Activities of Japanese Steel Industry to Combat Global Warming

Report of "JISF's Commitment to a Low Carbon Society"

January 2019

The Japan Iron and Steel Federation

Index

On February 20, 2014, JISF became the first industry association in the world to receive ISO50001 certification (energy management system). This certification recognizes measures to combat global warming in the Voluntary Action Plan/Commitment to a Low Carbon Society as well as activities for conserving energy.

REGISTERED ORGANIZATION

No. N001-ISO 50001

Initial registration:	February 20, 2014
Extension:	February 2, 2017

JISF's Commitment to a Low Carbon Society - Phase I

Japanese steel industry is supporting the Commitment to a Low Carbon Society by fighting global warming with the "three ecos" created during the Voluntary Action Plan along with COURSE50.

2020←2013

Eco Process

The target is a CO_2 emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies. Of this reduction, JISF prioritizes 3 million tons of reduction arising from energy conservation and other voluntary actions by steelmakers. For waste plastics and other recycled materials, the emission reduction includes only a decrease resulting from the increase in the volume of these materials collected vs. the FY2005 level.

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 CO2 Ultimate Reduction System for Cool Earth 50 (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.

1. Eco Process

Reexamination of Stance for Targets Established in FY2016

Eco Process Before reexamination

The target is a CO_2 emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies.

Interim- Review

1. **Properly determine BAU by reflecting changes in steel production mix**
2. **Include actual emission reductions resulting from the use of waste plastics and other recycled materials**

Eco Process After reexamination

The target is a CO_2 emission reduction of 5 million tons by FY2020 vs. expected emissions for each production volume (BAU) by fully implementing state-of-the-art technologies. Of this reduction, JISF prioritizes 3 million tons of reduction arising from energy conservation and other voluntary actions by steelmakers. For waste plastics and other recycled materials, the emission reduction includes only a decrease resulting from the increase in the volume of these materials collected vs. the FY2005 level.

Calculation of BAU Emissions for FY2017 Performance Evaluation

(1) Calculation of BAU Emission prior to adjustment

Calculated using the regression equation* and crude steel output

BAU regression equation: $y = 1.271x + 0.511$ (x=Crude steel output)

* The correlation function for crude steel output and CO_2 emissions was established based on the regression equation obtained by analyzing the correlation between crude steel output and CO_2 emission intensity for FY2005-FY2009 (using the FY2005 electricity coefficient every year).

FY2017 crude steel output (total for participating companies) = 112.1 million tons

Adjustment FY2017 BAU emissions = 179.69 million tons of CO_2 (A)

(2) Calculation of change in CO_2 emissions due to change in production mix

CO_2 conversion using changes in upstream (pig iron ratio) and downstream (product category mix) processes based on the RITE index

Upstream change volume: +1.68mn tons of CO_2

Downstream change volume: -1.50mn tons of CO_2

FY2017 change in CO_2 due to change in production mix (upstream and downstream): +180,000 tons of CO_2 (B)

(3) Adjusted BAU Emissions

FY2017 adjusted BAU Emissions = 179.88 million tons of CO_2 [(A) + (B)]

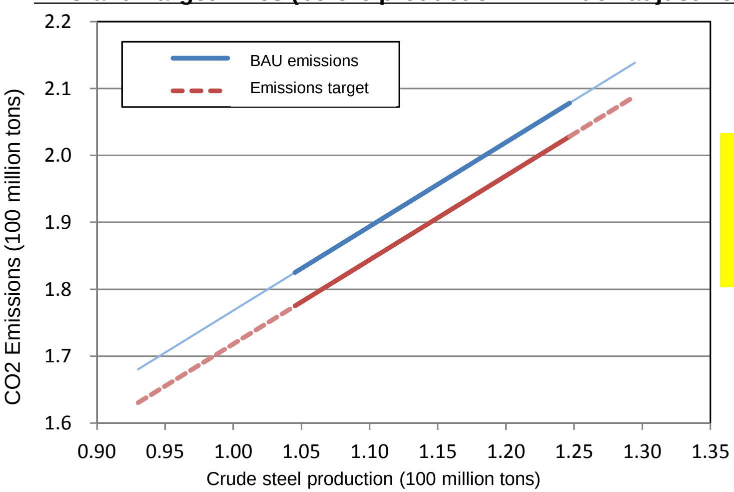
Reexamination of BAU by reflecting changes in steel production mix (1)

- Up to FY2014, the JISF's Commitment to a Low Carbon Society used evaluations with a BAU line (left graph) incorporating the assumption that the FY2005 production mix will not change.
- Currently, changes are taking place in the production mix. For example, as Japanese steelmakers move production to Southeast Asia and other overseas locations, the shift of some final production processes has raised the percentage of intermediate products (such as hot-rolled sheets). Also, the percentages of some finished products (such as galvanized sheets) are decreasing. Pig iron production has increased in proportion to these changes and CO_2 emissions are rising as a result.
- Incorporating these changes was not possible with the previous BAU line. Consequently, the change in CO_2 associated with the production mix change was calculated by using the production mix index produced by RITE (the RITE index). Starting in FY2015, emissions have been evaluated by using the adjusted BAU line, which incorporates the BAU line.

Until FY2014

Assumes no change in production mix from FY2005 level

BAU and Target Lines (before production mix index adjustment)



* This target assumes that Japan's crude steel output will be 120 million tons, with a variance of no more than 10 million tons.

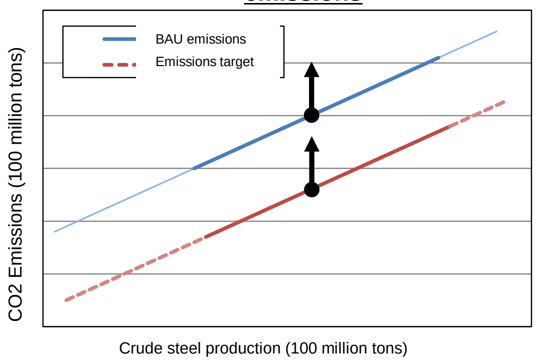
* The colored sections of the graphs on this page show the range of production at companies participating in the Commitment to a Low Carbon Society when Japan's crude steel output is between 110 million and 130 million tons.

