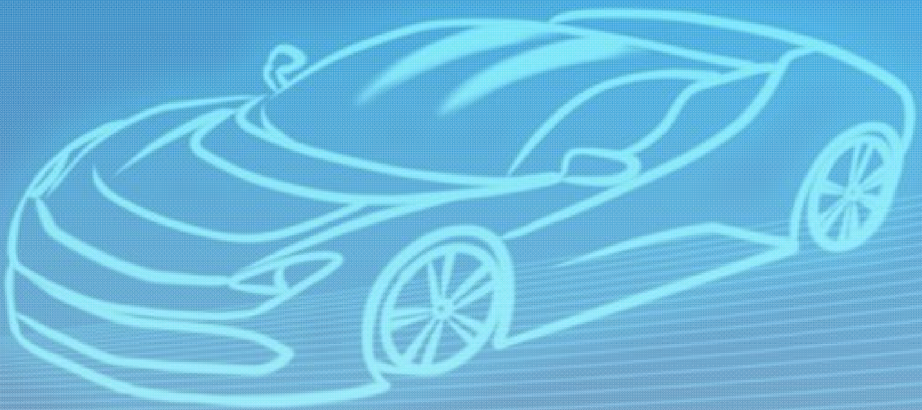
"汽车产业链关键轻量化技术碳排放核查联合研究"

汽车产业链低碳技术碳排放核查

2025年7月10日



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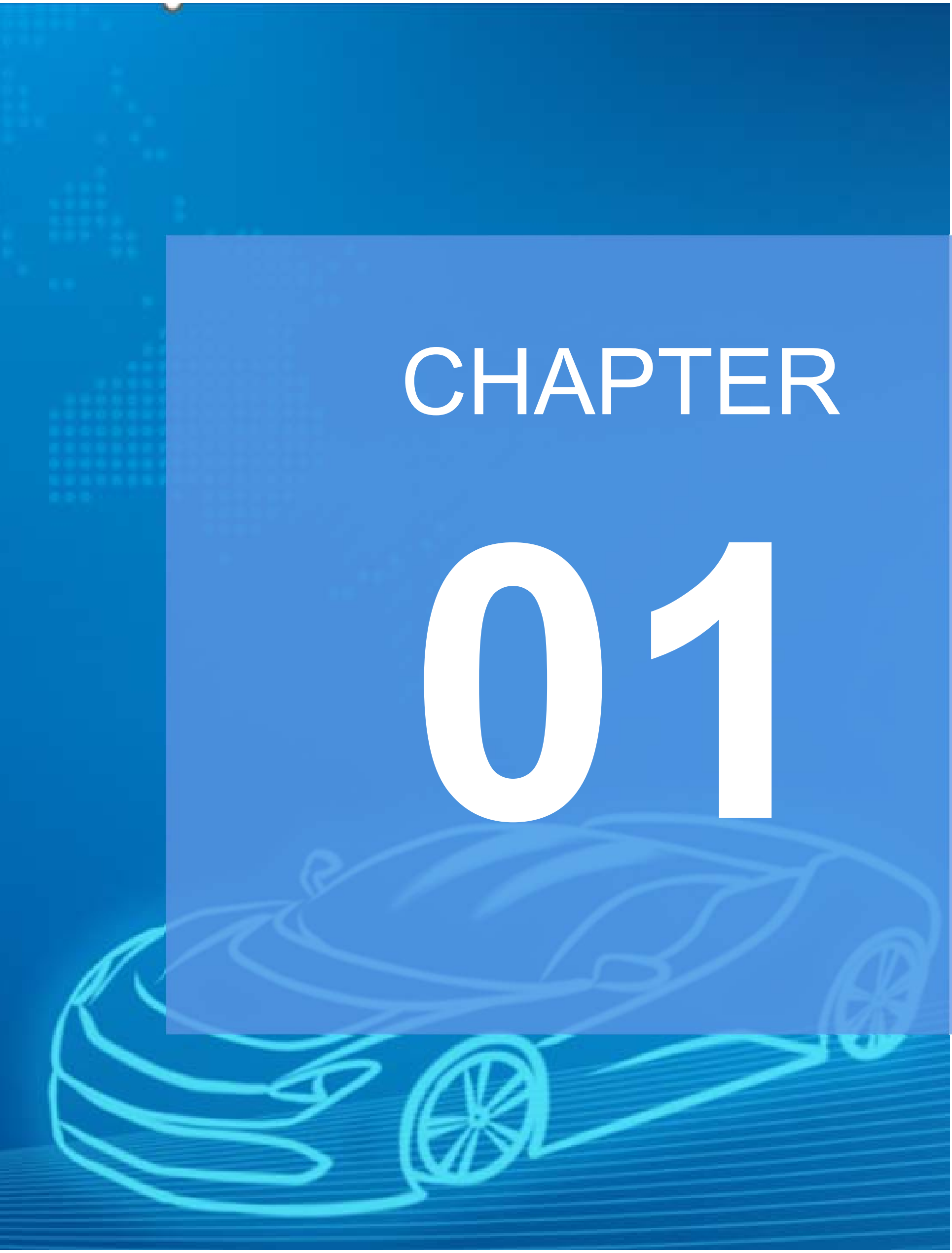


CHAPTER

01

Introduction to China-SAE

Introduction to China-SAE

中国汽车工程学会
China Society of Automotive Engineers

CHINA SAE

Established in 1963

100,000+

150,000+

2300+

One of the World's Top Three Automotive Technology Societies

·Managing Director of FISITA (International Federation of Automotive Engineering Societies)

·Sponsor Nation of the Asia-Pacific Automotive Engineering Conference (APAC)

01 Vision

To drive automotive and societal prosperity through technological innovation

02 Mission

To build a home for automotive technology workers

To advance automotive technology

03 Core Values

Passion, Professionalism, Service, and Collaboration

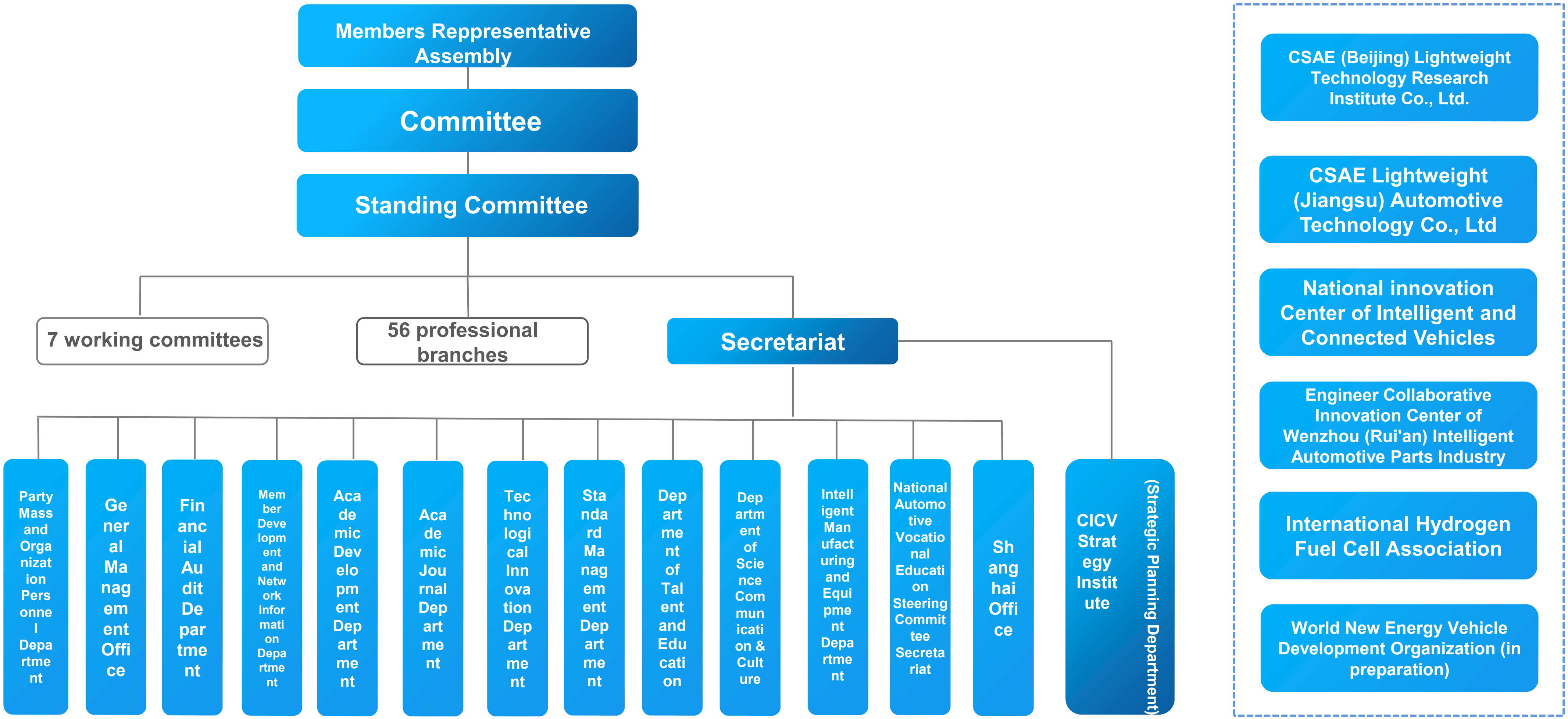
04 Positioning

Industry talent cultivator; Technology trailblazer; Collaborative innovation driver; Automotive culture ambassador

05 Objectives

To forge a world-class technology society

Organizational Structure of China-SAE



Main Business

Dual-carbon Research

- Successively executed multiple government-commissioned initiatives, including establishing a cross-industry taskforce in 2022 for carbon footprint accounting and assessment studies on critical lightweight pathways, culminating in the development of an automotive carbon footprint evaluation platform.

