Reduction of Environmental Load in Logistics Field

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Amidst the rampant fluctuations of crude oil prices the effective use of energy resources, which are economically risky and limited in quantity, is considered a high priority in Japan, where a large proportion of the energy supplied is dependent on foreign suppliers. Significant increases have occurred in the consumption of energy since the First Oil Crisis in the 1970s, particularly in the transportation sector, which similarly affected the consumer sector. Fuel economy improvements for automobiles were the only provisions previously implemented according to the Energy Conservation Law. The "Amended Energy Conservation Law", enforced since April 2006, means cargo owners are also subject to obligations pertaining to transportation activities.

The main method of transportation for OKI's business activities has been delivery by truck (two to four tons*) that comprise 40 % of OKI's overall transport requirements and transport by larger trucks (10 tons*), which comprised 50 %, with 4 % transported by railroad. The carbon dioxide emissions for FY2007 were about 3,900 tons (**Table 1**) (Note: Tonnage with an asterisk represents laden weight on trucks).

Table 1 Record of carbon dioxide emissions in logistics field

Classification		Transport volume (tons)		CO_2 emissions (tons of CO_2)	
	Maximum load capacity (kg)	FY06	FY07	FY06	FY07
Diesel fuel	1,000 to 3,999	23,625	24,348	1,687	1,855
	10,000 to 11,999	25,452	33,991	626	861
	Subtotal	49,077	58,338	2,313	2,716
	Others (undisclosed types of vehicles)	–	8,074	1,416	1,102
	Total for trucks	49,077	66,413	3,728	3,818
Railroad		1,680	2,513	56	84
Grand total		50,757	68,926	3,784	3,901

Promotion of modal shift

A modal shift brings about a reduction in the consumption of energy relating to the transport of cargo, through a shifting in the mode of transportation from trucking to railroad and ship transportation. The energy consumed by railroads is about one-third that of ten-ton trucks, as shown in **Table 2**. It is therefore a highly energy efficient mode of transportation.

Table 2 Energy consumption per volume of transportation (transport ton-kilometer) for individual modes of transport[1]

Classification	Energy consumption (MJ/ton-kilometers) required for transporting cargo of one ton over a distance of one kilometer
Ten-ton diesel truck (for 100 % load factor)	1.39
Railroad	0.491
Domestic ship transport	0.555
Aviation transport	22.2

MJ: Mega joule

In order to gain a proper understanding of the effects of a modal shift, it is important to not merely select modes of transportation but to consider the entire process of transportation starting from where the shipment is dispatched to where it is received, since route changes can occur and deliveries may be needed at either end of the journey. More specifically it is essential for comparative considerations to be made by including truck transport required at either end, as well as load transfers (cargo handling) at ports and airports, as shown in **Fig. 1**.

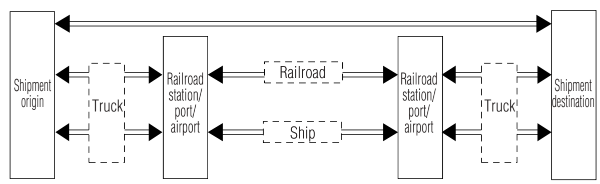

Fig. 1 Outline of logistical flow for individual modes of transport

Furthermore, railroad and ship transportation have additional limitations in comparison with truck transport, such as; (1) "Further transportation is required at either end so a dependency is placed on the dispatching and receiving locations"; (2) "Limitations are imposed due to train schedules or port clearance times"; and (3) "Subject to the impact of arranging for alternative transportation when an accident occurs or due to climatic and sea conditions", as shown in **Table 3**. It is for these reasons that the feasibility of applying a modal shift must be considered with a proper understanding of the conditions of transport (delivery schedules and lot sizes) as well as the economical practicality.

Table 3 Comparison of characteristics for feasibility considerations on application of modalshift[2]

Comparison items	Truck	Railroad & shipping
Cost	Time and distance based costs are set for each individual vehicle size category.	Cost competitiveness tends to improve for longer transportation distances.
Lot	Various lot sizes can be selected, depending on the size of a chosen vehicle. Transportation of smaller cargo lots can be accommodated through mixed loading.	The transportation of smaller cargo lots cannot be easily provided because mixed loading practices are not available for the transportation modes selected by the cargo carriers (minimum size of five or more tons is usually required for railroad and ship transportation).
Site location	No restrictions on origin or destination site, with services available door to door.	An infrastructure, such as railroad station, port or airport, is necessary in the vicinity (without such an infrastructure, trucking distances become longer, increasing the cost and producing more carbon dioxide emissions).
Time	Transporting time for each transport route is easily set according to an average travel distance (using expressways, for example).	Connections for coupling rolling stock increase the amount of time required. Times for arrival and departure are scheduled and cargo may not be loaded or unloaded on Sundays, holidays or during the night at ports where restrictions are placed on loading and unloading times.
Impact on environment	Large energy consumption per transport unit	Small energy consumption per transport unit Amount of carbon dioxide emissions is one-seventh that of truck transportation
Risks	Potential risk of being involved in traffic accidents is higher than railroad or ship transport, but arranging alternative transportation is easier.	Potential risk of being involved in traffic accidents is lower than truck transport, but if an accident does occur the impact is quite extensive. Measures must be taken and alternative transport arranged in order to respond to delays due to disasters and severe weather. Loading and unloading at ports can potentially not be carried out due to labor strikes, etc.

