



Innovation by Chemistry

**TORAY IR Day**

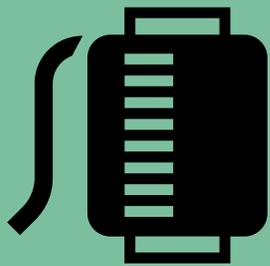
**Medium-Term Management Program Project AP-G 2025**

# **Carbon Fiber Composite Materials Business**

June 9, 2023

**Minoru Yoshinaga**

**Senior Vice President and Member of the Board,  
General Manager, Torayca & Advanced Composites Division  
Toray Industries, Inc.**



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#### [Glossary of Terms]

■ Regular Tow (RT)	: Carbon fiber with 1,000 to 24,000 filaments
■ Large Tow (LT)	: Carbon fiber with 40,000 filaments or more
■ AN	: Acrylonitrile (the main raw material of carbon fiber)
■ CFRP	: Carbon Fiber Reinforced Plastic
■ RNG	: Recycled Natural Gas
■ rCF	: Recycled Carbon Fiber
■ CCUS	: Carbon dioxide Capture, Utilization and Storage
■ Subsidiary Abbreviation	
CMA	: Toray Composite Materials America, Inc. (US)
CFE	: Toray Carbon Fibers Europe S.A. (France)
TAK	: Toray Advanced Materials Korea Inc. (South Korea)
TACQ	: TAK Composites (Qingdao) Co.,Ltd.(China)
ZOLTEK	: Zoltek Companies, Inc. (US)
CIT	: Composite Materials (Italy) s.r.l. (Italy)
DELTA	: Delta Tech S.p.A. (Italy)
TAC-G	: Toray Advanced Composites Group
EACC	: Euro Advanced Carbon Fiber Composites GmbH (Germany)
TCM	: Toray Carbon Magic (Japan)

I

# Overview of Carbon Fiber Composite Materials Business

# Overview of Carbon Fiber Composite Materials Business

## General

Start of Commercial Production : **1971**

Products Brand : **Torayca™ TORAYCA**

Subsidiaries : **10 Companies**

(Consolidated) (Japan 1, Overseas 9)

Employees : **6,656** (as of March 31, 2023)

Toray HQ 1,169 (18%)

Subsidiaries 5,487 (82%)



## Main Production Sites / Capacities

Unit: t/year

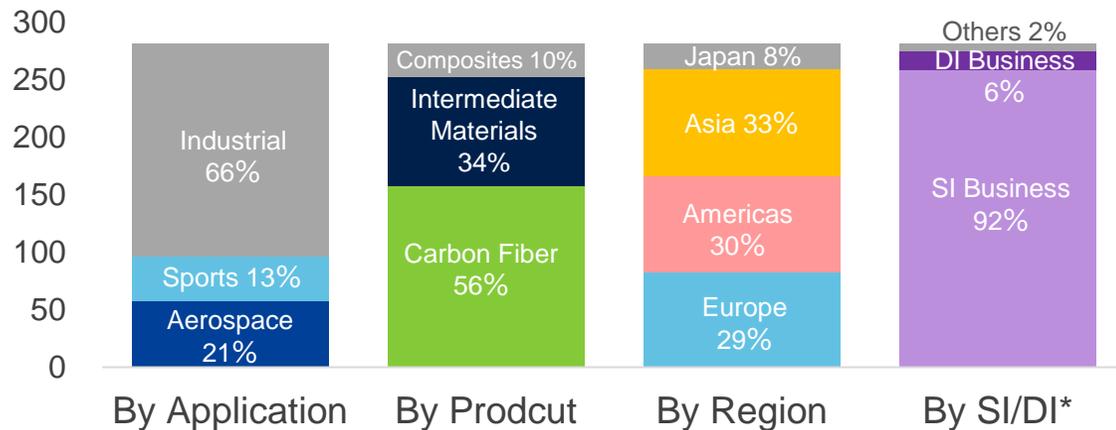
	Regular Tow Carbon Fiber	Large Tow Carbon Fiber
Japan (Ehime)	8,970	-
United States	9,900	-
France	5,200	-
South Korea	4,700	-
Hungary / Mexico	-	35,000
<b>Total</b>	<b>28,770</b>	<b>35,000</b>

(As of March 31, 2023)

## Sales Breakdown

Revenue in FY 2022

Unit: Billion yen

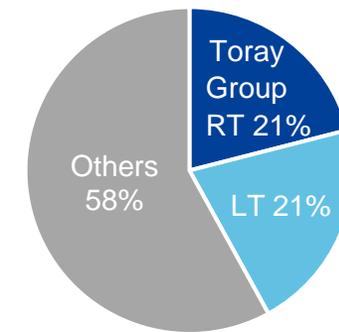
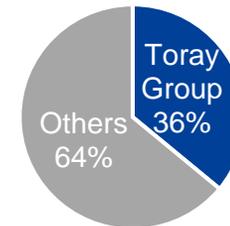


\*SI: Sustainability Innovation DI: Digital Innovation

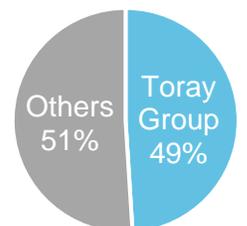
## Market Share

### Whole Market of Carbon Fiber

#### Regular Tow Carbon Fiber



#### Large Tow Carbon Fiber



(As of 2021)

