Steel Industry Measures to Combat Global Warming

Report of “Commitment to a Low Carbon Society”

January 2015

The Japan Iron and Steel Federation

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1. Performance report of “Commitment to a Low Carbon Society” (Eco Process)

Commitment to a Low Carbon Society

Japanese steel industry is supporting the Commitment to a Low Carbon Society by fighting global warming with the “three eco’s” created during the Voluntary Action Plan along with COURSE50.

2020←2013

Eco Process

Aiming 5 million-tons CO_2 reduction vs BAU emission in FY2020 by fully implementing state-of-the-art energy technologies

Eco Solution

Contribute worldwide by transferring the world’s most advanced energy-saving technologies to other countries (especially to developing countries)and increasing the use of these technologies.
(Estimated emission reduction contribution of about 70 million tons in FY2020)

Eco Product

By supplying the high-performance steel that is essential to create a low-carbon society, contribute to lowering emissions when finished products using this steel are used
(Estimated emission reduction contribution of about 34 million tons in FY2020)

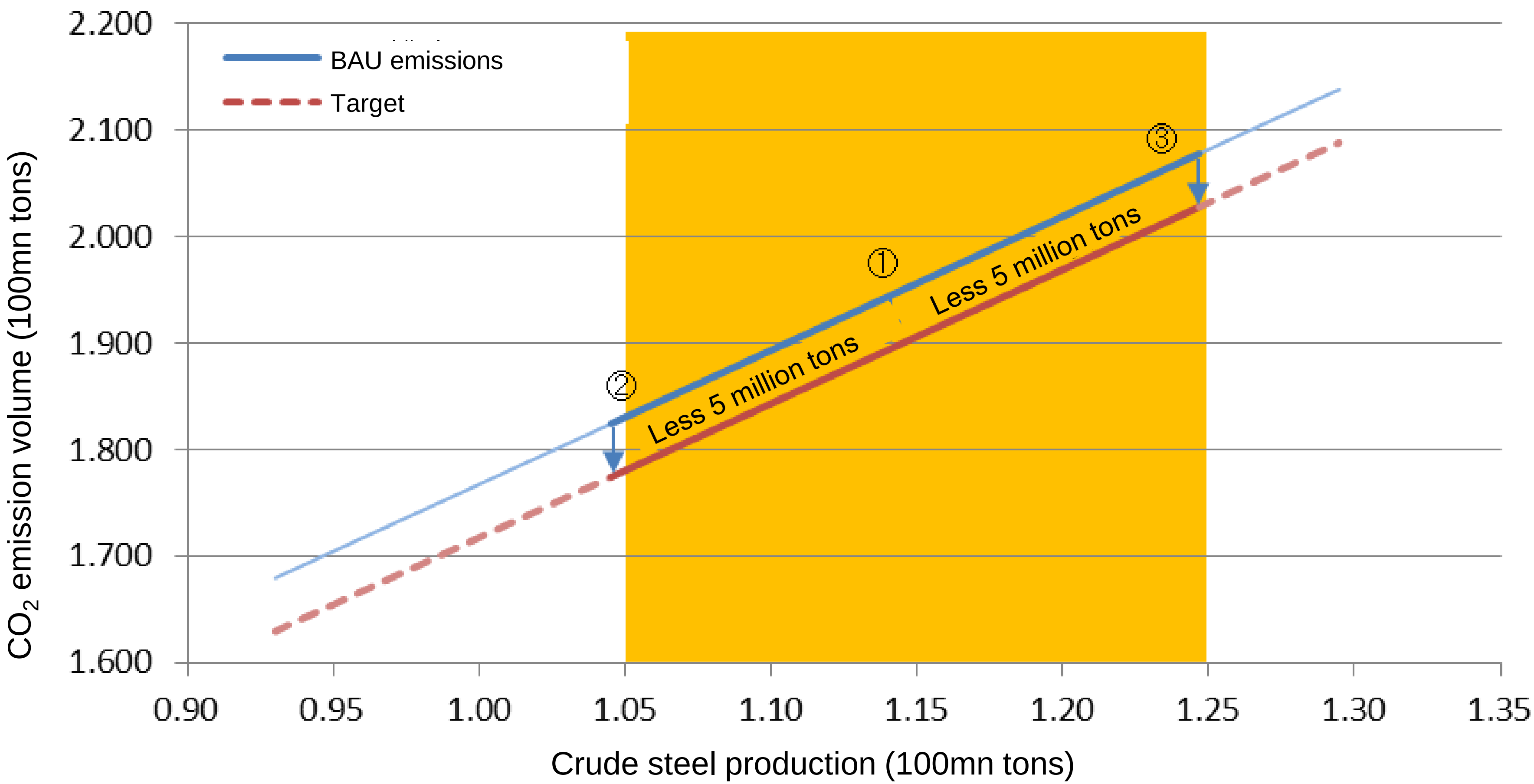
2050←

Development of revolutionary steelmaking processes (COURSE50)

Cut CO_2 emissions from production processes about 30% by using hydrogen for iron ore reduction and collecting CO_2 from blast furnace gas. The first production unit is to begin operations by about 2030*. Goal is widespread use of these processes by about 2050 in line with timing of updates of existing blast furnace facilities.

* Assumes establishment of economic basis for CO_2 storage infrastructure and creation of a practical unit using these processes.

(Reference) BAU Emissions and Target



- This is a commitment to reach the target based on total crude steel production of 120 million tons in Japan plus or minus 10 million tons. The shaded section of this graph shows the range of production of companies participating in the Commitment to a Low Carbon Society for crude steel production of 110 million to 130 million tons.
- The BAU line assumes that steel product mix remains the same as in FY05.
- May be outside the anticipated range if there is a big change in production volume. If this happens, suitable levels for BAU and the reduction will have to be examined based on actual conditions.

Results of the Commitment to a Low Carbon Society in FY13

Progress toward achieving goals

*Totals for companies participating in the Commitment to a Low Carbon Societ

Crude steel production: 184.6mn tons (+0.3% vs. FY05)

A) BAU emissions for FY13 crude steel production: 188.79mn tons of CO_2

B) CO_2 emissions (using FY05 coefficient for electric power emissions): 189.42mn tons of CO_2 (+0.6% vs. FY05)

C) Change vs. BAU emissions (A-B): +630,000 tons of CO_2 (+5.63mn tons vs. target)

FY13 energy consumption and CO_2 emissions

- Energy consumption: 2,289PJ (+0.1% vs. FY05)
- CO_2 emissions (using electric power coefficient with FY13 credits): 194.39mn tons of CO_2 (+3.2% vs. FY05)

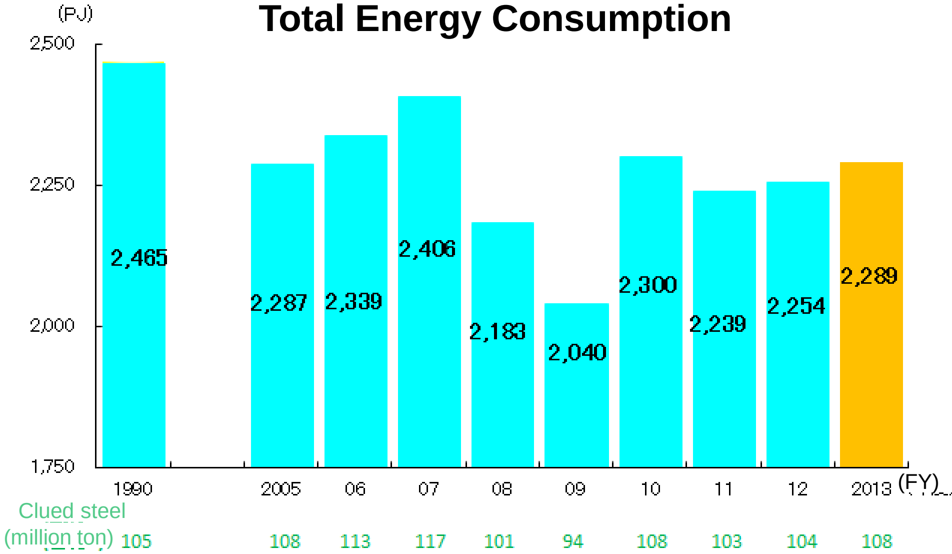
Reference: Steel industry totals

- Crude steel production: 111.52mn tons (-1.1% vs. FY05)
- Energy consumption: 2,361PJ (same as FY05)
- CO_2 emissions (using electric power coefficient with FY13 credits): 198.69mn tons of CO_2 (+3.2% vs. FY05)

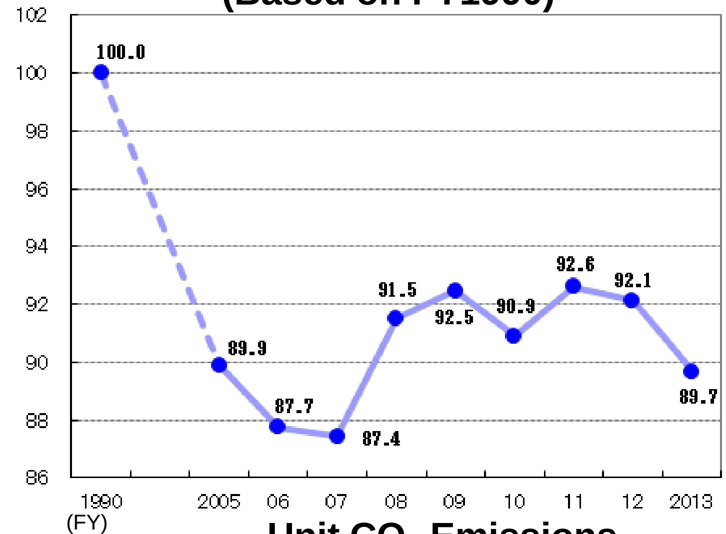
* Steel industry energy consumption and CO_2 emissions are estimates that use statistics for consumption of petroleum and other fuels.

Annual trend of Energy Consumption and CO_2 Emissions

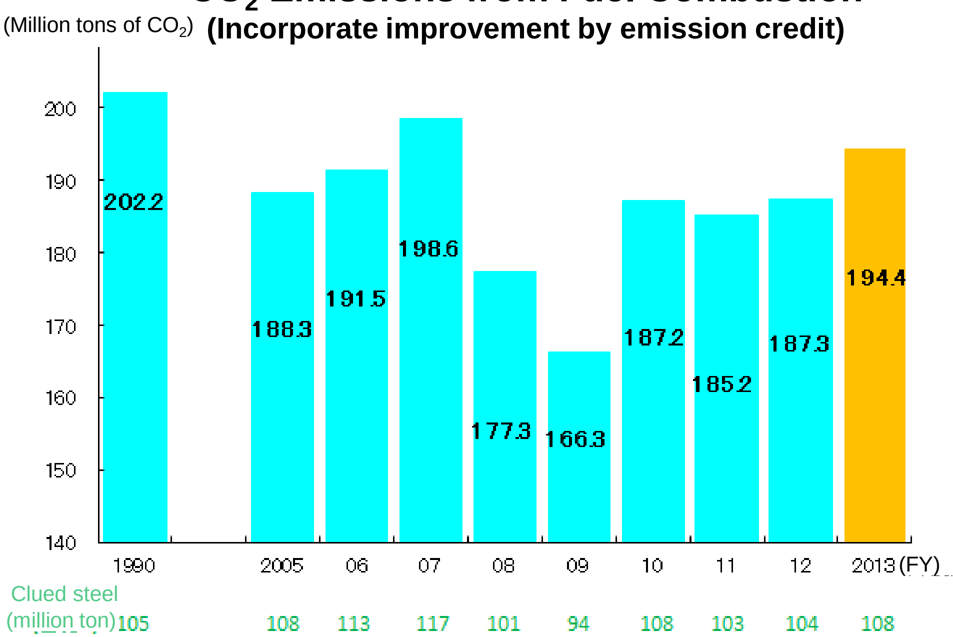
Total Energy Consumption



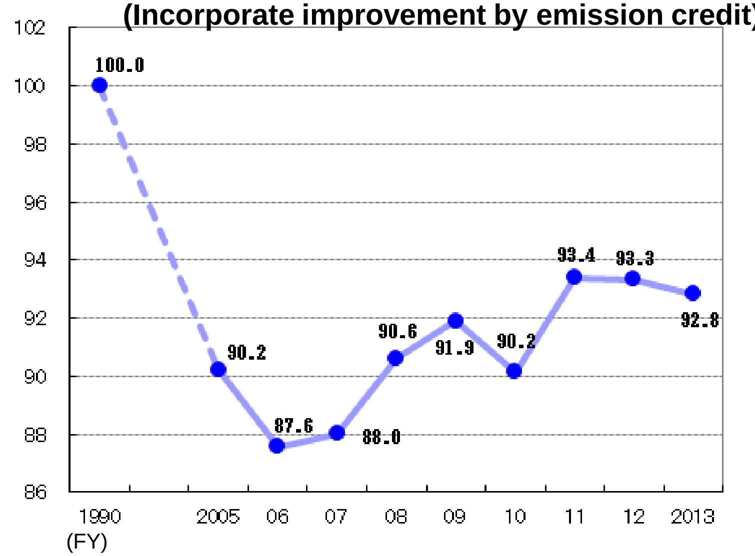
Unit Energy Consumption (Based on FY1990)



CO_2 Emissions from Fuel Combustion (Incorporate improvement by emission credit)



