

# LIFECYCLE ASSESSMENT of AIRCRAFT, AUTOMOBIL & WINDMILL

The Japan Carbon Fiber Manufacturer Association's Assessment Model



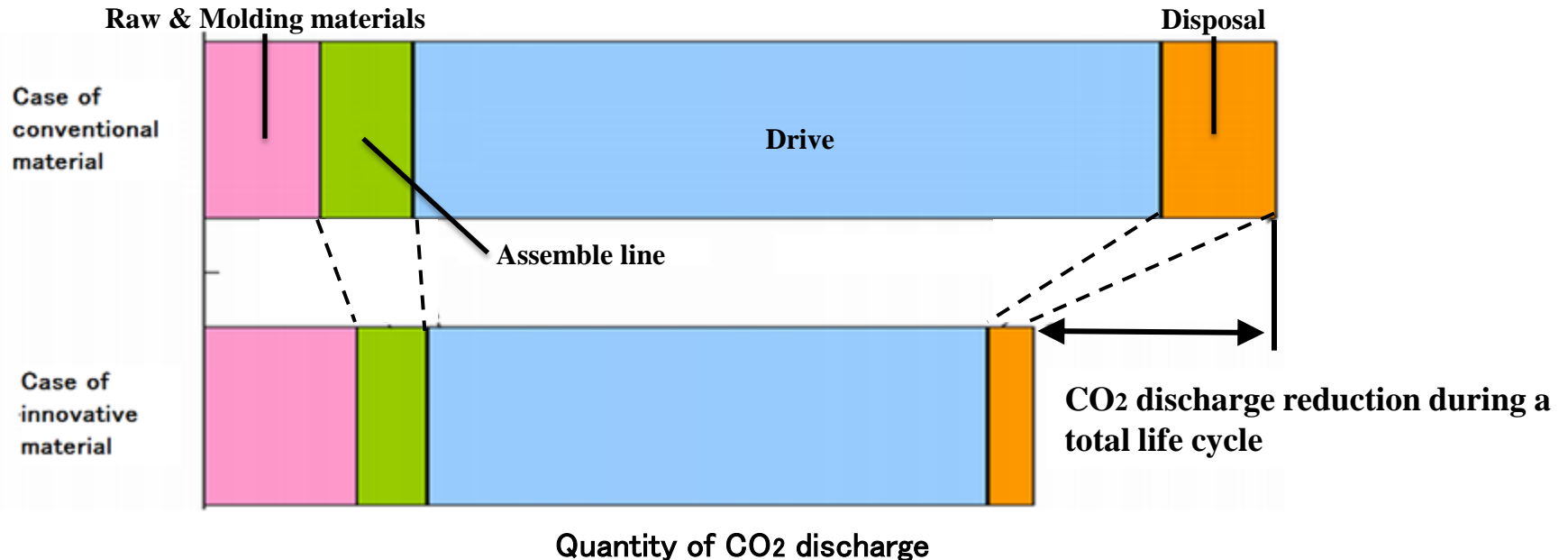
The Japan Carbon Fiber Manufacturer Association  
(JCMA)

**Lifecycle assessment (LCA)**  
**Carbon fiber reinforced plastics (CFRP)**

# Why societies inevitably need to make LCA?



Reduction of CO<sub>2</sub> discharge by replacing conventional material by innovative material



**Don't forget to evaluate burden to environment of CO<sub>2</sub> discharge during the total life cycle of machinery**

Even if CO<sub>2</sub> discharge during manufacturing/molding stages of a innovative material exceeds that of the conventional material, LCA of an innovative material possibly has big advantage in terms of the overall CO<sub>2</sub> discharge burden to environment.