\* Toray (RT) includes CMA, CFE and TAK

## II

# Review of the Medium-Term Management Program AP-G 2022

# Basic Strategies and Performance Goal of AP-G 2022

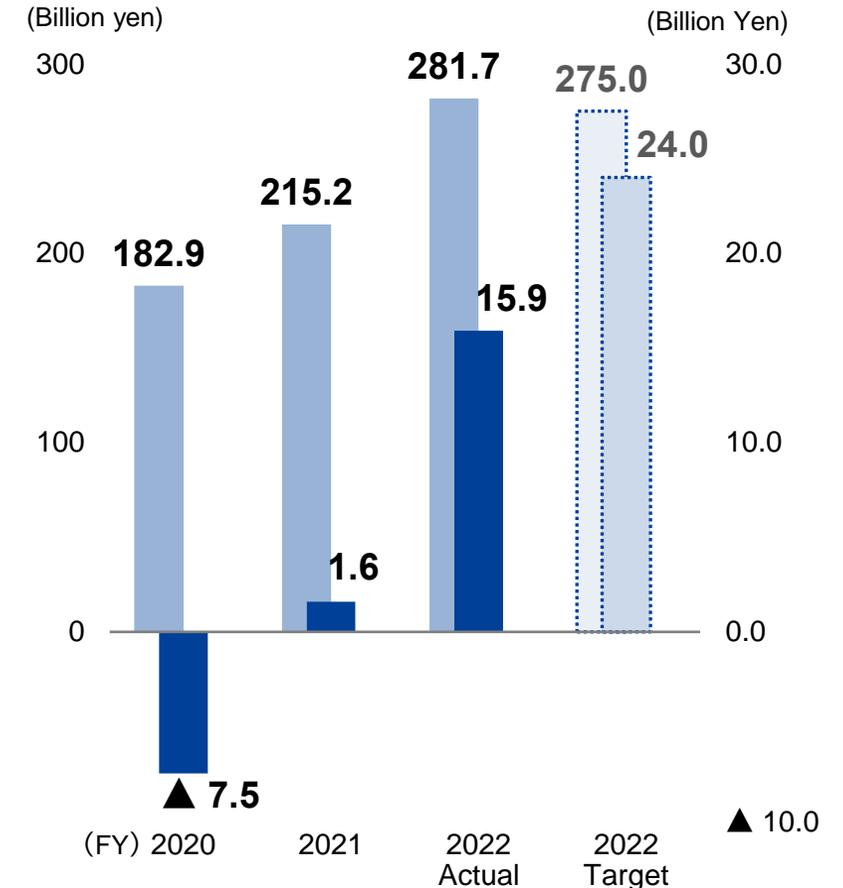
## Our Vision

- Pursuing high performance that is expected for performance materials
- Pursuing quality reliability that is required for structural materials

Basic Strategy	Major Tasks
1 Response to decrease in demand for commercial aircraft	(1) Divert existing production lines for other applications (2) Material selection for the next generation aircraft program
2 Synergy with TAC-G	(1) Business development for a new large-scale application such as UAM (2) Full use of carbon fibers made in Toray
3 Clear Pricing Policy	(1) Pricing method linked to AN price and exchange rate (2) Provide stable prices to customers under a globally unified policy
4 Strengthen Cost Competitiveness	(1) Cost reduction in existing products (2) Conversion to value-added products (3) Development of high-performance carbon fiber
5 Strengthen Technical Services	(1) Quick response through our global technical center system (2) Locally driven development at suitable sites by the global production team

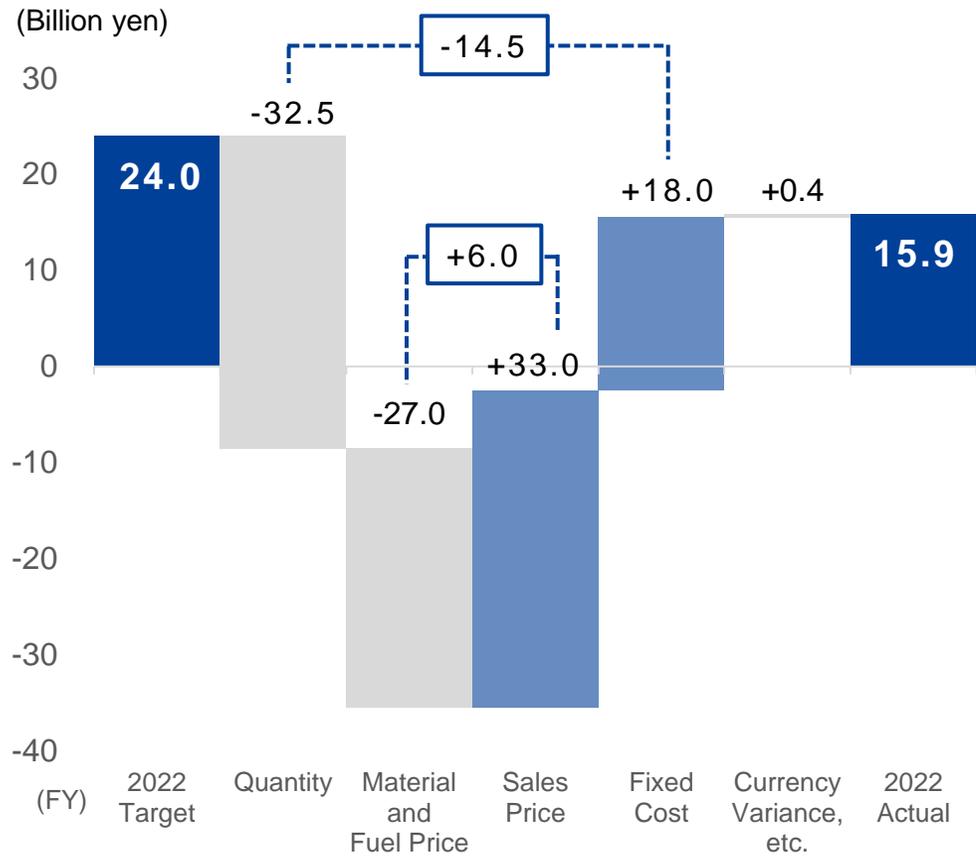
## Revenue, Core Operating Income

■ Revenue (left axis) ■ Core Operating Income (right axis)



# Variance Analysis of Core Operating Income

Recovered from the largest deficit in the history of the business in FY 2020 by **expanding sales of industrial and sports applications** and **reducing total costs** in response to a sharp decline in demand for aerospace applications.