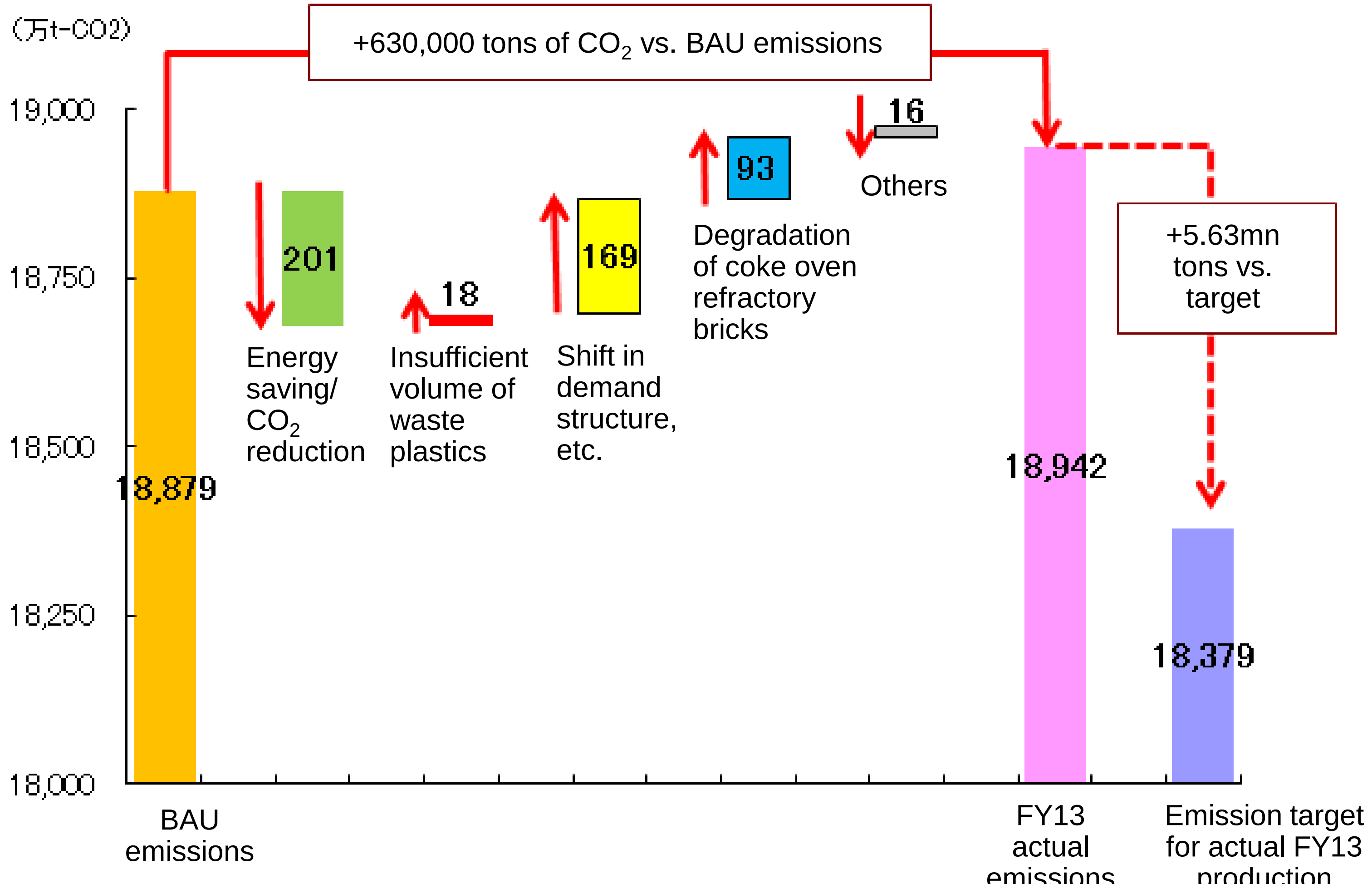
Unit CO_2 Emissions (Based on FY1990) (Incorporate improvement by emission credit)



*PJ is a petajoule (10^{15} joules). One joule is 0.23889 calories. 1PJ is equivalent to about 2.58 million kiloliters of crude oil.

Components of Changes in FY13 CO_2 Emissions

- FY13 BAU CO_2 emissions increased 630,000 tons, the result of -2.01mn tons due to energy conservation/CO_2 reductions, +180,000 tons due to an insufficient volume of waste plastics, +1.68mn tons due to a structural change in demand, +930,000 tons due to degradation of coke oven refractory bricks, and -160,000 tons for other factors.
- The result was a 5.63mn ton shortfall vs. the target.



* FY13 CO_2 emissions use a fixed electric power coefficient (based on FY05).

Evaluation of FY13 Performance

In FY13, there was a reduction in emissions due to the initiatives of steelmakers. However, emissions exceeded BAU because of factors that could not be foreseen when the targets were established.

1. Progress with measures envisioned when target was established (Unit: 10,000 tons of CO_2)

	Target	FY13	
Reductions due to own initiatives • Higher coke oven efficiency • More efficient electricity generation • More energy conservation measures	-300	-201	• Achieved about 60% of the target in 8-year period from FY05 to FY13 • Goal is a further 1mn ton reduction over the next 7 years
• Increase use of waste plastics, etc.	-200	+18	• The 2mn ton target assumes that a collection system will be created. • Due to problems involving the collection system and other items, the volume collected in FY13 was 50,000 tons less than in FY05, resulting in higher CO_2 emissions.
Total (A)	**-500**	**-183**	

2. Negative factors not foreseen when targets were established (Unit: 10,000 tons of CO_2)

	Target	FY13	
Shift in demand structure	—	+169	• Higher demand for high-performance steel raised the share of blast furnace/BOF use, resulting in higher CO_2 emissions. • High-performance steel is believed to help cut CO_2 emissions when products incorporating this steel are used.
Degradation of coke oven refractory bricks	—	+93	• Unit CO_2 emissions increased because of coke oven refractory brick degradation. The causes are probably aging (particularly at furnaces above a certain age) and the effects of the Great East Japan Earthquake of March 2011. • All JISF member companies are making steady progress with upgrading their coke ovens.
Other items	—	-16	• Analyzing all other factors is difficult, but this reduction is probably due to measures to improve mill operations and other initiatives.
Total (B)	**Not included**	**+246**	

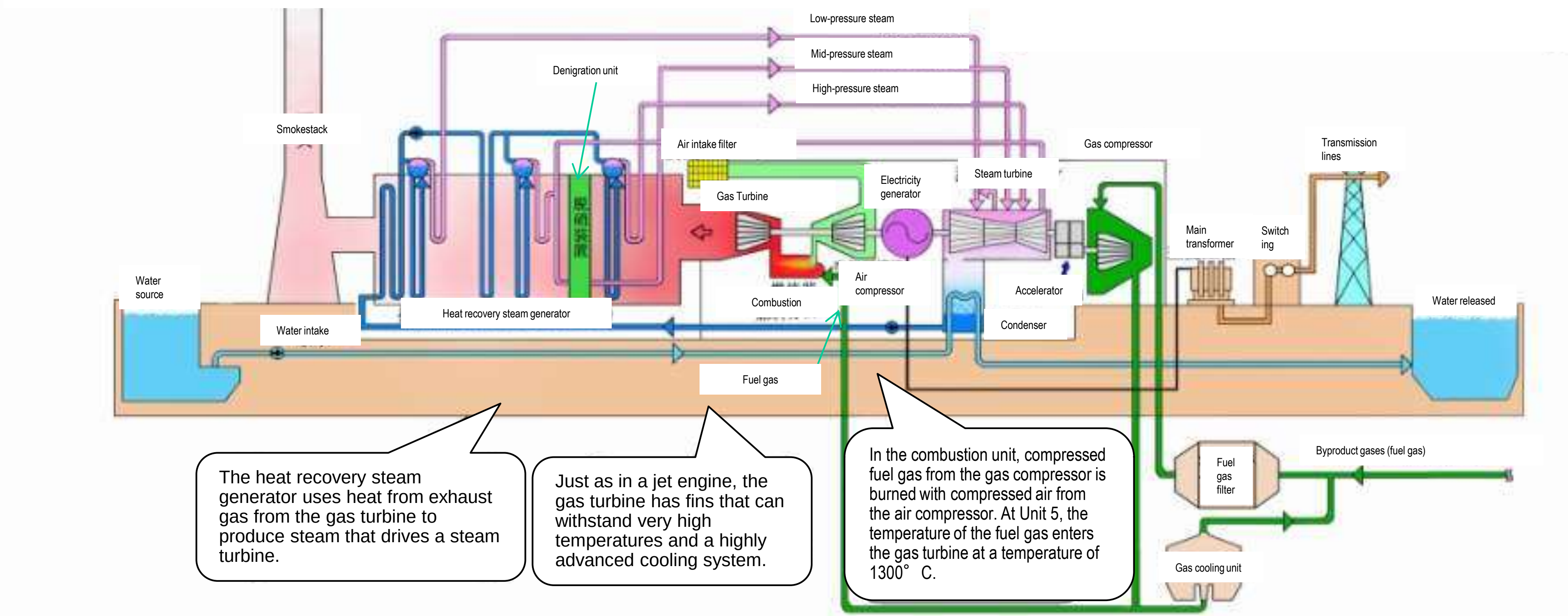
A + B = +63 (5.63mn ton (CO_2) shortfall vs. the target)

Major Initiatives since FY05

1. Next-generation coke oven (SCOPE21)
Nippon Steel & Sumitomo Metal Oita Works (2008)
Nippon Steel & Sumitomo Metal Nagoya Works (2013)

2. More efficient power
Kobe Steel Kakogawa Station No. 1 Gas turbine combined cycle unit (2011)
Kimitsu Joint Thermal Station No. 6 Advanced combined cycle unit (2012)
Kashima Joint Thermal Station No. 5 Advanced combined cycle unit (2013)

Advanced Combined Cycle Power Generation

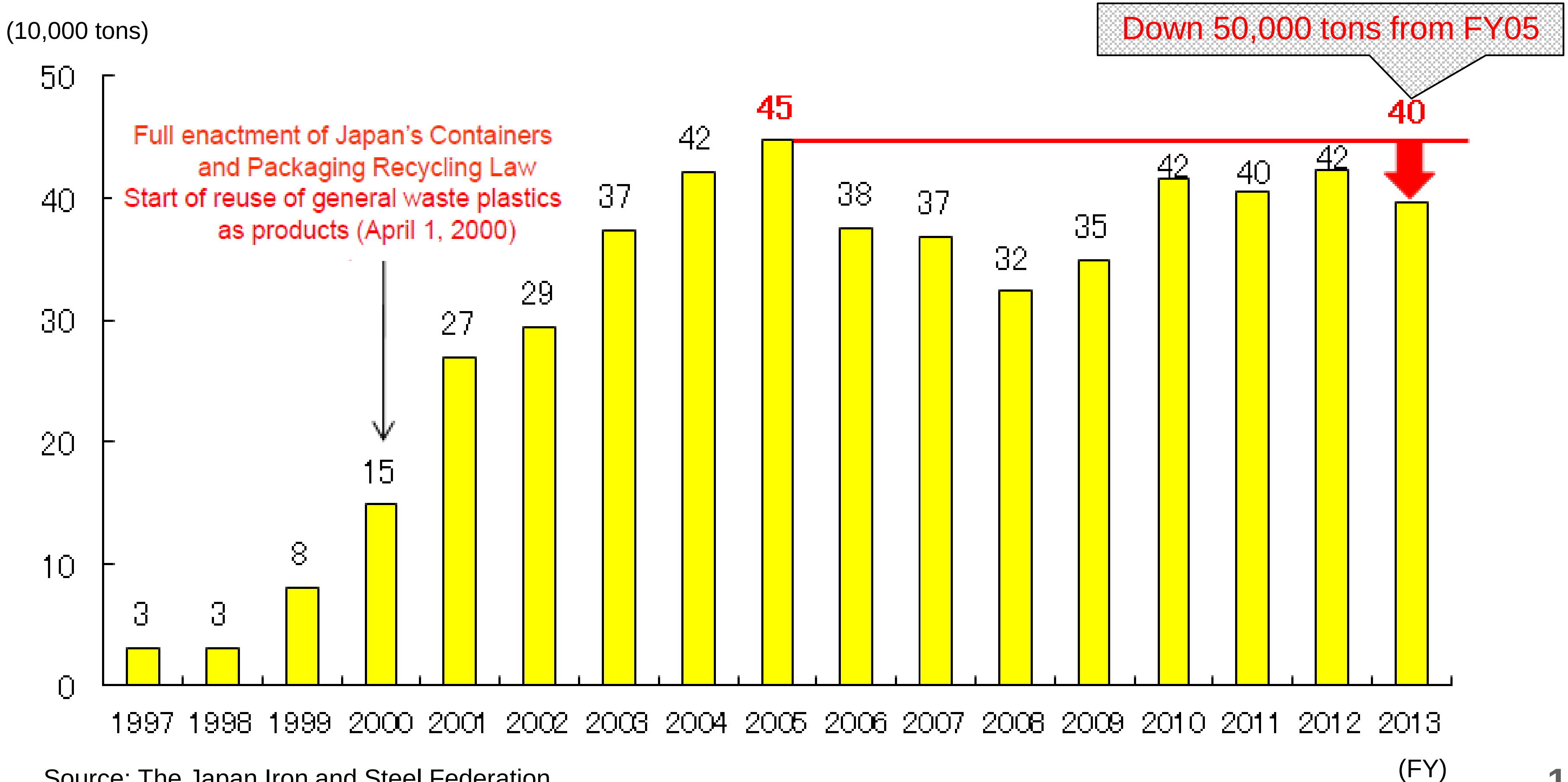


Source: Kimitsu Cooperative Thermal Power Company, Inc.

Reuse of Waste Plastics etc.

- In the low-carbon society plan, the goal was to use 1 million tons of waste plastics and other materials based on the premise that the government would create a collection system. But the volume collected in FY13 was only 400,000 tons, down 50,000 tons from FY05.
- A big CO_2 emission reduction is possible by reexamining associated policies for the use of waste plastics and other materials. We want to continue moving quickly to review this issue using gov't conferences and other measures.