(1) Status of modal shift activities implemented at OKI

The current status of implementation for modal shift activities at OKI is shown in **Table 4**. These activities cover locations where OKI branches are located, with the standard range being 500 km from the shipment origin at Isesaki in Gunma Prefecture.

Table 4 Modal shift network at OKI

Location	Truck transport			JR container transport		
	Origin	Destination	Distance (km)	Start	End	Distance (km)
Hokkaido (Sapporo)	Isesaki	Sapporo	1,081	Kuragano	Sapporo	1,175
Tohoku (Sendai)	Isesaki	Sendai	378	Kumagaya	Sendai	404
Chubu (Nagoya)	Isesaki	Nagoya	500	Kuragano	Nagoya	549
Kansai (Osaka)	Isesaki	Osaka	520	Kuragano	Osaka	549
Chugoku (Hiroshima)	Isesaki	Hiroshima	915	Kuragano	Hiroshima	887
Shikoku (Takamatsu)	Isesaki	Takamatsu	719	Kuragano	Takamatsu	745
Kyushu (Fukuoka)	Isesaki	Fukuoka	1,199	Kuragano	Fukuoka	1,225

The main impetus behind the modal shift at OKI is the containers used, which are five-ton containers available from Japan Railways (JR). A breakdown of the performance in terms of transport per ton-kilometers is shown in **Table 5**. Furthermore, a modal shift was also promoted centering Hokkaido (Sapporo), Chugoku (Hiroshima), Shikoku (Takamatsu) and Kyushu (Fukuoka) primarily with long distance scheduled transportation services. In FY2007 this resulted in a transport per ton-kilometer performance 1.5 times that of the previous year.

Table 5 Annual transport per ton-kilometer performance by railroad transport at OKI

Location		Item	JR five-ton container transport		FY06	FY07
			Start	End	Ton-kilometers	
Hokkaido	Sapporo	Information & communication equipment	Kuragano	Sapporo	728,190	669,465
Tohoku	Sendai	Information & communication equipment	Kumagaya	Sendai	2,019	4,037
Chubu	Nagoya	Information & communication equipment	Kuragano	Nagoya	0	3,547
Kansai	Osaka	Information & communication equipment	Kuragano	Osaka	13,730	10,984
Chugoku	Hiroshima	Information & communication equipment	Kuragano	Hiroshima	492,230	993,328
Shikoku	Takamatsu	Information & communication equipment	Kuragano	Takamatsu	227,073	245,685
Kyushu	Fukuoka	Information & communication equipment	Kuragano	Fukuoka	1,090,072	1,873,944
Total					2,553,314	3,800,990

(2) Modal shifting rate at OKI

The modal shifting rate is the proportion of transport volume transported by railroad or ship transport from the total volume of transport for distances of 500 km or more.

The performance record for the modal shifting rate at OKI hovers around 50 %, as shown in **Table 6**.

Furthermore, the cause of deterioration in the modal shifting rate from FY2006 to FY2007 was due to the delivery schedule demanded by our customers, resulting in a major shift from railroad transport that requires a longer lead time to scheduled long distance trucking.

Our next target is to shift primarily our scheduled long distance trucking using ten-ton trucks, which comprise the majority of our shipments and for which a lot of effects can be expected from a reduction in the load on the environment, to further reduce carbon dioxide emissions and create positive economical effects.

Table 6 Modal shift for FY2006 to FY2007 at OKI

Vehicle type	Transport per ton-kilometers	
	FY2006	FY2007
Ten-ton trucks	1,799,476	4,101,290
Four-ton trucks	78,139	221,356
JR five-ton containers	2,551,294	3,793,400
Total for scheduled long distance trucking	4,428,909	8,116,060
Modal shifting rate	58 %	47 %

(3) Activities intended for acquiring Eco-rail mark certification

The Eco Rail Mark accreditation symbol is an initiative for businesses and products intended to promote activities for reducing the load on the environment through the use of railroad cargo transportation. The scheme is sponsored by the Ministry of Land, Infrastructure, Transport and Tourism and participated in by consumers and businesses alike. It is hoped that by displaying this mark on products, catalogs and media with a high exposure to consumers, a better understanding on the part of consumers would be gained, which would contribute towards the prevention of global warming and the differentiation of products.

