Based on Presentation at the JLCA Forum
March 23、 2005

LCA on Automobiles as a tool of Transportation

Current Status of LCA on Automobiles

Junichi KASAI
NIMS, National Institute for Materials Science
ex-head of the LCA Subcommittee, Japan Automobiles Manufacturers Association

Self Introduction: Who is Junichi KASAI

Jan., 1959 Born in Yokohama

Mar., 1981 Graduated from Energy Conversion Engineering Course of the University of Tsukuba

Apr., 1981 Entered Isuzu Motors Limited

Aug., 1988-Spt., 1989 Lived in Flint, MI, USA and Joined General Motors Overseas Fellowship Program,

Jun., 1989 Certified Graduation from GMI Engineering & Management Institute

Apr., 2005 Quit Isuzu and Entered NIMS

Materials Engineering, LCA, DfE, Management

What we will study and discuss at this Lecture

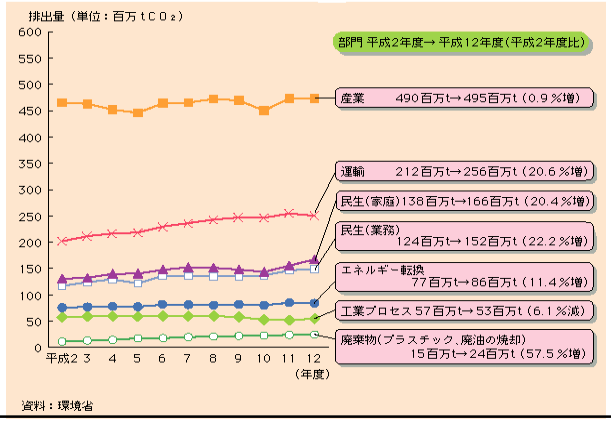
1. Introductory Presentation by KASAI
2. Group discussion on "Environmentally Friendly Transportation System" and make proposals to the prime minister, Mr. Junichirou Koizumi: Measures to be implemented by the Japanese Government in order to improve the Environment due to Transportation System Operation
3. Presenting the Measures by each group, and discussion by all participants

Contents

LCA on Automobiles as a tool of Transportation

Transportation and Environment : CO2 Gas Emissions thru 1990 to 2000

Growth in Industry Sector=0.9%、Transportation=more than 20%



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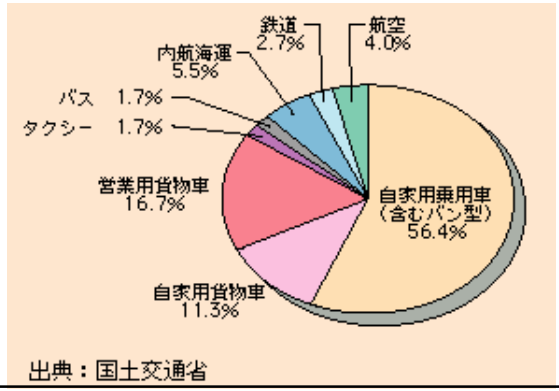
Transportation and Environment : CO2 Gas Emissions among Transportation Sector

Private Use of Passenger Cars=56.4%、Private Use of Trucks=11.3%

Business Use of Trucks=16.7%, Taxi=1.7%, Bus=1.7%, Sea=5.5%, Rail way=2.7%, Air=4%



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Transportation and Environment : Energy Consumption and Amount of people transported

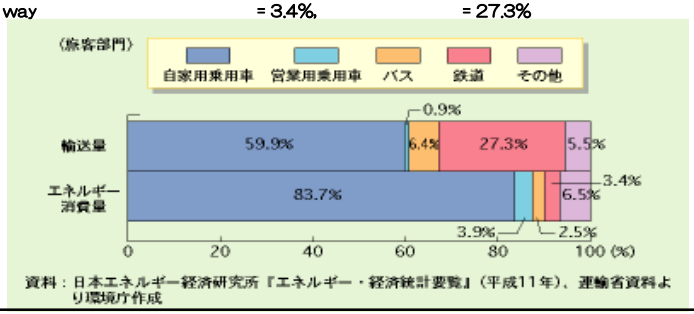
Private Use of PC, Passenger Cars = 83.7%, = 59.9%

Annual growth rate is 8.3%

Business Use of PC = 3.9%, = 0.9%

Bus = 2.5%, = 6.4%,

Rail way = 3.4%, = 27.3%



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Transportation and Environment :

- CO2 Gas Emissions
- Energy Consumption
- Resource Depletion
- Waste to be Land-Filed
- Exhaust Gas Emissions, NOx, SOx, PM
- Ozone Layer
- Global Warming Gases (other than CO2)
- Release to Water
- VOC Emissions
- Chemical Compounds
- Heavy Metals
- Sick-House
- Others

We need Evaluation Tools to identify problems and to seek ways for improvements.