2021

- Research on the carbon neutrality roadmap for automotive industry

2022

- Research on the carbon neutrality roadmap for commercial vehicles
- Introduction to new energy vehicles leading the green and low-carbon transformation of the automotive industry

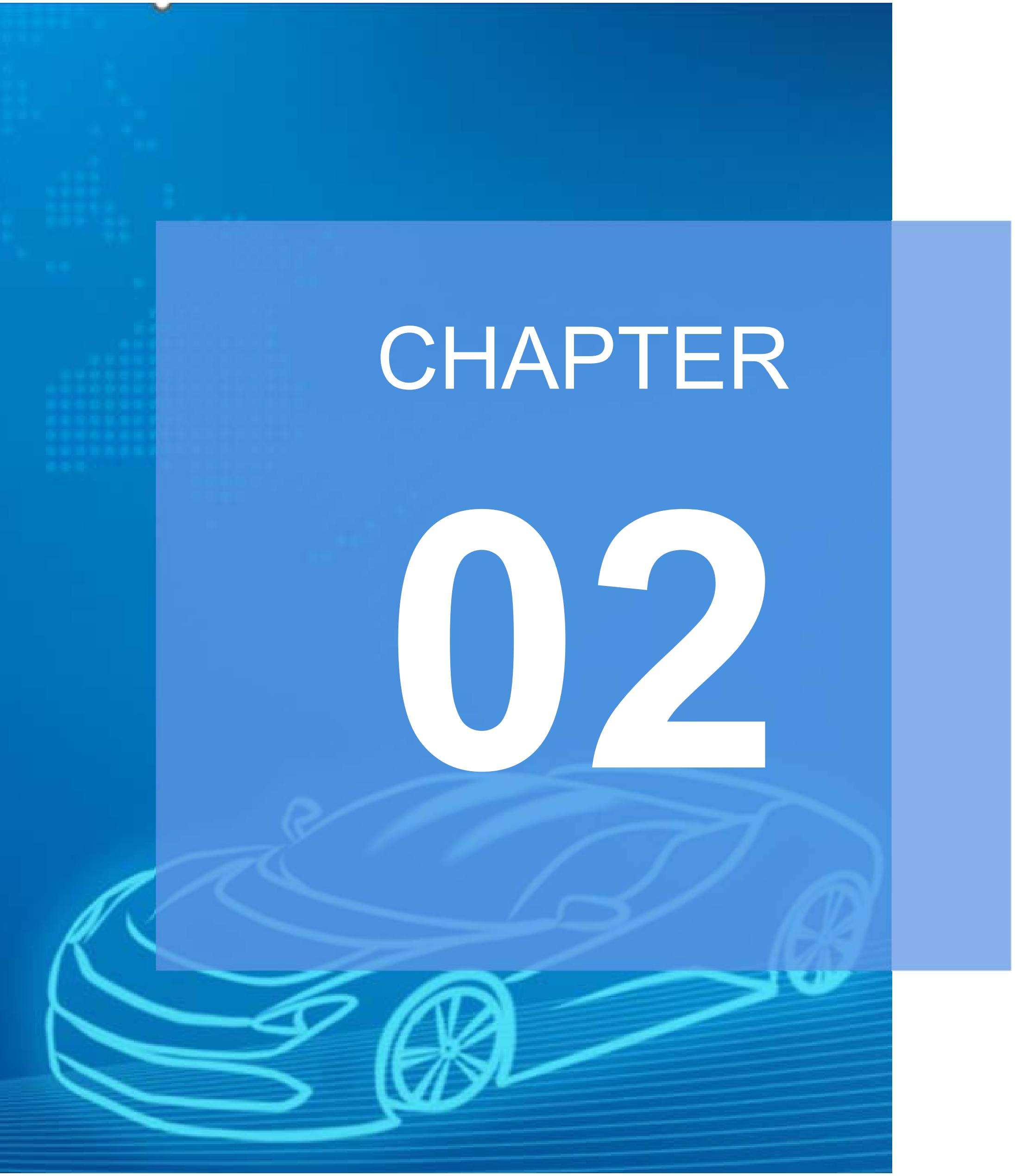
2023

- Research on the carbon footprint management system for vehicles and power batteries

2024

Research acceptance of the carbon footprint verification taskforce for key lightweight technology in automotive industry chain:

- Comprehensive assessment and verification report on carbon emissions of key technologies in automotive industry chain
- Carbon footprint assessment system 1.0 in automotive industry

CHAPTER 02

Carbon Footprint Evaluation of Critical Technology Pathways

1 Research Background

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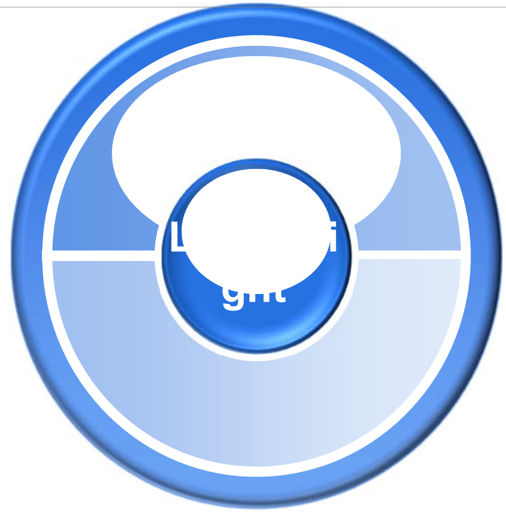
→ The Lightweight Alliance is responsible for dual-carbon research in the automotive industry chain phase, where carbon emissions still face challenges such as an unclear industry background.

Past

Reducing fuel consumption during the use of ICVs
Reducing electricity consumption during the use of EVs

Drives →



← Drives

Future

Reducing carbon emissions across the entire lifecycle

1 Supporting government policy research

- ✓ Research on the carbon neutrality roadmap for automotive industry in 2021
- ✓ Research on the carbon neutrality roadmap for commercial vehicles in 2022
- ✓ Research on the carbon footprint management system for vehicles and power batteries in 2022

2 Clarifying the true industry background

- ✓ Carbon emission calculation methods for components?
- ✓ Calculation reference database?

3 Evaluating the impact of technology pathways

- ✓ How to choose lightweight technology pathways in the context of dual-carbon? Europe and the U.S. have conducted related research on the impact of lightweight on carbon emissions, such as the 2022 Material Lifecycle research.

It is estimated that by 2030, the application of low-cost lightweight could reduce emissions of the European HVD fleet by approximately 2.1%, and by 3.7% by 2050.

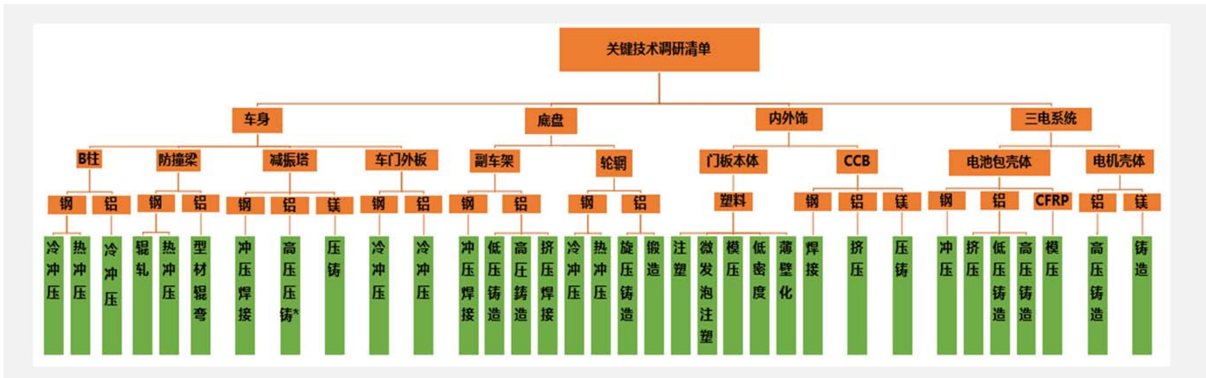
1 Research Background

→ In June 2022, China SAE and the Lightweight Alliance jointly established the "Joint Research on Carbon Emission Verification of Key Lightweight Technologies in Automotive Industry Chain" taskforce with industry partners.

SN	Company name
1	Ansteel Group Corporation
2	China Baowu Group Corporation
3	Bengang Steel Plates Co. Ltd.
4	University of Science and Technology Beijing
5	Beijing Automotive Technology Center
6	Tsinghua University
7	Dongfeng Motor Corporation
8	Guangdong Haomei New Material Co., Ltd.
9	Advanced Automotive Materials Technology Innovation Center, NEVC
10	Geely Auto
11	Chery Motors
12	Shandong Steel Rizhao Co., Ltd.
13	Nio Inc.
14	Yangzhou Chaofeng New Materials Co., Ltd.
15	Aluminum Corporation of China Limited
16	China Automotive Engineering Research Institute Co., Ltd.
17	CITIC Metal Co., Ltd.
18	CITIC Dicastal Co., Ltd.