# Illustration of quantitative LCA of contribution of carbon fiber for CO<sub>2</sub> discharge reduction

“Made in accordance with JCMA assessment model”



**Conventional aircrafts** made of metallic material

Reduction of overall weight of an Aircraft

**Innovated aircrafts** newly adopted carbon fiber

## <Adopted assumptions>

- Domestic-flight type medium-sized passenger aircraft (Boeing 767)
- Domestic flight between Tokyo-Haneda airport ↔ Sapporo-Chitose Airport (both ways 5,000 miles)
- 2,000 flights a year X 10 years (based on ANA data)

**Adopting CFRP in 50% of body-wings material resulting 20% saving of the total body weight in comparison with that of conventional-type aircraft**

## < Life cycle CO<sub>2</sub> discharge per 1 aircraft >

< Per 1 aircraft in LCA >

### CO<sub>2</sub> discharge curtailment

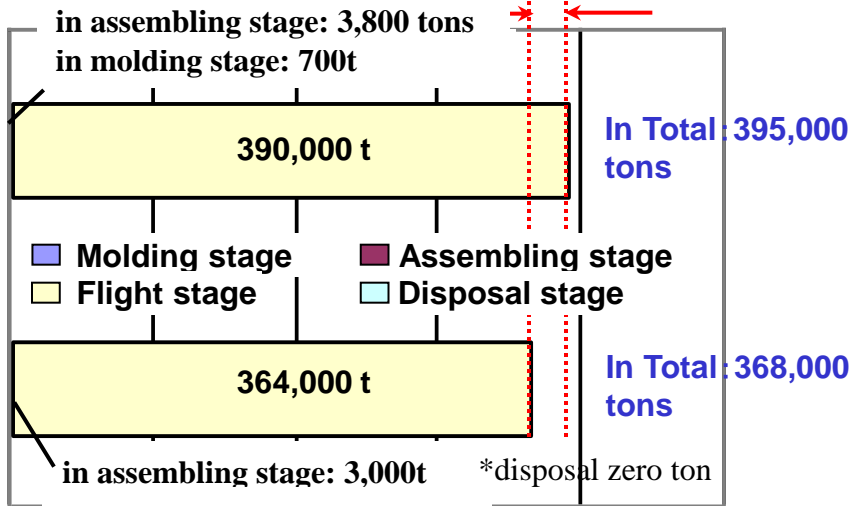
27,000 tons (7%)

**Conventional aircrafts**

made of metallic material

**Innovated aircrafts**

newly adopted carbon fiber



CO<sub>2</sub> [ tons /1 aircraft/ 10years ]

## < due to 1 ton of carbon fiber >

CO<sub>2</sub> emission in carbon fiber manufacturing

CO<sub>2</sub> emission curtailment in LCA

(inclusive of CO<sub>2</sub> emission curtailment in aircraft assembling stage)



20 tons

▲1,400 tons

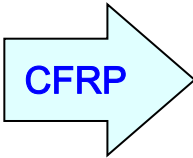
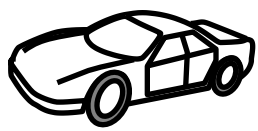
reduction

Approximately 20 tons of carbon fiber consumed per 1 aircraft

**Overall total CO<sub>2</sub> discharge curtailment 27,000 tons/aircraft/10 years**

# Illustration of quantitative LCA of contribution of carbon fiber for CO<sub>2</sub> discharge reduction

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**Conventional automobiles**  
made of metallic material

Reduction of overall weight of an Automobile

**Innovated automobiles** newly adopted carbon fiber

< CO<sub>2</sub> emission quantity in LCA >

<Adopted assumptions>

- Automobile weight: 1,380Kg\*1 (gasoline driven, 4 doors, FF)
- Actual fuel consumption on public road: 9.8Km/liter\*1
- The total running millage till being scraped down 94 thousand Km\*2 (average years of life: 10 years)
- Estimated life cycle: 10 years (Date sources: \*1 Automobile Industry Association, \*2 The Ministry of Land, Infrastructure and Transport (MLIT) )

**Innovated automobile newly introducing carbon fiber (CFRP) :**  
Adopting CFRP in 17% of body parts, in total attaining 30% curtailment of car weight

