Business Strategy for Energy & Functional Materials Sector

September 26, 2017

Contents (Overall)

- Part 1 – Overview of Energy & Functional Materials Sector
- Part 2 – Business Environment and Needs for Energy & Functional Materials
- Part 3 – Business Strategy for Each Product Group
- Part 4 – Next Generation Businesses and Products

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What Energy & Functional Materials Sector Strives to Be

‘Current Priority Management Issues and Business Strategy, June 2, 2017’

Current Challenges

- Review of business portfolio
- Build foundation for growth

Basic Strategy (Strategic Themes)

- **Select and foster growth businesses**
- **Restructure underperforming businesses**

FY2016-18 Business Strategy/ Action Plan

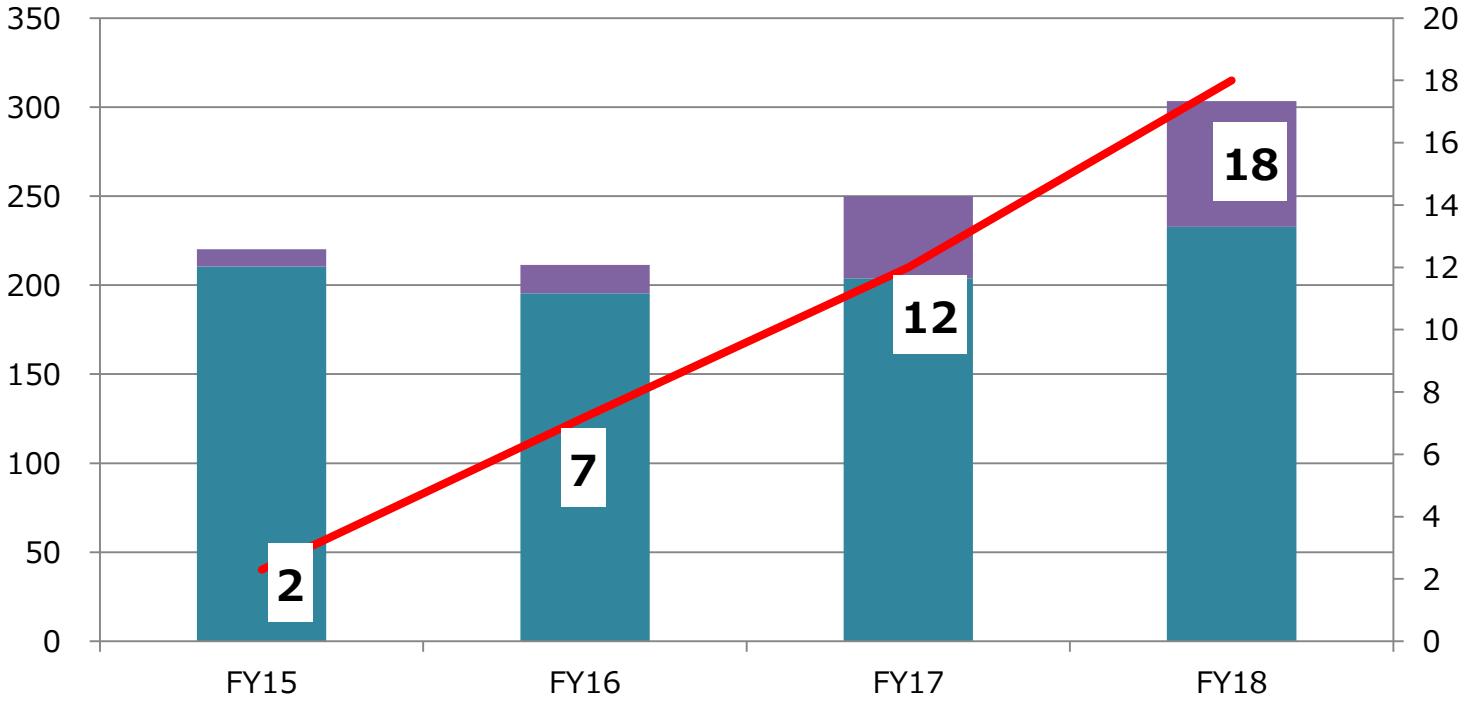
FY2019- Business Strategy/ Action Plan

Our Long-Term Goal (For Around FY2025)

Contribute to resolving environmental/energy issues through innovative technology

Sector Sales and Operating Income (2015-2018)

(Billions of yen)



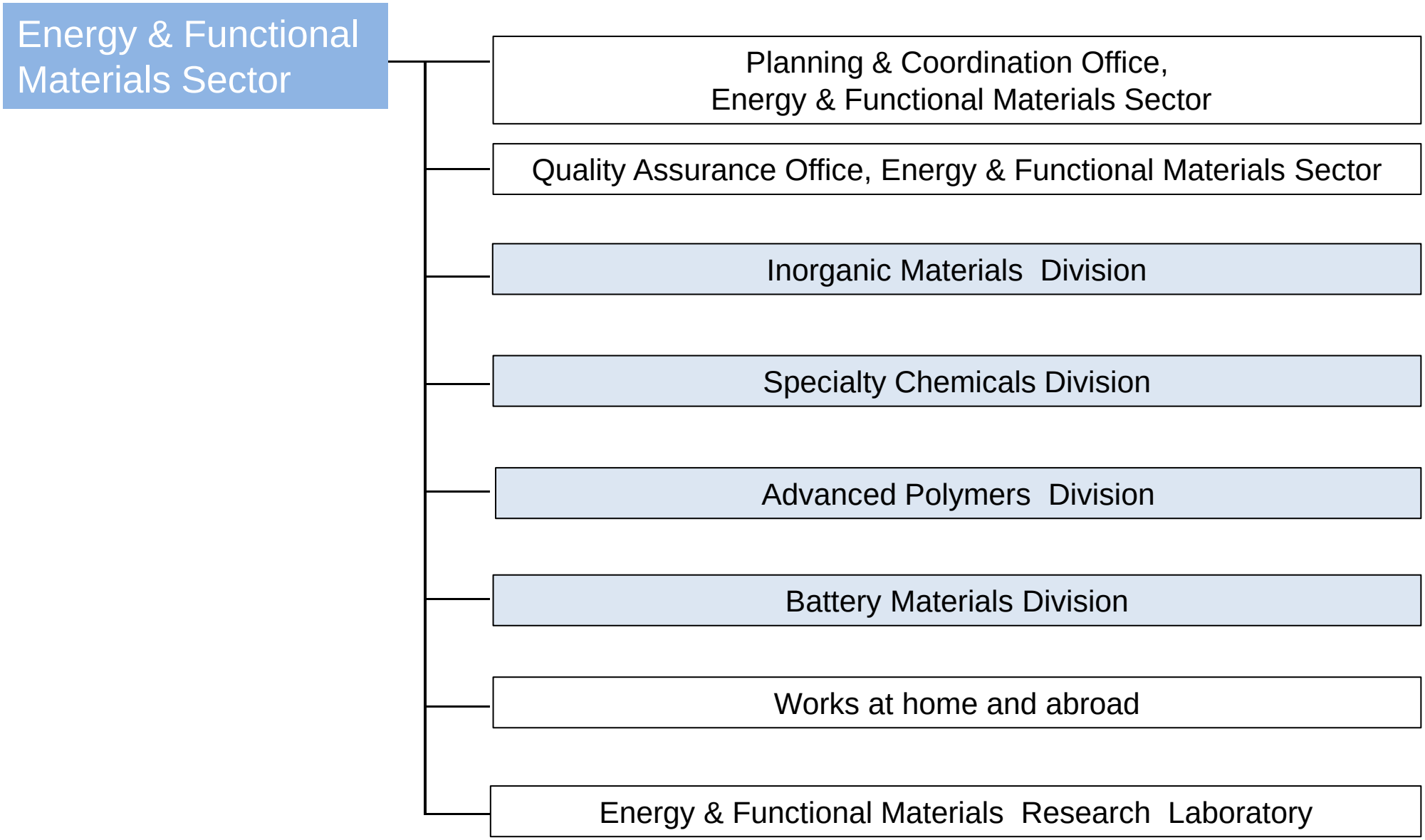
*Based on current organization

***Values are for operating income**

2015-2016 are actual results
2017 is a forecast
2018 is a near-term goal

- ✓ Sector operating income has improved significantly through the execution of this medium-term action plan
  (restructuring underperforming businesses, fostering growth businesses)
- ✓ Increased ratio for battery materials such as separators and cathode materials

Sector Organization (Overall – Business Divisions)



Energy & Functional Materials Sector's Products

High ↑ Market growth rate ↓ Low

-Devote management resources, proactive expansion	**-Grow into future businesses**
・Heat-resistant Separator **・Super Engineering Plastics (SEP)**	**・Cathode Materials** **・CO_2 Separation Membrane** ・DPF
-Develop to meet demand for high added value	**-Business contraction**
・(Bayer) Alumina/ High-purity Alumina ・Resorcinol ・Rubber Chemicals ・EPDM ・S-SBR	

Large ← Market share → Small

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Paradigm Shift in the Automobile Industry (1)