Content 1: Conducting dual-carbon technology training

Content 3: Developing dynamic carbon accounting and decision-making models for key technologies

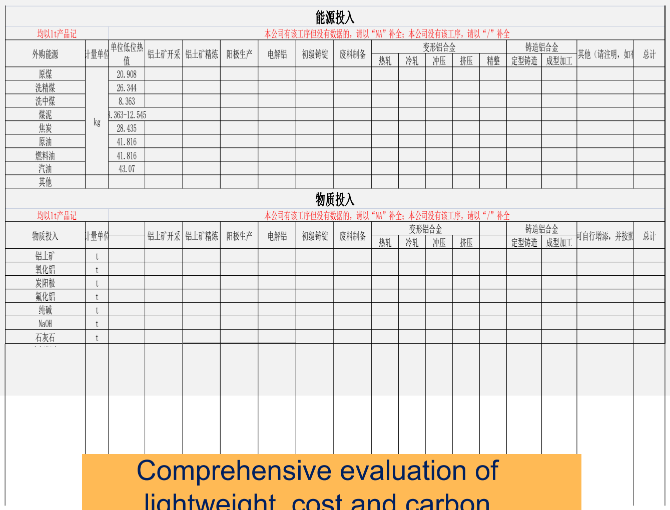


Content 2: Verifying carbon emissions of key technology pathways

2 Research Thinking

- The research primarily follows ISO 14067:2018 Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification to calculate the product's "cradle-to-gate" carbon footprint, while comprehensively evaluating key lightweight technology pathways based on lightweight, cost and carbon emissions.

Sort out energy and material inputs



能源投入

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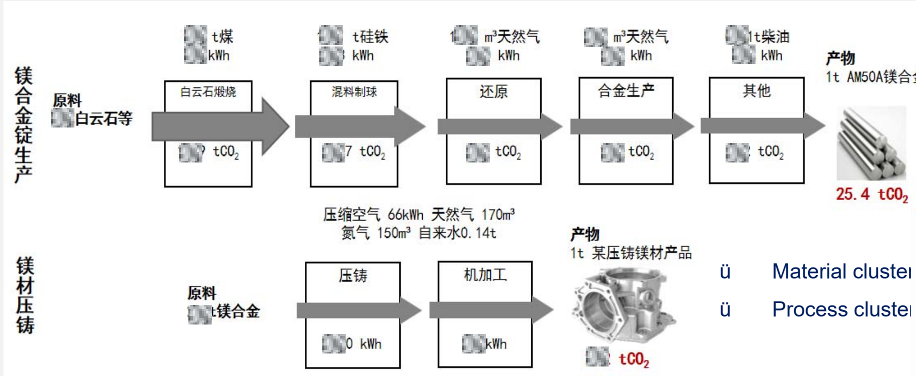
外购能源	计量单位	单位低位热值	铝土矿开采	铝土矿精炼	阳极生产	电解铝	初级铸锭	废料制备	变形铝合金					铸造铝合金		其他（请注明，如	总计
									热轧	冷轧	冲压	挤压	精整	定型铸造	成型加工		
原煤	kg	20.908															
洗精煤		26.344															
洗中煤		8.363															
煤泥		8.363-12.545															
焦炭		28.435															
原油		41.816															
燃料油		41.816															
汽油		43.07															
其他																	

物质投入

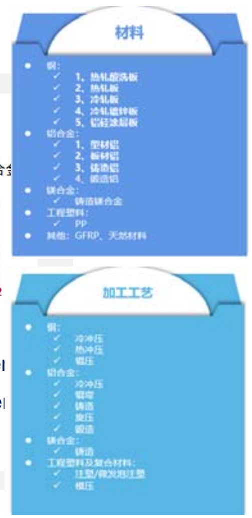
均以1t产品记 | 本公司有该工序但没有数据的，请以“NA”补全；本公司没有该工序，请以“/”补全

物质投入	计量单位		铝土矿开采	铝土矿精炼	阳极生产	电解铝	初级铸锭	废料制备	变形铝合金					铸造铝合金		可自行增添，并按照	总计
									热轧	冷轧	冲压	挤压		定型铸造	成型加工		
铝土矿	t																
氧化铝	t																
炭阳极	t																
氟化铝	t																
纯碱	t																
NaOH	t																
石灰石	t																

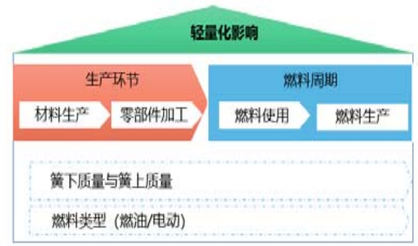
Calculate carbon emission intensity for each process



- Material cluster
- Process cluster



Component-level carbon emission calculation based on key lightweight solutions



- Determine the accounting approach for components such as calculation stage prerequisite conditions.
- Identify comparable lightweight schemes
- Consider the use of recycled materials and material utilization rates for differe components in the calculations

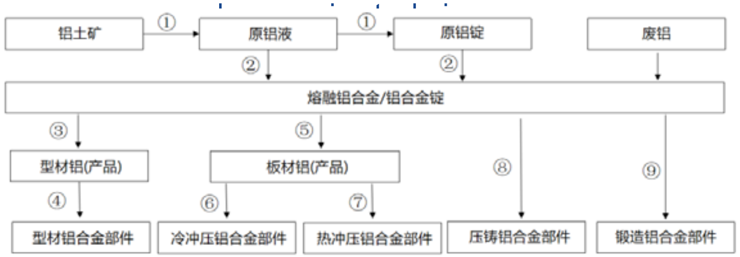
Comprehensive evaluation of lightweight, cost and carbon emissions

- Determine the benchmark for cost comparison calculations
- Adopt relative values compared to the benchmark scheme for comparison
- Display different scheme comparisons using radar charts

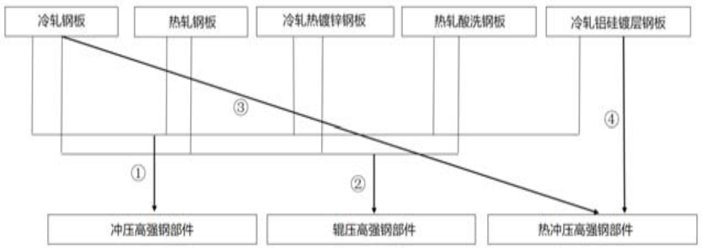
3 Research Result - Carbon Footprint Factors Across the Industrial Chain

- **Based on research requirements, scenario data was investigated, and carbon footprint factors for the entire chain - from basic raw materials and material products to forming processes and components - were calculated.**