		Difference (Billion yen)	Factors for Increase / Decrease
Prices	Raw Materials	-27.0	Increase in the prices of AN, the main raw material, and electricity, natural gas, etc., mainly in Europe
	Sales Price	+33.0	Raw material and fuel price increases passed through to sales price as well as sales price recovery
Fixed Cost		+18.0	Curtailment of increase in headcounts due to decline in orders and reduction in expenses of technical development
Others		+0.4	Adjustment for consolidation, etc.
<b>Total</b>		<b>-8.1</b>	

# Summary of “AP-G 2022”

Basic Strategies	Contents	Self Evaluation	Summary
Response to decrease in demand for commercial airplane	<ul style="list-style-type: none"> <li>Promote sales expansion of sports and industrial applications in response to decrease in demand for aerospace applications</li> </ul>	Good   Fair	<ul style="list-style-type: none"> <li>Realized full operation in both RT and LT carbon fiber production</li> <li>Prepreg production lines for aerospace remain in surplus</li> </ul>
Synergy with TAC-G	<ul style="list-style-type: none"> <li>Utilize carbon fibers made in Toray</li> <li>Reduce capital expenditure at TAC-G by outsourcing high volume production to CMA</li> <li>Promote joint sales between CMA and TAC-G</li> </ul>	Good	<ul style="list-style-type: none"> <li>Completed switch to carbon fiber made in Toray</li> <li>Started toll manufacturing of TAC-G’s thermosetting prepreg at CMA</li> <li>Progressed sales collaboration between CMA and TAC-G</li> </ul>
Clear Pricing Policy	<ul style="list-style-type: none"> <li>Promote transition to a pricing method linked to AN and price recovery</li> </ul>	Good   Fair	<ul style="list-style-type: none"> <li>Shifted to price range (including price increases) linked to AN and raw material prices</li> <li>Promoting review of pricing in response to rising logistics and utility costs</li> </ul>
Strengthen Cost Competitiveness Enhance high value-added products	<ul style="list-style-type: none"> <li>Promote headcount adjustment in response to decrease in prepreg production for aerospace applications as well as fixed cost reduction by reducing technical development expenses.</li> <li>Establish a production base for high performance carbon fibers (T1100G, etc.)</li> </ul>	Good	<ul style="list-style-type: none"> <li>Implemented thorough fixed cost reductions including R&amp;D</li> <li>Strengthened R&amp;D of high-performance carbon fiber and thermosetting / thermoplastic resins, focusing on next-generation aircraft</li> <li>Completed the proposal for the installation of a semi-mass production facility for T1100G at CMA</li> </ul>
Strengthen Technical Services	<ul style="list-style-type: none"> <li>Establish a global technical center</li> <li>Dispatch experts to local technical service sites (USA, Europe and CHN)</li> </ul>	Good	<ul style="list-style-type: none"> <li>Strengthened technical service capabilities in Europe (gas diffusion layer base materials), China (industrial applications), and the USA (pressure vessel applications)</li> <li>Deepened partnerships with customers</li> </ul>

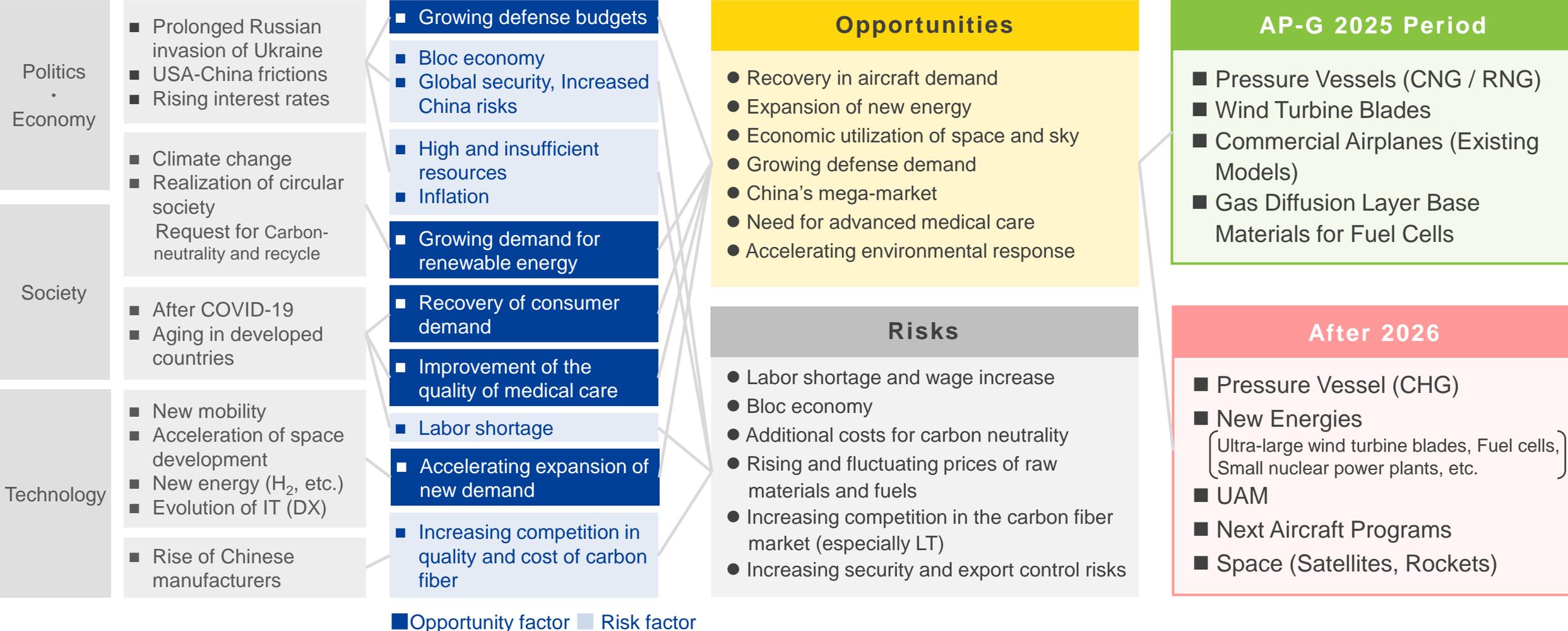
III

# Medium-Term Management Program AP-G 2025

# Business Environment

## Assumed Macro Environment

## Growth Driver



# Carbon Fiber Demand Outlook

Megatrends such as carbon neutrality drive demand, **expanding at an annual rate of 17%**

## By Application

### Aerospace

17% annual growth due to **recovery of demand for commercial airplanes** and expansion of rocket and satellite applications

### Sports

5% annual growth due to steady expansion of demand for outdoor applications

### Industrial

18% annual growth mainly due to expansion of demand in the **environmental and energy-related fields**