Use of Waste Plastics and Waste Tires



Source: The Japan Iron and Steel Federation

Effective Use of Waste Plastics (Containers and Packaging Recycling)

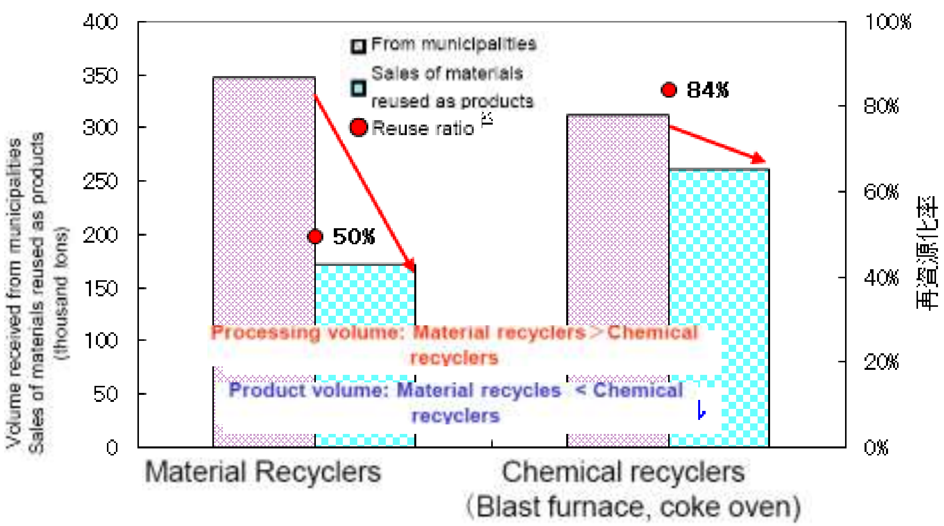
- Due to priority on recycling materials, purchased 230,000 tons of waste plastics in FY2013 under the container and packaging recycling system; current waste plastic processing capacity in the steel industry is about 400,000 tons, leaving significant unused capacity (utilization rate is slightly over 60%)
- A review of policies can produce a big drop in CO_2 emissions through the effective use of waste plastics, etc. We hope to see a quick reexamination of recycling systems from the following standpoints.

(1) From the standpoint of efficiently and effectively using waste materials (recycling waste materials that are highly effective at cutting CO_2 emissions and have a low social cost), the container and packaging recycling system should stop placing priority on recycling materials that produce only small reductions in CO_2 emissions.

(2) A payment system should be considered to provide incentives to local governments that cut costs below a certain level or make big improvements; this would lower the social cost of recycling by encouraging local governments to improve efficiency of collecting and storing waste materials in separate categories

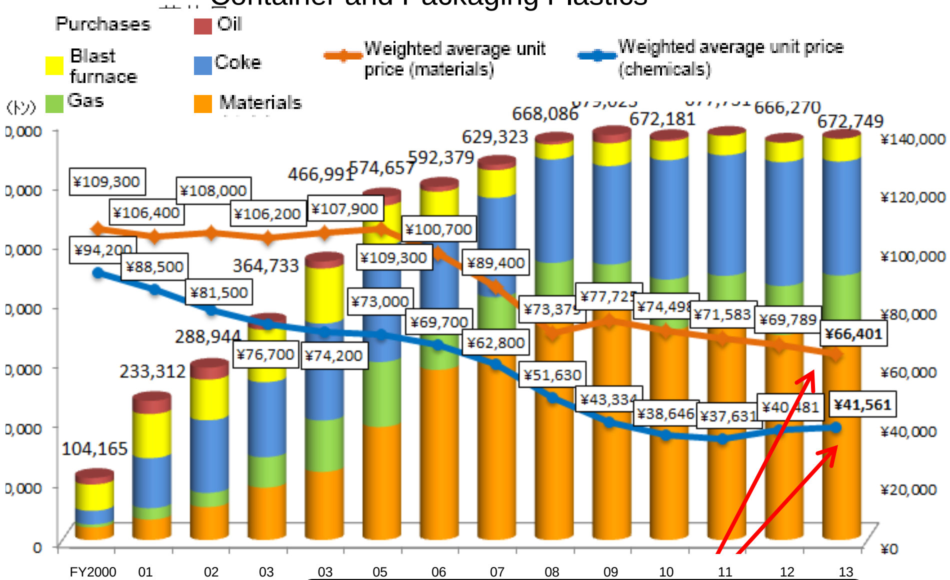
(3) Collection of waste materials should not be restricted to items covered by the Container and Packaging Recycling Law; collecting product plastic waste and other materials too could reduce the need for consumers to discard trash by category and reduce the trash classification expenses for local governments. The government should thus consider enlarging recycling activities to include more types of materials.

Materials Received, Products Sold and Reuse Ratio by Method (FY2013)



Source: The Japan Containers and Packaging Recycling Association

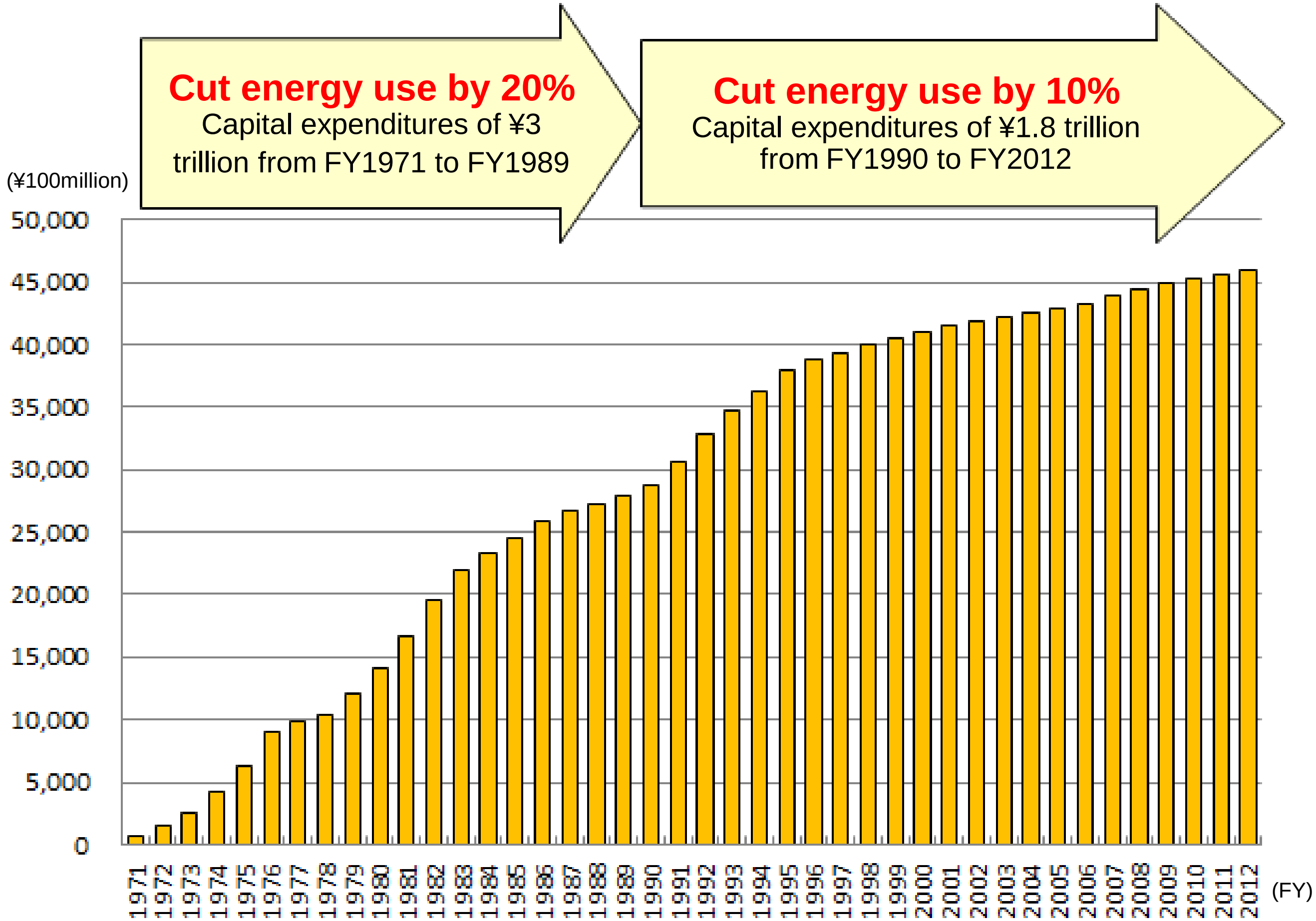
Volume Purchased and Unit Price by Method for Recycling Container and Packaging Plastics



FY13 unit purchase price for recycled materials was 66,000/ton and ¥42,000/ton for chemicals

Steel Industry Environmental/Energy Conservation Investments

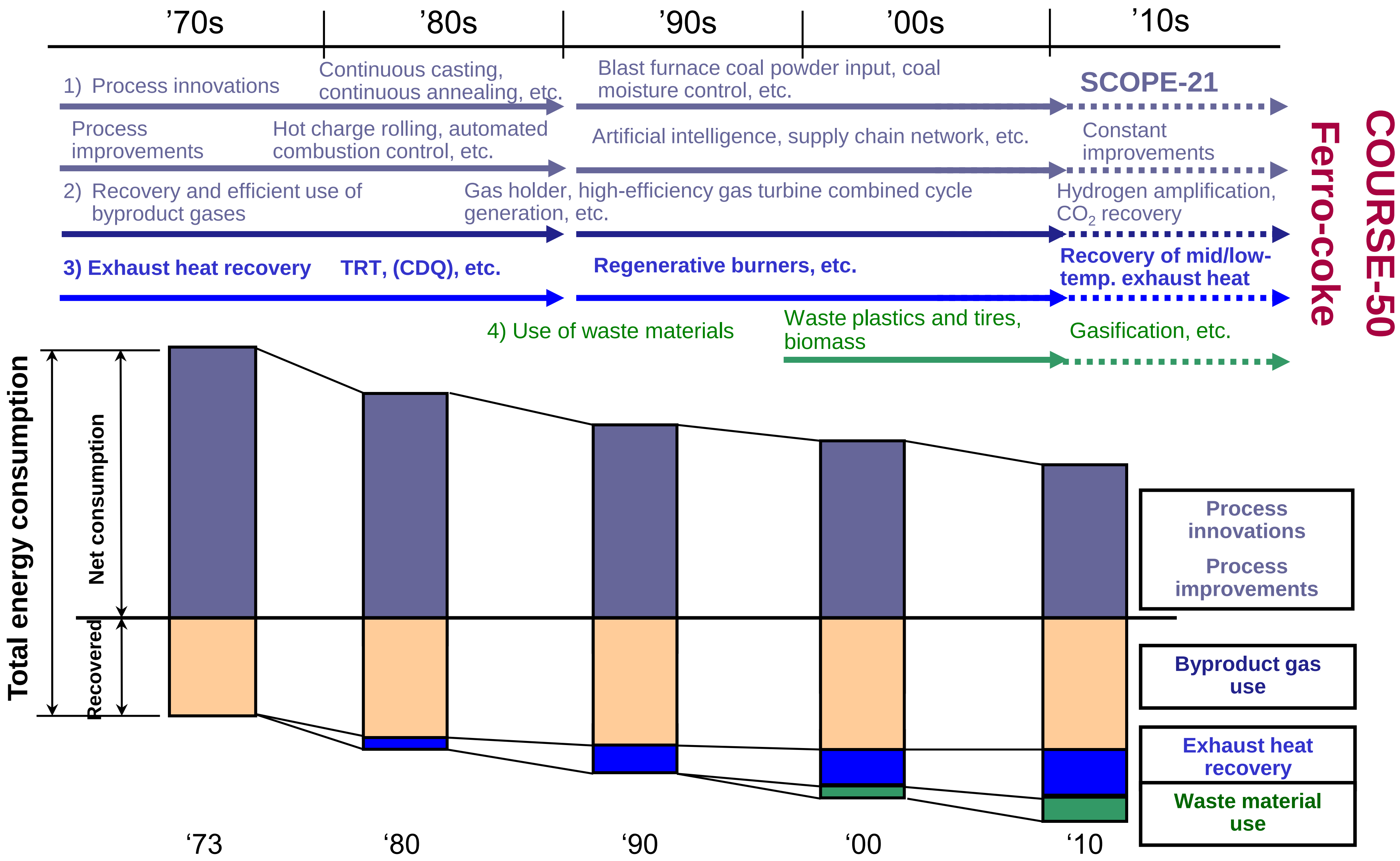
- The steel industry made investments of about ¥3 trillion between FY1971 and FY1989 for environmental protection and energy conservation. These investments totaled about ¥1.8 trillion between FY1990 and FY2012.
- Accumulative investment between FY2005 and FY 2012 reached to ¥350 billion.