Only 47 businesses have been accredited with this mark as of December 2008. This number, however, is expected to increase in the future. Corporate segments in charge of logistics at the OKI Group are currently conducting activities to acquire the Eco Rail Mark certification by FY2009.

Use of bio-diesel fuel (BDF)

Two major types of bio-fuel categories are available, bio-ethanol and bio-diesel. Activities by OKI deal with the use of “waste food oils”, which belongs to the bio-diesel category, as shown in **Fig. 2**.

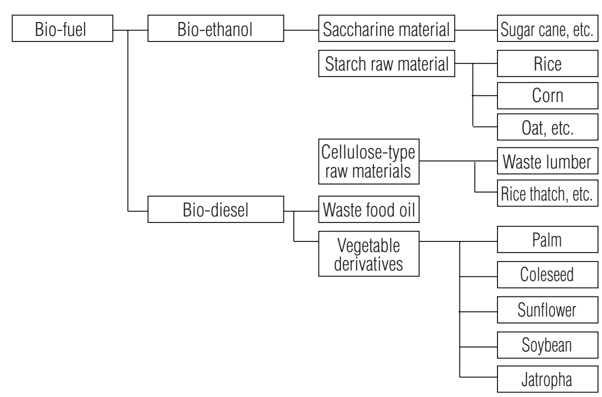

Fig. 2   Bio-fuel classifications

OKI has been reusing deep frying oil, used at employee cafeterias at Hachioji City in Tokyo and Warabi City in Saitama Prefecture, as truck fuel since FY2008, by refining the used oil into bio-diesel fuel. This endeavor has been due to; (1) Rising diesel fuel prices; (2) Activities implemented to reduce carbon dioxide emissions; and (3) Activities implemented to reduce industrial waste materials. Bio-diesel fuel is considered a biomass energy that is created using vegetable derivative waste food oils as raw materials, which in the past was processed and disposed of as waste material. A number of the resulting benefits are shown in **Table 7**.

(1) Refining of bio-diesel fuel

Approximately 90 % of the vegetable derived waste food oil can be refined as bio-diesel fuel, whereas roughly 10 % of the remaining amount is a byproduct that can be refined to create glycerine, which is a reusable product. The result is the realization of a recycling process wherein no waste material is produced (**Photo 1**).

(2) Carbon dioxide emission reduction effects from use of bio-diesel fuel

The use of bio-diesel fuel instead of diesel fuel effects a reduction in carbon dioxide emissions.

Table 7 Principal environmental benefits of bio-diesel fuel

◎ Carbon dioxide emissions significantly reduced Vegetable oils used as raw materials to produce bio-diesel fuels are substances with nutrients obtained from the absorption of carbon dioxide and the process of photosynthesis during the growth of plants, such as coleseed or soybeans. A review of the life cycle of such plants indicates that a large amount of carbon dioxide is reduced.
◎ Black smoke emissions reduced to one-third or less The flash point is higher than diesel fuel and complete combustion occurs as oxygen is included in the combustion process, which in turn results in one-third the black smoke emissions of diesel.
◎ Sulfur oxides significantly reduced Sulfur oxides (SOx), which are responsible for atopy and acid rain, are almost nonexistent in the gas exhaust.
◎ Usable without vehicle modifications Motor vehicle conversion is not necessary in order to change the fuel from diesel to bio-diesel.
◎ Diesel delivery tax is not applicable Since bio-diesel fuel is not hydrocarbon oil it is not subject to diesel delivery tax, provided the purity is 100 %.
◎ Effective use of glycerine Glycerine, which is acquired as a byproduct during the refining of bio-diesel fuel, can be used effectively in detergents, fertilizers, etc.

Photo 1 Bio-diesel fuel refining process

This is because vegetable oils, used as a raw material to produce bio-diesel fuels, are substances with nutrients obtained from the absorption of carbon dioxide and the process of photosynthesis during the growth of plants, such as coleseed or soybeans.

Furthermore, trucks utilizing bio-diesel fuels are used for the collection of waste food oil and since the amount of electric power consumed by the refining process is about the same as the amount consumed by household washing machines, a significant amount of carbon dioxide is being reduced, which is indicated by a review of the life cycle for such oils.