## By Region

### Europe

**Wind turbine blades**, Commercial airplanes and Automobile

### Americas

**Pressure vessels**, Wind turbine blades and Commercial airplane

### China

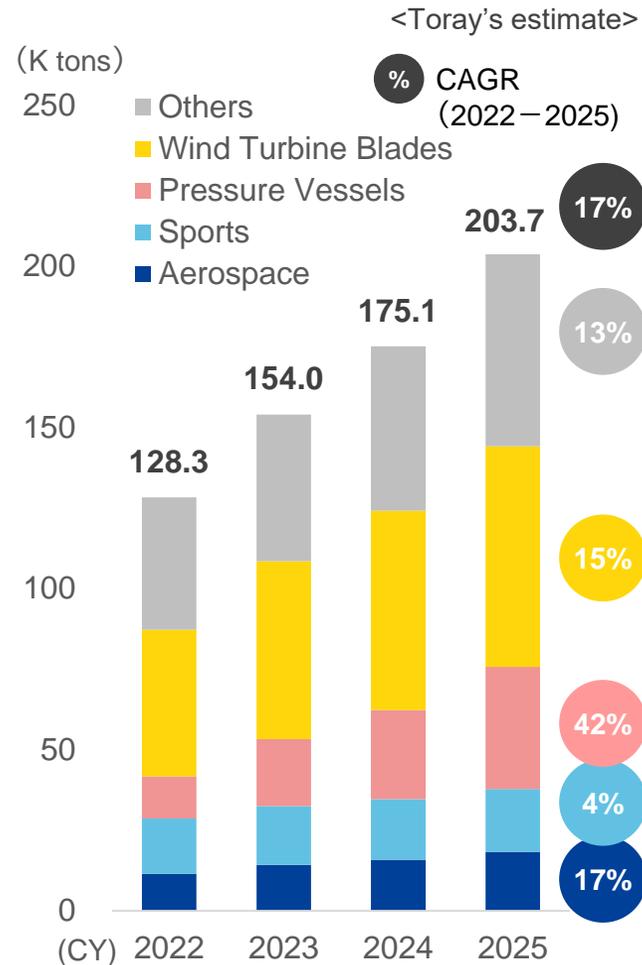
**Pressure vessels**, Wind turbine blades, and Sports

### Others

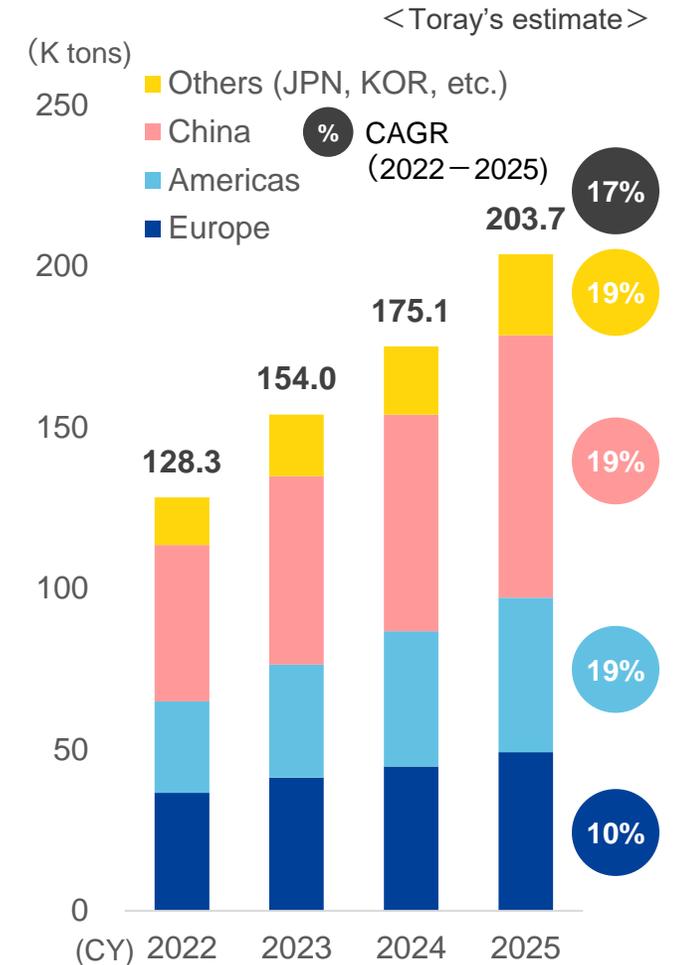
**Commercial airplane** and Pressure vessels

\* In descending order of growth from left to right

## Demand Forecast by Application



## Demand Forecast by Region



# Basic Policies of Project "AP-G 2025"

In order to seize the business opportunity of the **carbon-neutral society**, which is expanding and accelerating on a global scale, as a business opportunity, we provide the best products and realize business expansion through social contribution by leveraging our core strengths of carbon fiber composite materials, "**high functionality**" and "**reliability (usability)**"

## What We Need to Accomplish in the Next Three Years

### 1 Respond to Recovering Demand for Commercial Airplanes and for New Demand

Reorganize production bases for airplane (securing personnel) and gain new demands such as UAM and next-generation aircraft programs

### 2 Capture Expanding Industrial Market

Increase production capacity to capture growing demand for industrial applications such as pressure vessel (CHG), wind turbine blades, and centrifuge

### 3 Business Structure Reform without Over-Dependence on Aerospace Applications

Expand production and sales for industrial and sports applications after aircraft demand recovers, and shift to business without over-dependence on aerospace applications

### 4 Strengthen Regional Cooperation

Improve services by strengthening collaboration among regional subsidiaries in the Americas (CMA – TAC-G) and Europe (CFE - CIT - DELTA - EACC)

### 5 Develop a Road Map for Carbon Neutrality

Achieve carbon-neutrality in Europe (CFE) by 2040 and entire carbon fiber composites businesses by 2050

### 6 Improve Compliance

Improve operation of security trade control and quality control, etc.