CASE – A next generation automobile concept promoted by Daimler

Dieter Zetsche, chairman of Daimler AG, speaking about CASE at the Paris auto show

https://blog.daimler.com/2016/10/05/generation-eq-paris-et-moi/

Paradigm Shift in the Automobile Industry (2)

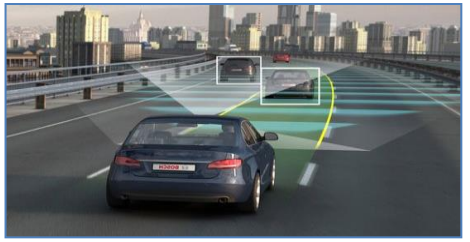
CASE is…

Connected

Autonomous

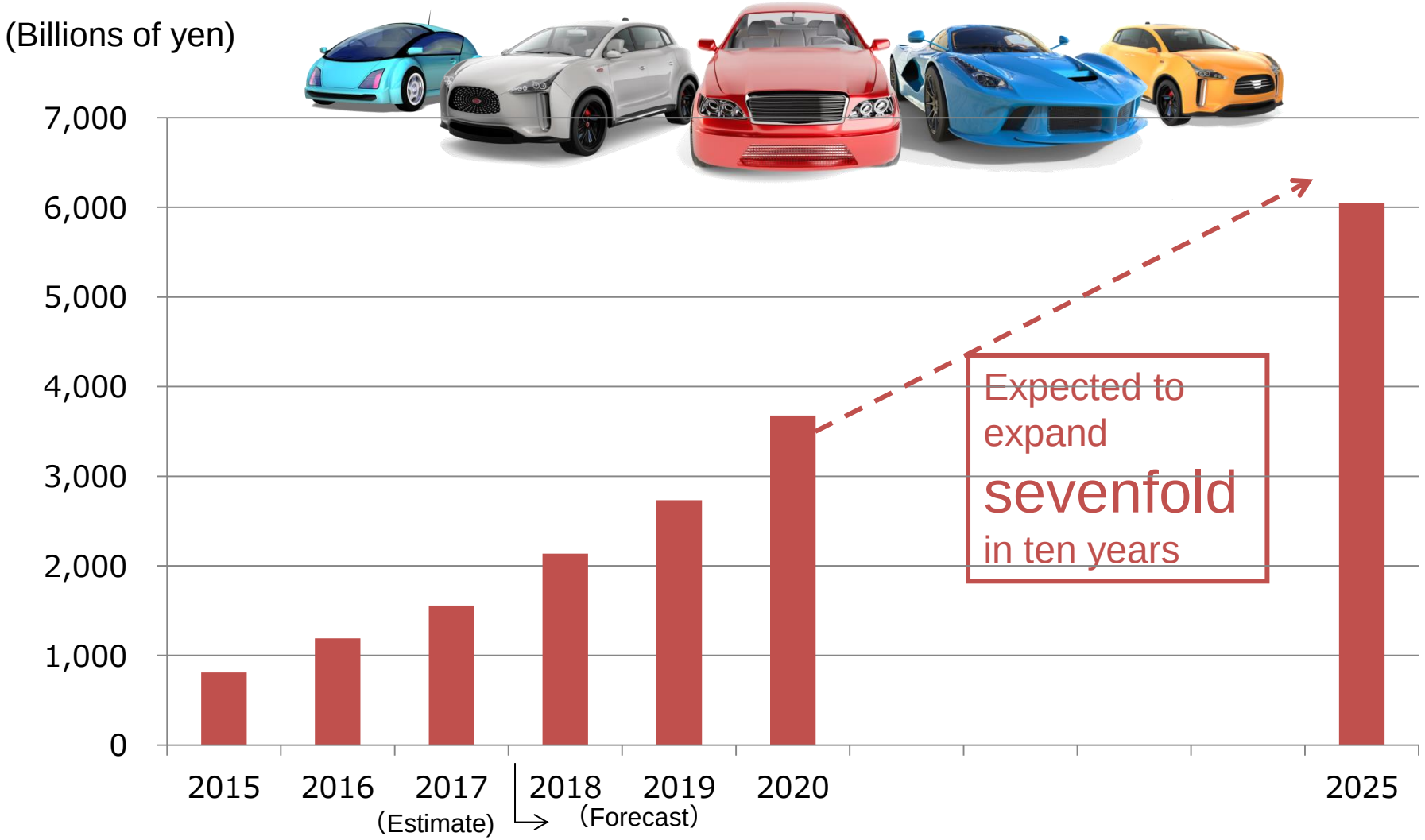
Shared

Electric



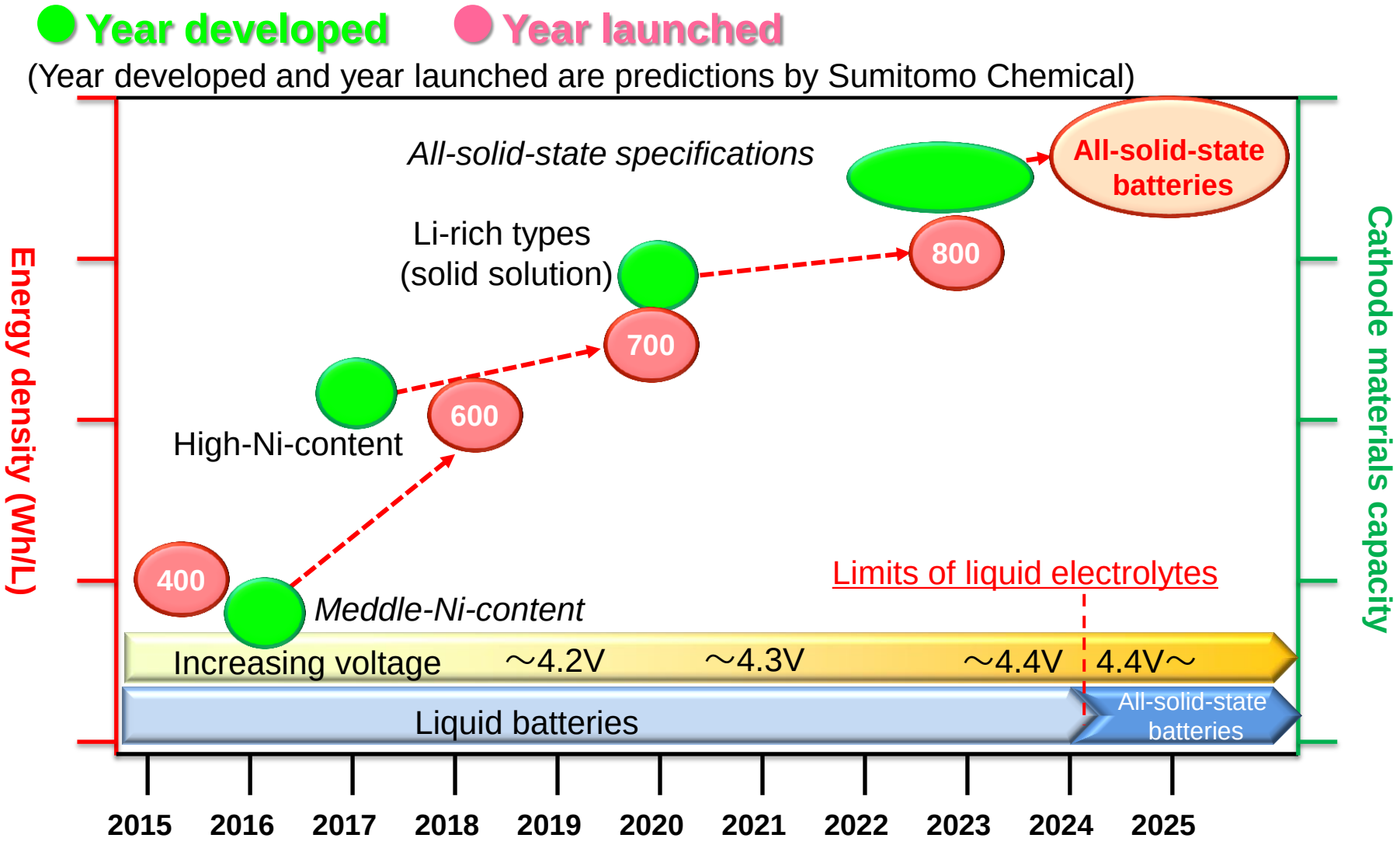
Future Trends of Batteries for Automotive Use

Market for Lithium-ion Secondary Batteries for Automotive Use



(Source) "Future Outlook of Energy, Large Scale Secondary Battery, and Materials 2017; Energy Devices" by Fuji Keizai

Battery Materials Requirements for Automotive Use (Energy Density)



Battery Materials Requirements for Automotive Use
(Safety)

✓ **There is a trade-off between energy density and safety. therefore in order to further increase density, technical safety measures are needed.**