Used for FY2017

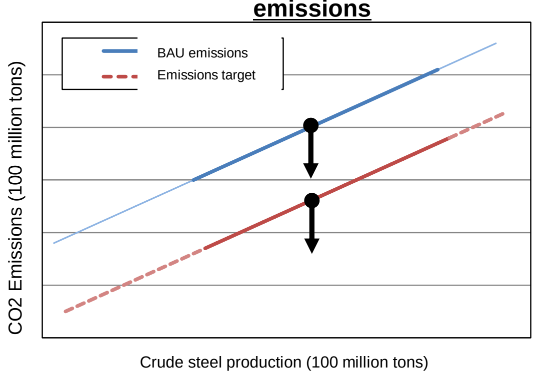
Since FY2015

Adjusted to reflect production mix change since FY2005

When production mix change increases CO_2 emissions



When production mix change reduces CO_2 emissions



(Reference) Changes in steel production mix

- When determining the RITE index, the total change in CO_2 emissions caused by a production mix change is evaluated by adding the changes in emissions associated with a change in the pig iron ratio for upstream processes and a change in the product mix for downstream processes.
- The BAU line uses a production mix that remains the same as in FY2005. As a result, it is possible to perform a proper evaluation with the BAU line in which the changes in the production mix are incorporated by shifting the line according to the changes.

Share of Pig Iron (Upstream processes)

	2005	2016	2017	17-05	17/05 (%)	17-16	17/16 (%)
Crude steel (1000t)	112,718	105,166	104.837	-7,881	-7.0	-329	-0.3
BF-BOF (1000t)	83,645	81,294	79,252	-4,393	-5.3	-2,042	-2.5
EAF(1000t)	28,595	23,545	25,201	-3,394	-11.9	1,657	7.0
Pig Iron (1000t)	82,937	79,829	78,365	-4,571	-5.5	-1464	-1.8
BF-BOF (%)	74.2	77.3	75.6	1.4	-	-0	-
EAF (%)	25.4	22.4	24.0	-1.3	-	0	-
Pig Iron (%)	73.6	75.9	74.7	1.2	-	-1	-

Share of Long and Flat Products (Downstream processes)

		2005 ratio (%)	2016 ratio (%)	2017 ratio (%)	17-05	16-17
Long	Shape	7.5	6.6	6.8	-0.7	0.2
	Bar	12.3	9.8	9.9	-2.4	0.1
	total	**23.5**	**19.8**	**20.0**	**-3.5**	**0.2**
Flat	Plate	11.3	10.2	9.7	-1.7	-0.6
	HRS	11.3	19.3	18.4	7.0	-1.0
	Cold-rolled flat products	8.6	7.9	7.9	-0.8	0.0
	Galvanized sheet	14.6	12.5	12.7	-2.0	0.1
	total	**46.3**	**50.4**	**49.1**	**2.8**	**-1.3**

- An increase of 1.2 percentage point in pig iron's share from FY2005 to FY2017

- Between FY2005 and FY2017 the share of long products decreased and the share of flat products increased.
- In flat products, HRS (hot-rolled strips) increased and cold-rolled flat products and galvanized sheets decreased.

CO_2 conversions using the RITE index to incorporate the above changes

Upstream: +1,681 mmtCO_2

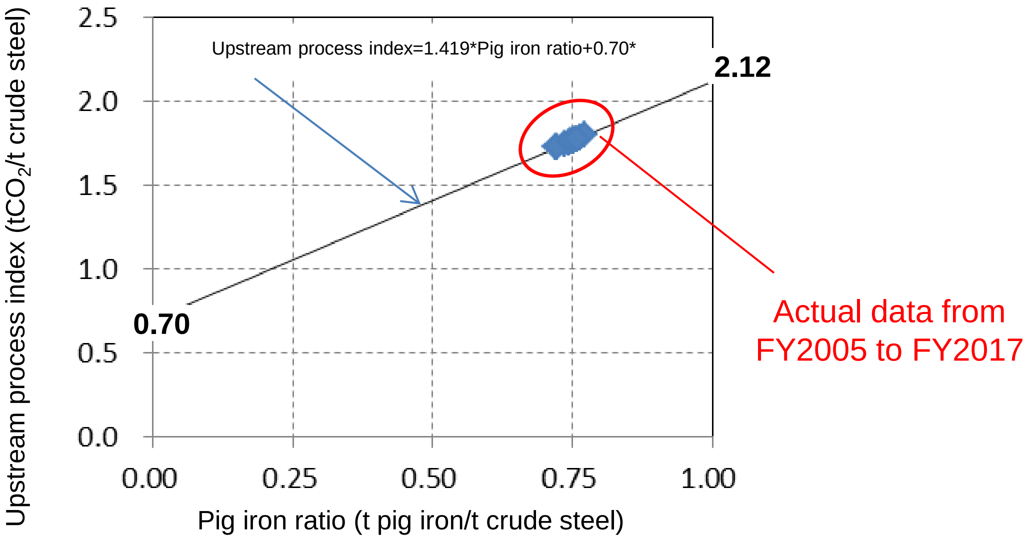
Downstream: -1.497 mmt-CO_2

Total: +185mmt-CO_2

(Reference)Summary of the Upstream Process Index

- Crude steel is made by reducing natural resources to make pig iron or by using steel scrap that has already been reduced. The pig iron ratio is the amount of pig iron produced in relation to the production of crude steel (pig iron output divided by crude steel output). Variations in this ratio also affect unit CO_2 emissions.
- To evaluate this effect properly, a primary coefficient is established that includes (1) comprehensive energy statistics, (2) IEA energy balance table, (3) environmental reports of steelmakers, (4) international peer-reviewed papers and other items.
- The number obtained by using this primary coefficient is the upstream process index. The formula is: y (Upstream index) = 1.419 x (Pig iron ratio) +0.70.
- Changes in CO_2 emissions caused by changes in the pig iron ratio are calculated multiplying the difference between the upstream process index for FY2005 and each subsequent year by crude steel output.

