What are measures for preventing Global Warming?

Railways are considered environmentally friendly because their CO_2 emission levels per unit transportation volume is lower than that of other types of transportation. JR East Group as a whole, however, emits a great deal of CO_2, so that using energy more efficiently is a major focus for us. Our main activities to this end are as follows:

Efforts to prevent global warming

Energy supply and consumption by JR East

The JR East energy supply consists of electricity and other power sources. Our electricity comes from dedicated thermal power plants and hydraulic power plants, along with electric power purchased from power companies. We use this electricity to power electric trains, as well to illuminate and control the climates of stations and offices. Other forms of energy, such as light gas oil, are used to operate diesel vehicles and air-conditioning systems at stations and offices.

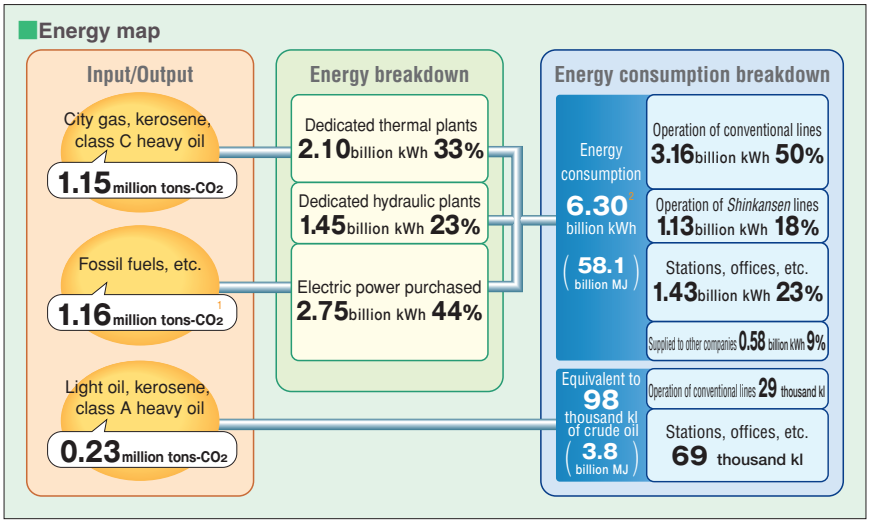
CO_2 is a known source of global warming. We have succeeded in reducing our overall CO_2 emissions by 16% since FY 1990, primarily due to increased energy efficiency.