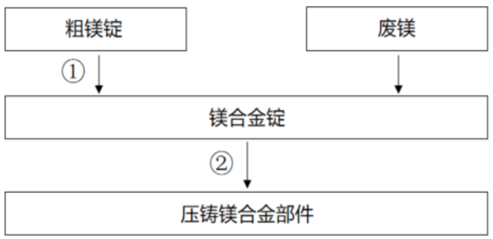
Aluminum alloy materials

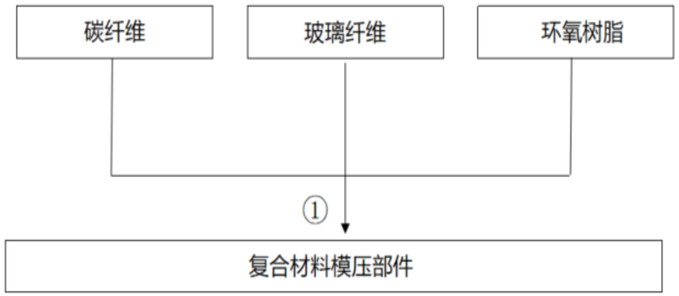


Steel materials and

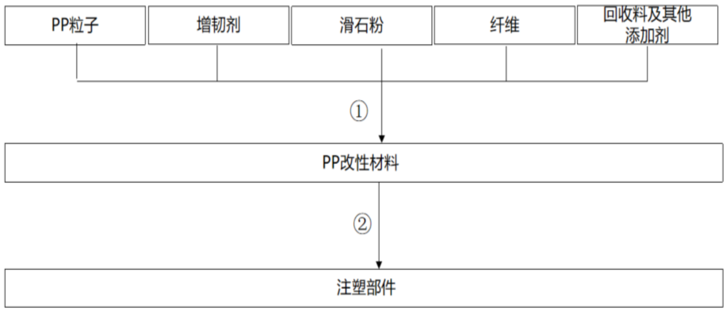


Magnesium alloy

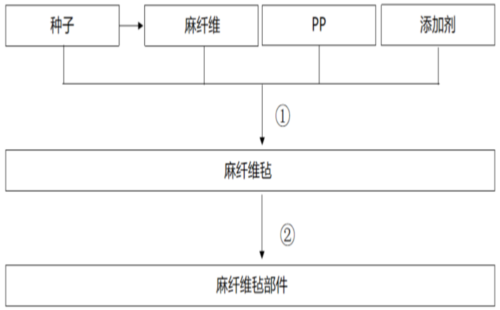




Composite materials and processing techniques



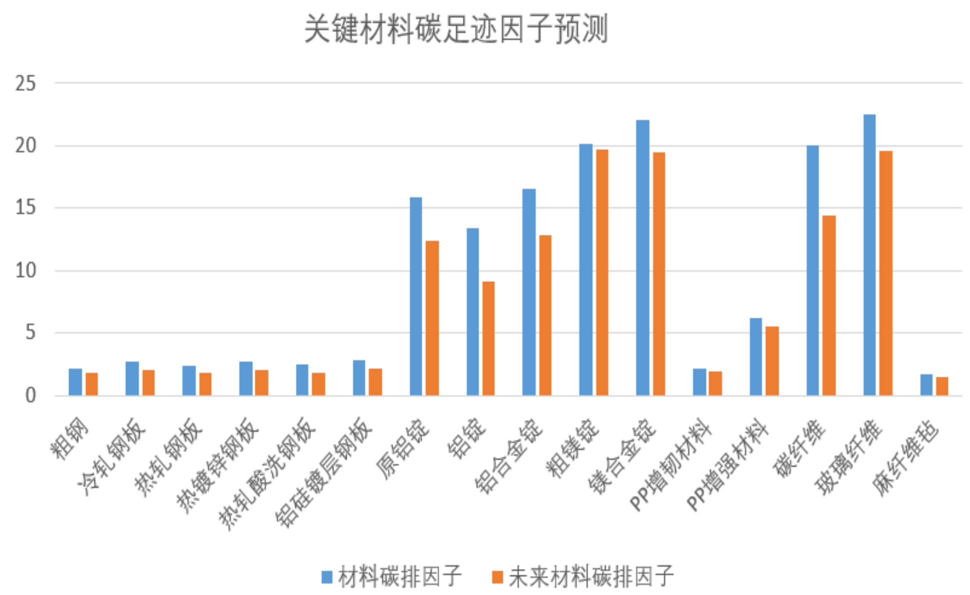
Plastics and processing techniques

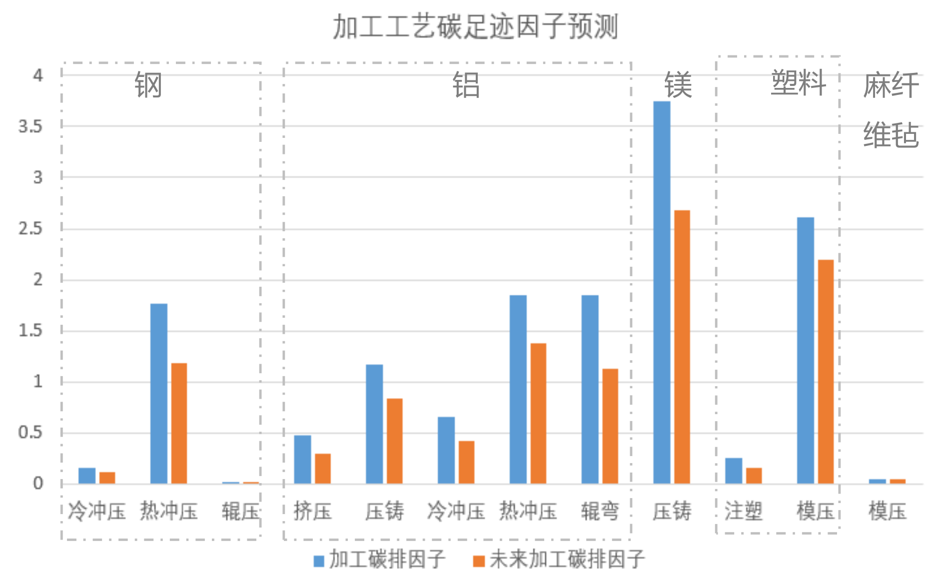


Bio-based composite materials and processing techniques

3 Research Result - Carbon Footprint Factors Across the Industrial Chain

- **Through research on the application level of recycled materials and the evolution of power structure by 2030, predictive carbon footprint factors for materials and manufacturing processes have been developed.**



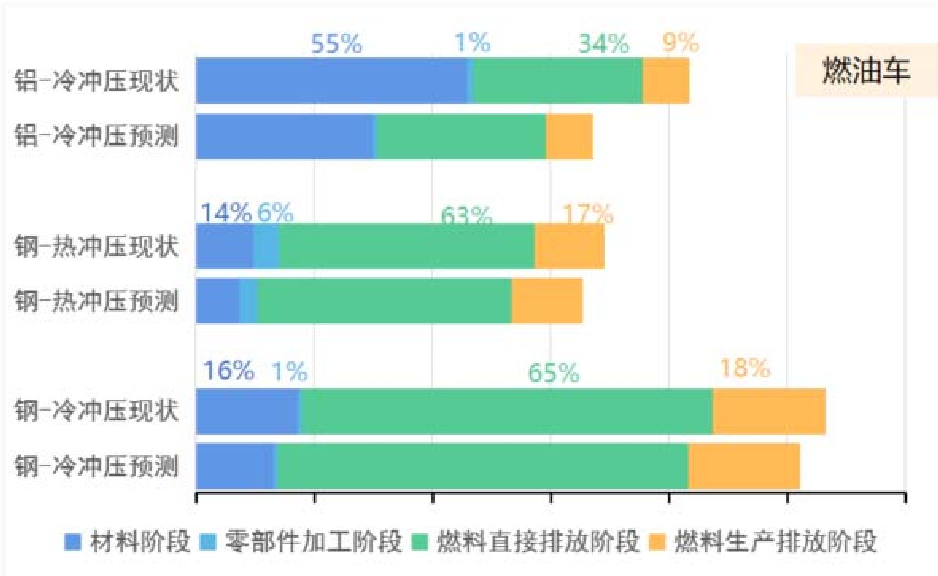


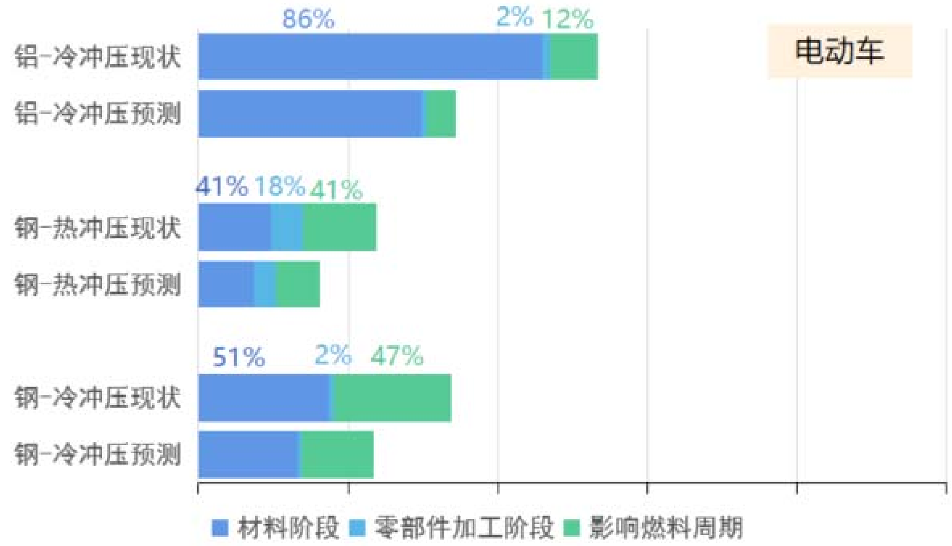
- The carbon footprint factors of materials are expected to decrease by 3%–32%, primarily influenced by the cleansing of electricity and the adoption of recycled materials. Aluminum ingots show the highest reduction due to their strong dependence on cleaner electricity.
- The carbon footprint factors of component processing techniques are expected to decrease by 16%–40%, primarily influenced by the decarbonization of energy sources.

3 Research Result - Component Accounting Case 1: B-pillar

- ICV: Compared to the benchmark "Steel - cold stamping" route, the hot-stamped B-pillar accounts for 65% of its carbon footprint, while aluminum cold stamping solution accounts for 78%. Compared to the current status, "Steel - cold stamping", "Steel - hot stamping" and "Aluminum - cold stamping" have reduced emissions by 4%, 5%, and 20%, respectively, primarily due to a more than 20% decrease in carbon footprint during the production phase.
- EV: Compared to the benchmark route, the hot-stamped B-pillar accounts for 70% of its carbon footprint, while aluminum cold stamping solution accounts for 158%. Compared to the current status, "Steel - cold stamping", "Steel - hot stamping" and "Aluminum - cold stamping" have reduced emissions by 31%, 32%, and 35%, respectively, with the reduction in carbon footprint factor of electricity playing a significant role.