Needed Safety Measures

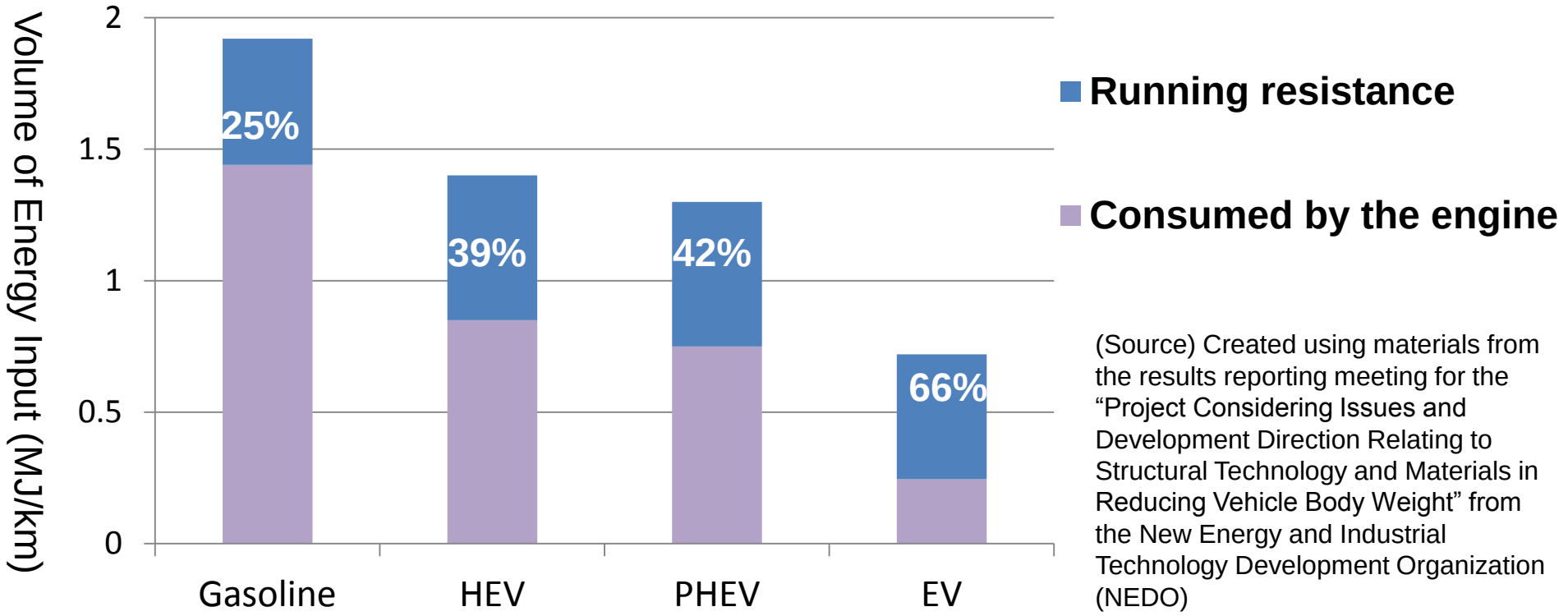
Quality management
(eliminating the risk of internal short-circuit)
Protective mechanisms in case of heat generation
(materials characteristics and device design)

Product Safety Committee, Consumer Affairs Council, Ministry of Economy, Trade and Industry

Materials Needed for Electrification of Automobiles (1)

✓Energy Consumption by Engine Type

*Energy Consumption Ratio When Driving



(Source) Created using materials from the results reporting meeting for the "Project Considering Issues and Development Direction Relating to Structural Technology and Materials in Reducing Vehicle Body Weight" from the New Energy and Industrial Technology Development Organization (NEDO)

- ✓ Energy efficiency when driving is improved by advancements in engine types
- ✓ **As more vehicles shift to electric engines, reducing running resistance becomes more important.**

Material Needs for Electrification of Automobiles (2)

✓Reducing Running Resistance

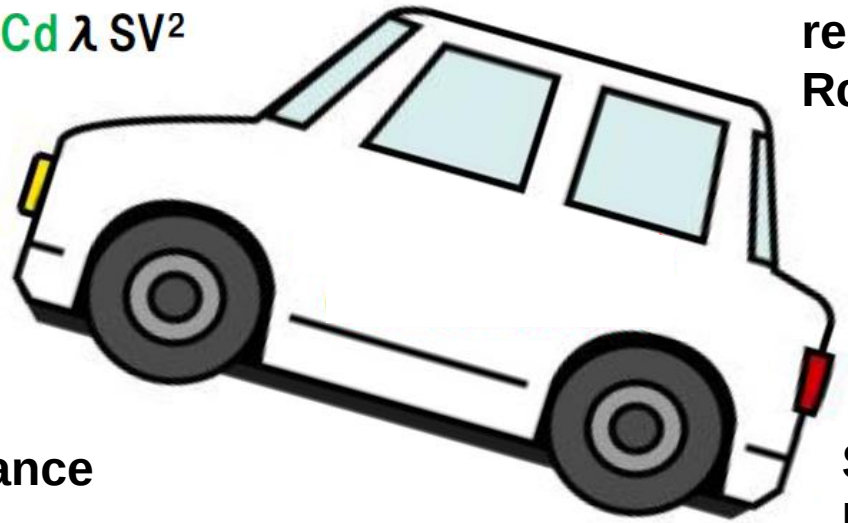
Running Resistance: R = Ra + Rr + Rc + Re

Air resistance
$Ra = \frac{1}{2} Cd \lambda S V^2$

Acceleration resistance
Rc= (m+△m)b

Of all kinds of running resistance, only air resistance is not proportional to vehicle weight (m)

m: Mass (vehicle weight)
Cd: Coefficient of drag (air resistance)



Rolling resistance
Rr= μ m g

Slope resistance
Re= m g sinθ

Under the JC08 Mode test, which is close to day-to-day driving, the relative contribution of each resistance is: air resistance 15%, rolling resistance 23%, acceleration resistance 54%, others 8%

In order to reduce running resistance, it is important to reduce air resistance and vehicle weight

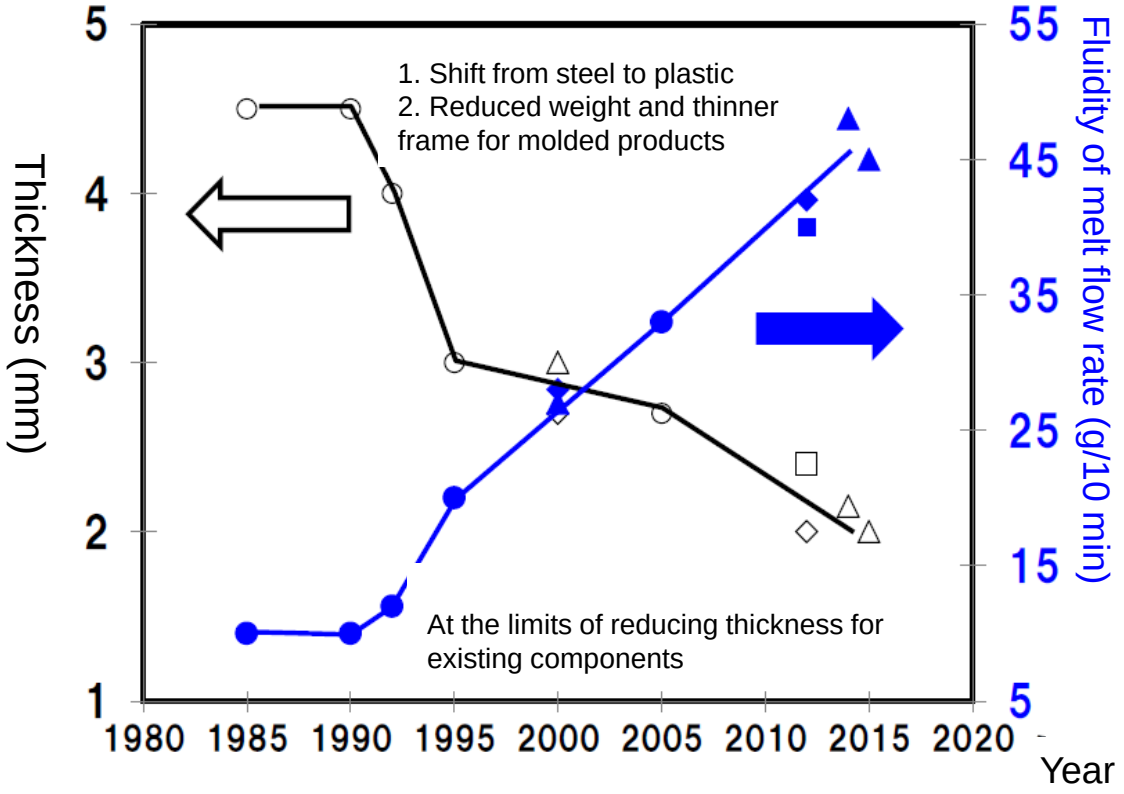
Functionality Needs for Automotive Components
(Reducing Vehicle Weight)

(1)Switching to light materials
(Materials technology)
Steel ⇒
Other metals ⇒
Plastic compounds, other materials

(2)Reducing the volume of materials used
(Design technology)
Thinner frame, reduced size, eliminating components through integration, modularization

