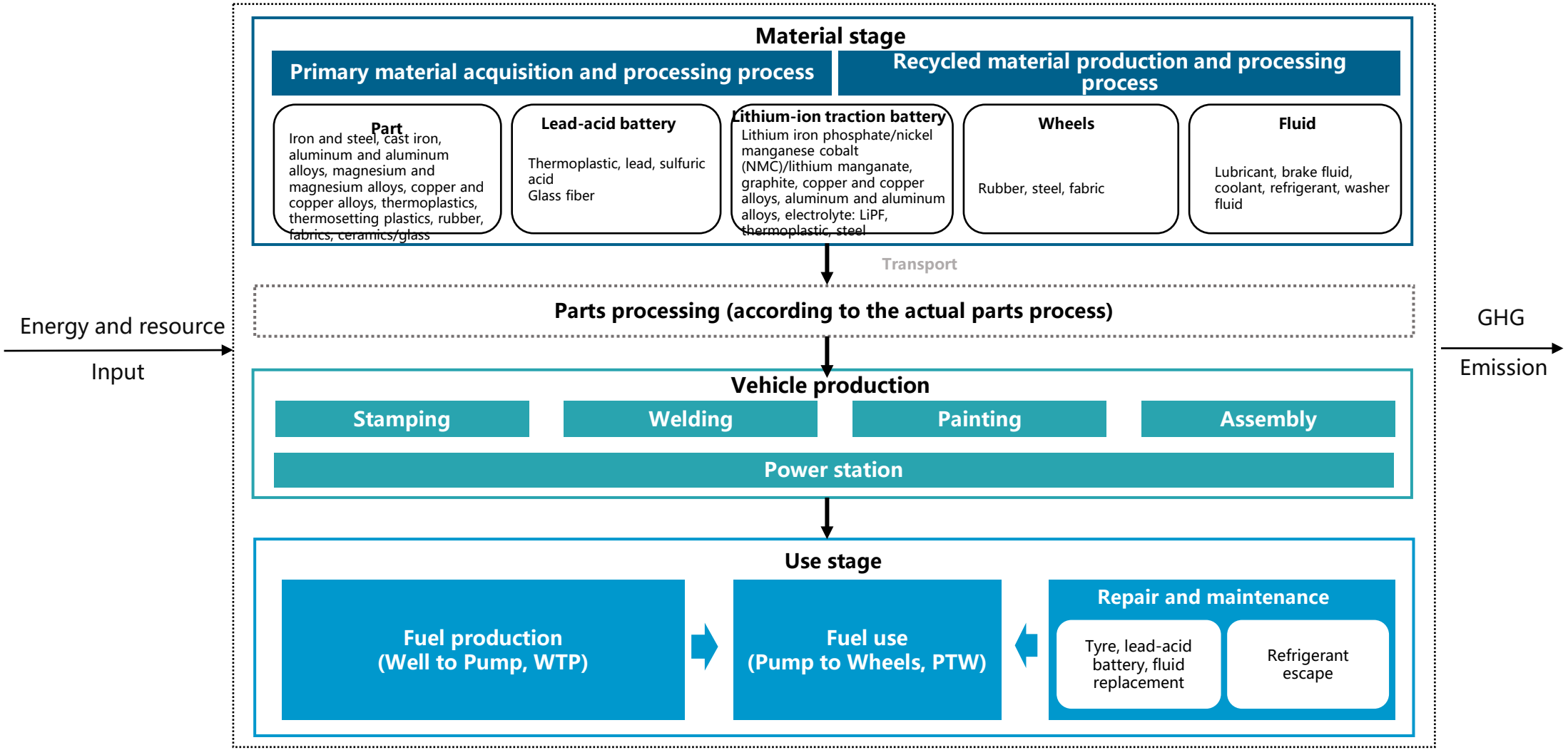
✓ **Determination principle of 13000km: In this study, conservative considerations are made due to the uncertain factors, and the annual change in vehicle mileage is assumed to be small according to the reference parameter scenario set by (the World Resources Institute, 2019), that is, the annual average mileage of passenger cars in China will continue to be *13000km* in 2019.**

✓ **Determination principle of 11.5 years: According to the *Standard for Compulsory Scrapping of Motor Vehicles* jointly issued by the Ministry of Commerce, the National Development and Reform Commission and the Ministry of Public Security, the reference service life of passenger cars is 8-15 years. In order to make the study representative, the average value of *11.5 years* is taken as the life cycle of passenger cars in this study.**