Source: ~FY2011: METI Survey on Capital Investments of Major Industries

FY2002~: METI Survey on Corporate Finance (former Survey on Capital Investments)

Energy Conservation Initiatives of the Steel Industry

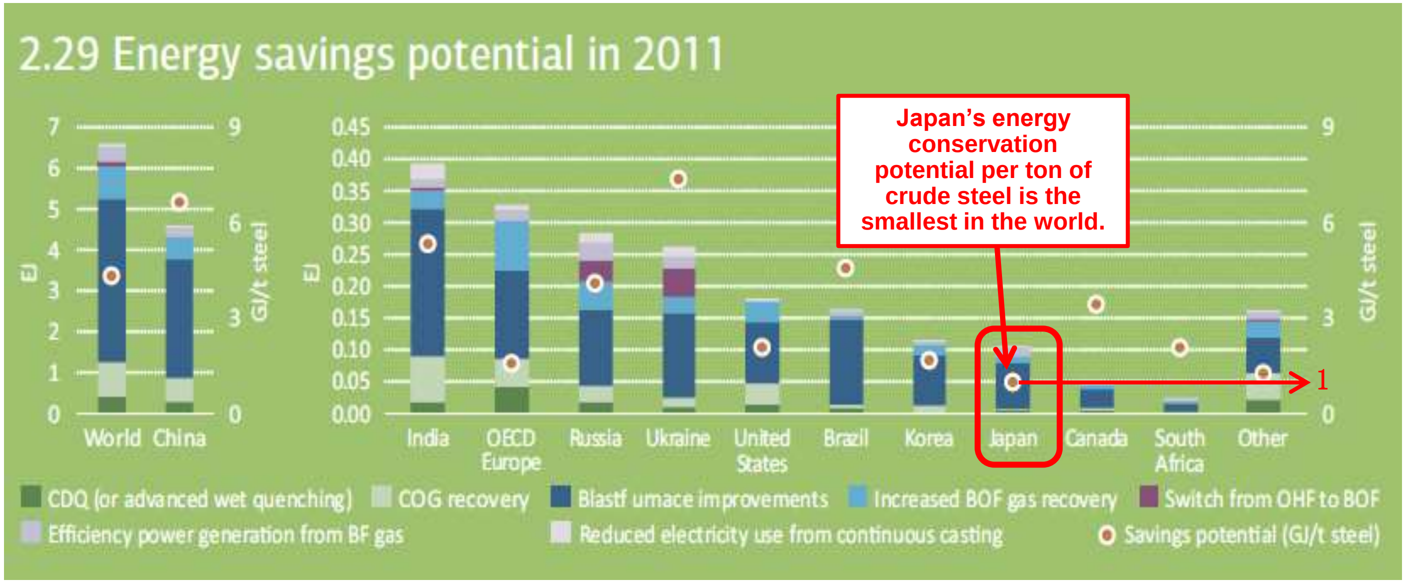


International Comparison of Energy Efficiency in the Steel Industry

- According to the IEA, Japan has world's smallest potential for energy conservation per ton of crude steel. According to RITE, Japan has the world's most energy efficiency steel industry. These figures demonstrate that virtually all steel mills in Japan use existing technologies and that there is very little potential for further energy-conservation measures.

Energy Saving Potential from Transferring and Promoting Energy Conservation Technologies (2011)

Source: IEA "Energy Technology Perspective 2014"



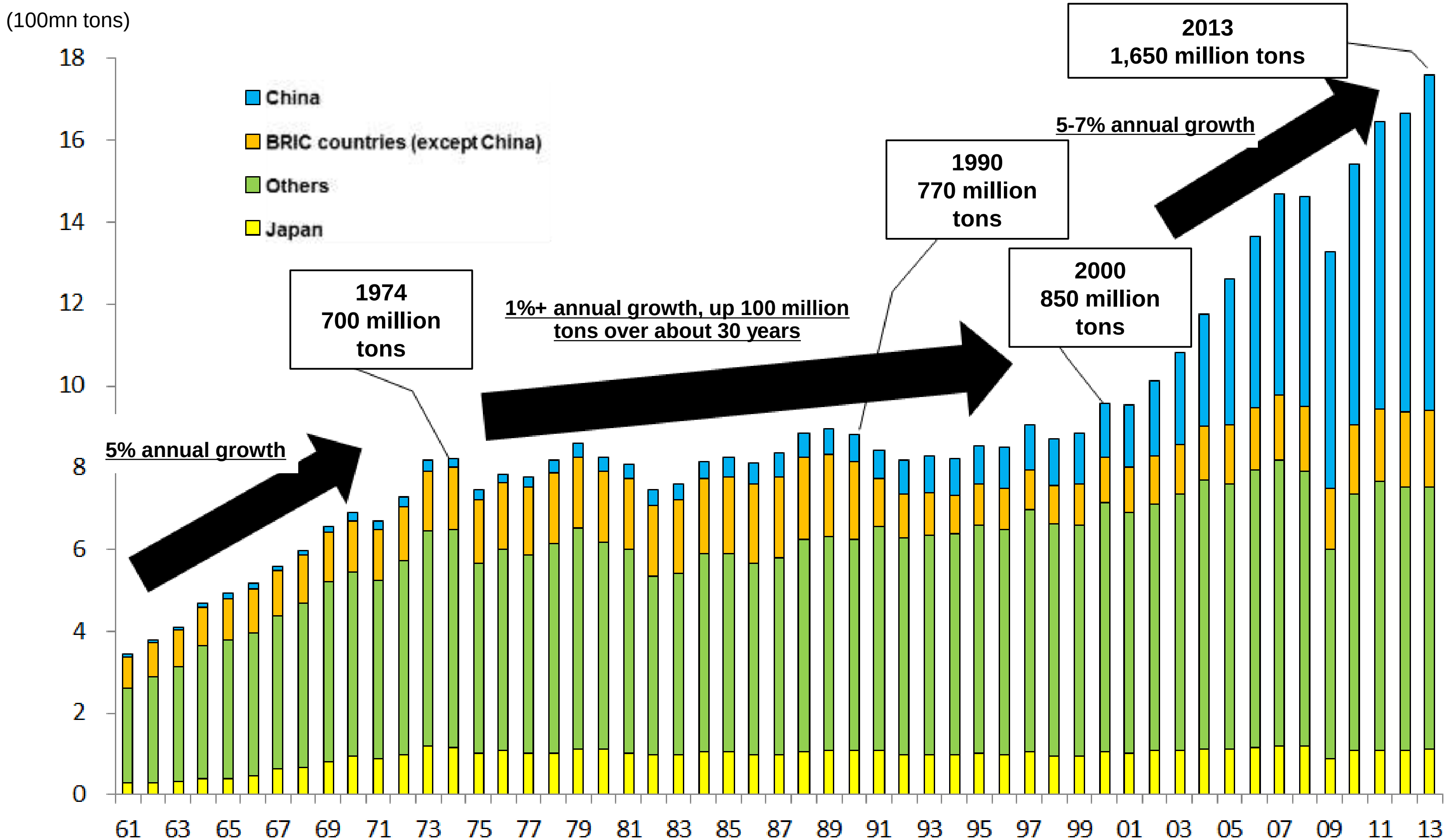
Comparison of Steel Industry Energy Efficiency (2010)

Source: RITE "Estimated Energy Unit Consumption in 2010"
(converted to an index by JISF)

2. Eco Solution

Eco Solution: Global Crude Steel Production (Countries and regions)

- Global crude steel production in 2013 was a record-high 1.65 billion tons. During the 23 years since 1990, production has approximately doubled.
- China is the world's largest producer of greenhouse gases. China's steel production has grown more than tenfold since 1990 and the country accounts for almost half of global steel production volume.

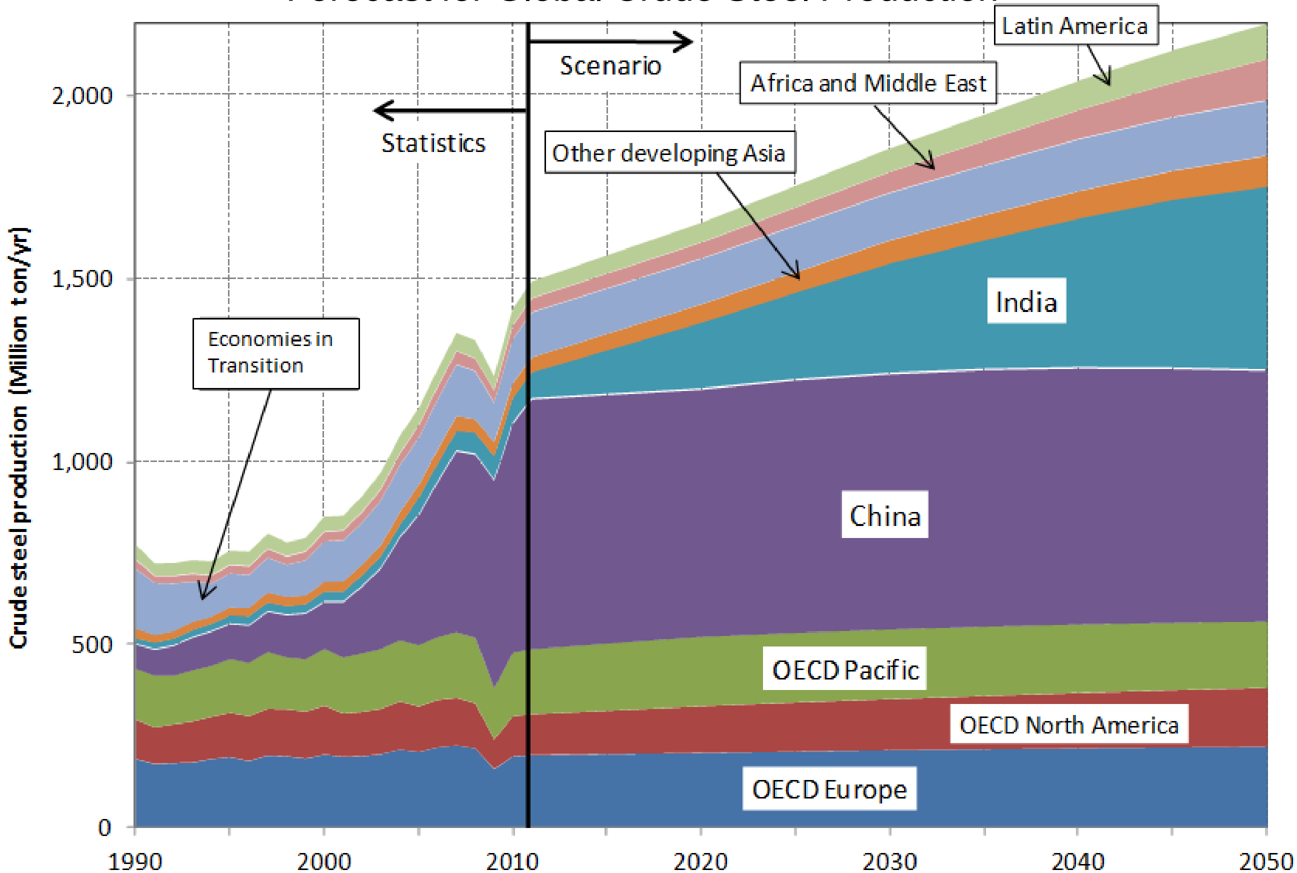


Source: worldsteel

Importance of Increasing Eco Solution

- Global steel demand is expected to increase, mainly in emerging countries, and steel production will climb with this demand. The RITE forecast for 2050 global crude steel production is 2.2 billion tons. This is about 30% higher than the 1.65 billion tons in 2013.
- Technologies are the only way to minimize CO_2 emissions as demand for steel increases. Japan's steel industry is the most energy-efficient in the world. Sharing energy conservation technologies and increasing their use will become even more important as an effective means of fighting global warming.

Forecast for Global Crude Steel Production

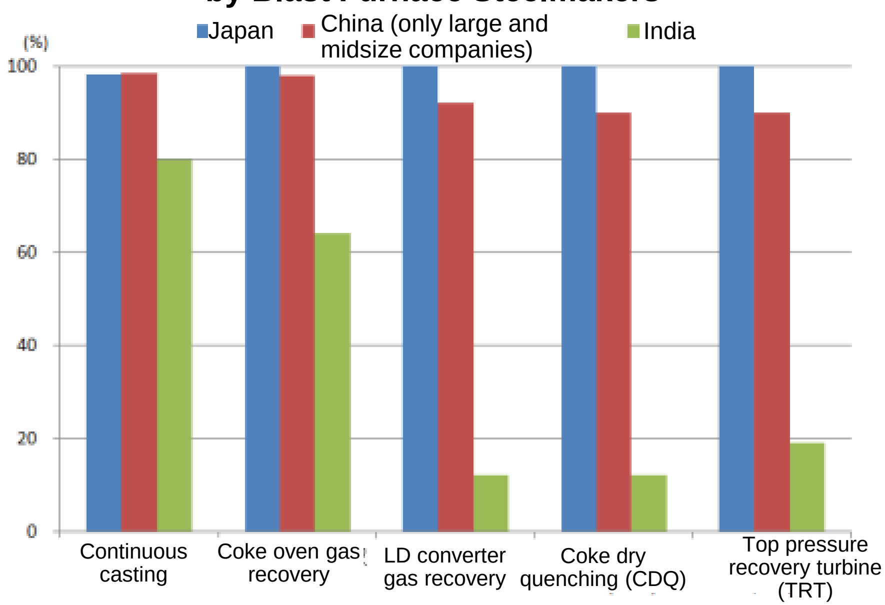


Source: Excerpt from "Research for Strategy to End Global Warming and Achieve a Sustainable Economic Society – ALPS Project" (April 2011) by RITE

Eco Solution: CO_2 Emission Reduction from Increasing Use of Technologies

- There is much potential for increasing the use of major energy conservation technologies in China, which accounts for almost half of global crude steel production, and India, where steel production is expected to continue to grow.
- Major energy conservation technologies developed and used in the Japanese steel industry are already lowering CO_2 emissions overseas as Japanese companies provide these technologies to other countries. CDQ, TRT and other major types of equipment alone are already lowering annual aggregate CO_2 emissions in China, Korea, India, Russia, Ukraine, Brazil and other countries by approximately 50 million tons.