# Main Tasks (1) Capture the Recovering Demand for Aircraft

## Production Plan Announced by Boeing

- Resumed 787 deliveries to airlines in August 2022. Plan to reach 5 per month by the end of 2023 and 10 per month in the 2025/2026 timeframe
- Pauses 777X production until 2023 and delays first delivery until 2025

## Production Plan Announced by Airbus

- Increased A320 to 45 per month from October 2021. Plan to reach 65 per month until 2024 and 75 per month in 2026
- Currently produces A350 at 6 per month. Plan to reach 9 per month in 2025

## Demand Growth for Next-generation Aircrafts

- NASA announces collaboration with Boeing on “Sustainable Flight Demonstrator”, a sustainable demonstration program to reduce fuel consumption and CO<sub>2</sub>
- Airbus announces the development of a next-generation single-aisle airplane with state-of-the-art production, design and propulsion technology, aiming to enter service in early 2030



## Our Response

- Preferential supply from qualified existing production lines  
→ Reorganize production bases (securing personnel, etc.) at each site (JPN, USA, and Europe) without delay in order to supply reliably
- Promote increase in capacity of existing machines (RT)  
→ Minimize impact on other applications
- Promote material development and selection for next-generation aircrafts

## Our Supply Bases for Boeing, Airbus and Next-gen Aircrafts

	Boeing	Airbus	Next-gen Aircraft
TORAY (JPN)	● Prepreg ● Carbon Fiber	Carbon Fiber	● Prepreg ● Carbon Fiber
CMA (USA)	● Prepreg ● Carbon Fiber	—	● Prepreg ● Carbon Fiber
CFE (FRA)	Carbon Fiber	Carbon Fiber	—
TAC-G (USA·NLD)	●● Prepreg	● Prepreg	● Prepreg

\* For primary and secondary structural materials

# Main Tasks (2) Business Structure Reform

Reform business portfolio without overdependence on aircraft applications through capturing of demand in the growing industrial market and strengthening of earning base

## Expansion of Supply Capacity by Large-scale Investments

### ■ Regular Tow

1. Expansion of high-strength carbon fiber production lines for **pressure vessels (RNG·CHG)** both in **the USA (CMA)** and **South Korea (TAK)**
2. Expansion of high modulus carbon fiber production line in **Europe (CFE)** to gain the increasing demand for **wind and nuclear power generation**

### ■ Large tow

Expansion of carbon fiber production line at ZOLTEK's cost-competitive **Mexico plant** for **wind turbine blades**

## Strengthening of Profit Structure

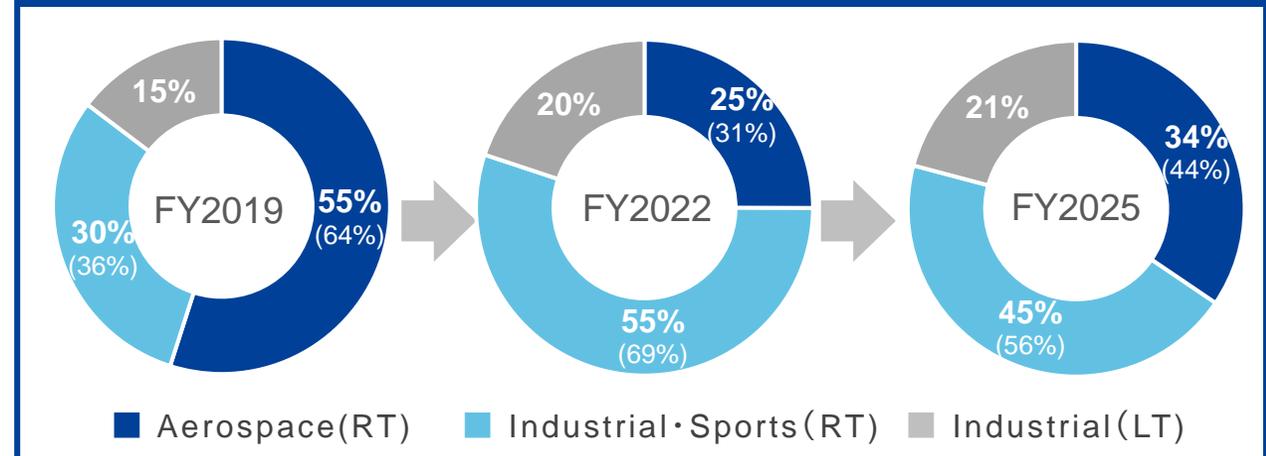
- Installation of new cost-competitive equipment
  - Variable cost reduction by improving utility unit consumption
  - Fixed cost reduction through production innovation
- Price formula linked to AN, fuel prices, etc.
- Enhance product value through technical services and quality improvement

Cost Reduction

## Major Large-scale Capital Investments Under Consideration

	Location	Capacity	Production Start	Main Application
Regular Tow Carbon Fiber	USA KOR	6,500t/y	Mid 2025	Pressure Vessels
Regular Tow Mid/high-modulus Carbon Fiber	FRA	1,000t/y	Mid 2025	Uranium Centrifuge
Larger Tow Carbon Fiber	MEX	2,500t/y	TBD	Wind Turbine Blades

## Marginal Profit Structure by Application



\*Numbers in parentheses indicate the ratio of RT.

# Main Tasks (3) Strengthen Quality and Cost Competitiveness

## Advantages of Our Carbon Fiber Composite Materials Business

### Global Power

- World's largest production capacity
- Number of global locations  
Production: 26 Sales: 18 R&D: 18
- Diverse Human Resources (Europe, Americas, KOR and JPN)

### Quality Reliability

- Qualified materials for aerospace applications
- Accumulated data over 50 years and its reliability

### Development Capability

- Diverse technologies
  - Regular Tow
  - Large Tow
  - Thermoset
  - Thermoplastic
- Development capacity from carbon fiber to intermediate materials\* and composites

\*Prepreg, Torayca® Carbon Paper, GDL, etc.

## Enhancement of Cost Competitiveness

- Promote increase in production capacity and expansion of production lines in proper locations
- Optimization of SCM globally
- Promote development of innovative processes and continuous cost reduction through digital transformation

## Enhancement of Quality Capability

- Creation of leading-edge materials and products
- Global quality standardization
- Deepen customer partnerships / integration of processing and molding
- Carbon neutrality, recycling and improvement of carbon footprint

# Strategies for Growth Drivers (1) Pressure Vessels (CNG, RNG, CHG)

## High-strength Carbon Fiber Meets the Needs for High Pressure Resistance and Light Weight

### Business Environment

- Global demand growth on the back of the carbon neutrality megatrend

**CNG/RNG** For home delivery and large transport vehicles

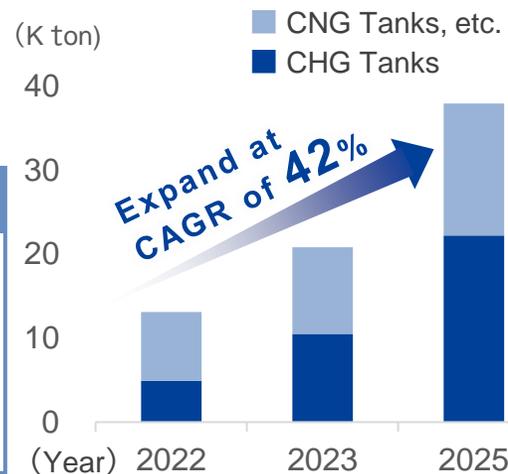
**CHG** For commercial vehicles, trains, ships, and cars using fuel cells