2.1 Definition of Scope

■ **System boundary:**

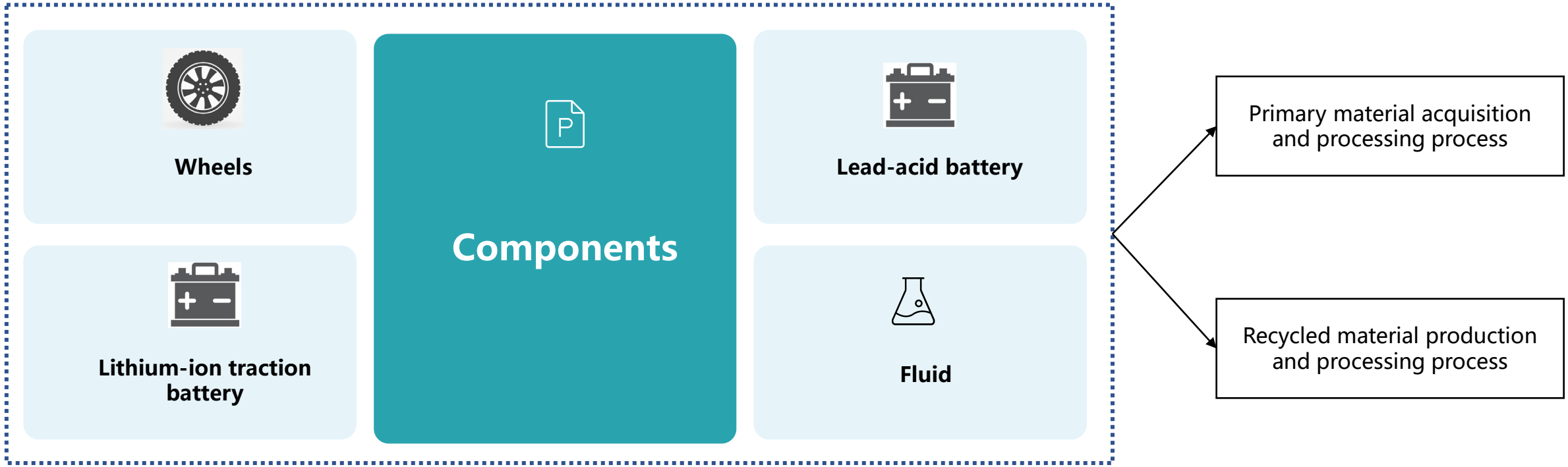
The vehicle material production stage, parts production stage, vehicle production stage and use stage are included in the scope of carbon emission accounting for life cycle. It does not include carbon emissions from infrastructure such as roads and plants, equipment in each processes, personnel and living facilities in the plant.



2.1 Definition of Scope

■ **Material production stage**

The material production stage includes the primary material acquisition and processing as well as the recycled material production and processing. The materials mainly covers five portions: auto parts materials, wheel materials, lead-acid battery materials, lithium-ion traction battery materials and fluid materials.



2.1 Definition of Scope

■ **Recycled material production and processing process**

In the recycled material production and processing process, only the manufacturing processing of recycled materials are considered, excluding the carbon emissions from automobile scrapping, infrastructure such as roads and plants, equipment in each processes, personnel and living facilities in the plant.

Only manufacturing processes of recycled materials are considered

1. No tracking of recycling process by OEMs

- At present, domestic OEMs have not tracked the vehicles for the full life cycle, and there is a lack of data on the disposal of end-of-life vehicles.

2. Imperfect scrapping system

- Currently, China's automobile scrapping system is not perfect and lacks data support
- Recycling of end-of-life vehicles is low and declining

3. Standard-based operability

- Recycling and reusing materials in other products involves distribution issues, and will extend the boundaries infinitely, so it is not operational

2.1 Definition of Scope

■ **Boundary of material production phase:**

The materials weight, carbon emission and data availability are considered as principles when selecting the accounting materials.

01

Material weight proportion in the weight of corresponding part

>1%

02

Material carbon emission proportion in the carbon emission of the corresponding part

>1%

03

Data availability

Refer to the MRV system in the carbon market to periodically check the collection and reporting of GHG emission data, help regulatory authorities to control the accuracy and reliability of data to the greatest extent, and improve the credibility of the overall reporting results of GHG emission.