Relationship between Pig Iron Ratio and Upstream Process Index



* This equation incorporates (1) comprehensive energy statistics, (2) IEA energy balance table, (3) environmental reports of steelmakers, (4) international peer-review papers and other items.

Actual data (FY2005 and FY2017)

	Pig iron ratio	Upstream process index
FY2005	0.736	1.743
･ ･ ･	･ ･ ･	･ ･ ･
FY2017	0.747	1.760

FY2005: 1.419×0.736+0.70=1.743
FY2016: 1.419×0.747+0.70=1.760

Change in CO_2 emissions due to change in pig iron ratio (FY2017)

(1.760-1.743)×101.21mnt = 1.68mnt
⇒Assessed as a 168 million ton increase in CO_2 emissions

Summary of the Downstream Process Index

Unit CO_2 emissions per ton of production* have been established for different shapes of ordinary steel and types of specialty steel, a total of 35 product categories, for which general statistics are accessible. Using FY2005 as the reference year, the change in CO_2 emissions caused by the change in the production mix in each year is then calculated. This calculation is performed as follows.

A. The product mix ratio for each steel product in each year (Table 1) and unit CO_2 emissions (Table 2) are multiplied (Table 3).

B. All the numbers obtained from the step A are added (which yields a composite unit emission value weighted for the production mix): 0.846 in FY2005 and 0.831 in FY2017 in the table below

C. Multiply the difference between the composite unit emission value for the year being evaluated and the reference year (FY2005), which is the composite unit emission difference) and crude steel output (convert the unit difference into a total volume).

For FY2017: (0.831-0.846) x 101.21mnt = -1.50mnt

*Unit CO_2 emissions for each steel product category for all years are based on the worldsteel LCI data collection. Averages for Japan calculated by using actual FY2014 data are used when available for these products. For products where there is no Japan average, unit emissions are estimated by using the relationship between unit emissions for steel for which Japan averages exist and selling prices (FY2010 export prices using trade statistics).

		Steel bars	Hot-rolled strips	Cold-rolled sheets	Galvanized sheets	……	Total
Product mix ratio (1)	FY2005	12.3%	9.9%	6.6%	12.0%		100%
	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	FY2017	9.9%	16.0%	6.4%	10.1%		100%
Unit CO_2 emissions per ton of production (2) (common figures)		0.73	0.67	0.71	0.96		—
(3) = (1) x (2)	FY2005	0.09	0.07	0.05	0.11		0.846
	⋮	⋮	⋮	⋮	⋮	⋮	⋮
	FY2017	0.07	0.11	0.05	0.1		0.831

A composite unit emission figure that reflects the product mix in each year

FY2017 Results of JISF's Commitment to a Low Carbon Society

Progress toward targets
*Totals for companies participating in the Commitment to a Low Carbon Society

- Crude steel production: 101.21 million tons (down 6.4% from FY05)
- BAU emissions for FY17 crude steel production: 179.88 million tons of CO_2 - (1)
- CO_2 emissions (using FY05 electricity coefficient): 177.52 million tons (down 5.8% from FY05) - (2)
- Reduction vs. BAU: 2.29 million tons of CO_2 (0.71 million tons above the target)※

* Waste plastic use increased from 450,000 tons in FY2005 to 470,000 tons in FY2017, resulting in a decrease of 70,000 tons in the CO2 conversion. For the management of targets in the low carbon society action plan, only the portion of the increase vs. FY2005 in waste plastics corresponding to the higher capacity to collect these materials is counted. The deduction of 2.29 million tons of CO2 from BAU does not include the 70,000 ton reduction due to higher waste plastic use.

FY2017 Energy Consumption and CO_2 Emissions

- Energy consumption: 2,155PJ (down 5.8% from FY05)
- CO_2 emissions (using electricity coefficient with FY17 credit): 181.20 million tons (down 3.8% from FY05)

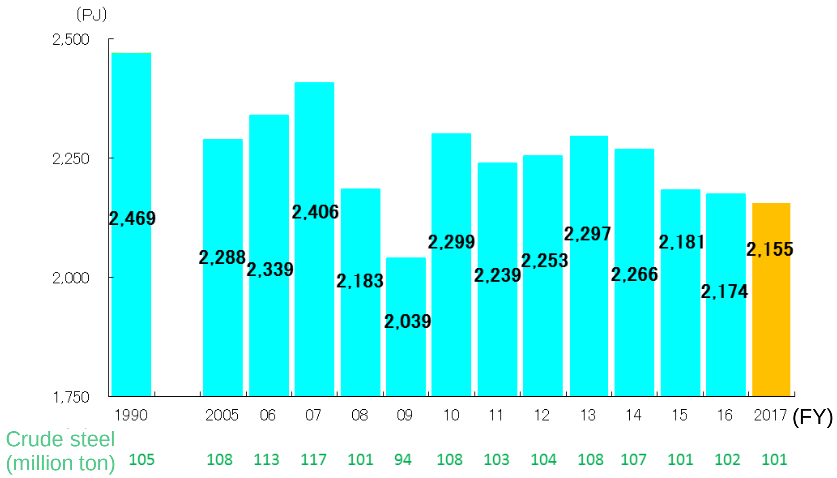
Reference: Japanese steel industry total

- Crude steel production: 104.84 million tons (down 7.0% from FY05)
- Energy consumption: 2,230PJ (down 5.5% from FY05)
- CO_2 emissions (using electricity coefficient with FY16 credit): 185.64 million tons (down 3.6% from FY05)

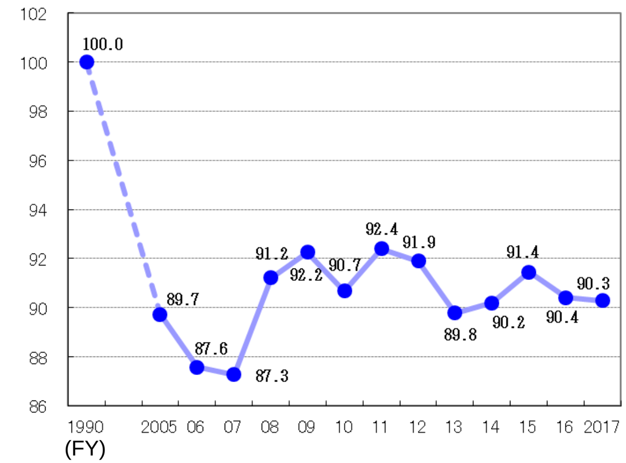
* Energy consumption and CO_2 emissions for the Japanese steel industry are estimates based on statistics for the use of petroleum and other energy sources.