(3) Future developments and other effects

We are hoping to collect all vegetable derived waste oil from all OKI employee cafeterias in the Kanto area. Furthermore, since glycerine, a byproduct produced during the bio-diesel fuel refinery process, is a useful detergent for removing oil stains, we have replaced our previous reliance on chemical detergents with glycerine at our employee cafeteria at Hachioji and therefore we are making a corporate contribution in the reduction of the environmental burden from yet another angle.

Development of Eco-drive

OKI started offering an Eco-drive seminar to drivers of our principal transportation partners in FY2007 at the Tokai Training Center of OKI Customer Adtech, which involves the use of actual vehicles.

The purpose of this seminar is for truck drivers to “learn about the theoretical concept of eco-drive and for them to acquire know-how through the driving experience”, with the expectation of realizing the effects shown in **Table 8**.

Table 8 Effects expected from Eco-drive

1. Economization of fuel costs!	• Increased revenue for companies. The revenue of the drivers themselves also increases. • Fuel costs are the second largest expense of all expenditures, second to personnel expenses. Economization is possible through self-help efforts.
2. Contribution to safe driving!	• Fuel conserving driving is also driving without "sudden starts, sudden acceleration or sudden stops", which leads to safe driving while inhibiting traffic accidents.
3. Consideration for global environment!	• Reduction of carbon dioxide emissions, which are a cause for global warming. • Important undertaking for observing amended Energy Conservation Law.
4. Consideration for vehicles!	• Fuel conserving driving does not involve "sudden starts, sudden acceleration or sudden stops", which means there is less maintenance expenses relating to vehicle malfunctions.

(1) Recommendation on ten articles of Eco-drive

It is essential for the ten articles shown in **Fig. 3** to be kept in the mind of drivers as much as possible while they drive, in order to inhibit the emission of carbon dioxide, which is exhaust from vehicles. These are critically important for the safety aspects of driving and they impact businesses significantly both economically and qualitatively.

Considerate of wallets Improves fuel economy!	Considerate of the earth Reduces carbon dioxide emissions
Article 1 Accelerator “e-Start”	Article 2 Driving with less acceleration and deceleration
Article 3 Earlier release of accelerator pedal	Article 4 Reduce use of air conditioner
Article 5 Stop idling	Article 6 Proper warm-ups
Article 7 Use of road traffic information	Article 8 Check tire air pressure
Article 9 No loading of unnecessary luggage	Article 10 Pay attention to where vehicle is parked

Fig. 3 Ten articles of eco-drive

Such a seminar on Eco-drive should be provided by our transportation partners (transport service providers) to their own drivers, but these businesses often lack organization to offer such seminars. As cargo owners we are therefore providing and supporting employee training and seminars to our transportation partners.

In order to provide effective driver training and seminars, however, it is essential for us to have specialized knowledge of the truck manufacturers available.

In collaboration with major truck manufacturers OKI is providing Eco-drive seminars based on the training program outlined by the Foundation for Promoting Personal Mobility and Ecological Transportation, which is accredited by the Ministry of Land, Infrastructure, Transport and Tourism. A certificate, as shown in **Photo 2**, is bestowed upon participants of these seminars to raise their awareness of the subject.

Photo 2 Accreditation from Ministry of Land, Infrastructure, Transport and Tourism
Participation certificate issued by the Foundation for Promoting Personal Mobility and Ecological Transportation

(2) Effects of Eco-drive

Data was collected and analyzed by mounting Eco-drive support equipment, such as fuel economy gauges, on vehicles to verify the effects of Eco-drive. The results, shown in **Table 9**, attest to improvements in the fuel economy by an average of about 16 %.

Table 9 Verification results from actual driving of vehicles (eight-ton trucks)[3)]

	Fuel economy, km/l	Idling time ratio, %	Sudden start & acceleration ratio, %	Sudden deceleration ratio, %	Average speed, km/h		Excessive engine revolution ratio, %	
					Ordinary roads	Expressways	Ordinary roads	Expressways
Prior to instructions	4.4	18.1	18	0	44	91	0.6	70.8
After instructions	5.11	14.9	12	0	44	79	0	17.1
Improvement effects	+0.71	-3.2	-6.0	0	0	-12	+0.6	-53.7

Improvement of fuel economy from 4.40 km/l to 5.1 km/l (improvement by 16 %)

Conclusion

Depleted resources and global warming are worldwide issues, requiring awareness and the accumulation of even the smallest endeavor by each individual. We believe that environmental strategies involve the elimination of "waste, unevenness and overburden" and they prove to be economically viable as well. We intend to continue with our proactive activities pertaining to green logistics and to make endeavors towards the realization of "Ecology & Economy."

References

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2) "Energy Conservation Guidebook for Cargo Owners," Energy Efficiency and Conservation Division, Energy Conservation and Renewable Energy Department, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry.
3) Eco-drive Promotion Manual, Japan Trucking Association.

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