(3)Expanding applicable areas
Currently about half is plastic by volume

History of reducing bumper weight with polypropylene

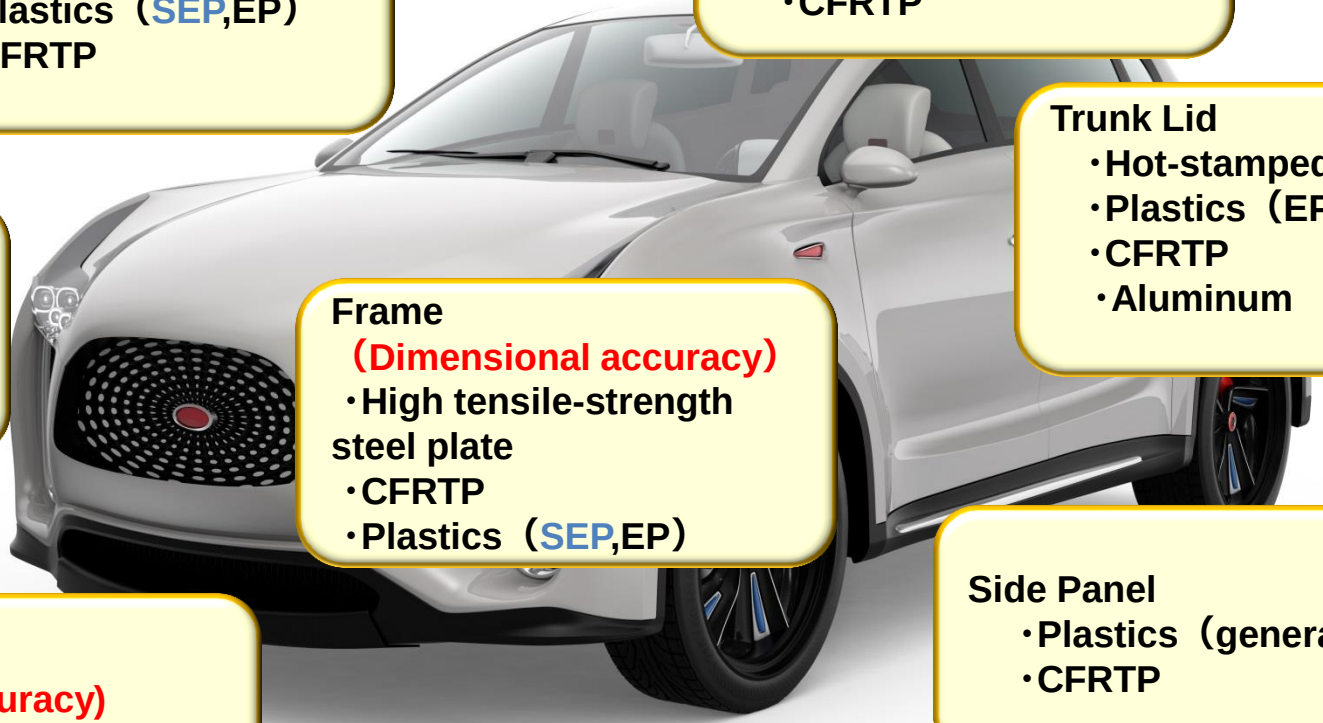


Source: Sumitomo Chemical

Three Elements of Weight Reduction

Functionality Needs for Automotive Components
(Besides Reducing Weight)

***Red items: Important characteristics needed for each component**



Hood（Heat resistance）
- Aluminum
- Plastics（SEP,EP）
- CFRTP

External panel
（Noise control）
- Aluminum
- Plastics（SEP,EP）
- CFRTP

Trunk Lid
- Hot-stamped materials
- Plastics（EP, general）
- CFRTP
- Aluminum

Engine
(Heat resistance)
- Aluminum
- Plastics（SEP）

Frame
（Dimensional accuracy）
- High tensile-strength steel plate
- CFRTP
- Plastics（SEP,EP）

Side Panel
- Plastics（general）
- CFRTP

Transmission
(Dimensional accuracy)
- Aluminum
- Plastics（SEP）

- Part 1 – Overview of Energy & Functional Materials Sector
- Part 2 – Business Environment and Needs for Energy & Functional Materials
- Part 3 – Business Strategy for Each Product Group
  - Battery Materials
    - (Heat-resistance Separators and Cathode materials)
  - Super Engineering Plastics
- Part 4 – Next Generation Businesses and Products

What Energy & Function Materials Sector Strives to Be

'Current Priority Management Issues and Business Strategy, June 2, 2017'

Current Challenges

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Basic Strategy (Strategic Themes)

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- Restructure underperforming businesses

FY2016-18 Business Strategy/Action Plan

- Expand separator business (expand production capacity, develop new products, expand customer base)
- Grow cathode materials business (acquire, develop and launch new products)
- Expand super engineering plastics business (develop new uses, expand production capacity)
- Establish S-SBR joint venture

FY2019- Business Strategy/Action Plan

- Expand battery materials business
- Expand super engineering plastics business
- Full-fledged sales of CO2 separation membrane

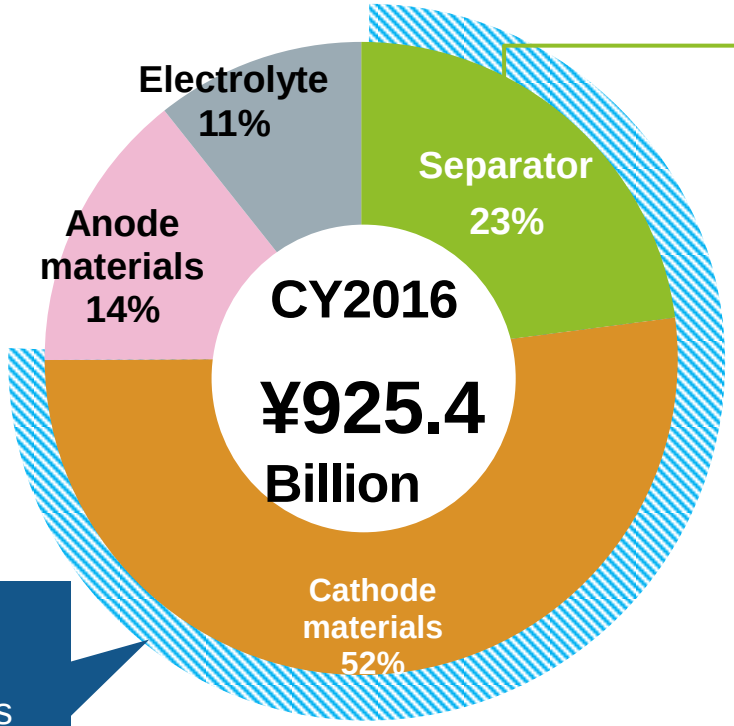
Our Long-Term Goal (For Around FY2025)

Contribute to resolving environmental/energy issues through innovative technology

Battery Materials
(Heat-resistant Separators and Cathode Materials)

Market Size of 4 Major Components and Materials for Lithium-ion Secondary Batteries