Process Routes	Steel - cold stamping	Steel - hot stamping	Aluminum - cold stamping
Average Weight (kg)	9.703	6.04	4
Material Clustering	Cold-rolled sheet	Al-Si coated sheet	Aluminum sheet

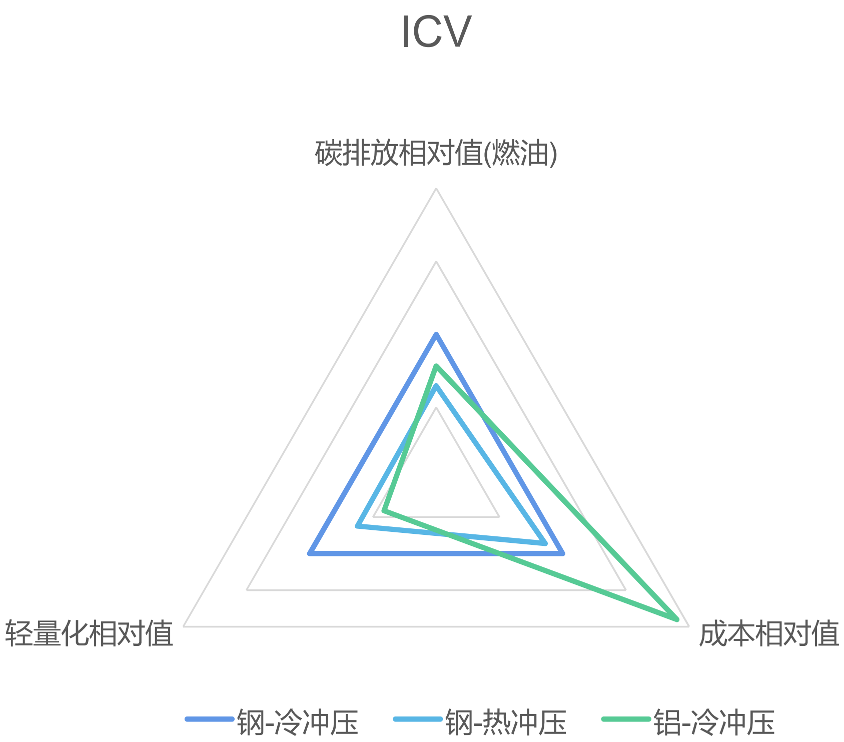


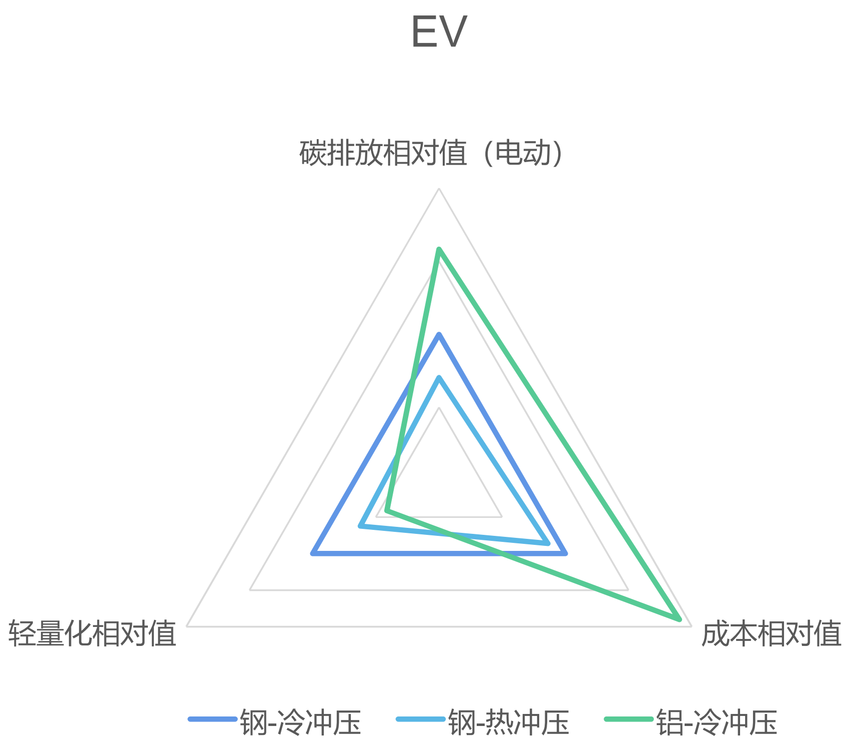


Note: The percentages labeled in the above figure represent the current proportion distribution at each stage.

3 Research Result - Component Accounting Case 1: B-pillar

- In terms of dual-carbon and cost, the hot stamping solution holds the most advantages. From an energy-saving standpoint, the cold-stamped aluminum alloy solution is the most advantageous.

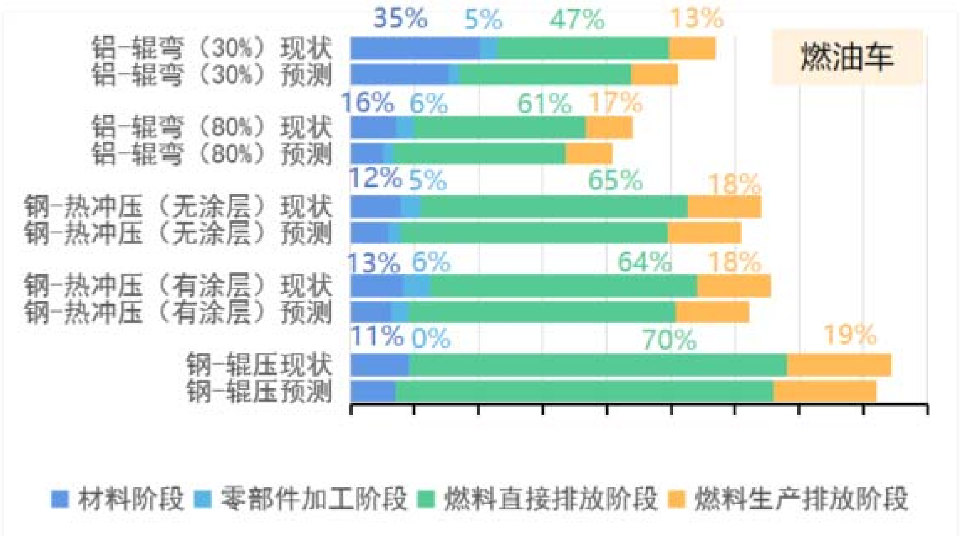


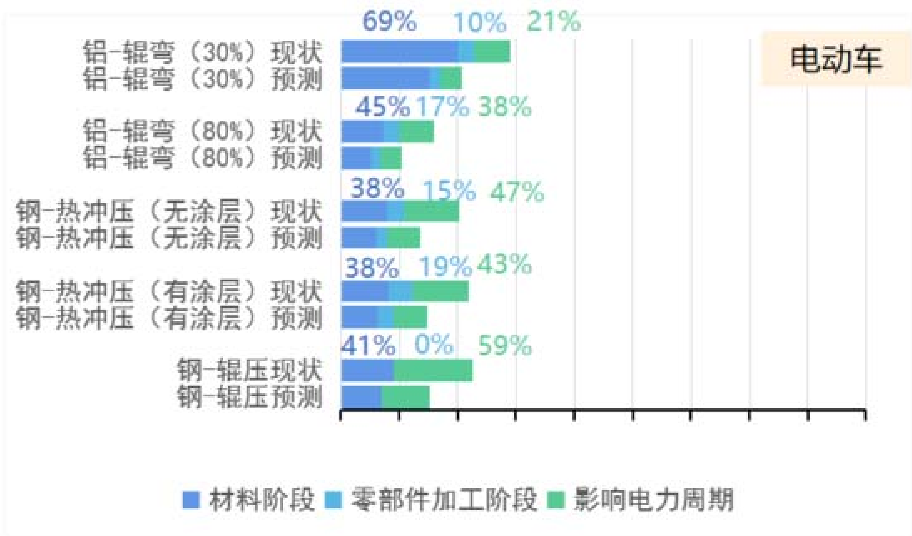


3 Research Result - Component Accounting Case 2: Crash beam

- ICV: Compared to the benchmark "Steel - roll-in" route, the hot-stamped crash beam accounts for 77% of its carbon footprint, while the aluminum roll bending solution accounts for 52%. Compared to the current status, the respective solutions achieve reductions of 3%, 5%, 5%, and 10%, respectively. Projections indicate that the recycled aluminum content will reach 50% on average, resulting in a 17% reduction compared to the current aluminum roll bending process (30%).
- EV: Compared to the benchmark route, the hot-stamped crash beam accounts for 97% of its carbon footprint, while the aluminum roll bending solution accounts for 71%. Compared to the current status, the respective solutions achieve reductions of 33%, 32%, 33%, and 29%, respectively. The aluminum roll bending process (50%) achieves a 43% reduction compared to the current aluminum roll bending process (30%).

Process Routes	Steel - roll-in	Steel - hot stamping	Steel - hot stamping	Aluminum - profile roll bending
Average Weight (kg)	6.6	4.67	4.67	2.99
Material Clustering	Cold-rolled steel	Al-Si coating	Cold-rolled steel	Aluminum profile





Note: The percentages labeled in the above figure represent the current proportion distribution at each stage.