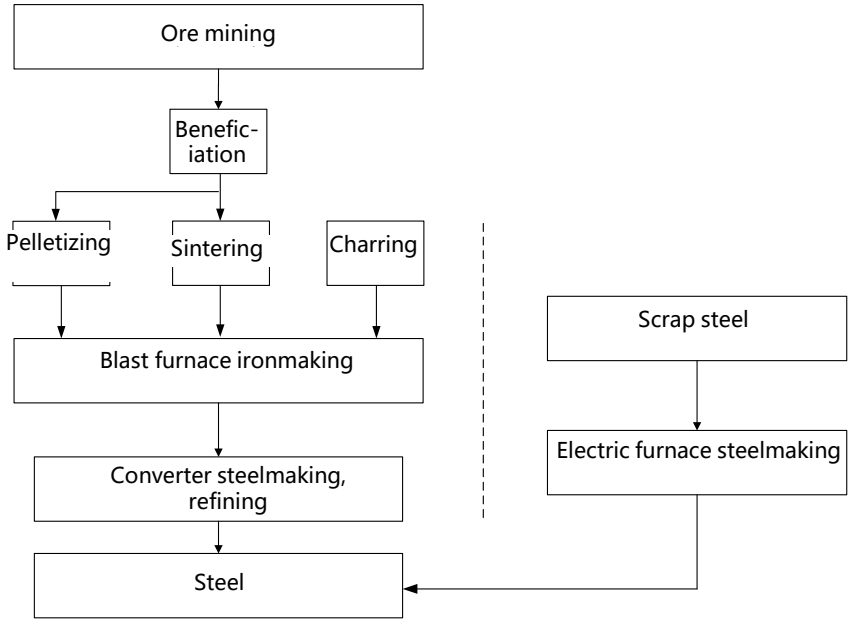
2.1 Definition of Scope

■ **Boundary of material production phase:**

Material accounting boundary: The system boundary of material production includes the acquisition and processing of primary materials and the production and processing of recycled materials, while the equipment manufacturing, plant construction and other infrastructure involved in the production and are not included in the boundary.

Taking steel as an example:

Material	Steel
Accounting boundary	Including the main processes of iron ore mining, iron ore beneficiation, sintering, iron making (BF), steel making to the production process of relevant auxiliary materials (metallurgical lime, metallurgical coke, ferrosilicon), including the scrap steel recycling process
Default value	2.38
Unit	$kgCO_2e/kg$

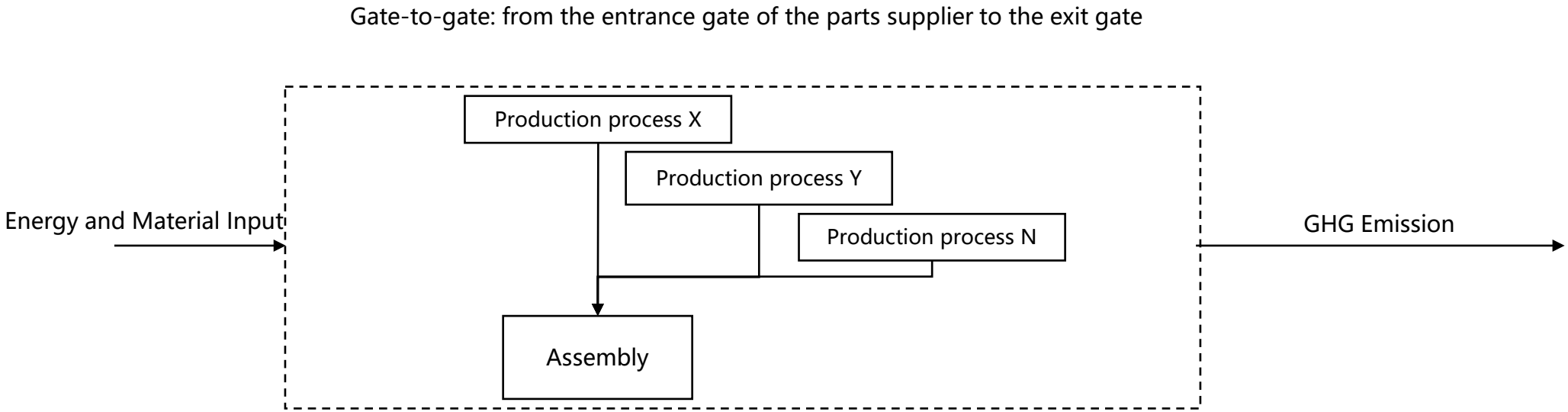


1. Material production stage | **2. Components production stage** | **3. Vehicle production stage** | **4. Vehicle use stage**

2.1 Definition of Scope

■ **Boundary of parts production stage: the process of manufacturing materials into parts.**

The process from materials entering the supplier plant to completing parts manufacturing.