Annual Trend of Energy Consumption and CO_2 Emissions

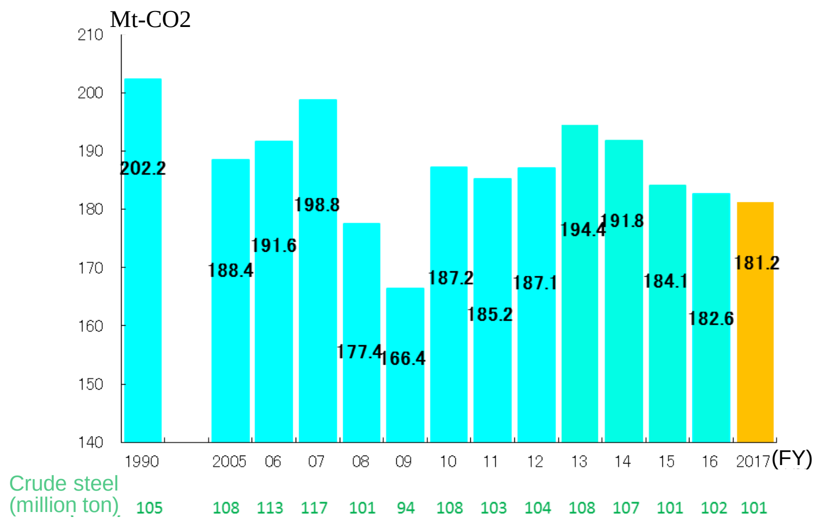
Total Energy Consumption



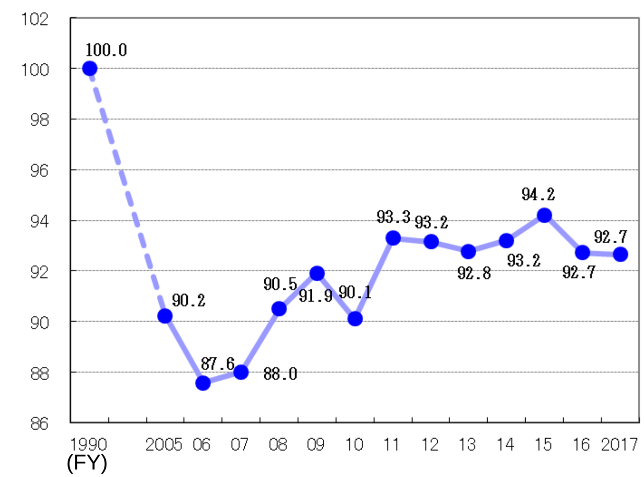
Unit Energy Consumption (FY1990 level=100)



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



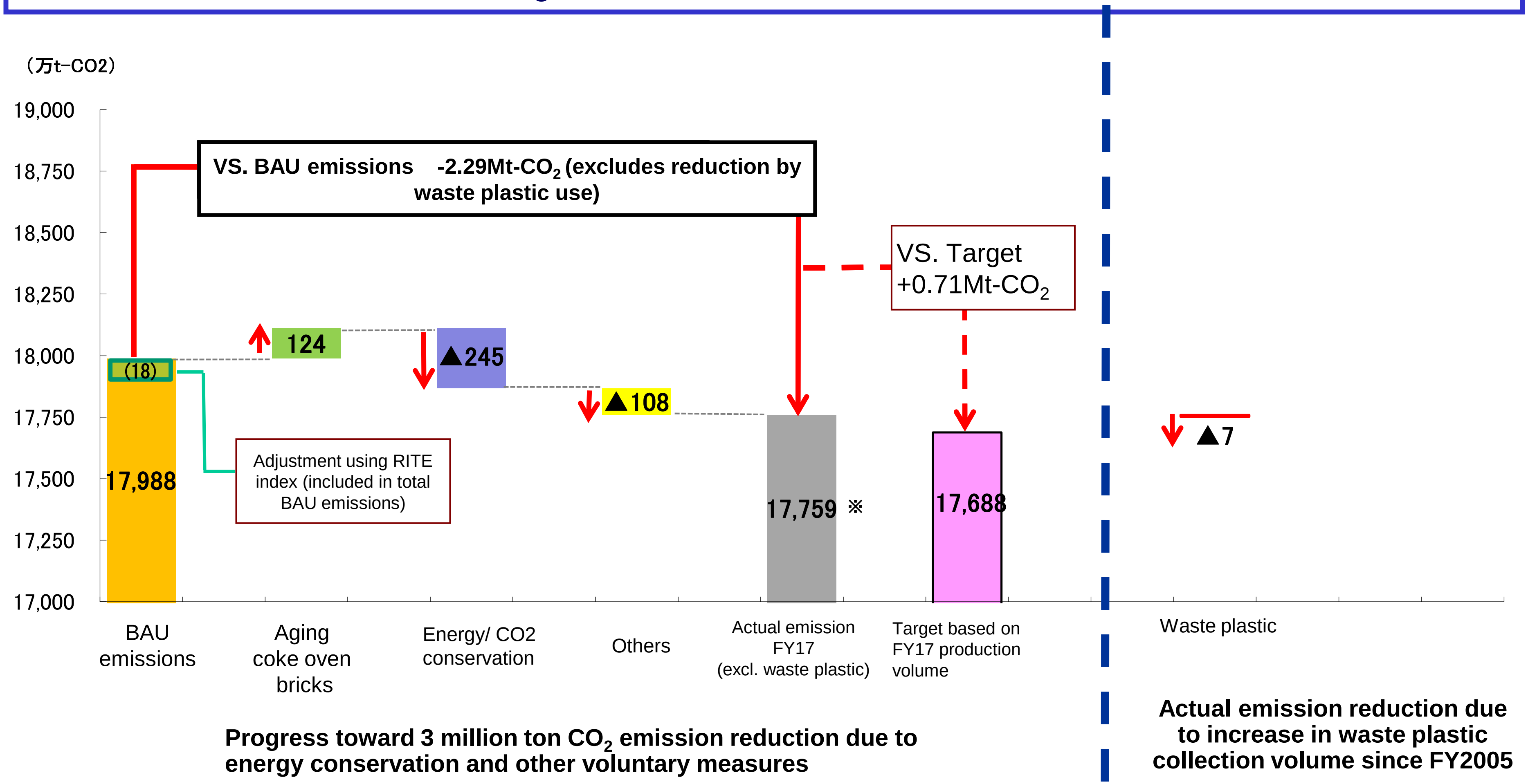
Unit CO_2 Emissions (FY1990 level=100) (Incorporate improvement by emission credit)