LCA can be a useful tool.

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LCA, Life Cycle Assessment, studies on Automobiles

★What is LCA, Life Cycle Assessment? = Not covered here

■ LCA evaluates not a product, but a product system.

$[CO_2]$ = FC * VMT * $<CO_2>$

–FC : Efficiency of Fuel Consumption (liters/100km)

–VMT : Vehicle Mileages Transported(km),

–$<CO_2>$: Emission per unit fuel(kg- CO_2 /litter)

Performance of a Product

Users choices

Transportation conditions

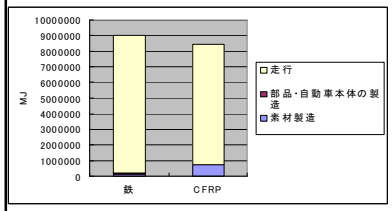
CO2 emitted from production of a product, fuel, transportation, end of life product treatment, maintenance, and so on.

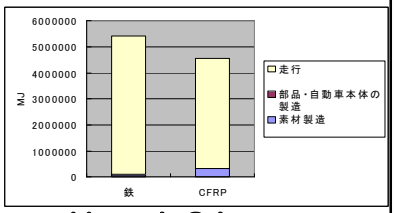
LCA on Automobiles as a tool of Transportation

（1） Case studies of LCA on Automobiles and Transportation System
Energy Consumption of Light-Weight Bus and Current Bus

	Current 鉄製大型バス	CFRP Body CFRP製大型バス
Materials Production 素材製造(MJ)	112058	764134
Parts+Vehicle Production 部品・自動車本体の製造(MJ)	67914	0
Use 走行(MJ)	8816715	7656468
Total 合計(MJ)	8996687	8420602

	Current 鉄製小型バス	CFRP Body CFRP製小型バス
素材製造(MJ)	71533	323662
部品・自動車本体の製造(MJ)	43353	0
走行(MJ)	5295125	4241175
合計(MJ)	5410011	4564837





Positive and Negative Effects due to Materials Selection can be quantified and Future Action Plans can be derived.

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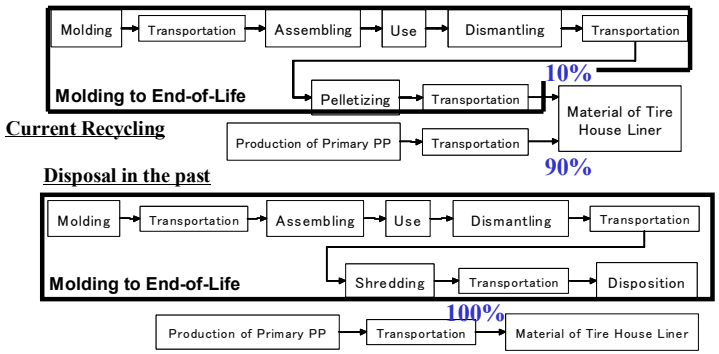
（2） Case studies of LCA on Automobiles and Transportation System
Recycling or Disposal?



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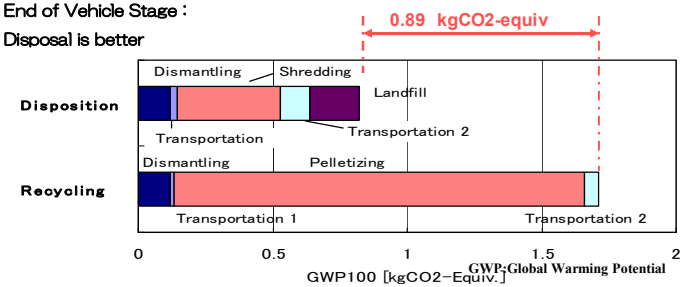
（2） Case studies of LCA on Automobiles and Transportation System
Recycling or Disposal?