Utilization Rates of Major Energy Conservation Equipment by Blast Furnace Steelmakers



Emission Reductions in Other Countries from Japanese Energy-conserving Equipment

(10,000 tons/year)

	No. of units	Reduction
Coke dry quenching (CDQ)	87	1,533
Top-pressure recovery turbines (TRT)	58	1,073
Byproduct gas combustion (GTCC)	45	1,492
Basic oxygen furnace OG gas recovery	21	792
Basic oxygen furnace sensible heat recovery	7	85
Sintering exhaust heat recovery	6	88
Total emission reduction		5,062

CDQ：Coke Dry Quenching
TRT：Top Pressure Recovery Turbines
GTCC：Gas Turbine Combined Cycle system

Note: Continuous casting figures for all three countries include blast furnace and EAF steelmakers (Total continuous casting production/Total crude steel production in 2013). For other equipment, figures are for FY2013 in Japan, 2013 for coke oven gas recovery and LD converter gas recovery and 2010 for CDQ and TRT in China, and 2000 for all other categories in India.

Sources
Japan: JISF
China: Coke oven/LD converter gas recovery = China Iron and Steel Association; CDQ = Metallurgy report (Nov. 27, 2012); TRT = Wang Wei Xing (China Metallurgy Association, *Information on Major Steel Companies in 2010, World Metals Report (March 8, 2011)*
India: Steel edition of Diffusion of energy efficient technologies and CO_2 emission reductions in iron and steel sector (Oda etal. Energy Economics, Vol. 29, No. 4, pp 868-888, 2007)

International cooperation to support Eco Solution

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

Bilateral Activities

- **Japan-China Steel Industry Environmental Protection and Energy Conservation Technology Conference (2005~)**
- The Public and private collaborative meeting between Indian and Japanese Iron and Steel Industry (2011~)
- **ASEAN-Japan Steel Initiative (2013~)**

Multilateral Activities

- **APP Steel TF (2006~2010)** — APP: Asia Pacific Partnership
- **GSEP Steel WG(2010~)** — GSEP: Global Superior Energy Performance Partnership

worldsteel etc.

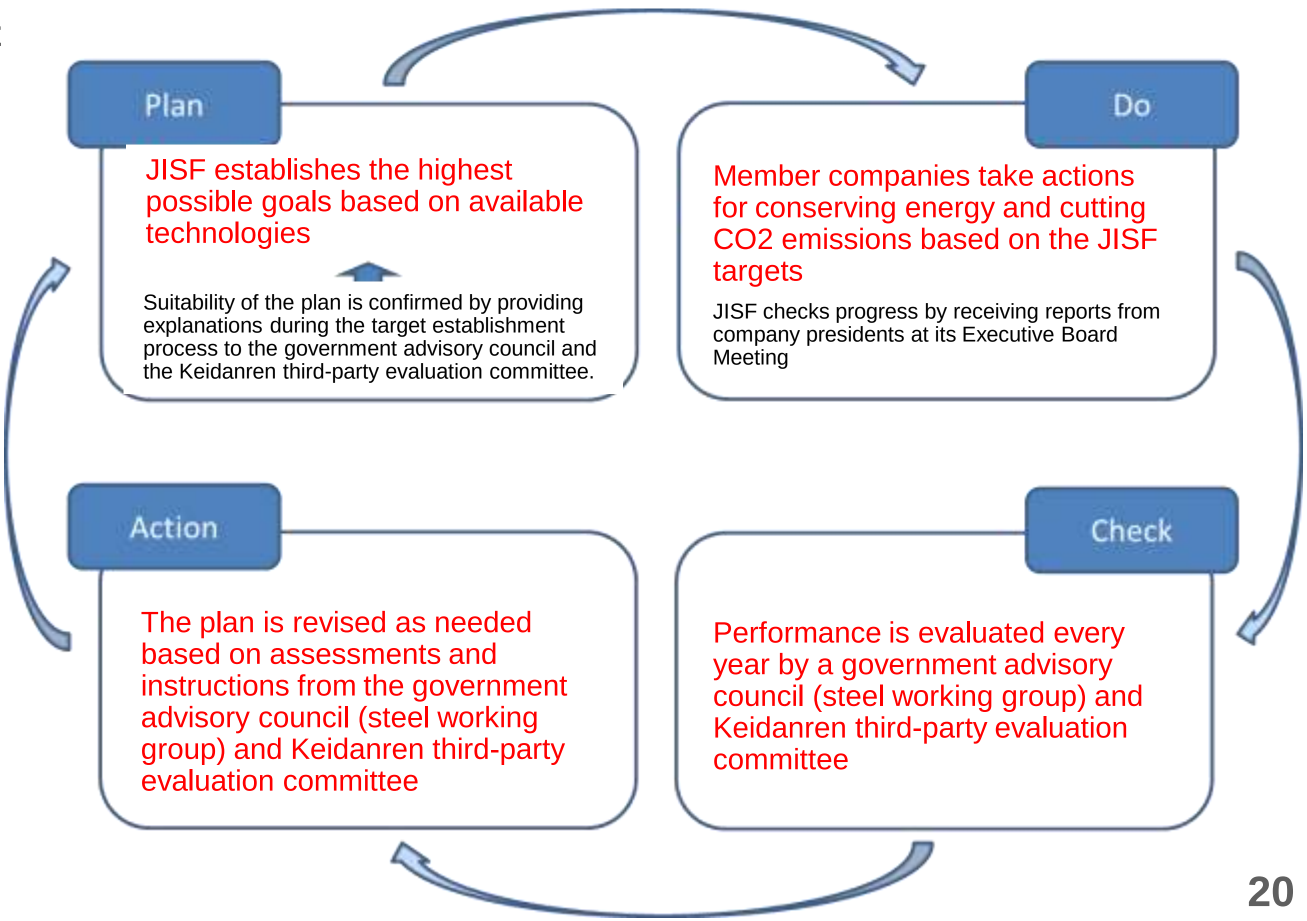
- ENCO (~2009) Environment Committee
- EPCO (2010~2013) Environmental Policy Committee
- ECO (2014~) Environment Committee
- "CO_2 Breakthrough Program": Participating with COURSE50 (2003~)
- CO_2 data collection (2007~)
- Development of ISO14404* (2009～2013) Issued as ISO in March 2013

*Standards for the calculation of CO_2 emission from steel plants

Eco Solution: ISO50001 Certification

- ISO50001 is an international standard for energy management systems that was issued in June 2011.
- On February 20, 2014, JISF became the first industrial association in the world to receive ISO50001 certification, the result of global warming and energy conservation measures associated with the voluntary action plan and the Commitment to a Low Carbon Society.
- This certification is proof that the voluntary actions of the steel industry are sufficiently transparent, reliable and effective in relation to the requirements of international standards.

The JISF Energy Management System



ISO50001 Certificate

Eco Solution: Three pillars of the energy management in the steel plant

ISO14404 (issued in March 2013)

- This standard, which incorporates the proposal of the Japanese steel industry, permits comparisons and evaluations using more effective data by establishing uniform global indicators for individual steel mills for energy efficiency (unit CO_2 emissions)

Technologies Customized List (List of facilities and technologies)

- Includes the most suitable energy conservation equipment based on the characteristics of each country using items selected from the steel industry list of this equipment (India: 19 items, including CDQ and TRT)

Energy Management System (ISO50001 certified in Feb. 2014)

- An energy management system ideally suited for conducting energy conservation activities

Accurate measurements and evaluations by using a uniform standard (ISO14404)

Your blood pressure is higher…..

Best energy conservation technologies based on evaluations (Technologies Customized List)

I will give you medication to lower your blood pressure.

You need to exercise regularly.

Energy conservation PDCA (ISO50001)

Take medicine every day and jog on weekends

Measure blood pressure daily to confirm progress and work even harder if there are no benefits!

Higher energy efficiency

(Goal achieved)

Meet targets and return to good health!

Eco Solution: The Public and private collaborative meeting between Indian and Japanese Iron and Steel Industry

Overview

Japan and India discuss cooperation involving equipment and technologies. One objective is for Japan's steel industry to provide India with suggestions about the transfer of energy conservation and environmental protection technologies. Japan's steel industry can share technologies and experience as the world's most efficient steel producer. Government officials and representatives of steel companies from Japan and India attend these meetings.

Collaborative meeting since 2011

2011	2012	2013	2014	2015
1st meeting	**2nd meeting**	**3rd meeting**	**4th meeing**	**5th meeting**
(Nov. 2011, New Delhi)	**(Nov. 2012, New Delhi)**	**(Feb. 2013, Tokyo)**	**(Feb. 2014, Tokyo)**	**(India, TBD)**

Three pillars for energy management in steel plants

ISO14404

Steel Plant Diagnosis by applying ISO14404 (SAIL Bhilai Steel Plant, 2013)

Technologies Customized List

Technologies Customized List v2(2014)

Technology Seminar (2014)

Energy Management

Site visit in Japan (2013 and 2014)

JISF started cooperation with ASEAN steel industry in 2013 in energy saving and environmental area

3. Eco Product

Eco Product: Japanese Industrial Products that Conserve Energy and Cut CO_2 Emissions

- Japanese manufacturers have taken the lead in developing and commercializing many highly efficient industrial products. Examples include fuel-efficient automobiles and highly efficient power generation equipment and transformers. These products have made a big contribution to conserving energy and cutting CO_2 emissions in Japan and worldwide.
- The Japanese steel industry has established a close relationship with these manufacturers by developing and supplying steel that has a variety of characteristics. This high-performance steel is a vital to achieving the outstanding functions of advanced products and has earned a reputation for reliability among manufacturers.

➢Airplane components

Strong and durable jet engine shafts further boost maximum thrust = Longer range, better fuel efficiency

➢Motors for hybrid/electric cars

High-efficiency non-oriented electrical sheets for higher fuel efficiency, more power, smaller size and lower weight

➢Automotive and industrial machinery parts

Strong gear steel increases gears and reduces size and weight – higher fuel efficiency

➢Boiler tubes

Steel tubes that resist high temperatures and corrosion make power generation more efficient

➢Suspension springs

Higher strength steel for valve and suspension springs used in punishing applications makes vehicles lighter and lowers fuel consumption

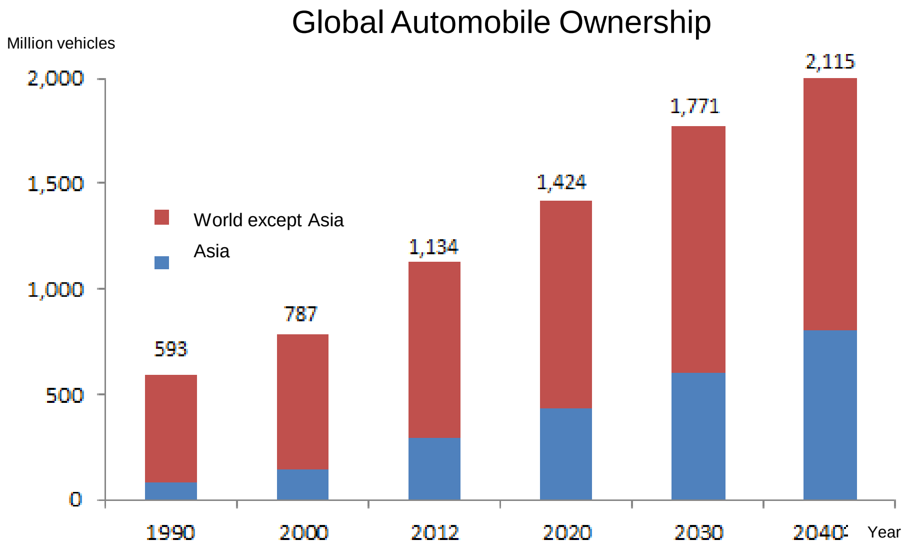
➢Generator parts

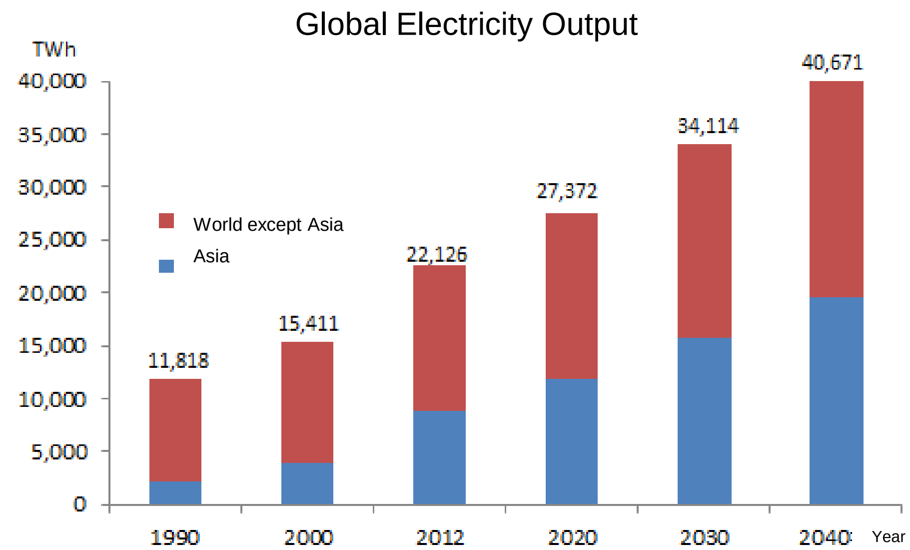
Steel for high-efficiency power plant turbines can withstand high temperatures and high rotation speeds

The Importance of Increasing the Use of Eco Products

- High-performance steel generally has higher CO_2 emissions than ordinary steel does during the manufacturing stage. But high-performance steel is an eco product because it greatly lowers CO_2 emissions when used by making finished products more energy efficient.
- By supplying high-performance steel, the Japanese steel industry is making a big contribution to energy conservation and cutting CO_2 emissions in Japan and around the world. Furthermore, this steel supports “green” economic growth in Japan and creates jobs as the steel is exported to users worldwide,
- Global demand for electricity and motor vehicles is certain to increase as economic growth continues, chiefly in emerging countries. Demand for high-performance steel is expected to become even greater as a result. Meeting the need for high-performance steel will therefore be critical from the standpoints of supporting Japan’s economic growth and protecting the global environment.