Market of 4 major components and materials for lithium-ion secondary batteries



Sumitomo Chemical's target markets
75%

Our products

Separators

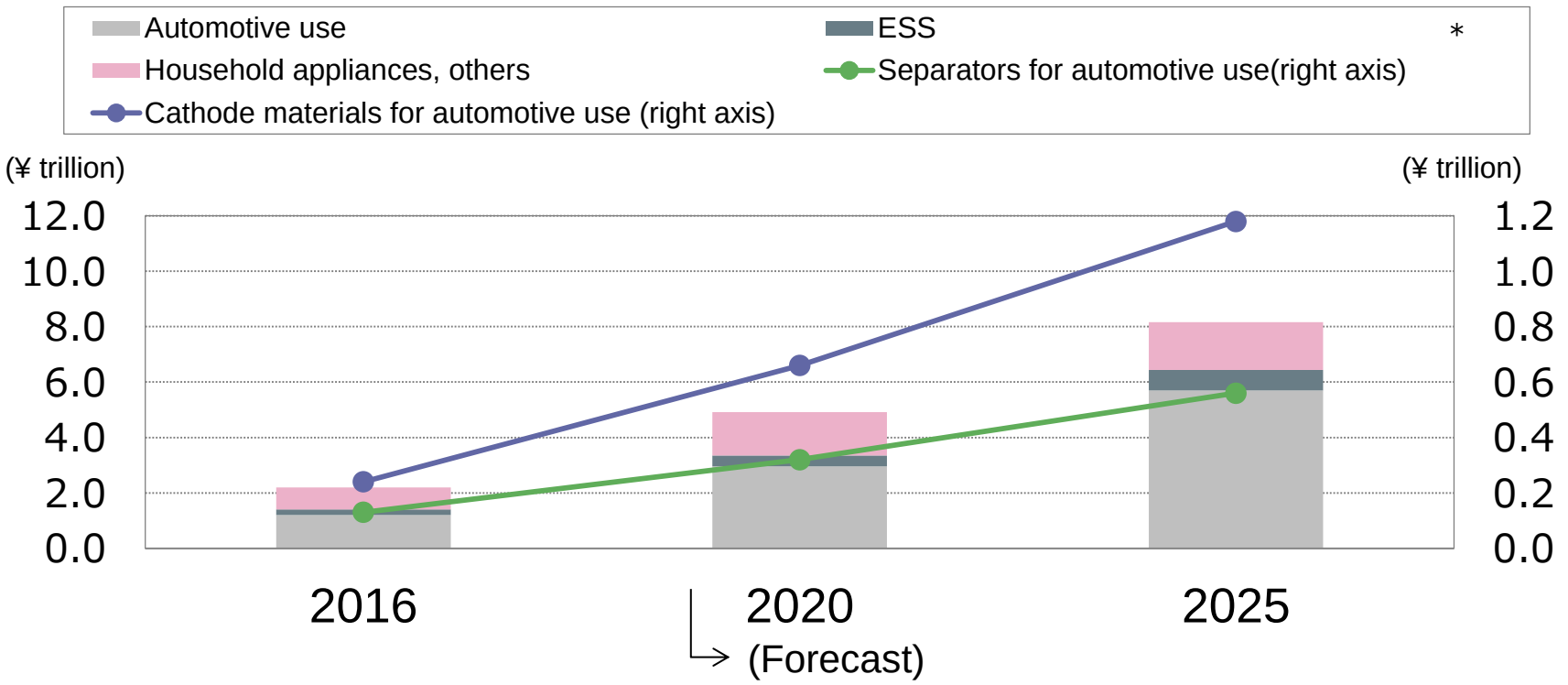
Panasonic and others

Lithium-ion secondary batteries

(Source) "Future Outlook of Energy, Large Scale Secondary Battery, and Materials 2017; Energy Devices" by Fuji Keizai

Heat-resistant Separators Overall Market Growth

Market outlook for lithium-ion secondary batteries and components and materials



(Source) “Future Outlook of Energy, Large Scale Secondary Batteries, and Materials 2017; Energy Devices” by Fuji Keizai

*Cited from:

・Automotive use: ‘Next-generation eco-friendly car field’, ESS: ‘Energy storage system field’, Household appliance, others: ‘Power filed’ and ‘Others (household appliance)’

・Separators for automotive use and Cathode materials for automotive use: ‘Next-generation eco-friendly car field’ on each page

Aramid Coated Separators

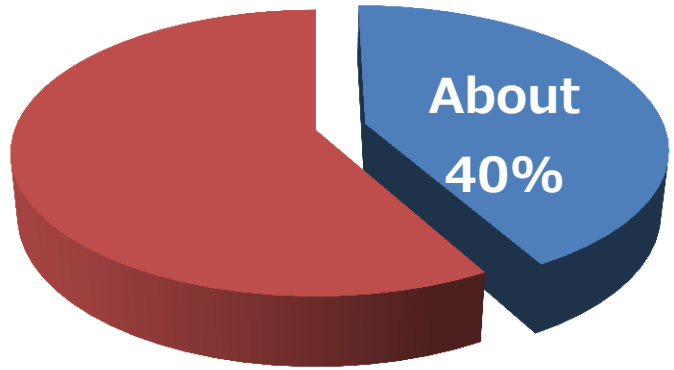
Advantages of aramid coated separators

(compared to ceramic separators)

- High heat resistance, improved safety
- Lightweight
- Low dust generation

Separator market share for lithium-ion secondary batteries for use in electric vehicles (2015, by volume)

Sumitomo Chemical estimates

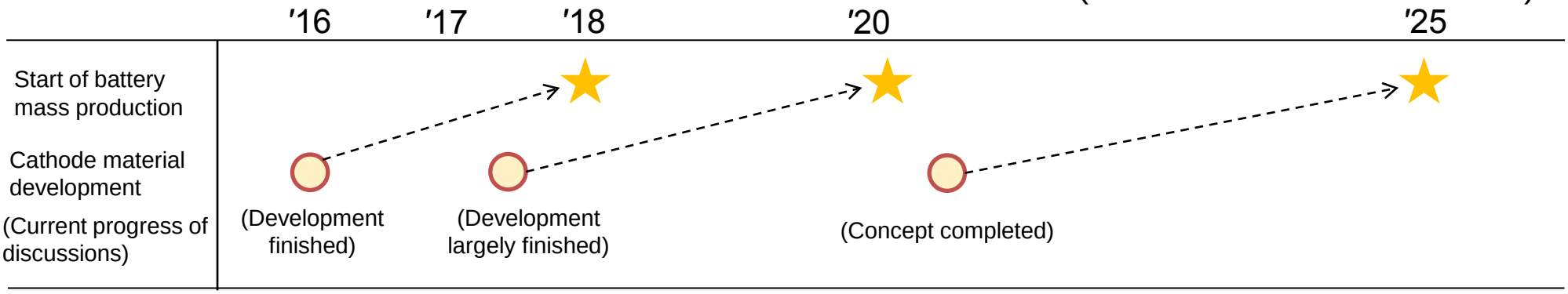


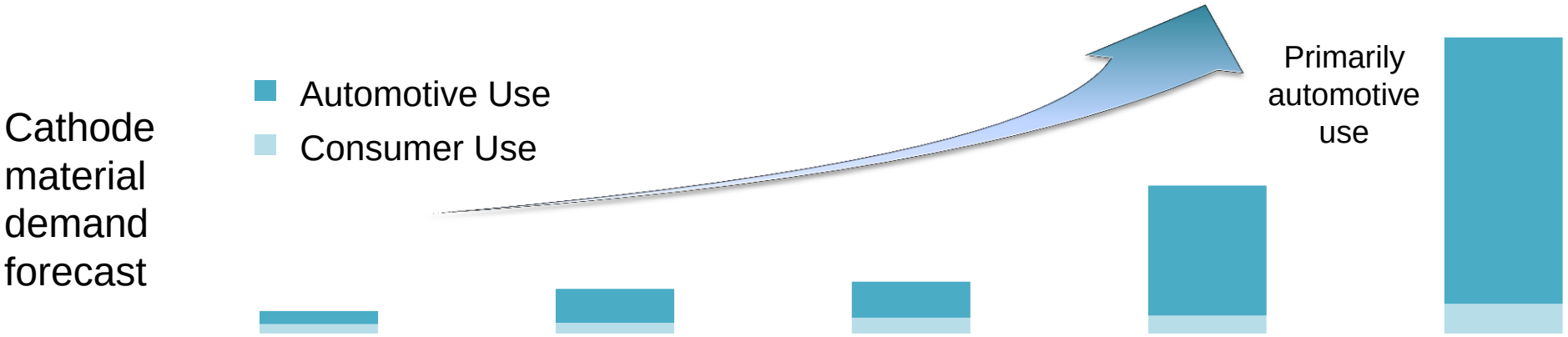
Building a solid position in the separator market by using the strengths of aramid coated separators, such as safety and light weight, when the electric vehicle market is establishing itself

Full Entry into the Cathode Materials Business

➢ Cathode Materials Development Schedule and Demand Forecast

(Sumitomo Chemical estimate)





✓ Fully entered the cathode materials business, with the goal of securing early adoption in automotive batteries whose demand is expected to grow sharply

August 2016 – Tanaka Chemical Corp.* acquired as a subsidiary (*2016 sales: 13.3 billion yen)

Battery Materials Business Strategy

Environment

・Expanding Lithium-ion secondary batteries market with the spread of electric vehicles

・Increased pressure to lower prices in order to help adoption of electric vehicles

・Increased electric vehicle range
→Increased energy density
→Increased need for safety countermeasures

Approach

◇**Increase production capacity in anticipation of an increase in inquiries from customers**