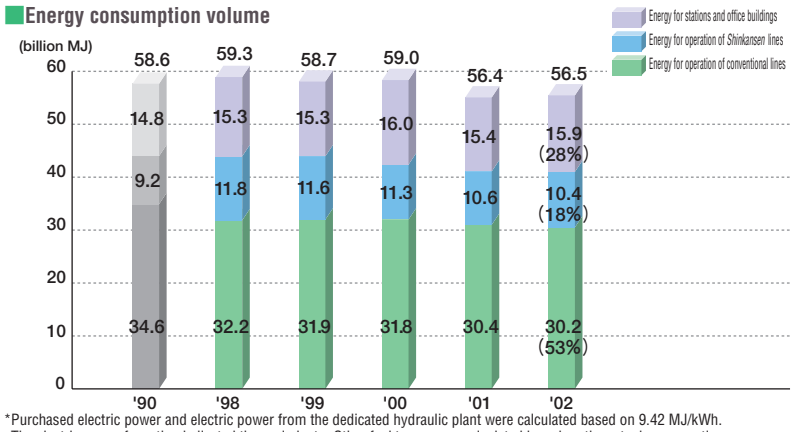
Using energy efficiently

Energy consumption reduction and rate of change

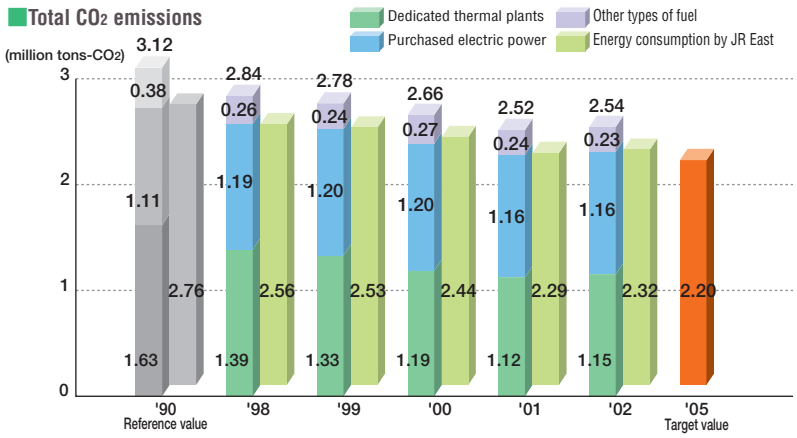
Energy consumption in FY 2002 was 56.5 billion MJ (mega joules), the equivalent of 1.46 million kl of crude oil, while CO_2 emissions stood at 2.32 million tons. Unfortunately our CO_2 emissions increased slightly from the previous fiscal year, due to increased energy consumption at stations and offices and decreased river water volume to generate power at dedicated hydraulic power plants. This was despite our great efforts toward reducing the energy consumed in train operations and to achieving maximum efficiency at dedicated hydraulic power plants.

One fundamental challenge is to reduce the amount of energy needed for train operation, which accounts for 72% of JR East's total energy consumption. To this end JR East has added energy-efficient railcars to its current rolling stock, and is pursuing research into hybrid trains and other next-generation options. (See page 32)





*Purchased electric power and electric power from the dedicated hydraulic plant were calculated based on 9.42 MJ/kWh. The electric power from the dedicated thermal plant. Other fuel types were calculated based on the actual consumption.



*Calculation of CO_2 emission factors from fuel and purchased electric power was based on the coefficient set forth in the Voluntary Action Plan established by Japan Business Federation and the Federation of Electric Power Companies Japan.

1 **1.16 million tons-CO_2**
As figures represent a historical comparison, the Federation of Electric Power Companies Japan CO_2 emission coefficient for FY 1990 is used; substitution of the FY 2001 coefficient would result in a figure of 1.02 million tons.

2 **6.30 billion kWh**
Equivalent to the annual electric power consumption of 1.74 million households.

Reducing energy consumption in train operations

As of end of FY 2002, 8,348 of our railcars were of the energy-efficient type. This is 68% of our entire fleet of 12,274 — an increase of 5 points over FY 2001. As a result, the energy required to move a single railcar one kilometer (energy consumed in proportion to unit transportation) dropped to 18.6MJ.

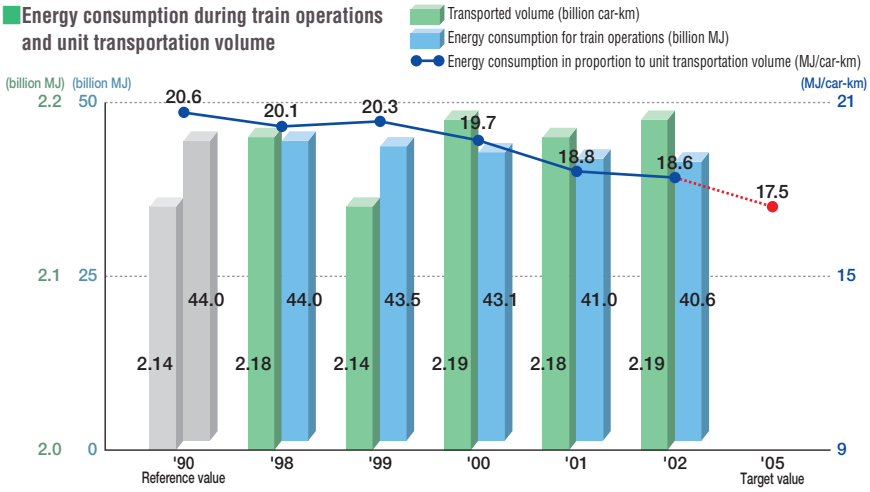
More specifically, our conventional railcar stock now includes 3,335 regenerative brake model cars [1] and 3,868 VVVF model [2] cars. Of a total of 10,632 railcars, 7,203 (68%) were the energy-efficient type — an increase of 5 points over FY 2001. The regenerative brake cars reduce operating power consumption to 66% compared to older cars, such as the rheostat control model. VVVF cars also reduce operating power consumption to as little as 47% of older units.