3 Research Result - Component Accounting Case 2: Crash beam

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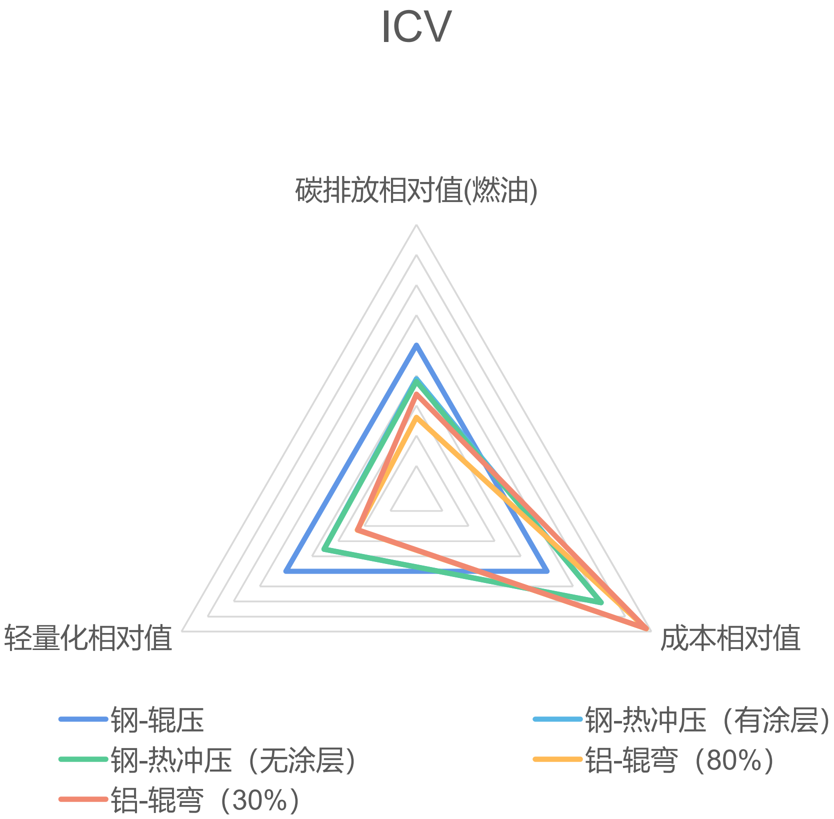
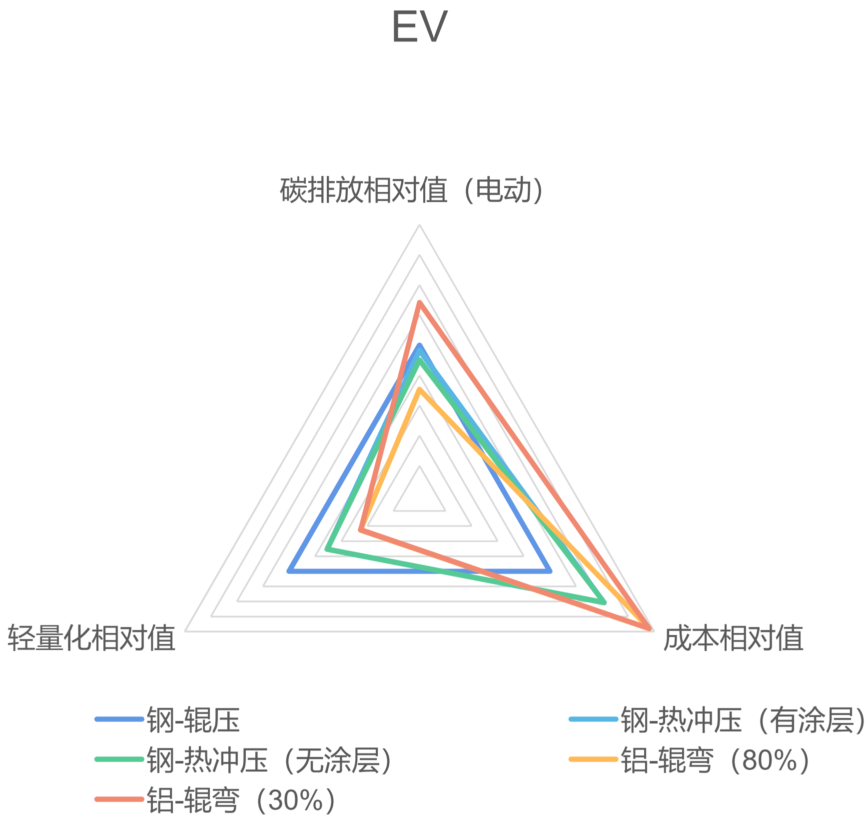
- In terms of carbon emissions, cost and lightweight, both ICVs and EVs show roughly similar trends. The aluminum roll bending crash beam outperforms other solutions in lightweight and carbon emissions but comes at the highest cost.

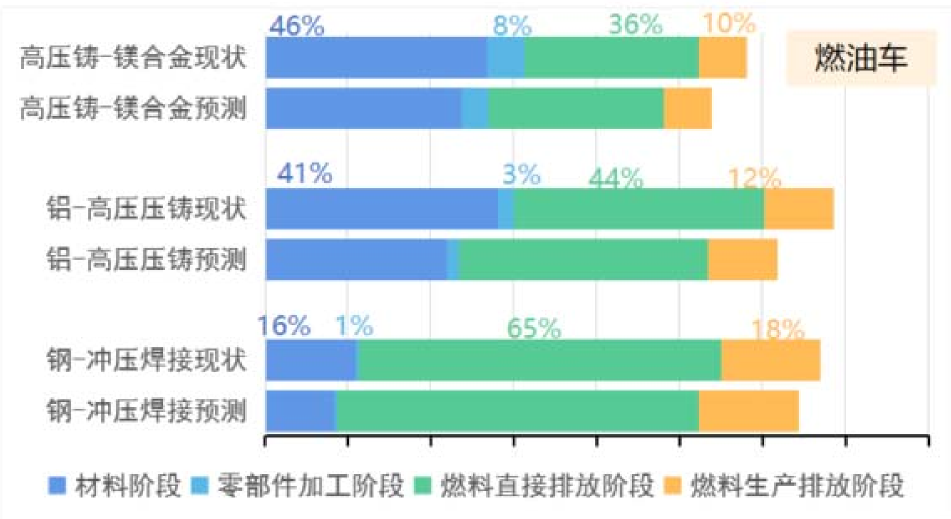


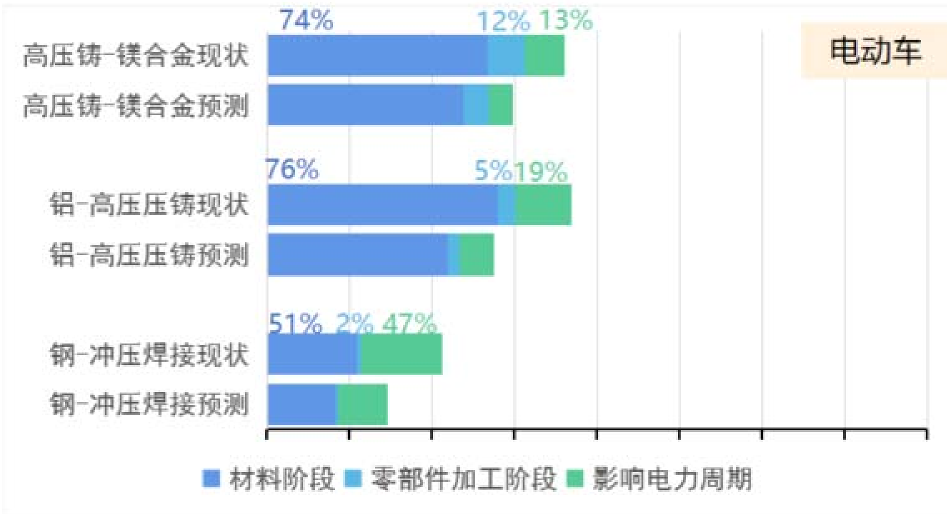


3 Research Result - Component Accounting Case 3: Shock absorber tower

- **ICV: Compared to the benchmark "Steel - stamp welding" route, the aluminum high-pressure die-cast shock absorber tower accounts for 102% of its carbon footprint, while the magnesium high-pressure die-casting solution accounts for 87%. Compared to the current status, the respective solutions achieve reductions of 4%, 10%, and 7%, respectively. The aluminum high-pressure die-casting solution has transitioned from being higher than the benchmark to lower than the benchmark.**
- **EV: Compared to the benchmark "Steel - stamp welding" route, the aluminum high-pressure die-cast shock absorber tower accounts for 174% of its carbon footprint, while the magnesium high-pressure die-casting solution accounts for 170%. Compared to the current status, the respective solutions achieve reductions of 31%, 26%, and 17%, respectively. Unlike in ICVs where magnesium high-pressure die-casting is the optimal solution, it results in the highest carbon footprint among all solutions in EVs.**

Process Routes	Steel - stamp welding	Aluminum - high-pressure die-casting	Magnesium alloy - high-pressure die-casting
Average Weight (kg)	12.16	8.43	5.9
Material Clustering	Cold-rolled sheet	Cast aluminum	Magnesium alloy



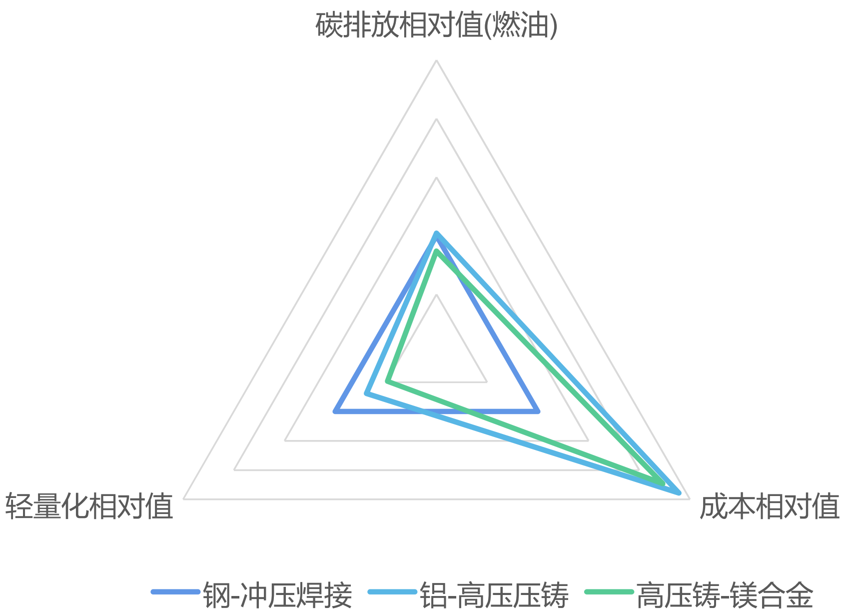


Note: The percentages labeled in the above figure represent the current proportion distribution at each stage.