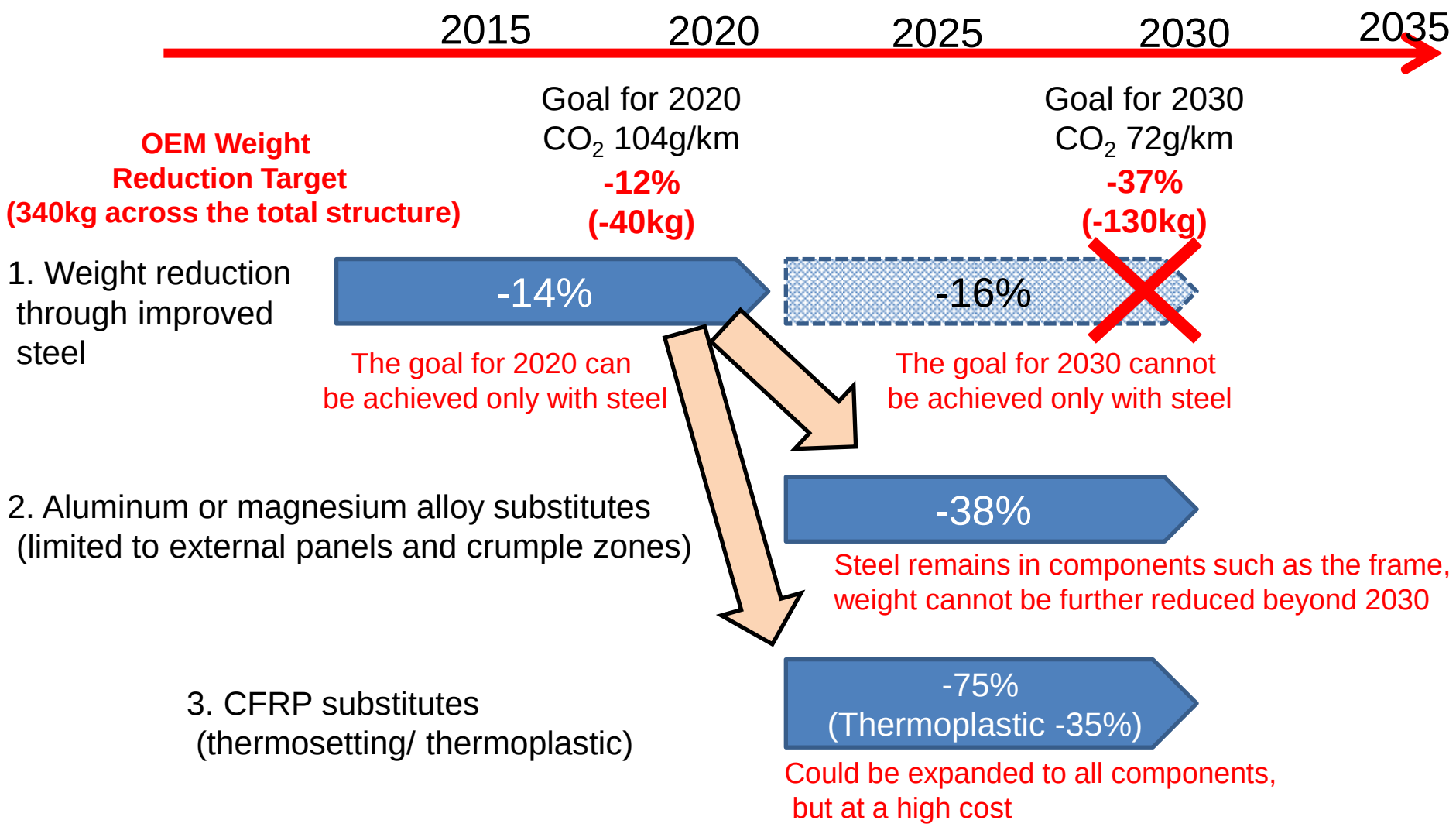
◇**Thorough cost rationalizations**

◇**Providing even greater added value**
(including heat-resistant separators, fast charging and discharging)

✓ Contributing to improved competitiveness of battery manufacturer customers by expanding business in strategic partnerships with those battery manufacturers

Super Engineering Plastics
（SEP）

Scenarios for Reducing the Weight of Car Body



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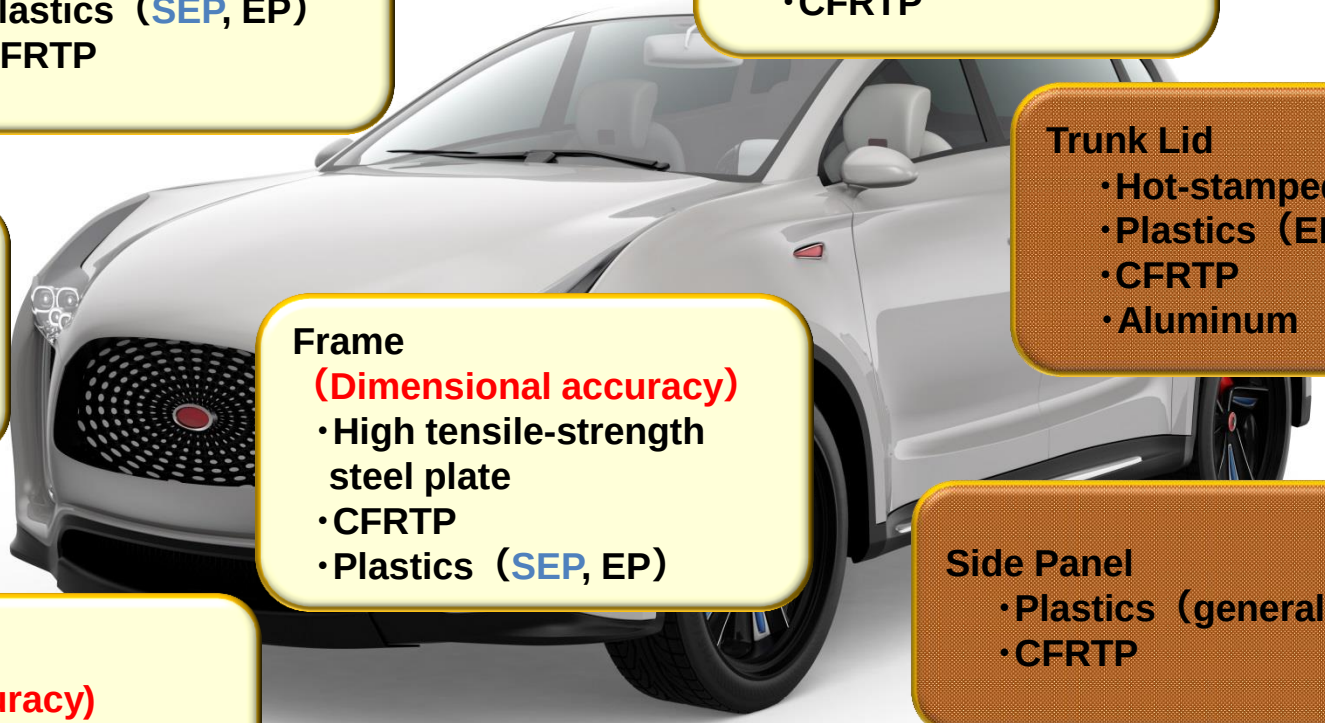
Proposal for Shift to Multi-Material Automotive Components

***Red items: Important characteristics needed for each component**



Hood（Heat resistance）
- Aluminum
- Plastics（SEP, EP）
- CFRTP

External panel
（Noise control）
- Aluminum
- Plastics（SEP, EP）
- CFRTP

Trunk Lid
- Hot-stamped materials
- Plastics（EP, general）
- CFRTP
- Aluminum

Engine
（Heat resistance）
- Aluminum
- Plastics（SEP）

Frame
（Dimensional accuracy）
- High tensile-strength steel plate
- CFRTP
- Plastics（SEP, EP）

Side Panel
- Plastics（general）
- CFRTP

Transmission
(Dimensional accuracy)
- Aluminum
- Plastics（SEP）

Features of Sumitomo Chemical's SEP
(Material Comparison)

	Steel (high-tensile)	Aluminum	General Use EP		SEP	
			PA66 (GF30%)	PC (GF30%)	PES (GF30%)	LCP (GF40%)
Specific gravity	7.85	2.75	1.34	1.42	1.50	1.65
Heat resistance (softening point)	◎	○	× (80℃)	△ (130~145℃)	○ (220~230℃)	○ (300℃~)
Dimensional accuracy	○	◎	×	△	◎	○
Noise control	×	(△)	×	×	×	○
Oil resistance	◎	○	○	×	○	○
Weight reduction (relative weight)	×××	×	○	○	○	○
Material cost	◎	○	○	○	△	△
Processing cost	△	×	○	○	○	◎

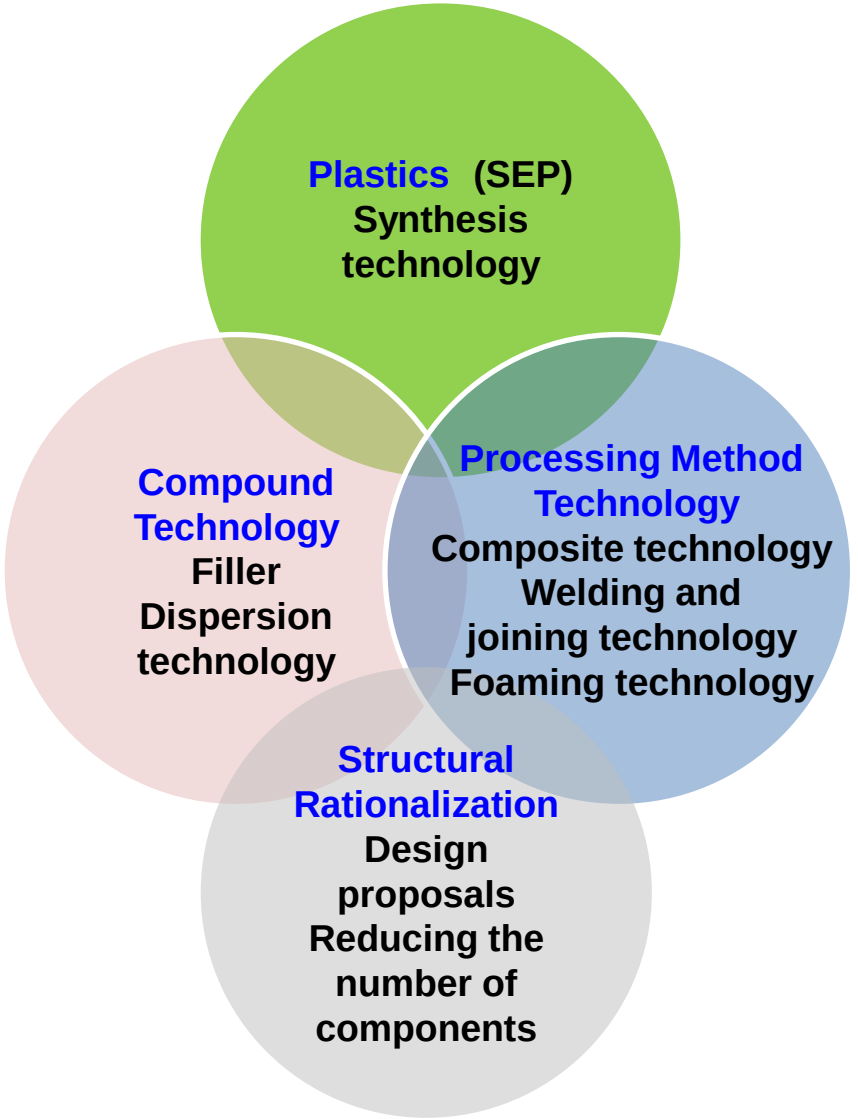
- ✓ In addition to weight reduction (low specific gravity), PES and LCP are superior for components which require the following functionality
  - Heat resistance: hood, areas near the engine
  - Dimensional accuracy: frame, transmission
- ✓ LCP is superior for external panels, which need both weight reduction and noise control