Asia/Global Energy Outlook 2014 by The Institute of Energy Economics, Japan

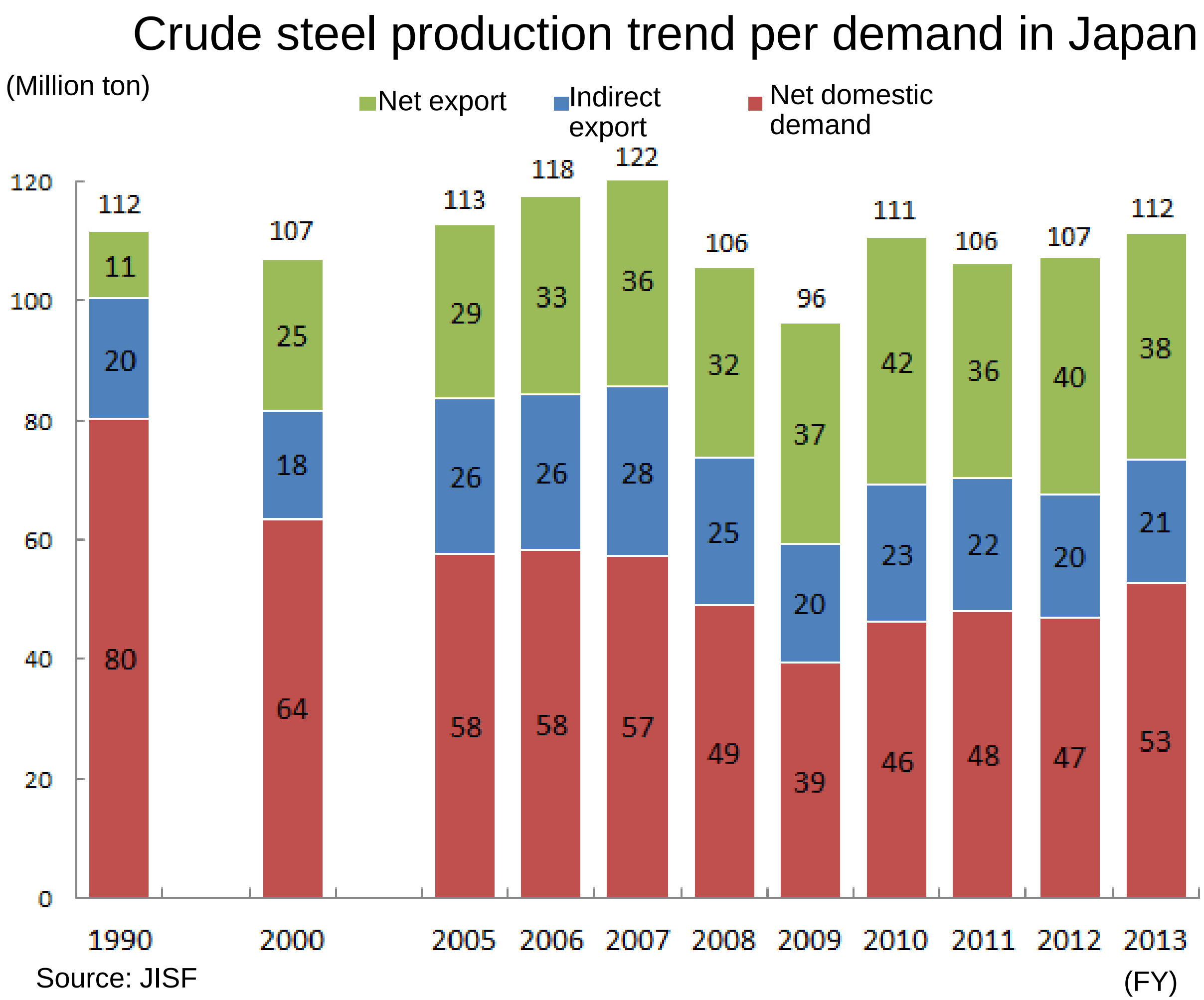


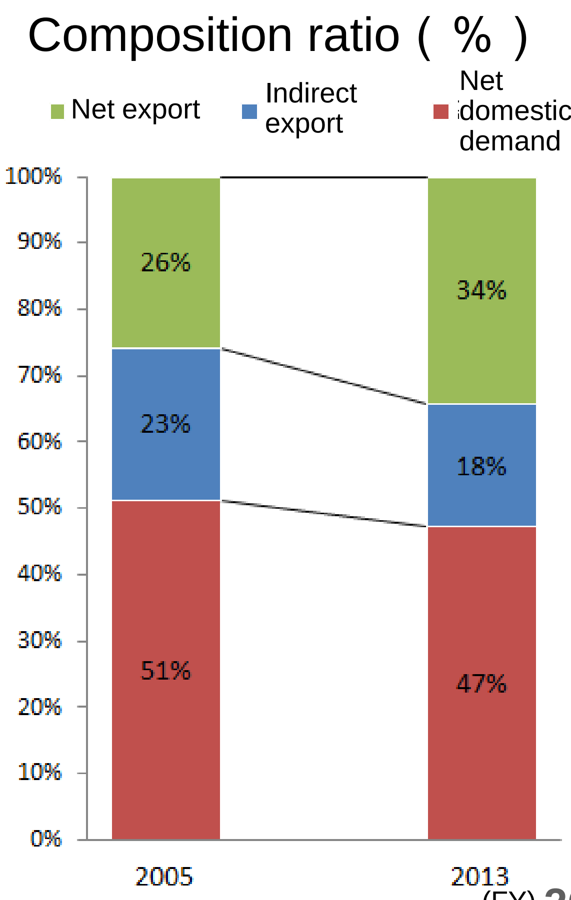


Source: The Institute of Energy Economics, Japan

Crude steel production trend per demand in Japan

- Steel exports from Japan have been increasing. The main reason is strong demand overseas for high-performance steel backed by global economic growth, primarily in Asia.
- In recent years, external demand (direct and indirect exports) has accounted for more than half of Japan's crude steel production.





Source: JISF

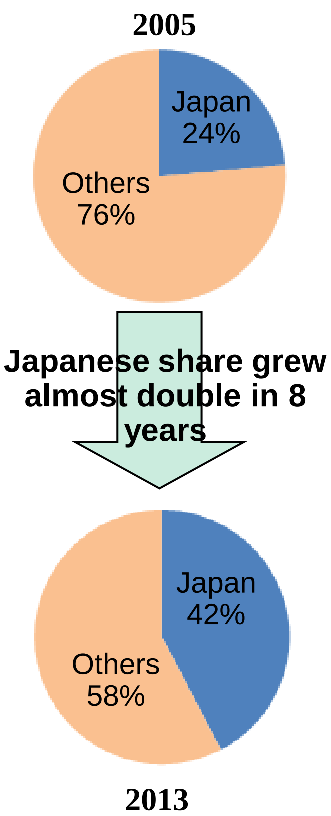
Eco Product: The global competitive edge of the Japanese steel industry, mainly for high-performance steel

- Steel from other countries cannot match Japan's high-performance steel in terms of performance, quality, supply and other attributes. This steel is the core element of the international competitive edge of the Japanese steel industry.
- China, the world's largest steel producer, became a net exporter of steel in 2006. Only Japan is still a net exporter of steel to China.

Steel Trade of China (Total)

(10,000 tons)

Japan's share of China's steel imports

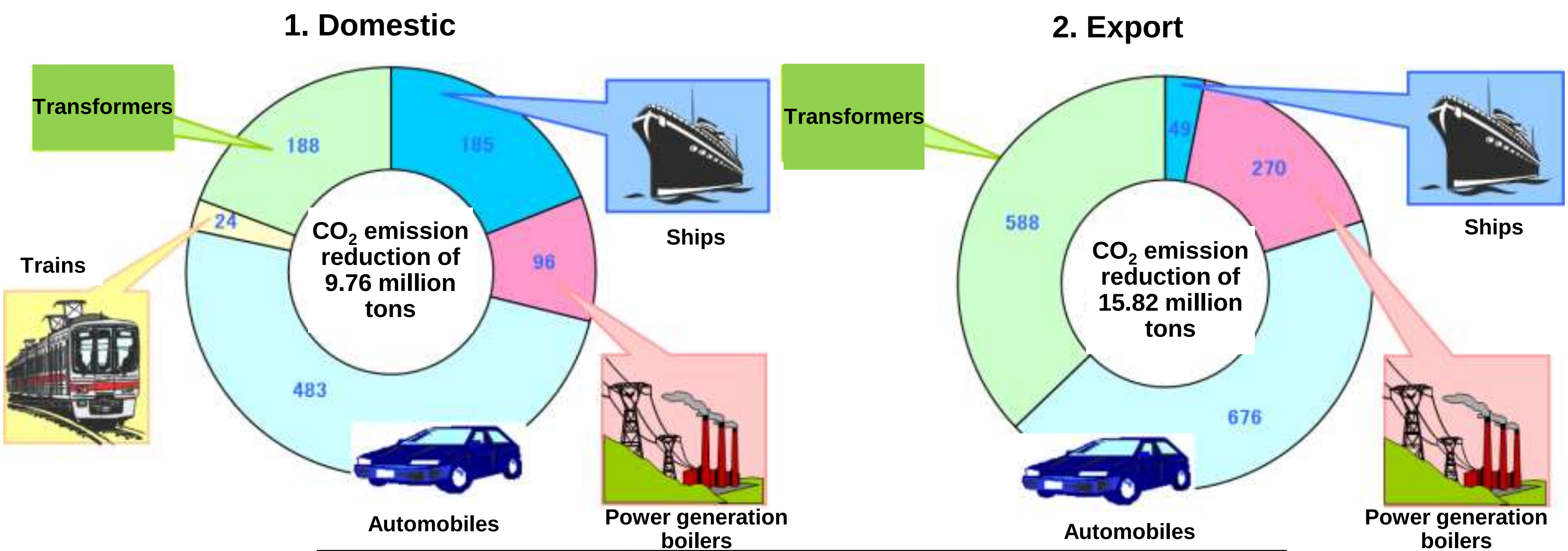


Source: Customs statistics China

Eco Product Contribution: Quantitative Evaluations – Contributions of Major High-performance Steel Products

- To establish a method to determine the quantitative contribution of high-performance steel, JISF established in FY2001 a committee with the participation of associations of steel-consuming industries, The Institute of Energy Economics, Japan and the Japanese government. The committee has been monitoring contributions every year since then.
- Statistics are for the five major types of high-performance steel for which quantitative data are available (FY2013 production of 7.52 million tons, 6.7% of Japan's total crude steel output). The use of finished products made of high-performance steel cut FY2013 CO_2 emissions by 9.76 million tons for steel used in Japan and 15,82 million tons for exported steel, a total of 25.58 million tons of CO_2.

CO_2 Emission Reductions by the five major types of high-performance steel (FY13)



CO_2 Emission Reductions: 25.58 million tons CO_2 in total (7.52 million tons of high-performance steel)

Source: The Institute of Energy Economics, Japan
*The five categories are automotive sheets, oriented electrical sheets, heavy plates for shipbuilding, boiler tubes and stainless steel sheets. In FY2013, use of the five categories of steel products in Japan was 3.677 million tons and exports were 3.845million tons for a total of 7.522 million tons.
*Assessments in Japan started in FY1990 and for exports assessments started in FY2003 for automobiles and shipbuilding, in FY1998 for boiler tubes, and in FY1996 for electrical sheets.

CO_2 Emission Reduction from Blast Furnace Slag Used in Cement

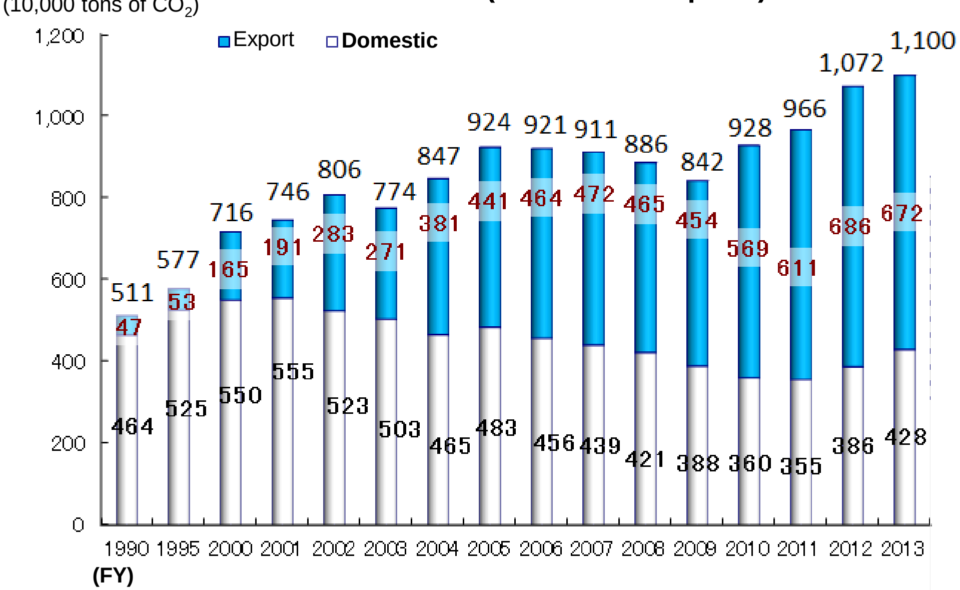
- Mixed cement (mainly slag cement) is one way to lower CO_2 emissions related to energy consumption. The use of this cement is growing and a further increase in the production ratio of mixed cement could significantly lower CO_2 emissions.