< For 1 automobile >

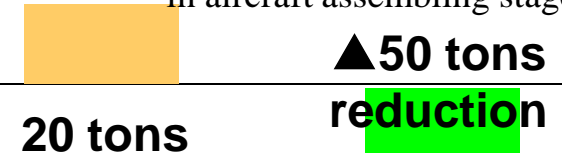
CO<sub>2</sub> emission curtailment:  
5 tons (16%)

< due to 1 ton of carbon fiber >

CO<sub>2</sub> emission in carbon fiber manufacturing

CO<sub>2</sub> emission curtailment in LCA

(inclusive of CO<sub>2</sub> emission curtailment in aircraft assembling stage)



Approximately 20 tons of carbon fiber consumed per 1 automobile

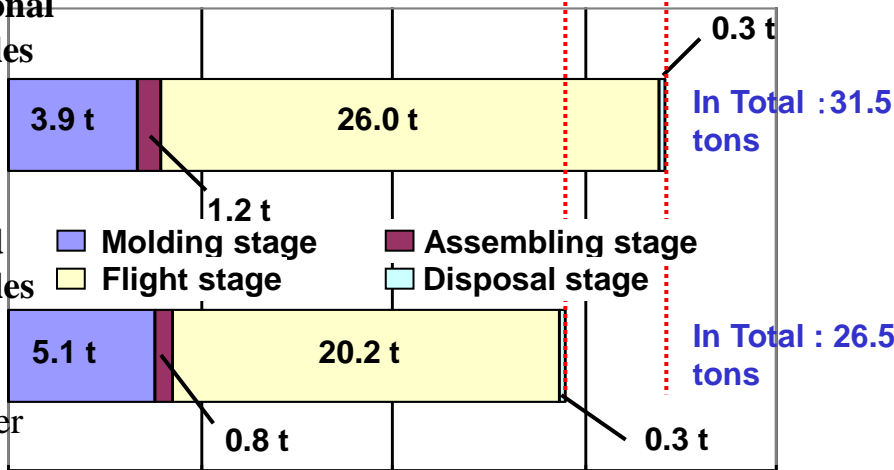


**Conventional automobiles**

made of metallic material

**Innovated automobiles**

newly adopted carbon fiber



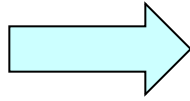
CO<sub>2</sub> [ tons /1 automobiles / 10years]

**Overall total CO<sub>2</sub> discharge curtailment 5 tons/automobiles/10 years**

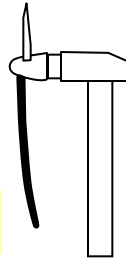
# Illustration of quantitative LCA of contribution of carbon fiber for CO<sub>2</sub> discharge reduction

“Made in accordance with JCMA assessment model”

Fossil fuel  
burning power  
generation



**Enlargement of size  
of blade of fan \***



Wind power generation  
(Large-scale fan-driven power generator)

<Total sum of CO<sub>2</sub> emission during whole Life cycle >

Wind power generator  
adopting large-scale  
CFRP fan

< Per 1kWh >

**5 g / kWh**

Date source: VESTAS company report (June, 2006)

Mixture of power  
sources

**423 g / kWh**

Date source: Electric Power Companies Association  
(Average of actual data in years 2008 to 2011, before credit)

**CO<sub>2</sub> emission curtailment 418 g / kWh**

**CO<sub>2</sub> emission curtailment by one unit of 3MW  
Wind power generator: 720,000 tons/20 years**

\*

\*Theoretical power generation of a Wind power generator raise proportional to 2nd power of length of blade

<Adopted assumptions>

- Wind power generator adopting large-scale CFRP fan
- Rated power output: 3MW (average actual power outlet: 1MW)
- Necessary quantity of carbon fiber: 3 tons/unit
- Assumed service life: 20 years

**Construction fabric**

- High stiffness carbon fiber reinforced resin compound for beam parts
- Glass fiber reinforced resin compound for all other parts

**Power output: mixed into other power sources**