*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 FY2017 CO_2 Emissions

- In FY2017, CO_2 emissions were 2.29 million tons below the BAU level. Energy and CO_2 conservation measures cut emissions by 2.45 million tons, aging bricks in coke ovens raised emissions by 1.24 million tons, and other measures cut emissions by 1.08 million tons. (excluding the 0.07 million tons reduction by waste plastic use)
- 0.71 million tons below the target.



※FY2017 CO_2 emissions use the FY2005 electricity coefficient.

Evaluation of FY2017 Performance

- Despite a number of factors unforeseen when targets were established, the emissions continued to decrease steadily in FY2017 as numerous voluntary actions took effect.

1. Progress with measures incorporated in the target ①

	Expected target	FY2016	FY2017	
(1) Reductions from energy saving actions ● Higher coke oven efficiency ● More efficient power generation ● More energy conservation	-3.00Mt	-2.44Mt	-2.45Mt	• Progress of about 80% toward the target between FY05-FY16 (12 years)

2. Factors affecting emissions that were unforeseen when targets were established ②

	Expected target	FY2016	FY2017	
Aging coke oven bricks	–	+1.11Mt	+1.24Mt	• Aging coke oven bricks caused unit energy consumption to climb. Probable causes are the aging of bricks (especially significant in ovens above a certain age) and the impact of the Tohoku earthquake and tsunami of 2011 • All member companies have started replacement work. But increase in emissions due to aging bricks is still more than the reduction due to ongoing replacements.
Other issues	–	-1.04Mt	-1.08Mt	• Difficult to analyze causes, but one probable cause is efforts by operational improvement in steel mills.
Total	Not incorporated	+0.07Mt	+0.16Mt	

3. Progress toward targets (①+②)

	Expected target	FY2016	FY2017	
Reduction vs. BAU	-3.00Mt	-2.37Mt*	-2.29Mt	• Reduction vs. BAU decreased in FY2017 mainly because of higher CO_2 emissions caused by aging coke oven bricks

4. Progress with using waste plastics

	Expected target	FY2016	FY2017	
Higher waste plastic use	–	0	-0.07Mt	• A reduction of 70,000 tons because the FY2017 capacity to collect waste plastics was 20,000 tons higher than in FY2005

*** The confirmed figure reported for FY2016 was a reduction of 2.46 million tons of CO2, which was 540,000 tons below the target. In the current fiscal year, some coefficients were retroactively revised, such as coefficients for the unit calorific value for city gas and some other types of fuel. After reflecting these revisions, emissions in FY2016 decreased 2.37 million tons, which was 630,000 tons below the target.**

Coke Oven Updates

- JISF member companies have started replacing aging bricks in coke ovens, which is one cause of the increase in CO_2 emissions. Improvements at eight coke ovens were already completed during Phase I of the Commitment to a Low Carbon Society.
- As shown below, although work has started, it will not be possible to update all coke ovens quickly because of the limited availability of workers (coke oven construction specialists) and the high cost of updates (tens of billions of yen for each oven).

JISF Member Company Coke Oven Update Plans (Company and newspaper announcements as of January 2019)

(1) Completed Updating Projects (8 ovens)

Year	Steel works	Cost
FY2013	JFE Steel, West Japan Works, Kurashiki	About ¥15 billion
FY2015	JFE Steel, West Japan Works, Kurashiki	About ¥20 billion
FY2016	Nippon Steel & Sumitomo Metal, Kashima Works	About ¥18 billion
	JFE Steel, East Japan Works, Chiba	
	Nippon Steel & Sumitomo Metal, Kimitsu Works	About ¥29 billion
FY2017	JFE Steel, West Japan Works, Kurashiki	About ¥18.4 billion
FY2018	Nippon Steel & Sumitomo Metal, Kashima Works	About ¥31 billion
	JFE Steel, West Japan Works, Chiba	

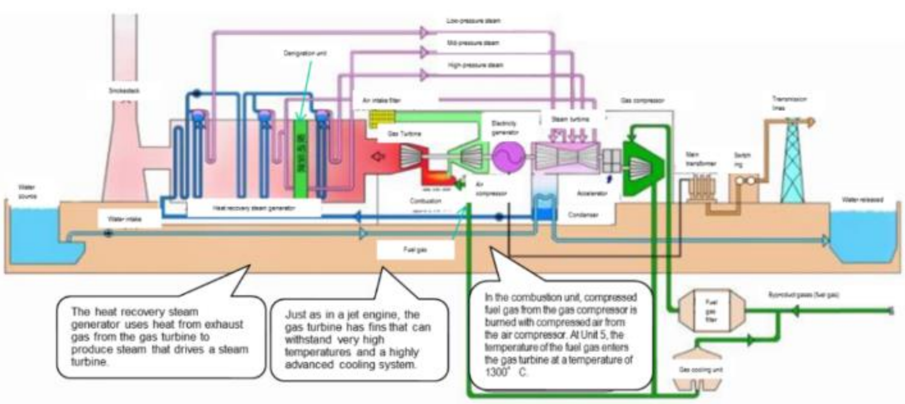
(2) Planned Updating Projects (5 ovens)