Sumitomo Chemical's SEP Technology

✓ In addition to the unique characteristics of the plastics and the compound technology, Sumitomo Chemical uses the experience developed through existing applications, aiming to penetrate the market by proposing:

- Technology for processing methods
- Structural rationalization

to automobile manufacturers.



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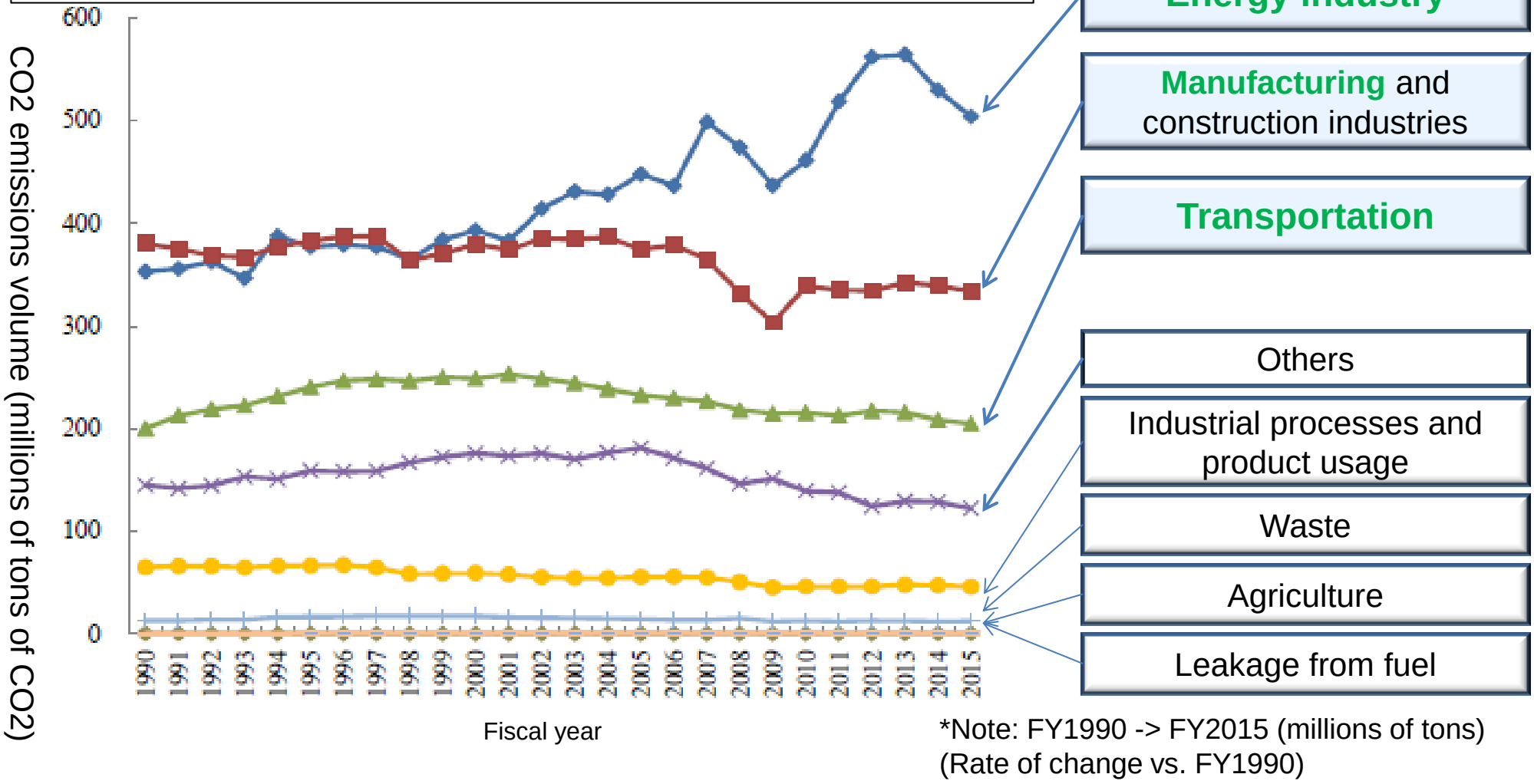
Goals for the Energy and Environment Business

SDGs

SUSTAINABLE DEVELOPMENT GOALS

Trends in Greenhouse Gas Emissions (CO2)

✓ **Contribute to reducing the three major sources of CO2**



*Note: FY1990 -> FY2015 (millions of tons)
(Rate of change vs. FY1990)

Source: Japanese Greenhouse Gas Inventory Report 2017

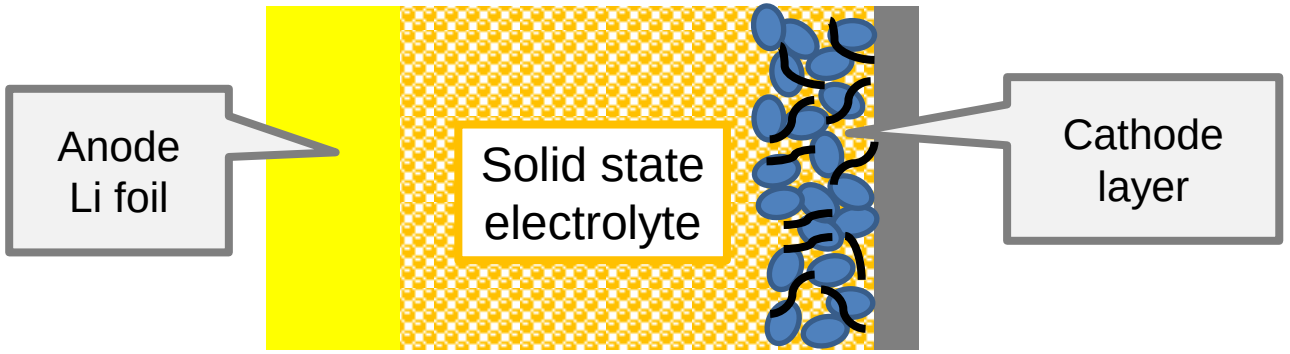
Trends in Battery Materials

Low → Energy density (=potential danger) → High

	Current	Future	
Cathode materials	Oxides (NCM, NCA) →	Oxides that can handle high voltages (Li-rich) →	Sulfur?, Air?
Electrolyte	Organic solvents (LiPF6) →	Ionic liquids? High concentration electrolytes? →	Solid state electrolyte (sulfides⇒oxides)
Separators	Olefin-type microporous membranes (heat resistant coating) →	(lower resistance /thinner)	No need for separators?
Anode materials	Carbon-based →	Silion, Tin? →Li metal (Ca, Mg, Zn, Al) ?	