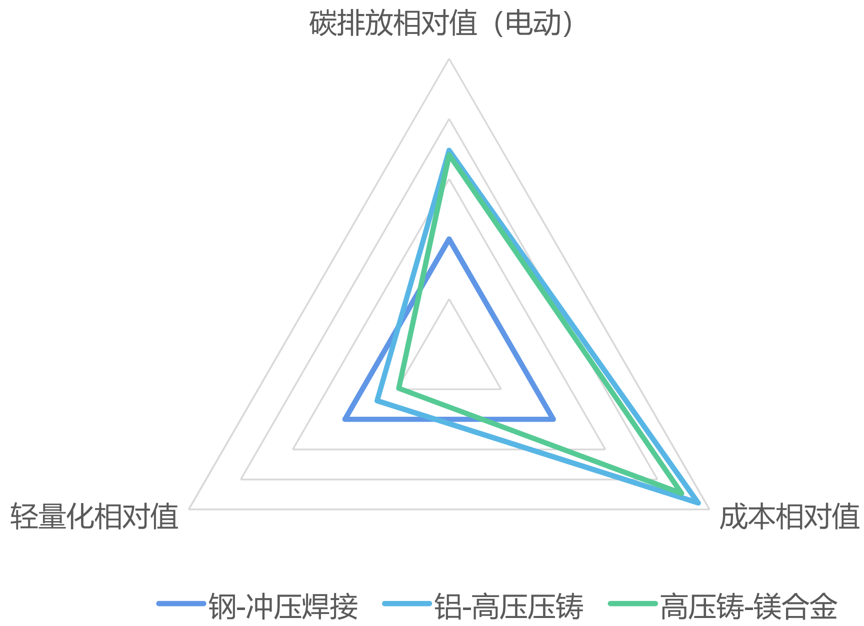
3 Research Result - Component Accounting Case 3: Shock absorber tower

- In terms of carbon emissions, cost and lightweight, both ICVs and EVs show roughly similar trends. The steel-stamped welding solution offers the most advantages in carbon footprint and cost, while the magnesium alloy high-pressure die-casting solution excels in lightweight.

ICV



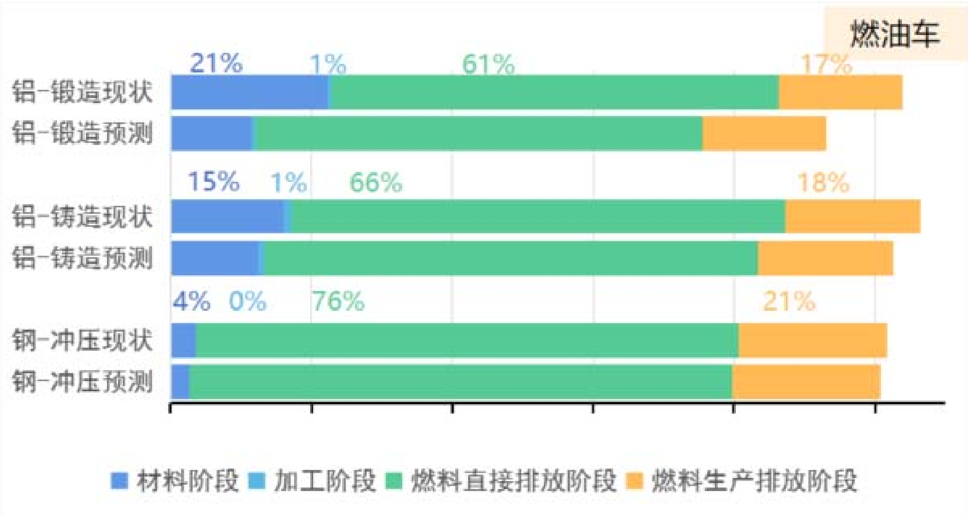
EV

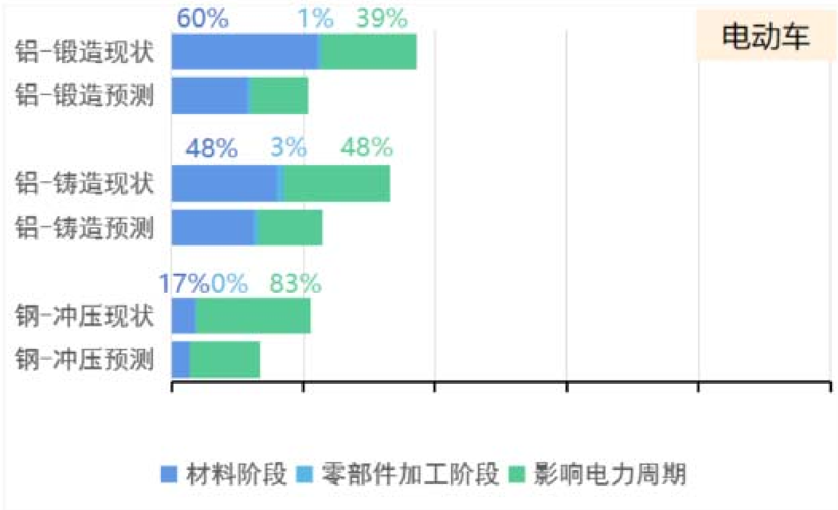


3 Research Result - Component Accounting Case 3: Shock absorber tower

- ICV: Compared to the benchmark "Steel - stamping" route, the carbon footprints of aluminum casting and aluminum forging solutions are 105% and 102%, respectively. Compared to the current status, the wheel hub solutions achieve carbon footprint reductions of 1%, 4%, and 10%, respectively. The fuel phase dominates the carbon footprint, while the impacts of electricity and recycled materials remain relatively minor.
- EV: Compared to the benchmark "Steel - stamping" route, the carbon footprints of aluminum casting and aluminum forging solutions are 156% and 176%, respectively. Compared to the current status, the solutions achieve carbon footprint reductions of 37%, 31%, and 44%, respectively.

Process Routes	Steel-stamping	Aluminum-casting
Average Weight (kg)	10.75	9.8
Material Clustering	Hot-rolled sheet	Cast aluminum