On our diesel railcars on conventional lines, we have introduced new types of railcars such as the *Kiha* 110 series, featuring lighter bodies and redesigned, fuel-efficient engines. In FY 2002, including railcars that were retrofitted with new engines, the energy-efficient railcars account for 82% of the total (532 railcars).

We have also been improving the efficiency of air conditioning systems. In some railway sections we have introduced an open/shut system for several of the doors, or a semi-automatic door system that allows customers to push a button to manually open and close only those doors required to embark or debark the railcar. This prevents unnecessary temperature fluctuations in the cars.

In addition, we have introduced new *Shinkansen* cars featuring lighter bodies, regenerative brakes and VVVF inverter controls. Other energy-saving improvements include more aerodynamically designed bodies that cut wind resistance while traveling at high speeds.

Energy consumption during train operations and unit transportation volume

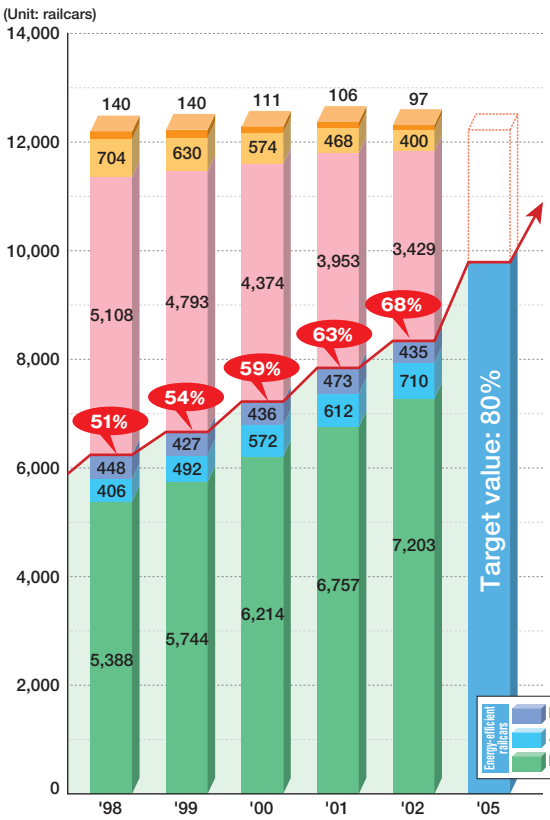


E231 series
VVVF cars introduced on the *Sobu* Line (among others), and on the *Yamanote* Line in FY 2002.

E257 series
VVVF cars Introduced on the *Kaiji* Express of the *Chuo* Line in FY 2001.

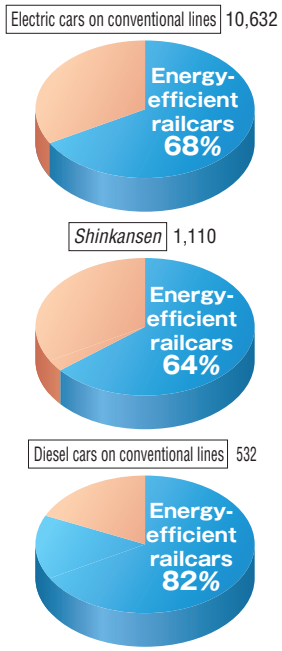
E2 series
VVVF cars introduced on the *Nagano Shinkansen Asama* trains, and on *Tohoku Shinkansen Hayate* trains.