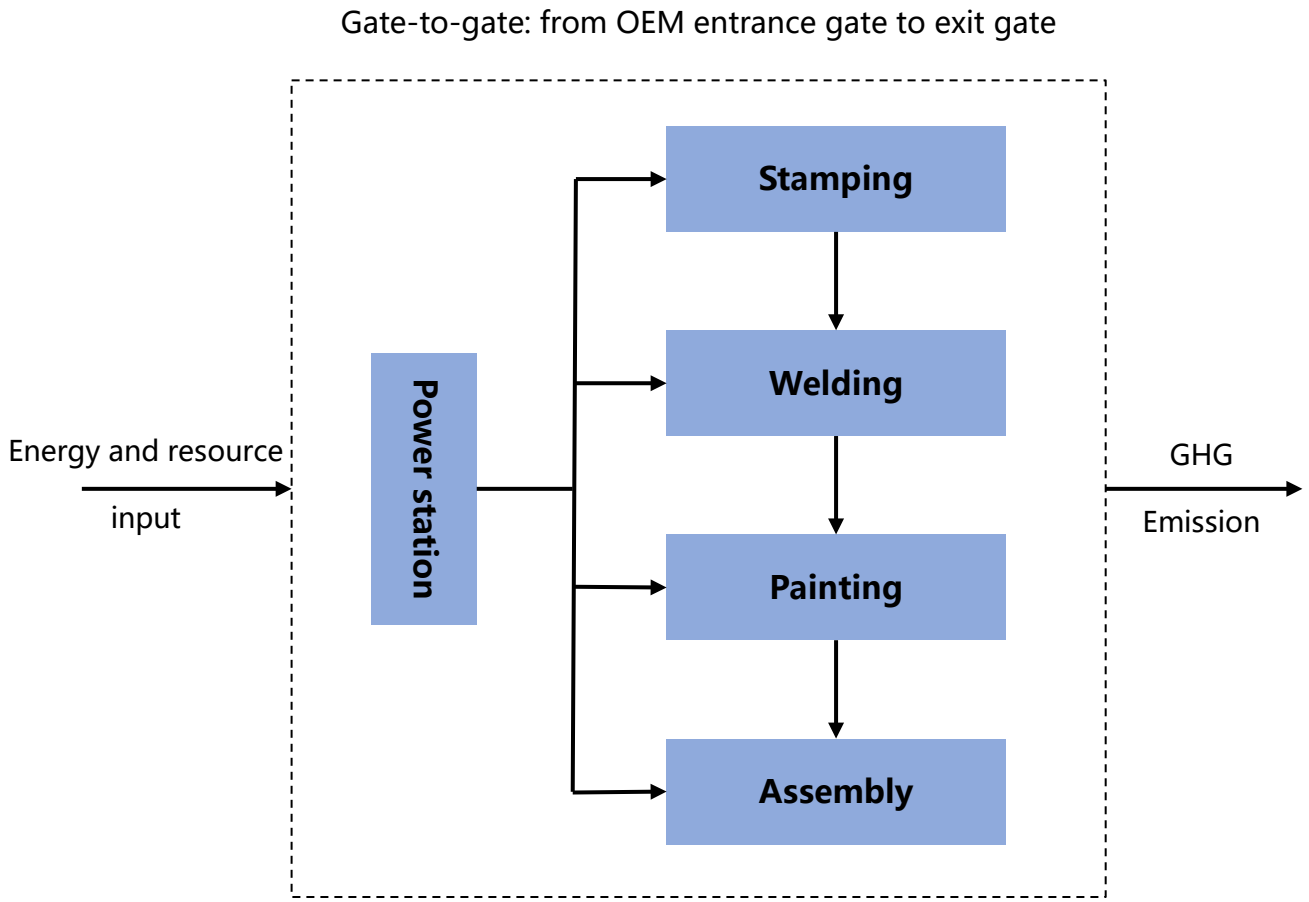


1. Material production stage | **2. Components production stage** | **3. Vehicle production stage** | **4. Vehicle use stage**

2.1 Definition of Scope

■ **Boundary of vehicle production stage:**

Including stamping, welding, painting, assembly and power station.