Liquid Electrolyte Lithium-ion Secondary Batteries and All-solid-state Lithium-ion Secondary Batteries

＜Diagram of a Li Anode All-solid-state Lithium-ion Secondary Batteries＞



	Liquid Electrolyte LiB	All-solid-state LiB
Cathode material	Oxides	**Same (Higher capacity, higher voltage tolerance)**
Electrolyte	Organic solvents (LiPF6)	Solid state electrolyte
Separator	Olefin-type microporous membranes	No need for separators?
Anode materials	Carbon-based	Li metal

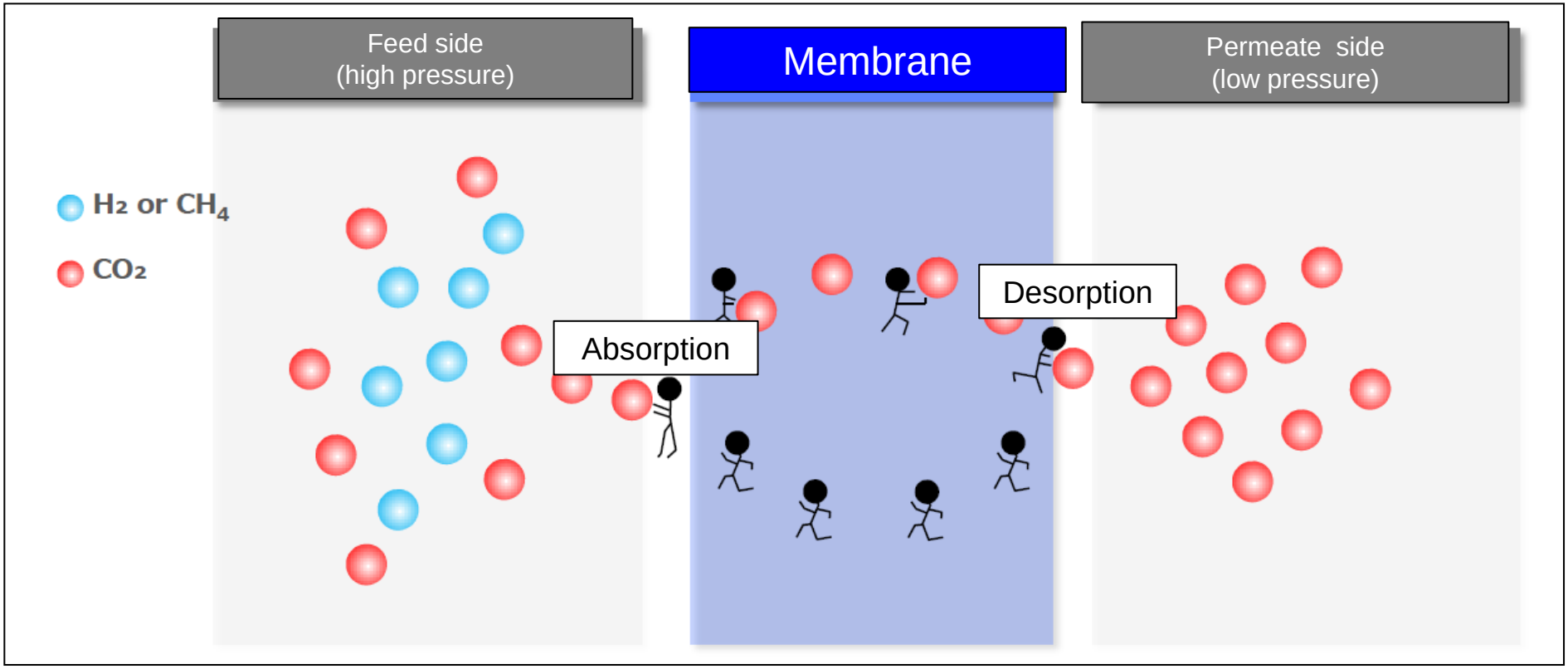
- Main characteristic is the solid state electrolyte
- Capacity is determined by the cathode material and voltage

Key components are
the solid state electrolyte
and **cathode material**

What are CO_2 Separation Membranes?

About selective CO_2 permeable membranes

- **Selective CO_2 permeable membranes consist of a pressure and heat resistant polymer containing a carrier that selectively react with CO_2.**
- **Its main characteristic is that if there is a difference in pressure or CO_2 concentration between the feed side and the permeate side, input energy is nearly zero.**



Future Developments in CO_2 Separation Membranes

CO_2 Separation Market （Forecast for 2030）

Hydrogen production (refinery and chemical plants)
Market: 520 million tons

Natural gas
Market: 600 million tons

Coal gasification combined power generation
Market: 500 million tons

Market Size
2.62 billion tons

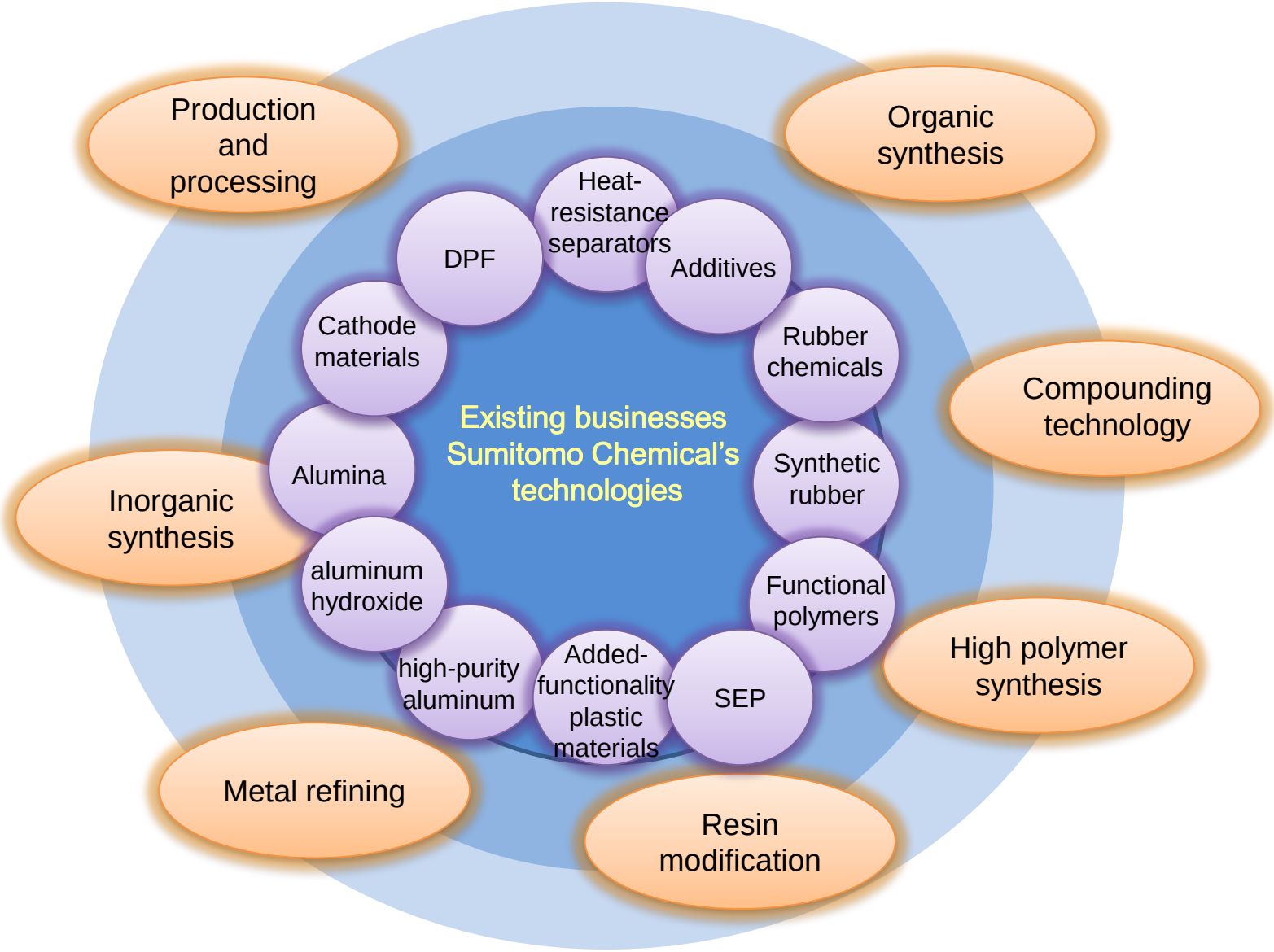
Coal to liquid
Market: 200 million tons

Power generation and Steel manufacturing (CCS/EOR)
Market: 500 and 300 million tons

Hydrogen stations
Market: Unknown

- Separation of H_2 and CO_2
- Separation of CH_4 and CO_2
- Separation of N_2 and CO_2

Development Structure of Energy & Functional Materials Sector



Development structure featuring diverse technology backgrounds

Examples of Technologies and Product Development

Battery Materials	Separators Cathode materials Alumina Next generation battery materials
Materials for Automotive	Super engineering plastics S-SBR for high-performance tires Functional rubber chemicals RES-type adhesives
High Functionality Products	Alumina for specialized applications High functionality additives Specialized adhesive materials High functionality EPDM New Super engineering plastics Plastics for medical use Specialized olefin copolymers
Gas Separation Membranes	CO_2 Separation Membranes

Conclusion

- As it becomes ever more clear that the resolution of energy problems and reduction of CO2 emissions is directly connected to business, this Sector will provide its wide variety of products to the market, contributing to the improvement of the environment on a global scale through value creation for markets and customers.

- For the automotive industry, where paradigm shift is happening, this Sector meet the need of the time by offering total solutions using its characteristic materials and composite technology, with the goal of further expanding business.

Cautionary Statement

Statements made in this document with respect to Sumitomo Chemical's current plans, estimates, strategies and beliefs that are not historical facts are forward-looking statements about the future performance of Sumitomo Chemical. These statements are based on management's assumptions and beliefs in light of the information currently available to it, and involve risks and uncertainties.

The important factors that could cause actual results to differ materially from those discussed in the forward-looking statements include, but are not limited to, general economic conditions in Sumitomo Chemical's markets; demand for, and competitive pricing pressure on, Sumitomo Chemical's products in the marketplace; Sumitomo Chemical's ability to continue to win acceptance for its products in these highly competitive markets; and movements of currency exchange rates.