- Expected to be used for hydrogen gas transportation / storage application in the future

#### Requests from Tank Manufacturers

- Stable **quantity and supply capacity**
- Quality and cost competitiveness** (including processing)
- Technical service support to global locations

#### Carbon Fiber Demand Forecast



### Our Strengths and Value Proposition

- Global de-facto high-strength carbon fiber (T700S)
- Over 20 years experience and data accumulation
- Production and technical service bases in consuming areas (USA and KOR)
- Propose the best carbon fiber & resin for pressure vessels
- Analytical ability of pressure vessels

### Business Strategy

- Promote **capacity increase and expansion** to meet increasing demand (USA and KOR)
- Strengthen **technical services**
- Enhance **quality and cost competitiveness**
- Further strengthen **SCM**
- Reinforce **partnerships** with key global customers

# Strategies for Growth Drivers (2) Wind Turbine Blade

## Lightweight High-stiffness Carbon Fiber Meets the Needs for Longer Blades, Effective in Reducing Electricity Costs

### Business Environment

- Global demand growth on the back of the carbon neutrality megatrend

**New Power Generation**

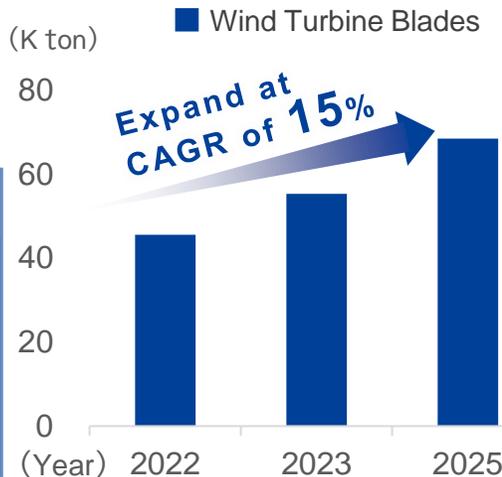
2022 : **86 GW/y** → 2025: **126 GW/y**

**Blade Length**

2022 : **70 - 80m** → 2025 : **Over 100m**

- Chinese carbon fiber manufacturers aggressively expanding their capacity in response to growing domestic demand in China

### Carbon Fiber Demand Forecast



### Requests from Blade Manufacturers

- Carbon fiber with stable **stiffness and processability**
- Stable **assurance of supply**
- Competitive **price**
- **Technical services** to global locations

### Our Strengths and Value Proposition

- ZOLTEK's LT carbon fiber (PX35) is the global de-facto standard
- The world's largest production and supply capacity
- Cost-competitive Mexico Plant
- Hungary Plant operations for European customers
- Continuous quality improvement by application of RT technology and know-hows

### Business Strategy

- **Capacity increase (Mexico)** to meet Euro-American demand
- Enhance non-price competitiveness through **improvement of technical service**
- **Structural reforms** and cost reduction at **Hungary plant**, currently facing utility price increase
- Profitability improvement by changing product mix in Hungary
- Avoid direct price competition with Chinese manufacturers by supplying re-export materials to avoid tariffs in Chinese market

# Strategies for Growth Drivers (3) Commercial Aircraft

Demand Increases Along the **Production Rate Recovery of Existing Models**  
Develop and Propose the Best Materials for High-rate Production of **Next-gen Aircraft**

## Business Environment

- Boeing and Airbus production rates will recover after end of COVID-19
- Demand for wide-body airplanes that utilize CFRP (Boeing 787, 777X, Airbus A350, etc.) will recover to 1.1 times as much as the 2019 level by 2025
- Development of high-rate production technologies toward mid-2030 on the back of the carbon neutrality megatrend

### Materials Required for Aircraft

- High **reliability, safety and quality control**
- Capability to develop and propose **the cutting-edge material**
- Stable **supply capacity** and commitment

### Carbon Fiber Demand Forecast



## Our Strengths and Value Proposition

- Advanced quality control capability and quality assurance
- Qualification for Boeing, over 30 years experience in supply and data accumulation
- Development and qualification experience for Airbus
- Qualified materials in public database (NAIR\*, etc.)
- Supply from Euro-American sites and technical services

\*National Institute for Aviation Research

## Business Strategy

- Prioritize production for aircrafts **in response to demand recovery**
- Promote **material qualification for Airbus**
- **Develop and propose** the best materials **for next-gen single aisle airplanes**
  - Thermoplastic / thermosetting materials for high-rate production
  - Development of ultra-high strength carbon fiber
- Expansion of **design allowable databases** for value materials

# Strategies for Growth Drivers (4) Gas Diffusion Layer for Fuel Cell

## Demand for Gas Diffusion Layer (GDL) Materials Expected to Grow for the Fuel Cells and Hydrogen Generators in the Coming Hydrogen Society

### Business Environment

#### Fuel Cell

Demand increase for mobilities in general such as commercial vehicles, and for stationary fuel cell

#### Hydrogen Generator

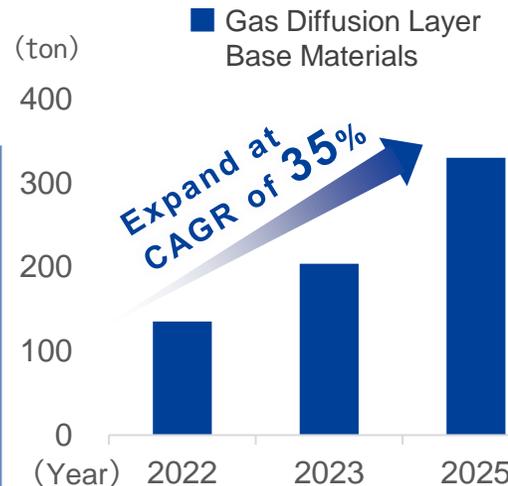
Demand increase for electrode materials in accordance with the development of commercial equipment