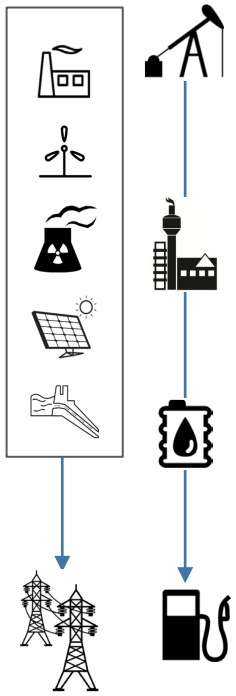


1. Material production stage | 2. Components production stage | 3. Vehicle production stage | 4. Vehicle use stage

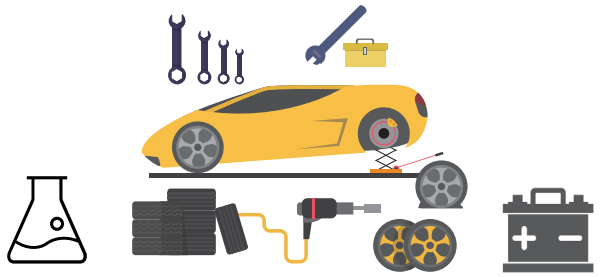
2.1 Definition of Scope

■ **Boundary of vehicle use stage:**

Includes carbon emissions from fuel production, fuel use and from tire, lead-acid battery and fluid replacement and refrigerant escape.



Carbon emission from fuel production process



Tire replacement, lead-acid battery replacement, fluid replacement, refrigerant escape

Carbon emission from fuel use process

1. Material production stage	2. Components production stage	3. Vehicle production stage	4. Vehicle use stage

2.1 Definition of Scope

■ **Carbon (Greenhouse gas) Emissions:**

The greenhouse gases in this document refer to the seven greenhouse gases specified in UNFCCC, namely, carbon dioxide, methane, nitrous oxide, hydrofluorocarbon, perfluorocarbon, sulfur hexafluoride and nitrogen trifluoride.

Industrial name or common name	Molecular formula	GWP_{100}
Carbon dioxide	CO_2	1
Methane	CH_4	27.9
Nitrous oxide	N_2O	273
Hydrofluorocarbon	HFCs	14600
Perfluorocarbon	PFCs	12400
Sulfur hexafluoride	SF_6	25200
Nitrogen trifluoride	NF_3	17400

- Data source：Sixth Assessment Report, IPCC

2.2 Inventory Data

■ **Requirements on data and data quality:**

Principles for data collection

Use on-site data preferentially

When the on-site data are not available,

Only when both the on-site and default data are not available

On-Site Data

Default Data

Other Secondary Data

Secondary data should be traceable and must be based on field research or data released by competent government authorities.

2.2 Inventory Data

■ **Description of data usage in each phase of the life cycle**

Life Cycle Stage	Data	Source
Material Production	Weight of primary materials	●
	Carbon emission factors of primary materials	●
	Weight of secondary materials	●
	Carbon emission factors of secondary materials	●
	Weight of materials (Primary and secondary)	● ●
	Carbon emission factors of materials (Primary and secondary)	● ●
	Material utility factor	● ●
Vehicle Production	Energy consumption data of vehicle production	●
	Carbon emission factors of fuel production	●
	Carbon emission factors of fuel use	●
	Carbon leakage	●
Vehicle Usage	Fuel consumption	●
	Carbon emission factors of fuel production	●
	Carbon emission factors of fuel use	●
	Tire replacements times	●
	Battery replacements times	● ●
	Liquid replacements times	● ●
	Refrigerant escapes times	●
Life Cycle	Life Cycle Mileage	●

● On-site Data

● Default Data

Note: On-site data and default values can be used in mix.

- ✓ If the default value is used for material weight, only the default value can be used for material carbon emission factor
- ✓ When the material weight uses site-specific data, the material carbon emission factor can use on-site data or default value.