Year	Steel works	Cost
FY2018	Nippon Steel & Sumitomo Metal, Kimitsu Works	About ¥33 billion
FY2019	Nippon Steel & Sumitomo Metal, Muroran Works	About ¥13 billion
	JFE Steel, West Japan Works, Fukuyama	About ¥27 billion
FY2021	JFE Steel, West Japan Works, Fukuyama	
	Nippon Steel & Sumitomo Metal, Nagoya Works	About ¥57 billion

Major Initiatives implemented or planned since FY2005

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

Advanced Combined Cycle Power Generation



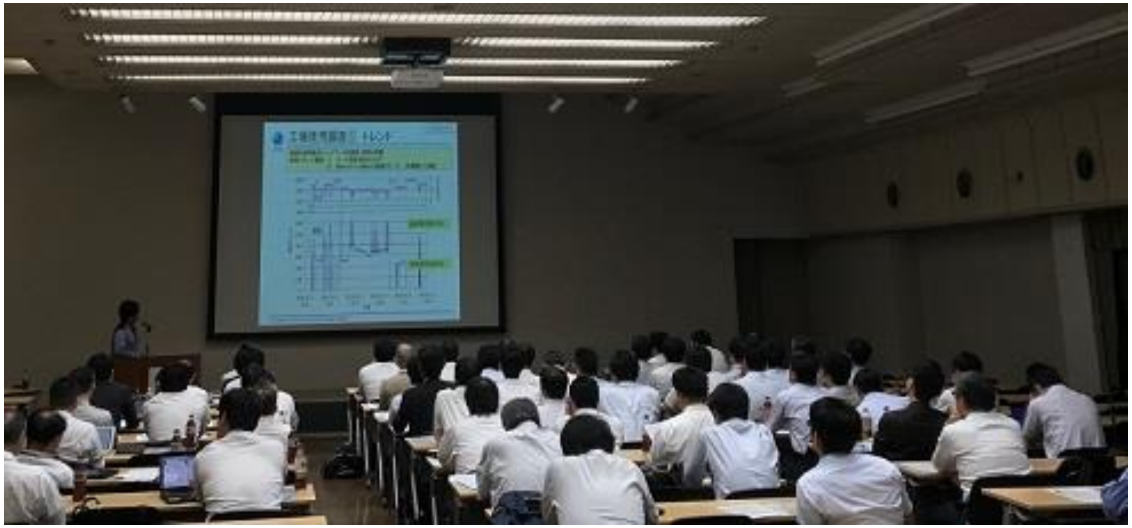
2. More efficient power
Kobe Steel Kakogawa Station No. 1 Gas turbine combined cycle unit (2011)
Kimitsu Joint Thermal Station No. 6 Advanced combined cycle unit (2012)
Kashima Joint Thermal Station No. 5 Advanced combined cycle unit (2013)
Wakayama Joint Thermal Station No. 1 Advanced combined cycle unit (2014)
Oita Joint Thermal Station No. 3 Advanced combined cycle unit (2015)
Kobe Steel Kakogawa Station No. 2 Gas turbine combined cycle unit (2015)
JFE Steel Chiba Station West-No. 4 Gas turbine combined cycle unit (2015)
Nisshin Steel Kure Power Station No. 6 Boiler, turbine and generator (planned for 2017)
JFE Steel Ohgishima Thermal Station No. 1 Gas turbine combined cycle (planned for 2019)
Fukuyama Joint Thermal Station No. 2 Gas turbine combined cycle (planned for 2020)

Source: Kimitsu Cooperative Thermal Power Company, Inc.

Activities to Share Best Practices Information in the Steel Industry

- JISF holds meetings that bring together energy personnel of the business sites (blast furnace and EAF) of all member companies at the steel mills of blast furnace steelmakers. These meetings are conducted under the Committee for Expanding the Use of Energy Technology Committees for the purpose of sharing information about effective energy conservation cases that can be made public. Thus far, 76 of these meetings have been held. Normally, about 60 to 70 people participate in these events every year and about 15 presentations are given. Participants come from blast furnace steelmakers and EAF specialty and ordinary steelmakers.
- Information at these events is not limited to equipment updates and replacements, participants also hear about improvements to operations. Every meeting is a valuable opportunity for sharing information and opinions in subject to detailed energy consecration efforts with other participants..
- In FY2018, a meeting was held at the Keihin District of JFE Steel’s East Japan Works. More than 70 people from blast furnace steelmakers and EAF specialty and ordinary steelmakers attended this event.

A Best Practices Information Meeting



Opening remarks by Mr. Tezuka, Chairman of the Energy Technology Committee

Energy Conservation Measures for Blast Furnaces

Boiler combustion control system – ULTY

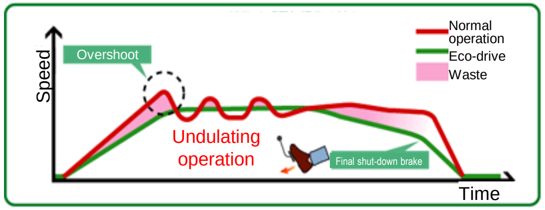
1. Summary

- ULTY was developed jointly by NYK Trading and Nippon Steel & Sumitomo Metal in 2005.
- This technology prevents burning excess fuel by adjusting combustion based on a correction figure obtained by using a special calculation method concerning excessive fuel input. ULTY can cut boiler fuel consumption by about 1% to 1.5%.