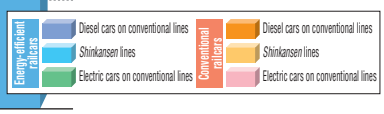
Introduction of energy-efficient railcars



Ratio of Energy-efficient railcars in FY 2002

(Unit: railcars)





1 Regenerative brake cars
Have lightweight bodies and regenerative brakes (a breaking system designed to convert heat generated by breaks into electric power with a motor that returns energy through wiring for subsequent use).

2 VVVF cars
Have lightweight bodies, regenerative brakes and VVVF inverter control.
VVVF stands for variable voltage variable frequency, an inverter that can efficiently control motor revolution without electrical resistance.

New energy-efficient railcars for the Tokyo Monorail

Tokyo Monorail Co., Ltd. joined JR East Group in FY 2001. The company provides the main access to Haneda Airport, and introduced a new type of VVVF inverter control-based "E2000 series" of energy-efficient railcars in FY 1997. Today there are 24 of the E2000 series railcars in service, comprising 20% of the total railcar fleet of 120 in an increase of 4 points over the previous year.

Tokyo Monorail with "E2000" series energy-efficient railcars

Saving energy in motor vehicle operations

JR East uses many service vehicles to maintain facilities, transport equipment and materials, and provide transportation services. We are now introducing low-emission vehicles such as hybrid cars, natural gas vehicles, and fuel-efficient automobiles with an idling-stop function. As of the end of FY 2002, 7% of our total service car fleet (3,110) were replaced with low-emission vehicles.

To foster energy-efficient bus transportation, JR Bus Kanto Co., Ltd. is now using the "*Megaliner*," a 15-meter-long double-decker bus. The bus can carry 86 passengers (double that of a conventional bus), yet emits only two-thirds the emissions, saving significant energy. In addition to current vehicles, four more *Megaliners* will be introduced in FY 2004.

In addition, JR Bus Kanto Co., Ltd. and JR Bus Tohoku Co., Ltd. introduce 35 vehicles with idling-stop function out of a total of 340 busses (excluding highway bus lines).

JR East Japan Logistics Co., Ltd. developed the idling-stop function by installing digital tachometers in its vehicles. As a result, the company successfully reduced idling rates to 1% in FY 2002, far exceeding the target of 5%.

Megaliners currently operate from Tokyo Station to the Tsukuba Research Park.

Some trucks used by JR East Japan Logistics Co., Ltd. are equipped with engines powered by natural gas. Such engines emit less NOx, particulate matter (PM) and CO_2 than diesel-engine trucks. Of the company's 229 vehicles, 17 trucks have natural gas engines.

More efficient support services through a new distribution company

In March 2003, JR East and JR East Japan Logistics Co., Ltd. established the JR East Logistics Platform Co., Ltd. This new company coordinates logistics for vendors serving JR East stations, aiming for optimal distribution efficiency within each group. The initial step, set to launch in spring 2004, will improve liquor and beverage distribution in the Tokyo metropolitan area. This should shorten delivery truck routes by approximately 20%, cutting overall fuel consumption and reducing environmental impact.

Saving energy in stations and office buildings

We are working to reduce energy consumption at JR East's stations and station buildings. One major undertaking has been to install cogeneration systems—using power generation/exhaust heat for hot-water supply and air-conditioning. This has been introduced at Sendai Station, the Machida Station Building, and General Education Center in Shirakawa City, Fukushima Prefecture. In FY 2002, we also began operating similar systems at Morioka Station and Hotel Metropolitan Edmont (Chiyoda-ku, Tokyo). In addition, we have installed 162 gas heat pump air-conditioners, mainly in the Tohoku region, to provide more efficient air-conditioning.