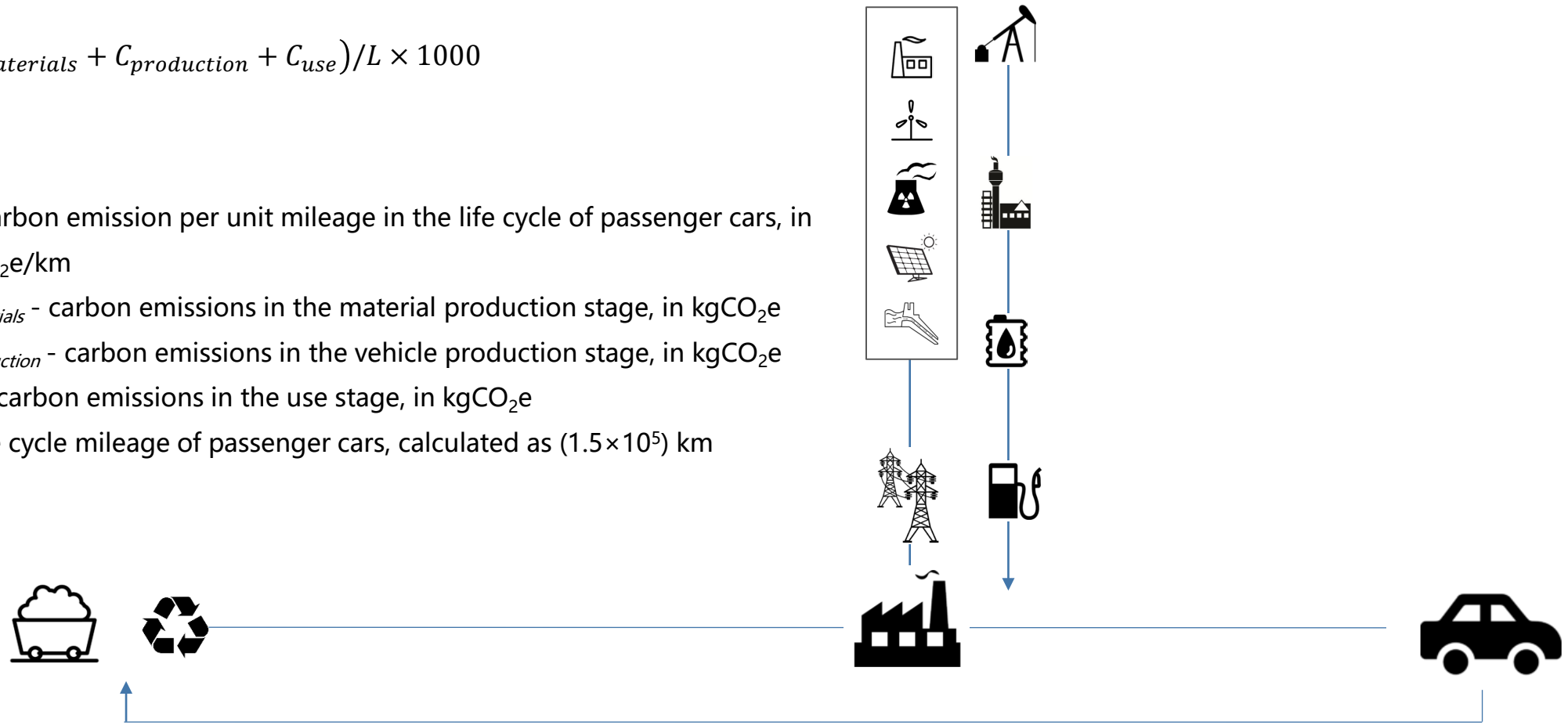
2.3 Calculation Methodology

■ **Carbon emission per unit life cycle mileage**

Carbon emission per unit mileage = (carbon emission in material production stage + carbon emission in vehicle production stage + carbon emission in use stage) / life cycle mileage

$$C = \left(C_{Materials} + C_{production} + C_{use}\right)/L \times 1000$$

- C - carbon emission per unit mileage in the life cycle of passenger cars, in $kgCO_2e/km$
- $C_{materials}$ - carbon emissions in the material production stage, in $kgCO_2e$
- $C_{production}$ - carbon emissions in the vehicle production stage, in $kgCO_2e$
- C_{use}- carbon emissions in the use stage, in $kgCO_2e$
- L- life cycle mileage of passenger cars, calculated as (1.5×10^5) km