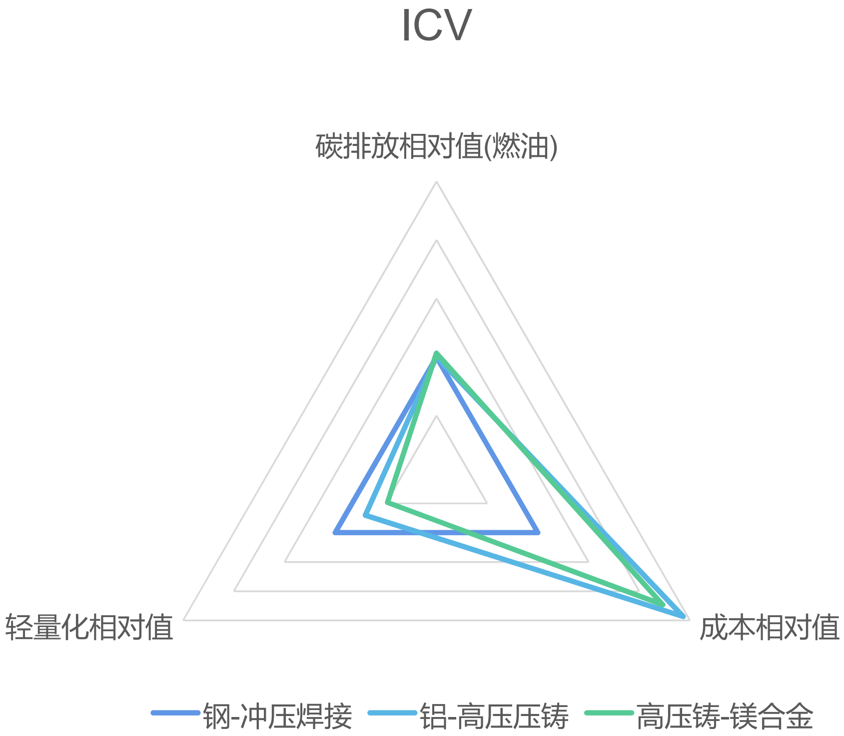


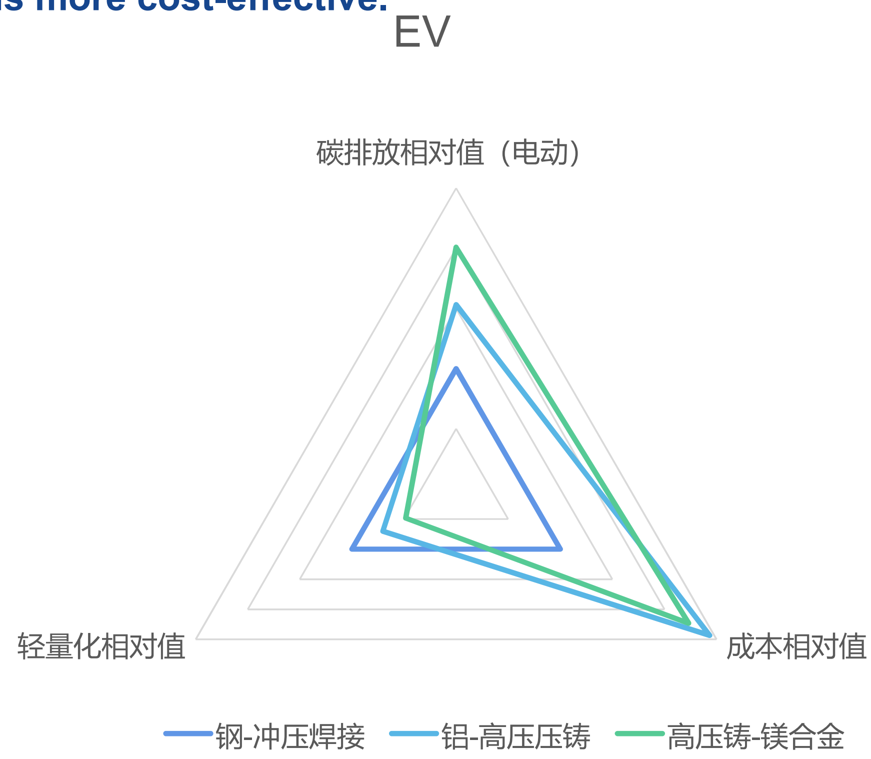


Note: The percentages labeled in the above figure represent the current proportion distribution at each stage.

3 Research Result - Component Accounting Case 4: Wheel hub

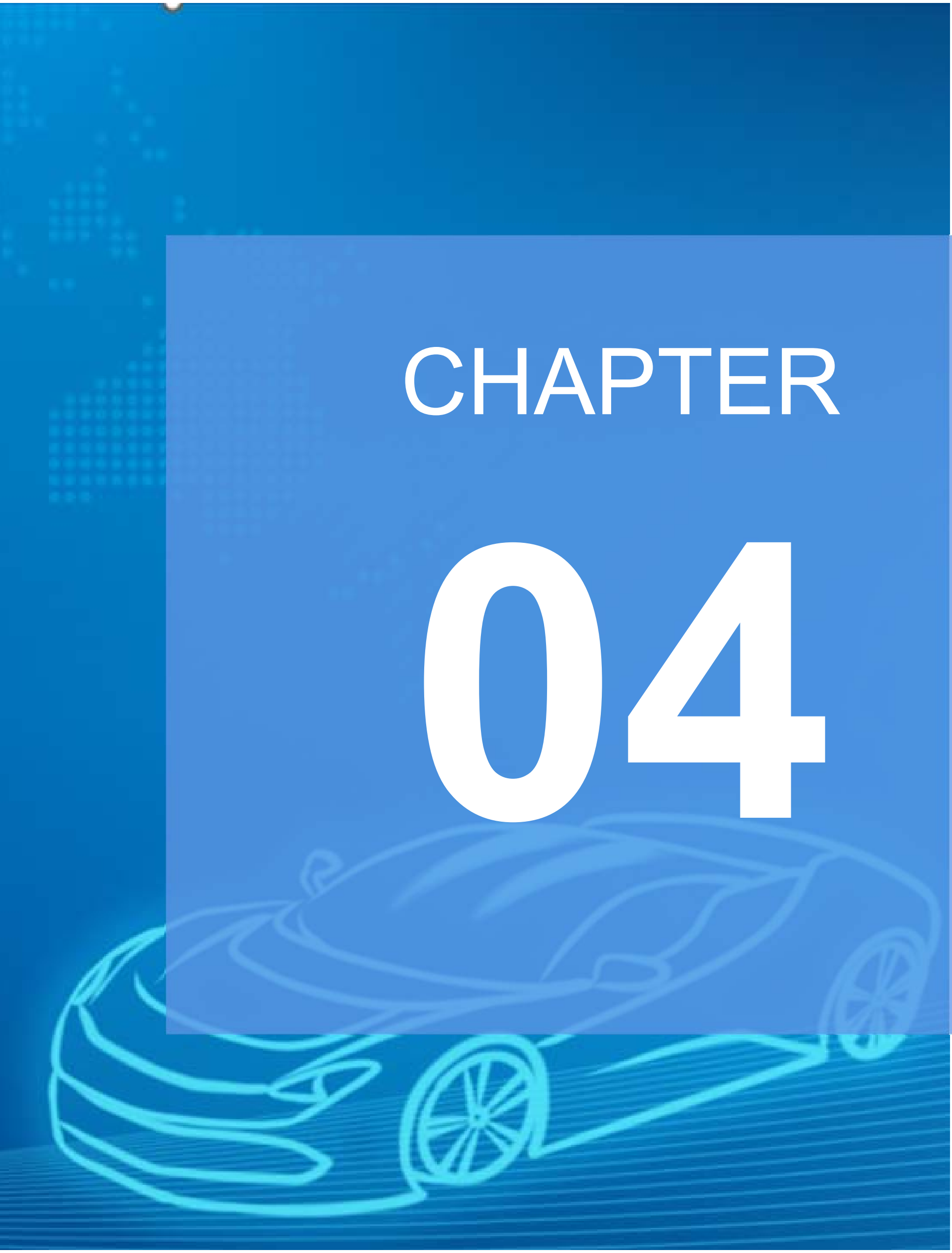
- In terms of carbon emissions, cost and lightweight, both ICVs and EVs show roughly similar trends. In terms of carbon footprint and lightweight, "steel-stamping" and "aluminum-casting" are similar, each with its own strengths, while the aluminum-casting solution is more cost-effective.





3 Research Result - Carbon Footprint Assessment System for the Automotive Industry

Carbon footprint assessment system for the automotive industry: Established key modules including a fundamental database, carbon footprint accounting, and carbon footprint prediction. The system enables the querying of carbon footprint factors for materials, processes and energy sources; the accounting, prediction and comparison of different technical solutions; as well as the submission and publication of enterprise data.



CHAPTER

04

Summary and Outlook

Summary

Different management requirements lead to different technical strategies

The calculated carbon footprint of ICV components is higher than that of EV components, though their production phase accounts for a smaller proportion compared to EVs.

Each material has suitable application scenarios

While traditional views hold that aluminum alloys, magnesium alloys, and heating processes like hot stamping have high carbon footprint factors, they can deliver significant carbon reduction benefits when applied in appropriate scenarios.

Design, manufacturing, and management capabilities significantly impact carbon reduction

Factors such as material utilization rate, process yield, energy application and management methods, and raw material supply modes have a substantial impact.

A closed-loop industrial chain system for circular low-

Recycled materials offer notable carbon reduction advantages. Circular economy means could enable the automotive industry to reduce lifecycle emissions per passenger-kilometer by up to 75%.

By 2030, the trends of various technical pathways will remain similar to the present, but the gaps between them will significantly narrow

By 2030, the carbon footprint factors of various materials and processes will decrease to varying degrees, and the gaps between different technology pathways will gradually narrow.

Enterprises have been proactively enhancing capabilities in lightweight structural design, manufacturing processes and management. By collaborating across the industrial chain to reduce carbon emissions, they adapt to management requirements in different periods and select optimal technology pathways based on component-specific scenarios.

Next Step

- In 2025, the preparatory work for the "Union for Joint Innovation on Automotive Green Industry Chain" was launched, with ongoing research related to green industry chains.

Specification

Environmental footprint research

- Environmental footprint of critical automotive materials and processes

Model

- Accounting models for key assemblies/components
- Multi-attribute assessment and multi-objective optimization

Low-Carbon Technologies

- Evaluation and recognition of low-carbon materials
- Application validation of low-maturity technologies

Public Service System

Industry exchange initiatives (technical seminars, standard interpretation, technology reports, technology promotion, etc.)

Building a circular low-carbon automotive industry chain is an inevitable choice for achieving carbon neutrality. It is essential to integrate industry chain resources, strengthen collaboration, and jointly promote the construction of a green automotive industry chain and the sustainable development of China's automotive industry.

中国汽车工程学会
China Society of Automotive Engineers

Thank you for watching

A home for automotive engineers, a group of research scientists

Jia Yanmin

Vice Director, CSAE (Beijing) Lightweight Technology Research Institute Co., Ltd.

China-SAE, Lightweight Alliance

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