Reducing CO_2 emissions with integrated transportation systems

Railways advantage toward environment

It is regarded that railways have lower environmental impact than that of other modes of transportation. Still, it is difficult for railways to carry all passengers in every corner. In order to reduce total CO_2 emissions generated by the overall transportation infrastructure, we are encouraging the integration of trains with other modes of transportation such as rental cars, buses and bicycles.

Intermodal transportation

JR East is promoting intermodal transportation that integrates railways with other transportation modes. We are improving facilities and services in order to increase customer convenience. For instance, we have expanded our existing Park & Ride facilities and are offering various other services such as Rail & Rent-a-Car.

Park & Ride

JR East is promoting the Park & Ride concept, whereby customers drive to a station and park their car, and then take a train to their final destination. By March 2003, JR East had 21,000 parking spaces at 47 *Shinkansen* stations, and 38,000 parking spaces available at 464 conventional line stations. We also encourage the use of the Park & Ride system by offering incentives such as discounts to intermodal commuters holding express tickets, and other value-added services.

Offering the Rail & Rent-a-Car *System*

Under the Rail & Rent-a-Car program, certain customers who purchase JR tickets and rental car vouchers at the same time receive discounts on both the rail and car rental portions. Although rental car service has been available at stations for many years, since 1995 JR East has been offering the *Torenta-Kun* discount car rental program at roughly half the standard price. The program continues to grow in popularity and today serves almost 140,000 users per year.

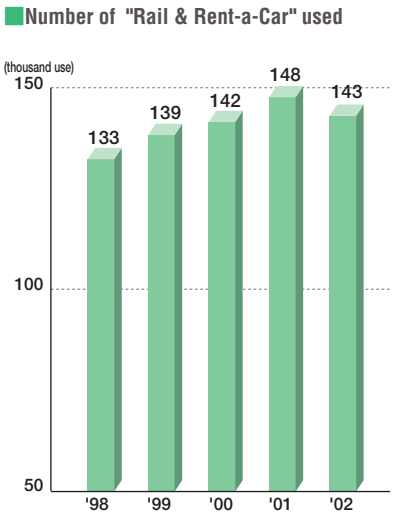
Car-rental counter at Sendai Station moved to more convenient location

Hybrid-type rental cars also available

Incorporating trains into bus and other tours

In order to avoid traffic jams, JR East offers bus tours that begin by using express lines or the *Shinkansen* to get the first 100 to 150 km outside the Tokyo metropolitan area.

In 2002 we introduced *Air Rail*, a new discount service combining airplane and train. This reduces CO_2 emissions from automobiles, which are prone to traffic jams, and ensures punctuality.



Using trains with bicycles

In 1998, JR East released the Traincle, one of the world's lightest folding bicycles. We also began waiving fees charged to passengers bringing bicycles onto trains, as long as they are folded or disassembled to fit into a dedicated bag.

Our Sendai branch office has initiated a limited offer of *Cycle Train*, a pilot program allowing passengers to bring unfolded bicycles onto trains. We are committed to developing an environment in which people can easily transport bicycles by train.

Passengers may bring bicycles onto trains for free if they fold or disassemble them to fit in a bag

Reducing automobile exhaust CO_2 emissions by eliminating traffic congestion

JR East is working to prevent morning and evening rush hour traffic jams by cooperating with local governments to replace railroad crossings with overpasses.

In FY 2002, we build continuous overpasses that eliminated railroad crossings at three sections. Given the ongoing construction of overpasses in the 13.1km stretch between Mitaka and Tachikawa, by FY 2010 we expect to eliminate 18 railroad crossings and greatly relieve rush hour traffic in this area.

Construction of overpasses between Mitaka and Tachikawa on the *Chuo* Line will be completed in FY 2009 to 2010.

Supplying energy efficiently

Utilizing networks

JR East's demand for electric power fluctuates throughout the day, reaching a peak during rush hours. To supply energy efficiently, we adjust to demand fluctuation by effectively combining dedicated thermoelectric and hydroelectric power generation, and control electricity production and the network of transmission lines and transformers. Our load-dispatch command center plays an essential role. This facility monitors and governs the energy supply in real time for optimal utilization of energy.