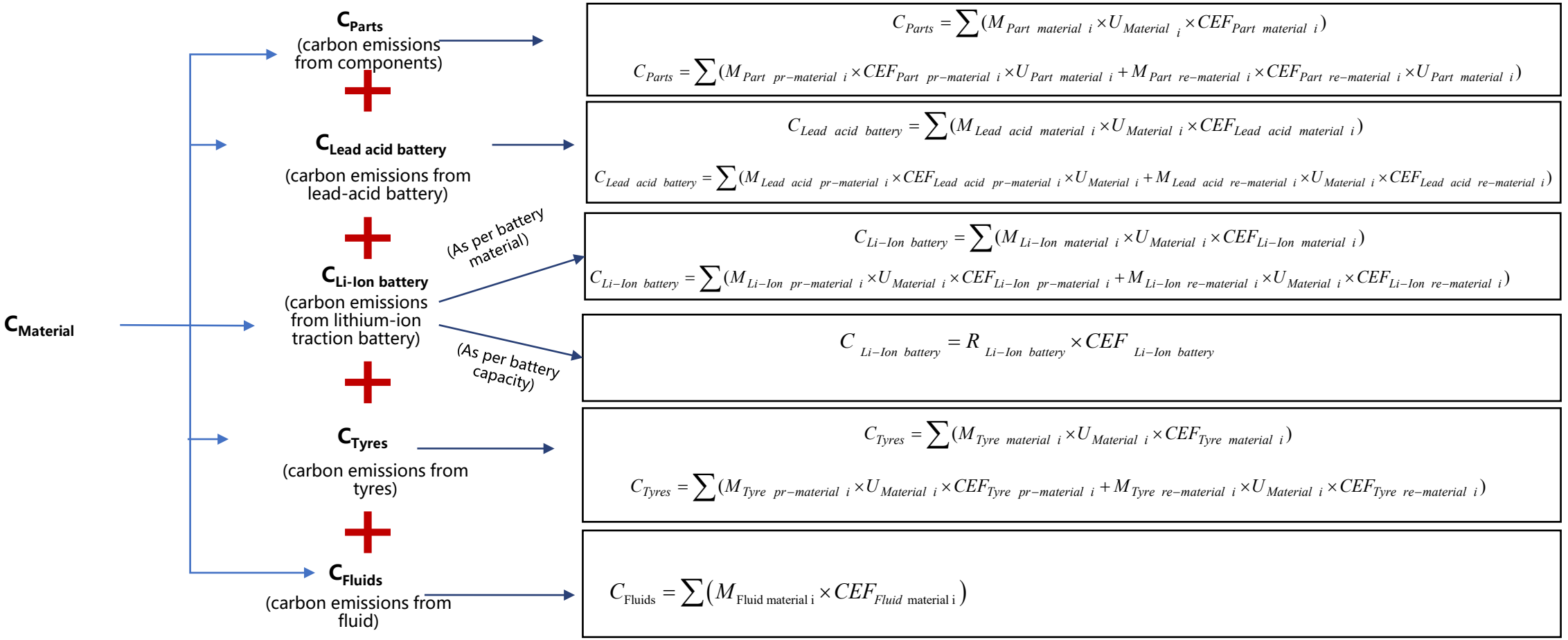


1. Material production stage
2. Components production stage
3. Vehicle production stage
4. Vehicle use stage

2.3 Calculation Methodology

■ Material production stage

Considering materials of five parts: components, lead-acid batteries, lithium-ion traction batteries, tires and fluids, and two processes: primary material acquisition and processing and material recycling



2.3 Calculation Methodology

■ Components production stage

Mainly include carbon emissions from the production of parts materials, semi-finished products and auto parts

Scope of accounting

It mainly includes the production of composite materials, semi-finished products and auto parts.

Accounting method

$$C_{Part\ \ production} = \sum \left(E_r \times CEF_r + E_r \times NCV_r \times CEF_r^{'} \right) + M_{CO_2}$$

Carbon emissions from parts production = carbon emissions from energy or fuel production + carbon emissions from energy or fuel use +CO_2 emissions leakage

$C_{Part\ Production}$ - carbon emissions from parts processing, in kgCO2e;
E_r - purchased amount of energy or fuel *r*, in kWh, m^3 or kg;
CEF_r - carbon emission factor for energy or fuel *r* production, in $kgCO_2e/kWh$, $kgCO_2e/m^3$ or $kgCO_2e/kg$;
CEF'_r - carbon emission factor for energy or fuel *r* use, in tCO_2e/GJ,
NCV_r - the average lower heating value (LHV) of energy or fuel *r*, in GJ/t, $GJ/10^4m^3$;
M_{CO_2} - amount of CO_2 emitted during welding, in $kgCO_2e$.