Replacing conventional cement (Portland cement), which generates CO_2 during the firing of raw materials, with slag cement, which does not generate CO_2 during production, reduced annual CO_2 emissions by 11.00 million tons/year (FY13).

- **Japan: Annual reduction of 4.28 mn tons of CO_2**
- **Exports: Annual reduction of 6.72 mn tons of CO_2**

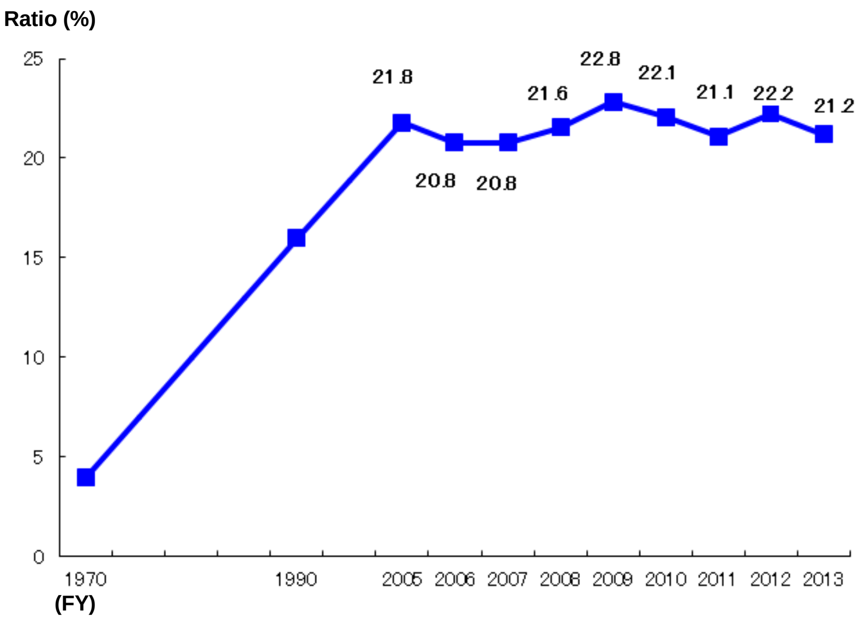
- **In 2001, slag cement was designated as a specified procurement item under Japan's Law on Promoting Green Purchasing.**
- **National and other green procurement programs along with green procurement programs of local governments (requiring green purchasing) are aiming for even more use of slag cement to significantly cut CO_2 emissions.**

Estimate of CO_2 Emission Reduction from Use of Blast Furnace Cement (Domestic + Exports)



Assumptions for emission reduction contribution Conversion to volume of cement: 450kg of slag/ Ton of cement CO_2 emission reduction: 312kg of CO_2/Ton of cement

Production ratio of mixed cement



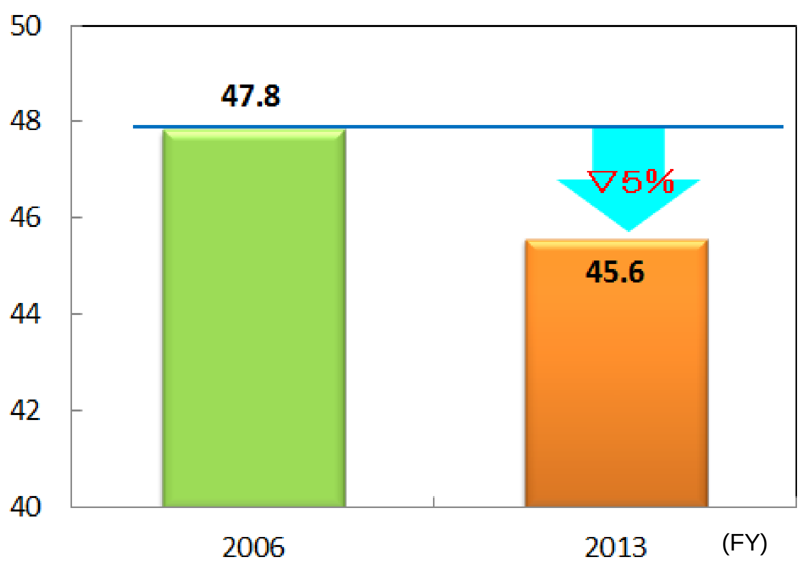
Source: Japan Cement Association, Nippon Slag Association

4. Initiatives commercial/residential sector and transport sector

Initiatives in transportation

- CO_2 emissions per unit of cargo transport decreased to 45.6kg of CO_2/k ton-km in FY13 from 47.8kg of CO_2/k ton-km in FY06.
- In FY13, the steel industry modal shift (ships + rail) was 77% for primary transportation and 97% for cargo transported more than 500km. This is far higher than the average modal shift rate of 38.1% for all industries in Japan (Ministry of Land, Infrastructure and Transport FY05 data for more than 500km).
- Steelmakers are taking other actions too, such as improving cargo transport efficiency by using a higher pct. of cargo space on ships, utilizing shore-based electric power supplies for ships and using eco-tires on trucks and using eco-friendly driving methods.

CO_2 Emissions per Unit of Cargo Transport



Note: Total CO_2 emissions from use of gasoline, light oil and heavy oil at 49 companies surveyed divided by total ton-kilometers of cargo transported

Fuel saving by using electricity from shore-based sources

Cuts fuel oil use by 70% to 90% while ships are docked

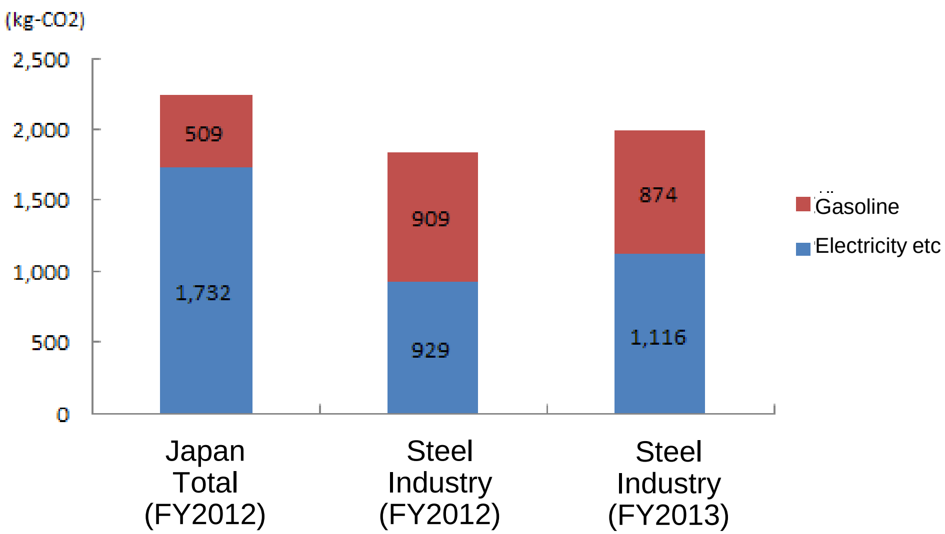
	No. of units
Steel mills	**218**
Junction port	**41**

(Totals for 4 blast furnace and 2 EAF steelmakers as of the end of FY13)

Initiatives in commercial/residential sector

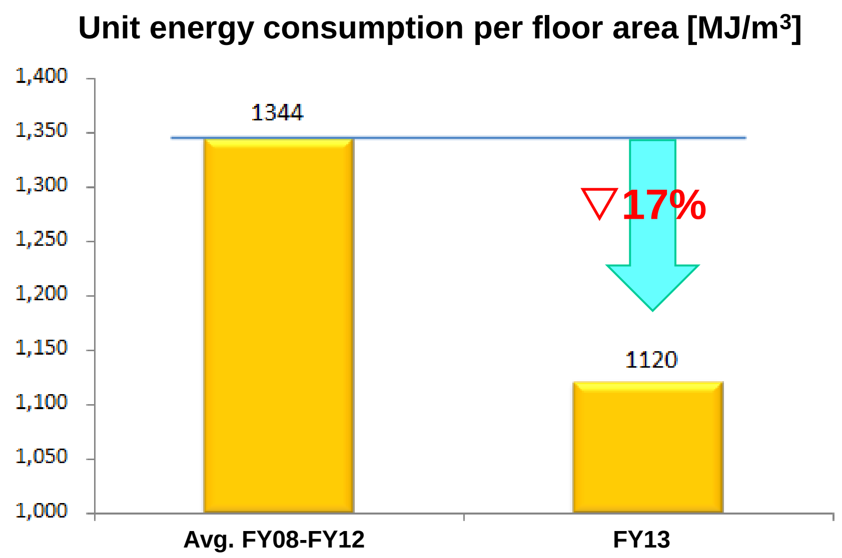
- In FY2005, Japan's steelmakers started energy conservation programs using environmental ledgers for residential sector. Steelmakers started education programs that included all employees, including at group companies, promotion of use of household environmental ledgers, and other actions. There are around 18,000 households participating in this program in FY2013
- Steel industry is taking actions to reduce energy consumption and CO_2 emission from offices. Unit energy consumption in offices in 2013 were down 17% compared to FY 2008-2012. Energy consumption also fell below the reference year.

Household CO_2 Emissions
(CO_2 emissions per individual: kg of CO_2/person-year)



Source: Estimates based on Greenhouse Gas Inventory Office materials
Notes:
1.Total for Japanese households includes households and household use of automobiles.
2. Total for steel industry households is an estimate by JISF based on the inventory in Japan

Unit energy consumption in offices



Data for 306 business sites of 73 companies in FY2013

Example of use of unused energy in nearby locations

Supply of heat to sake companies by a steelmaker in the Kobe area

Equipment to supply heat to sake companies

Features of the heat source system

1. **Supply of heat source**
   Steam from a power plant is used as the heat source.
2. **Energy conservation**
   Energy use is down 30% from when each company had its own boiler. Part of steam used for power generation is drawn off from between turbines and supplied in order to reduce energy lost to cooling water.

Equipment

Steam generators	**3**	Steam generation: 40 tons/hour Heating capacity: 29.5GJ Thermal transmission area: 382m2 Primary steam pressure: 1.01MPa (saturation temperature) Secondary steam pressure: 0.837MPa (saturation temperature)
Water softener: 1 set		
Water supply method: Two-pipe system with direct-buried steam (300-150A) and recirculated water (50A) (24-hour supply all year)		

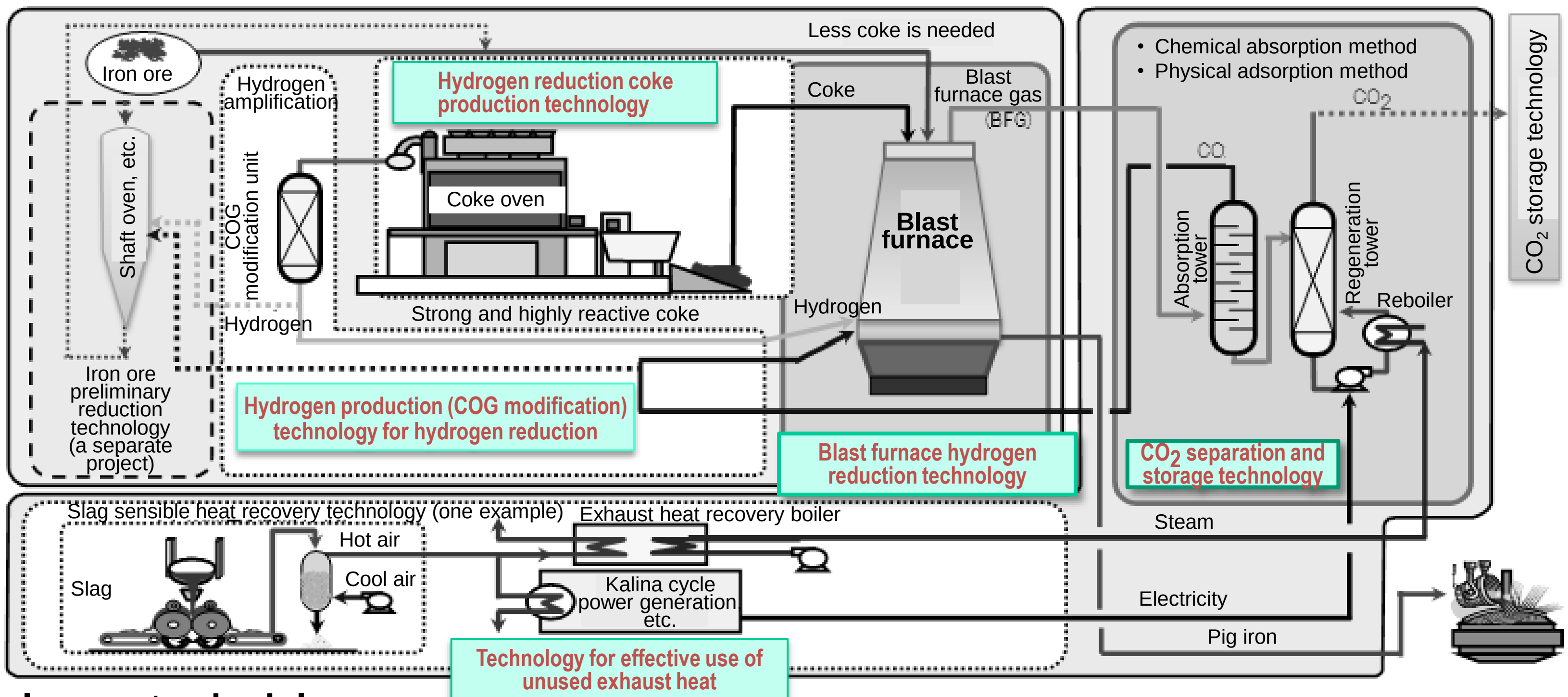
Steam generators

5. Promotion of Environmentally Harmonized Steelmaking Process Technology Development (COURSE50)

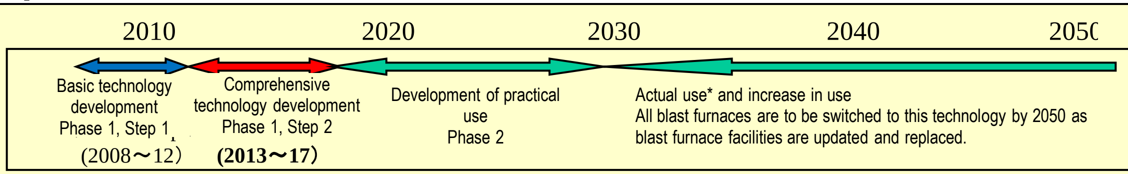
Development of Environmentally Responsible Steelmaking Processes (COURSE50)

Project summary

Work is under way on developing a technology for using hydrogen for the reduction of iron ore (method for lowering blast furnace CO_2 emissions). Hydrogen in the very hot coke oven gas (COG) generated during coke production is amplified and then used to replace some of the coke. Furthermore, for the separation of CO_2 from blast furnace gas (BFG), a revolutionary CO_2 separation and collection technology (technology for separating and collecting CO_2 from blast furnaces) will be developed that utilizes unused heat at steel mills. The goal is to use these technologies for low-carbon steelmaking that cuts CO_2 emissions by about 30%. (a project for NEDO)



Development schedule



* assumptions are that an international equal footing is established and the necessary social infrastructure is created, including the site selection and establishment of a storage facility for government-led carbon capture and sequestration programs. Targets will be reexamined if these conditions are not fulfilled.