Increasing thermoelectric power plant efficiency

Our Kawasaki Thermoelectric Power Plant, located on a 6.6-hectare site in the Keihin industrial belt, has four power-generating units with a total power output of 655,000 kW. Currently three of these units operate as an efficient combined-cycle power-generating unit*.

By optimizing the operating efficiently of these power-generating units, CO_2 emissions at the Kawasaki Power Plant dropped to a total of 1.15 million tons in FY 2002, while the ratio of emission volume per unit electric power generation was 519 g-CO_2/kWh—down 4% from FY 2001 levels.

Efficiently using hydropower generation

Hydropower is a source of clean energy that does not emit CO_2 or other greenhouse gases. JR East has three hydropower plants on the Shinano River Power Plant, including the Senju Power Plant (Kawanishi-cho, Niigata Prefecture), the Ojiya Power Plant and the Shinojiya Power Plant (Ojiya City, Niigata Prefecture). Combined, these have a maximum power output of 449,000 kW while generating 1.4 to 1.6 billion kWh per year.

Since FY 2001 we have been working with the Shinano River Construction Office of Ministry of Land, Infrastructure and Transport to improve the aquatic environment in the middle stretch of the government-controlled Shinano River. On an experimental basis we have begun increasing the dam discharge volume in summer when water temperatures rise, and also during the fall, when salmon run. As a result, an increase in the number of salmon was also confirmed during the 2002 season.

Using natural energy sources

Although still only a small portion of our overall energy, we do utilize some natural energy sources such as solar and wind power. Photovoltaic generators have been installed on the roof above the *Shinkansen* platforms at Tokyo Station and Takasaki Station, as well as at the General Training Center and at the Research & Development Center. At Takasaki Station, the photovoltaic generators are actually built in to the roof panels. The power generated at all of these facilities is used in the stations and office buildings.

From FY 2002, we began to establish a wind power generator system at Gosawa Station on the *Tsugaru* Line in Aomori Prefecture. This generator uses windmills that are quiet and rotate in any wind direction. Although still in the experimental stage, this system works to effectively melt snow on platform steps, for example.

Working to reduce CO_2 emissions from thermal power plants

Shinano River hydroelectric plants emit zero CO_2 or other harmful gases

Windmills on wind power generators at Gosawa Station on the *Tsugaru* Line rotate in any wind direction

The load-dispatch command center is essential to efficient power supply

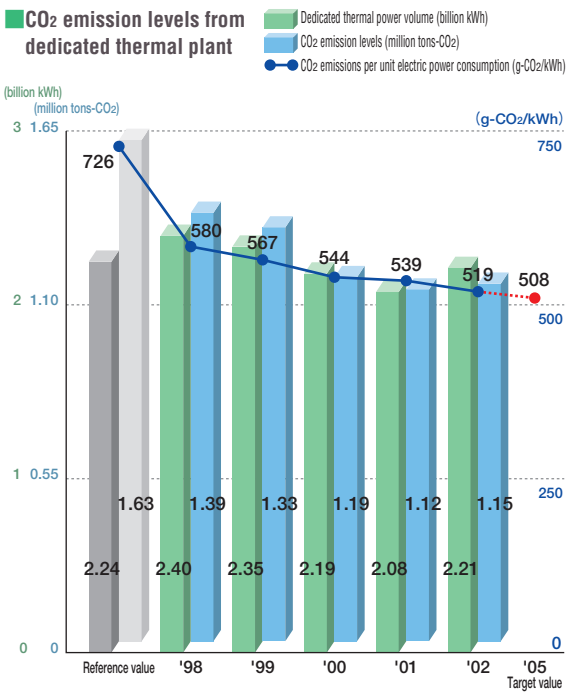
This facility provides a stable of supply of necessary energy by adjusting the power grid according to demand, and transformer and transmission line maintenance requirements. It issues daily power consumption forecasts, which instruct the ordering of electric power from our Kawasaki Thermoelectric Power Plant and Shinano River Hydroelectric Power Plant.