2.3 Calculation Methodology

■ Vehicle production stage

Carbon emissions from energy consumption and escaping in vehicle production process

Carbon emissions from vehicle production = carbon emissions from energy or fuel production + carbon emissions from energy or fuel use +CO_2 emissions leakage

$$C_{Production} = \sum \left(E_r \times CEF_r + E_r \times NCV_r \times CEF_r' \right) + M_{CO_2}$$

$C_{Production}$—— carbon emission during vehicle production stage, in kilogram of carbon dioxide equivalent ($kgCO_2e$);
E_r——purchase quantity of energy or fuel r, in kilowatt-hour (kWh), cubic meter (m^3) or kilogram (kg), etc.;
CEF_r——carbon emission factor for production of energy or fuel r, in kilogram of carbon dioxide equivalent per kilowatt-hour ($kgCO_2e/kWh$), kilogram of carbon dioxide equivalent per cubic meter ($kgCO_2e/m^3$) or kilogram of carbon dioxide equivalent per kilogram ($kgCO_2e/kg$);
CEF'_r——carbon emission factor for energy or fuel r use, in ton of carbon dioxide equivalent per giga-joule (tCO_2e/GJ)
NCV_r——average low calorific value of energy or fuel r, in giga-joule per ton (GJ/t) or giga-joule per ten thousand cubic meters ($GJ/10^4m^3$)
M_{CO2}——amount of escaping CO_2 during welding, in kilogram of carbon dioxide equivalent ($kgCO_2e$).

2.3 Calculation Methodology

■ Vehicle use stage

Carbon emissions from fuel production, fuel use, tyres, lead-acid batteries and fluid replacement and refrigerant escape

C_{Use}

- $C_{Fuel\ production}$ (emission from fuel production)
- +
- $C_{Fuel\ use}$ (carbon emission from fuel use)
- +
- $C_{Tyres\ r}$ (carbon emissions from tyre (4 PCS replacement)) → $C_{Tyres\ r} = C_{Tyres} \times 4/5 \times 2$
- +
- $C_{Lead\ acid\ battery\ r}$ (carbon emissions from lead-acid battery replacement) → $C_{Lead\ acid\ battery\ r} = C_{Lead\ acid\ battery} \times R_{Lead\ acid\ battery}$
- +
- $C_{Fluids\ r}$ (carbon emissions from fluid replacement and refrigerant escape (once)) → $C_{\text{Fluids r}} = \sum\left(M_{\text{Fluid material i}} \times CEF_{Fluid\ \text{material i}} \times R_{Fluid\ material\ i}\right) + M_{\text{Re}\ frigerant} \times GWP_{\text{Re}\ frigerant}$

1. Material production stage | 2. Components production stage | 3. Vehicle production stage | **4. Vehicle use stage**

Conclusion and Next Steps

1. Continue research on the LCA methodology, focus on consistency and comparability, and develop an LCA carbon accounting stardard for automotive products, to promote the decarbonization progress in the auto industry.

2. Develop various tools, such as the carbon publicity and carbon labelling, to improve the carbon transparency in auto industry from the supply side, and enhance the awareness of low-carbon consumption from the demand side.

3. Guide OEMs and upstream suppliers to reduce the carbon emission by using recycled material, green energy and improving the energy efficiency.

4. Build extensive connections and collaborations globally, get involved in IWG LCA in different topics, and make joint effort for automotive industry decarbonization.

More information

Please download the draft version of ***Technical specification of life cycle carbon emission accounting of passenger cars*** here http://auto-eaca.com/a/chengguofabunarong/ziliaoxiazai/zhongguoqichedit/2022/1027/568.html

Please download the ***China Automotive Low Carbon Action Plan (CALCP 2022) Executive Summary*** here http://www.auto-eaca.com/plus/view.php?aid=561
The whole book will be published by Springer in the end of 2022.

中国汽车技术研究中心有限公司

China Automotive Technology and Research Center Co ., Ltd.