- Full-scale expansion is expected to be in 2026-2030 timeframe. Demand in 2030 is forecasted to grow 10 times compared to 2022

#### Materials Required for GDL

- Uniform **web structure, strength** and **processability**
- **Generation performance** suited for operating environment and type of batteries
- **Cost competitiveness**
- **Supply capability**

#### Carbon Fiber Demand Forecast



### Our Strengths and Value Proposition

- World's largest GDL material capacity (JPN and KOR)
- Over 40 years production experience and a rich store of data
- Partnerships with global battery manufacturers and technical services
- Ability to propose material designs that meet customer needs
- Competitiveness from utilization of human resources and know-how of carbon fiber

### Business Strategy

- **Proactive capital investment** responding to growing demand
  - Development and proposal of materials to meet customer requests
  - Increase production capacity along the global demand
  - Strengthen technical center in Europe
- Strengthen cost competitiveness through **innovative process development**

# Road to Carbon Neutrality

## Policy of Carbon Fiber Composite Materials Business

As a leading carbon fiber company, we will promote progressive approach and proactive communication.

**By 2030**

**Over 30% reduction** in CO<sub>2</sub> emissions  
Start rCF production in Europe and US

**By 2040**

**Over 50% reduction** in CO<sub>2</sub> emissions  
Achieve Carbon Neutrality in Europe

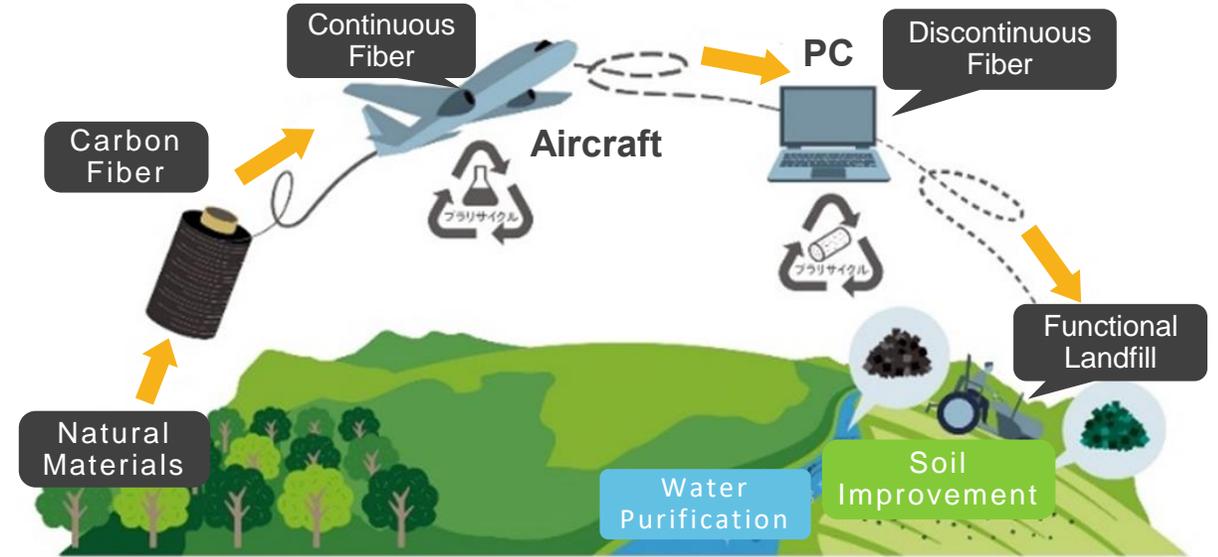
**By 2050**

**Achieve Carbon Neutrality**  
Introduction of **CCUS**

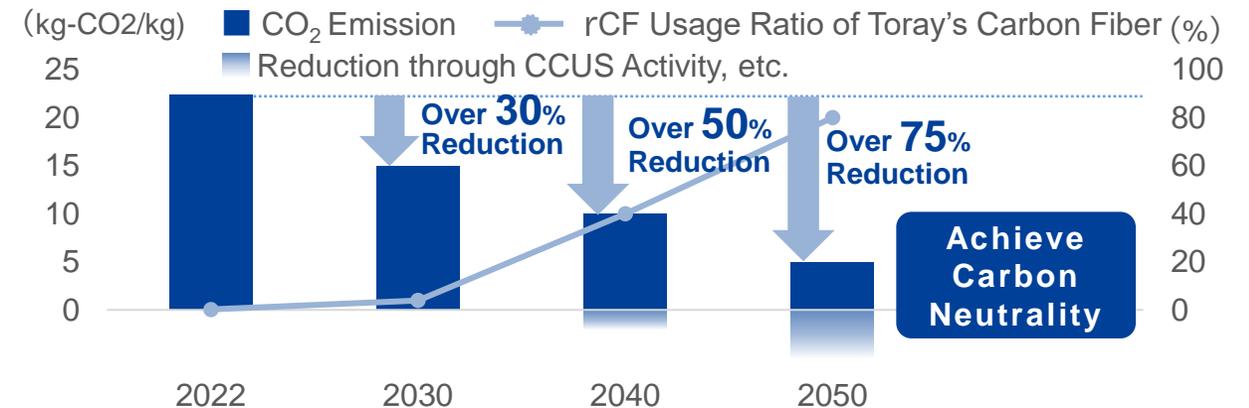
## Strategy for Carbon Neutrality

1. Quantify LCA improvement effect on customer's product
2. LCI reduction of our products (carbon fiber, prepreg, etc.)
3. Promote Material Eco-SYSTEM (use of recycled / bio-based raw materials)

## Environmental Improvement Model of Carbon Fiber



## Carbon Neutrality Milestone for Carbon Fiber

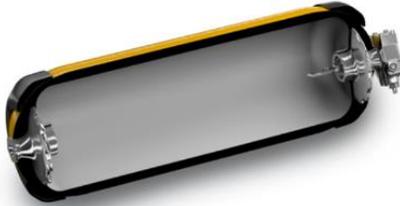


# Main Applications Expected to Expand After 2026

## Hydrogen Tanks

Carbon Fiber Demand Scale  
in 2030 Compared to 2025

**4X**  
(90,000t)



©TOYOTA MOTOR CORPORATION

## Wind Turbine Blade

Carbon Fiber Demand Scale  
in 2030 Compared to 2025

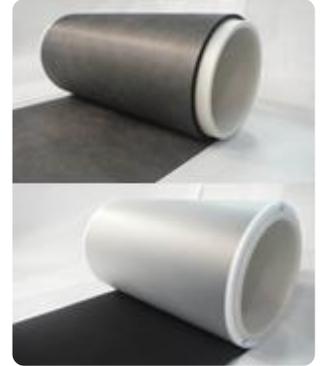
**1.3X**  
(92,000t)



## GDL Base Materials

Carbon Fiber Demand Scale  
in 2030 Compared to 2025

**3.5X**  
(1,200t)



(Top) Torayca® Carbon Paper  
(Bottom) GDL

## Urban Air Mobilities

Carbon Fiber Demand Scale  
in 2030 Compared to 2025

**10X**  
(2,000t)



©Joby Aviation, Inc.