End of Vehicle Stage :
Disposal is better



GWP100 of Recycled bumper is larger than that of Disposed in Disposition or Recycling.

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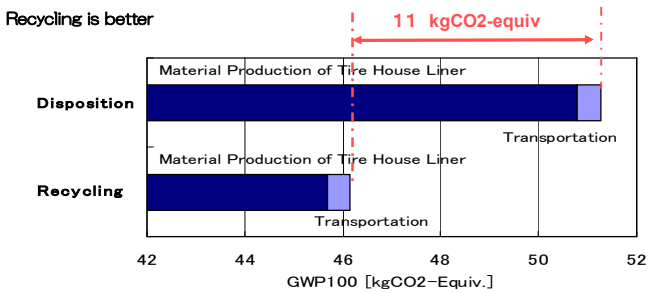
(2) Case studies of LCA on Automobiles and Transportation System
Recycling or Disposal?

Production Stage :
Recycling is better



GWP100 of Recycled bumper is smaller than that of Disposed in Material Production of THL.

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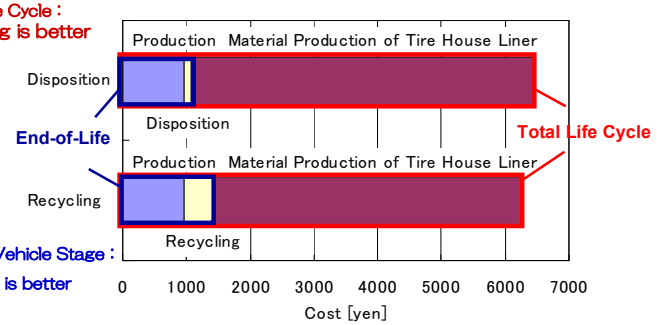
(2) Case studies of LCA on Automobiles and Transportation System
Recycling or Disposal?

Total Life Cycle :
Recycling is better

End of Vehicle Stage :
Disposal is better



Positive and Negative Effects due to Activity Selection can be quantified and Future Action Plans can be derived.

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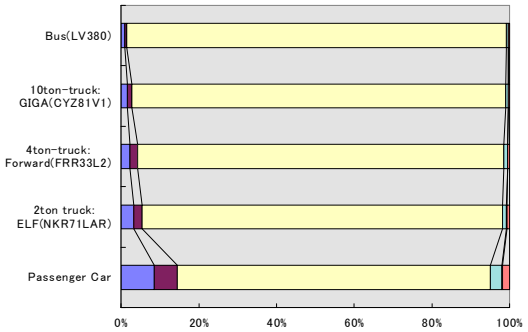
(3) Case studies of LCA on Automobiles and Transportation System
Types of Vehicles



Fuel Economy and Exhaust Gas Emissions from Bus and Truck are more important.

Life Cycle Stages

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(4) Case studies of Complete LCA on Automobiles
LCA results of an Average Passenger Car (Eco-Indicator '99)

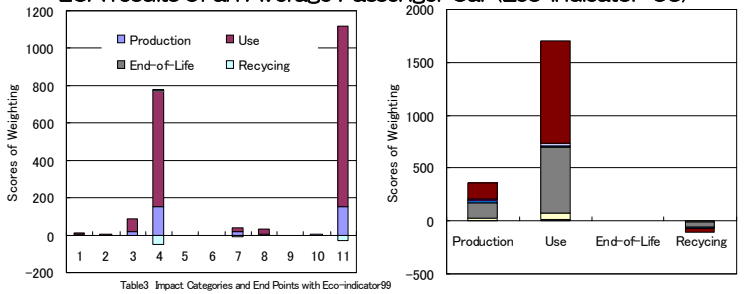

Table3 Impact Categories and End Points with Eco-indicator99

End Points	Impact Categories(影響領域)
Human Health (DALY)	1. Carcinogenesis(発ガン性) 2. Respiratory Organic Substance(呼吸器疾患:有機) 3. Respiratory Inorganic Substance(呼吸器疾患:無機) 4. Climate Change(気候変動) 5. Radiation(放射能) 6. Ozone Layer Depletion(オゾン層破壊)
Ecosystem Quality (生態系の健全)	7. Ecotoxicity(生態系毒性) 8. Acidification / Eutrophication(酸性化・富栄養化) 9. Land-use(土地利用)
Resources (資源)	10. Minerals(鉱物)

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(4) Let's Take a look at Performance of Vehicles