2. How ULTY works (concept)

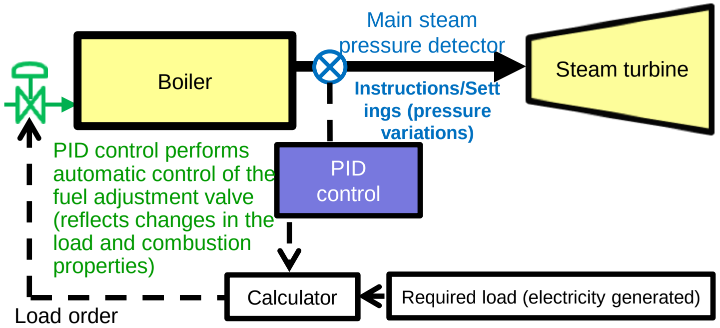
Per unit fuel input improves (better fuel efficiency) by using smooth operational control (eco-drive) to reduce the input of excessive fuel (Figure 1).
*There is no need to modify the boiler; only wiring is changed.

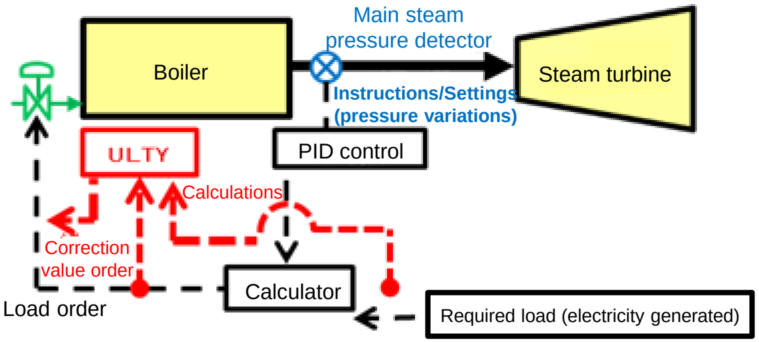
Figure 1 Smooth Operational Control



3. The technology behind ULTY

ULTY identifies operational misalignments and sends additional corrections to the existing control circuitry (alters the time constant, reduces control misalignments, quickly stabilizes operation). Eliminates control misalignments caused by external factors (change in load, change in combustion properties, etc.) in order to prevent the input of excessive fuel





4. Engineering schedule

Production: 3 months, Installation: 5 days, Final inspection by manufacturer: 6 days, Boiler run: 5 days

5. UTLY installations

50 UTLY systems were in use as of June 2016 (according to NYK Trading website information)

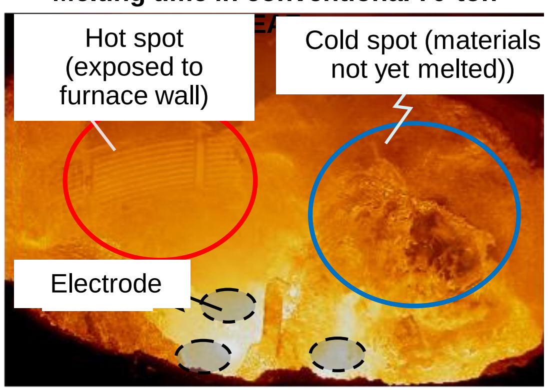
Energy Conservation in Electric Arc Furnace (EAF)

- As part of measures to streamline steel production, Daido Steel constructed and began operating in November 2013 a large EAF at its Chita Plant with technologies to achieve the highest possible uniformity of scrap melting. The new furnace raised capacity from 70 to 150 tons.
- Three-phase AC EAFs normally require three electrodes. Melting can be uneven due to differences in how far each electrode is from the furnace wall. To solve this problem, most companies place an auxiliary burner in locations far from electrodes (cold spots).
- Although burners improve melting performance, unit energy consumption is higher and flame rebound damages the furnace, which boosts maintenance expenses. Daido developed a rotating EAF that uses the spinning motion to move cold spots closer to the electrodes. This dramatically improves melting uniformity and cuts the amount of energy required.

EAF Problems

- Triangular configuration of three electrodes in a round furnace results in different electrode-wall distances
- Materials near electrodes (hot spots) melt before materials farther from electrodes (cold spots). This causes a big energy loss in hot spots if the furnace continues to operate.

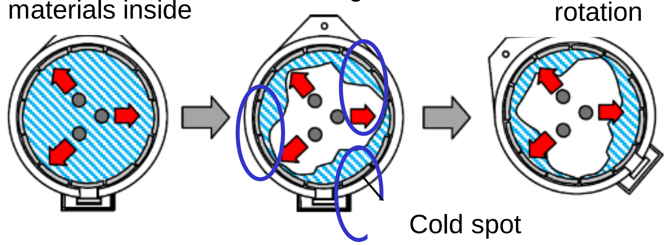
Melting time in conventional 70-ton EA



Rotating Furnace Technology

- Maximum furnace rotating angle is 50°

A typical rotating EAF

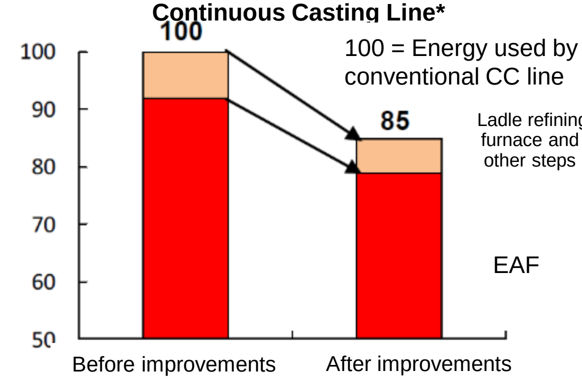


A rotating electric arc furnace

Benefits of the Rotating EAF

- Lower EAF unit energy consumption (including benefit of the larger furnace volume)
- In addition to EAF improvements, Daido Steel's improvements shortened processing time by creating a separate ladle transport line, greatly reduced variations in steel quality, and lowered the temperature required by the ladle refining furnace.
- Overall, Daido Steel cut unit energy consumption by about 15%.