## Next-gen Aircraft

Carbon Fiber Demand Scale  
in around 2030

**3,000t**



©The Boeing Company

## Space (Rockets)

Space Industry Market Size<sup>(\*)</sup>  
In 2040 compared to 2025

**2.3X**  
(1 trillion\$)



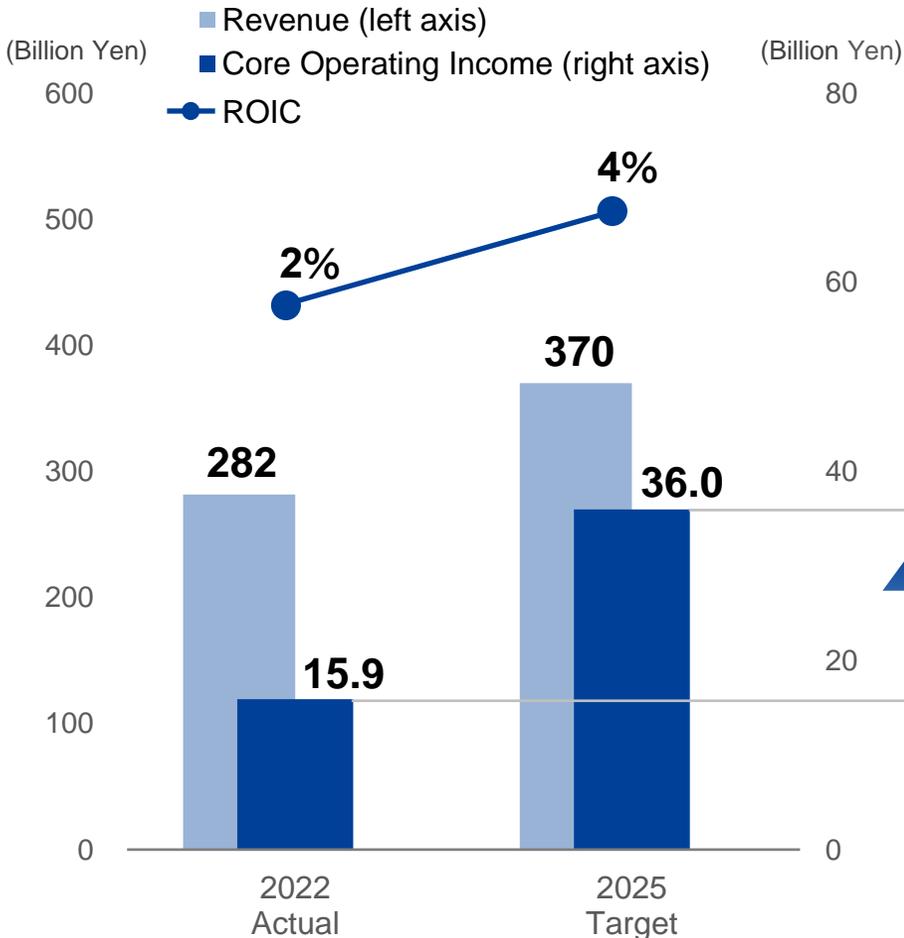
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Note: Carbon Fiber Demand Scale is Toray's Estimation

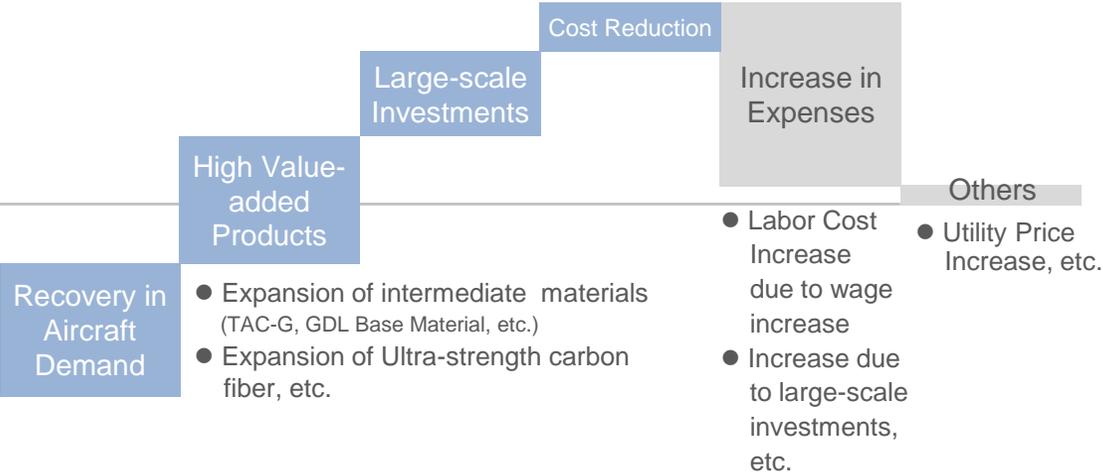
\*Source: Morgan Stanley's projection  
<https://www.morganstanley.com/ideas/investing-in-space>

# Revenue and Core Operating Income Target

## Revenue, Core Operating Income



We aim to achieve core operating income of **36.0 billion yen**, an increase of 20.1 billion yen from FY 2022, by strengthening our business structure through **capture of demand for commercial aircraft** and **expansion of high value-added products** as well as expanding the scale of business by **large-scale capital investments**.



Descriptions of predicted business results, projections and business plans contained in this material are based on assumptions and forecasts regarding the future business environment, made at the time of publication. Information provided in this material does not constitute any guarantee concerning the Toray Group's future performance.

**'TORAY'**  
**Innovation by Chemistry**