Fuel Consumption: Be(g/m),

Efficiency of Engine

$$Be = \frac{be}{\eta \cdot L} \cdot \frac{1}{c} \cdot (P + Pa)$$

Efficiency of Power Transmission

be : Fuel Consumed by Engine per unit power output(g/kW・h)、

$1/\eta$: Loss in Power Pant(—)、 L : Length Driven(m)、 c : constant

P : Power Output of Power Plant、

Pa : Power Output of Accessories

Weight Reduction and Efficiency Improvement of Engine, Friction Loss Reduction can improve be. Weight Reduction of Power Transmission, Improvement of Lubricants, and Rolling Loss Reduction of Tires improve η. Minor but improvement of Pa can contribute total Efficiency.

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(5) Let's Take a look at Whole Transportation System

Fuel Consumption: Be(g/m),

Eco-Drive, Green Purchasing, Improvement of Traffic Jam Conditions, etc

$$Be = \frac{be}{\eta \cdot L} \cdot \frac{1}{c} \cdot (P + Pa)$$

Eco-Drive, Green Purchasing,

Use of Public Transportation, Applying IT, etc.

be : Fuel Consumed by Engine per unit power output(g/kW・h)、

$1/\eta$: Loss in Power Pant(—)、 L : Length Driven(m)、 c : constant

P : Power Output of Power Plant、

Pa : Power Output of Accessories

Weight Reduction and Efficiency Improvement of Engine, Friction Loss Reduction can improve be. Weight Reduction of Power Transmission, Improvement of Lubricants, and Rolling Loss Reduction of Tires improve η. Minor but improvement of Pa can contribute total Efficiency.

But these are only product improvements, and we must consider other aspects.

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(6) Let's Take a look at P and Performance of Vehicles

$$P = m \cdot g \cdot f \cdot L + \frac{\rho}{2} \cdot Cw \cdot A \cdot v^2 \cdot L + m(\alpha + g\sin\alpha) + B$$

Vehicle weight m affects the first, third, and forth elements, excluding the second element.

Wight Reduction of a vehicle can improve fuel Consumption.

Cw and A reduce Resistance from the air and improve fuel consumption, especially when driven at high-speed, e.g. High Way Drive.

Weight Reduction, Improvement of Cw, etc.

LCA on Automobiles as a tool of Transportation

(7) Let's Take a look at Whole Transportation System

$$P = m \cdot g \cdot f \cdot L + \frac{\rho}{2} \cdot Cw \cdot A \cdot v^2 \cdot L + m(\alpha + g\sin\alpha) + B$$

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Eco-Drive, Green Purchasing, Improvement of Traffic Jam, Applying IT, etc.

LCA on Automobiles as a tool of Transportation

(8) Summary: Let's Take a look at Whole Transportation System

[CO2] = FC * VMT * <CO2>

FC ：Efficiency of Fuel Consumption (liters/100km)

VMT ：Vehicle Mileages Transported(km),

<CO2> ：Emission per unit fuel(kg- CO2 /litter)

Vehicle=Product・・・Manufacturers and Government

Transportation System・・・Government, Users, Manufacturers

Behavior of Consumers・・・Users, Government, Manufacturers

(Infrastructure of Transportation, Public Transportation Improvement, Eco-Drive, IT Application, etc.

What we will study and discuss at this Lecture

1. Introductory Presentation by KASAI
2. Group discussion on "Environmentally Friendly Transportation System" and make proposals to the prime minister, Mr. Junichirou Koizumi: Measures to be implemented by the Japanese Government in order to improve the Environment due to Transportation System Operation
3. Presenting the Measures by each group, and discussion by all participants

"Environmentally Friendly Transportation System"

1. List up All Ideas first,

2. then Ideas should be categorized into the three:
Vehicle=Product・・・Manufacturers and Government
Transportation System・・・Government, Users, Manufacturers
Behavior of Consumers・・・Users, Government, Manufacturers

3. Discuss which Idea(s) should be taken and Counter Measures to be set
- Choose Idea(s), Note your reasons why you choose it(them),
- and discuss Counter Measures

4. make proposals to the prime minister, Mr. Junichirou Koizumi: Measures to be implemented by the Japanese Government

5. Reasons and Estimated Effects of your Measures

In each group, please discuss according to the list above, and make presentation

Setting Priority based on agreement is one of the most important tasks.

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