JR East's demand for electric power fluctuates greatly throughout the day. Demand during rush hour is almost seven times greater than after midnight (Daytime demand at an electric company is usually about double the demand after midnight). Demand for electric power is also influenced by weather conditions. A mere 1 degree Celsius temperature rise increases power demand by approximately 10,000 kW.

Hourly electric power consumption forecasts are made for each period based on existing data regarding number of trains in service, the number of cars per train, passenger rates and official weather forecasts.

Tadayoshi Murayama, Commander on Duty, Load-dispatch Command Center Tokyo Branch Office Electronics Department, Power Supply Section

"We maximize the use of hydroelectric power, which generates zero emissions of CO_2 and NOx, and give priority to efficiently generated thermoelectric power. This allows the most environmentally friendly electricity generation through an optimal combination of thermal and hydraulic power."



* **Combined-cycle power–generating unit:** A power-generating unit that combines gas turbines (rotated by gas combustion), with steam turbines (rotated by steam generated by exhaust heat recovery).

JR East New Railcar Development

"Environment" is the keyword for R&D Forthcoming the zero emission railcars

Takashi Endo, Center Manager
Advanced Railway System
Development Center
JR East Research &
Development Center

Test runs of NE train[1] was started in May 2003. Tell us about its development.

One of our group vision has always been to develop technology that fully coexists with the environment. Therefore, we focus on saving energy and reducing exhaust gases. In the automobile industry, hybrid-engine cars already available and fuel cell cars will soon be practical. So what about in the railroad industry? We have spent two years developing hybrid vehicles to replace conventional diesel engines. Our NE Train is powered by electricity generated by diesel engine, and augmented by the power stored from regenerative brakes[2]. We also were able to cut engine idling while the railcars are stopped. In tests their performance compared with that of conventional electric railcars, but they consumed 20% less energy.

Hybrid-type NE Train

The NE Trains, however, are only an interim step as we expect to power trains with fuel cells eventually.

Tell us about the AC Train, Advanced Commuter Train[3]

While the E231 series is almost perfect as energy-efficient railcar, we developed our AC train by drastically redesigning the existing systems. We have added a DDM (direct drive motor) and reduced overall train weight, resulting in a greater than 10% reduction in energy consumption over the E231 series. What's more, the AC Train's overall design takes the whole picture into account, including disposal. Part of making "zero emission vehicles" means using recyclable materials like metal for the buffer materials in railcar flooring.

Using a tester to evaluate DDM reliability

How about stance on building faster *Shinkansen* trains?

This is one of our major projects now. Building trains that are faster yet also environmentally friendly is a major challenge. Faster *Shinkansen* cars increase noise and vibration, so we are developing new technologies to address these issues.

The JR East Research & Development Center is working to create new types of *Shinkansen* trains that balance high-speed performance with environmental concerns.

Given that railways already impact the environment less than other modes of transportation, what are you looking for in terms of further research and development?

I would like to emphasize on "alignment" and "autonomy." In a sense, railway technology has matured, but only when it comes to existing railway-specific technology. By introducing new technologies from the IT, power electronics and other industries, we can further enhance railway technology. Through this process we gain "autonomy" via "alignment" with other fields. And of course "environment" is the keyword of it all.

Modular tables foster group discussion

NE Train (left) and AC Train (right)

1 **NE (New Energy) Train**
An experimental train developed to reduce environmental impact by through the use of hybrid systems and fuel cells.

2 **Regenerative Braking**
This system, which uses a motor as a generator when the brakes are applied, is already available in new types of railcars, (see page 28); Installation in the NE Trains makes this train into hybrid-type.

3 **AC (Advanced Commuter) Train**
Test version of the next-generation, 21st Century commuter train featuring extensive redesign and use of IT.