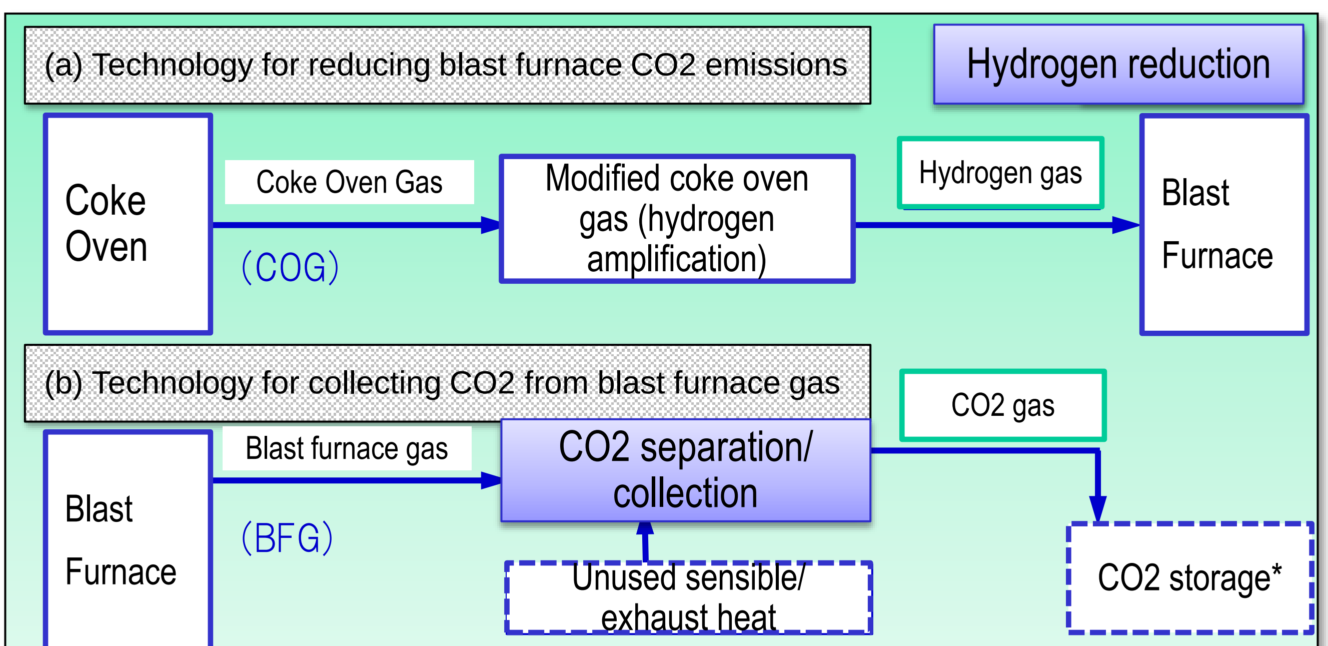
Phase 1, Step 2 (FY13-17) Initiatives

Development item (a): Technology for reducing blast furnace CO_2 emissions

To develop this technology, a 10m3 blast furnace was constructed for testing. Comprehensive trials were performed to verify the results of laboratory research conducted during Phase 1, Step 1. One goal is to create a reaction control technology that maximizes the effectiveness of hydrogen reduction. Another is to obtain data for increasing the scale for phase 2 tests using the demonstration test blast furnace.

Development item (b): Collection of CO_2 from blast furnace gas

The goal is to develop a technology that makes it possible to collect CO_2 at a cost of ¥2,000 per ton of CO_2, which is the cost that matches the requirements of the demonstration test blast furnace. This will require developing a high-performance chemical absorption liquid and other substances, creating a more efficient physical adsorption method, performing applied research for technologies for utilizing exhaust heat, and creating technologies for more cost reductions.



(a)+(b)=

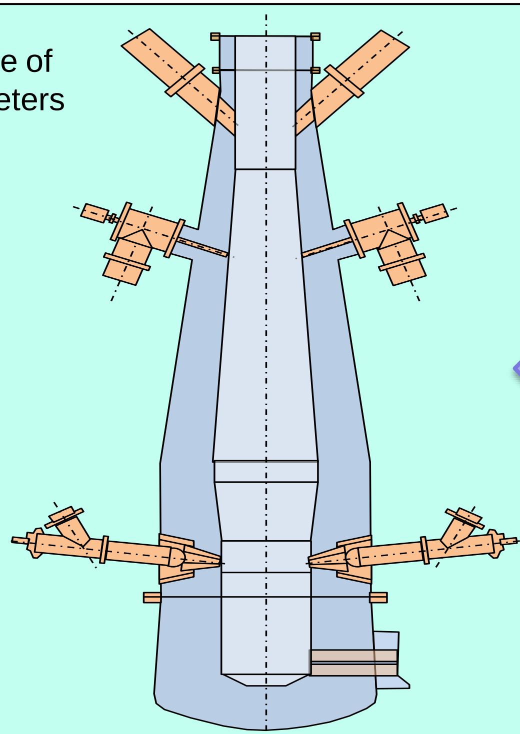
CO_2 reduction target is about 30%

* assumptions are that an international equal footing is established and the necessary social infrastructure is created, including the site selection and establishment of a storage facility for government-led carbon capture and sequestration programs. Targets will be reexamined if these conditions are not fulfilled.

Construction of Trial Blast Furnace

- In Phase 1, Step 2, a 10^3 blast furnace for testing will be constructed at the Kimitsu Works, which has a trial CO_2 separation and collection system (CAT1, CAT30) that can be used for tests with this blast furnace.
- The basic specifications for this blast furnace were finalized in FY13 and the furnace is to be completed in September 2015 (intermediate goal). Construction started in 1st October 2014 as design work and the fabrication of components proceeds.

Volume of 10^3 meters



Construction and operation of trial blast furnace

CAT1
（1t-CO_2/d）

CAT30
（30t-CO_2/d）

Kimitsu Works CO_2 separation and collection system

6. Promotion of "Commitment to a Low Carbon Society" Phase II

Commitment to a Low Carbon Society Phase II

2030←2020

Eco Process

Aiming 9 million-tons CO_2 reduction vs BAU emission in FY2030 by fully implementing state-of-the-art energy technologies

Eco Solution

Contribute worldwide by transferring the world's most advanced energy-saving technologies to other countries (especially to developing countries)and increasing the use of these technologies. (Ca. 50 million ton of CO_2 reduction contribution in FY2013. Ca. 80 million tons of estimated CO_2 emission reduction contribution in FY2030)

Eco Product

By supplying the high-performance steel that is essential to create a low-carbon society, contribute to lowering emissions when finished products using this steel are used.
(Ca. 26 million tons of CO_2 emission reduction contribution in FY2013. Ca. 42 million tons of estimated CO_2 emission reduction contribution in FY2030.)

Development of revolutionary steelmaking processes (COURSE50)

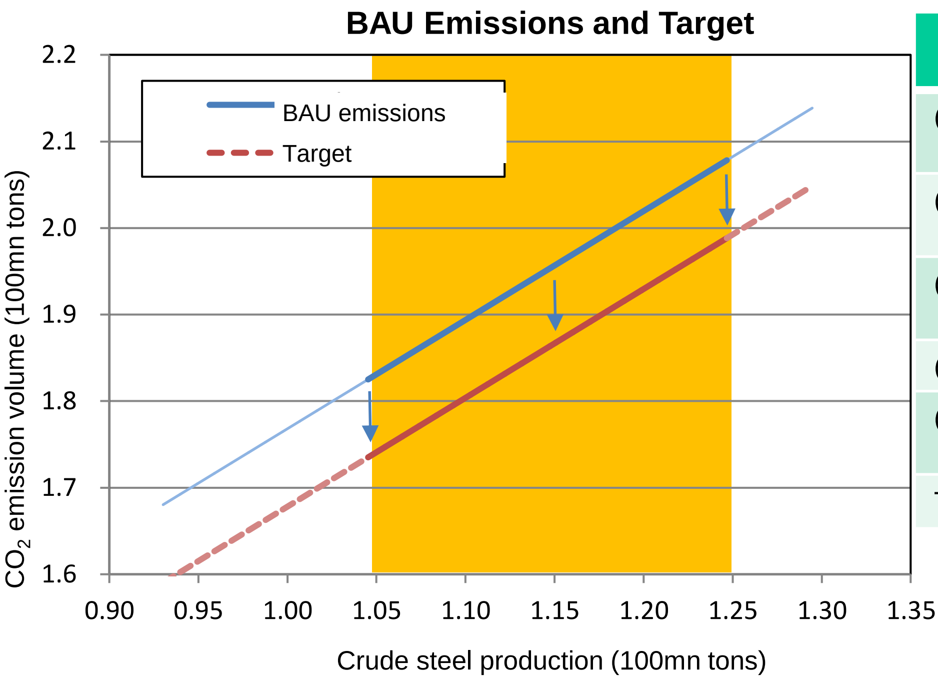
Cut CO_2 emissions from production processes about 30% by using hydrogen for iron ore reduction and collecting CO_2 from blast furnace gas. The first production unit is to begin operations by about 2030*. Goal is widespread use of these processes by about 2050 in line with timing of updates of existing blast furnace facilities.

Development of innovative ironmaking process (Ferro Coke)

Develop ferro-coke that can speed up and lower the temperature of the reduction reaction inside a blast furnace and create the associated operating process. Develop revolutionary technologies that can reduce energy consumption for pig iron production and permit the greater use of low-grade raw materials.

Eco Process (Reduction targets in Japan for production processes)

The 2030 goal for steel production processes is to use advanced technologies as much as possible to lower CO_2 emissions by 9 million tons compared with the volume of these emissions (BAU emission volume) expected from each production volume figure*1 (but excluding the improvement in the electricity coefficient).



Actions	Phase II 2030	Phase I 2020
(1) Improve coke oven efficiency	About 1.3mn tons of CO_2	About 0.9mn tons of CO_2
(2) More efficient electricity generation	About 1.6mn tons of CO_2	About 1.1mn tons of CO_2
(3) More energy conservation	About 1.5mn tons of CO_2	About 1.0mn tons of CO_2
(4) Waste plastics*2	2.0mn tons of CO_2	2.0mn tons of CO_2
(5) Develop and use revolutionary technologies*3	About 2.6mn tons of CO_2	—
Total	9mn tons of CO_2	5mn tons of CO_2

* These reductions do not include the effect of changes in the electric power emissions coefficient.

Fiscal 2030 Assumption

Crude steel output in Japan (10,000 tons)	Participants' Crude steel output (10,000 tons)	BAU emissions (tons of CO2)	Emissions after target is reached (tons of CO2)
12,000	11,508	19,675	18,775

*1 These targets are based on total crude steel production of 120 million tons in Japan, plus or minus 10 million tons. Emission reductions may be more or less than the anticipated range if there is a significant change in production volume. If there is a significant change, the suitability of the BAU figure and emission reduction will be reexamined in accordance with the actual production level.

*2 Points concerning increasing the use of waste plastics and other waste materials

a. Awaiting results of studies concerning a Japanese government review of the container, packaging and plastic recycling system and other related items; may be reviewed (target reduced) if there is no outlook for growth in the waste materials handling capacity of the steel industry by FY2030 in relation to the actual FY2005 capacity.

b. In addition, for the reduction target incorporated in the FY2020 target, awaiting results of a Japanese government study of the recycling system; may be reviewed (target reduced) if there is no outlook for growth in waste materials handling capacity by FY2020 in proportion to the above target.

*3 For the development and use of revolutionary technologies, assumptions are that (a) technologies will be in use in FY2030 and (b) the use of these technologies is economically feasible. In addition, for COURSE50, assumptions are that an international equal footing is established and the necessary social infrastructure is created, including the site selection and establishment of a storage facility for government-led carbon capture and sequestration programs. Targets will be reexamined if these conditions are not fulfilled.