Energy Saving Due to Streamlined Continuous Casting Line*

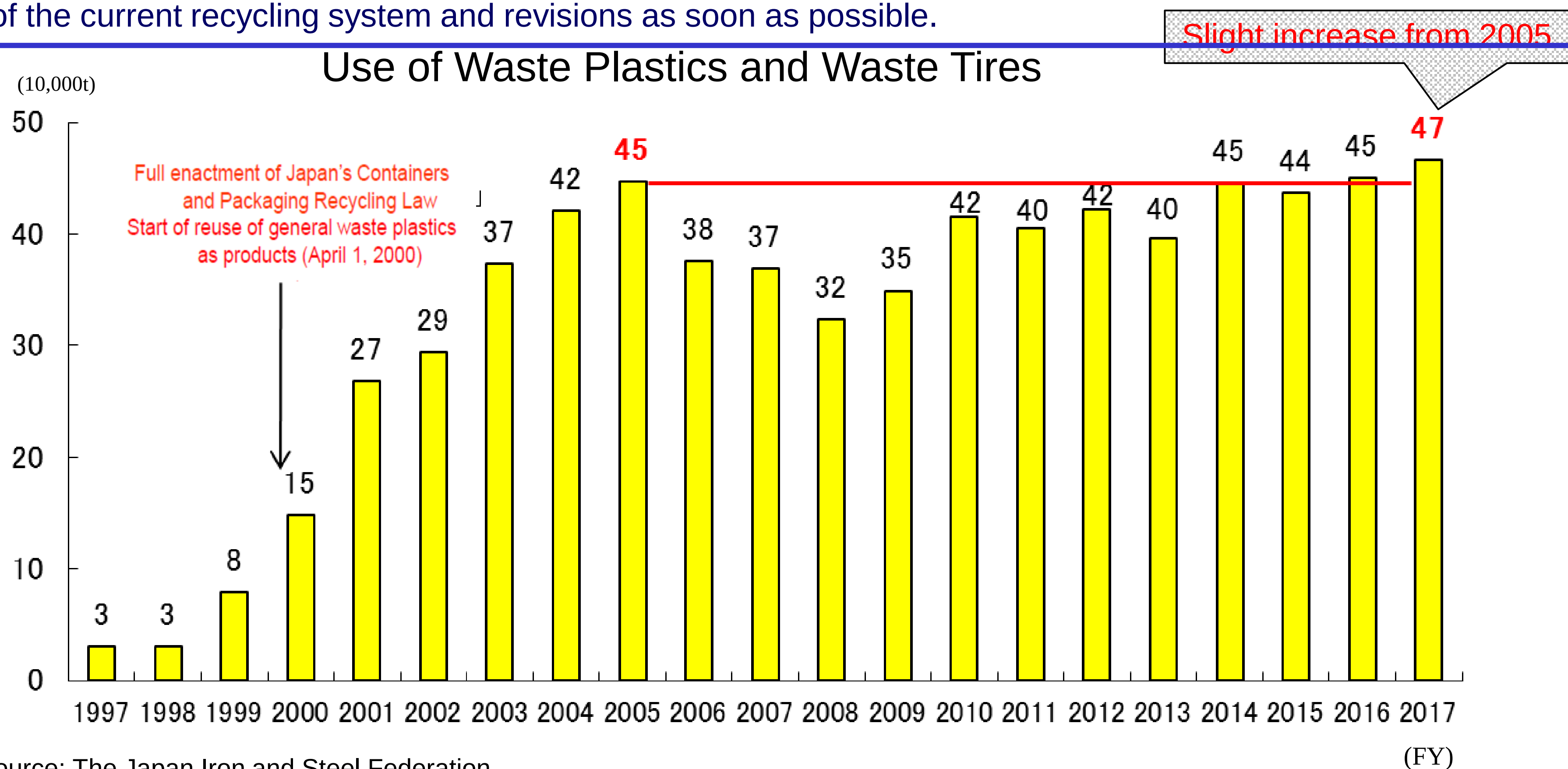


* Continuous casting covers all steps from the EAF through casting.

Source: Daido Steel

Use of Waste Plastics and Other Recycled Materials

- JISF's commitment to a Low Carbon Society has the goal of raising the use of waste plastics and other recycled materials to 1 million tons, assuming the government establishes the necessary collection infrastructure. However, collections totaled 470,000 tons in FY2017, unchanged from FY2005 collections of recycled materials.
- A great amount of CO_2 emission reduction is possible by reexamining associated policies for the use of waste plastics and other materials. At government councils and other opportunities, JISF constantly ask for reviews of the current recycling system and revisions as soon as possible.

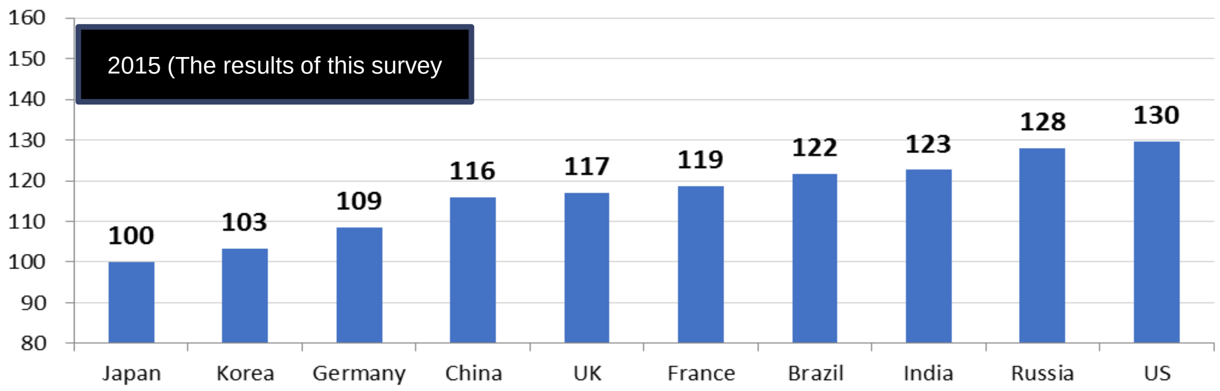


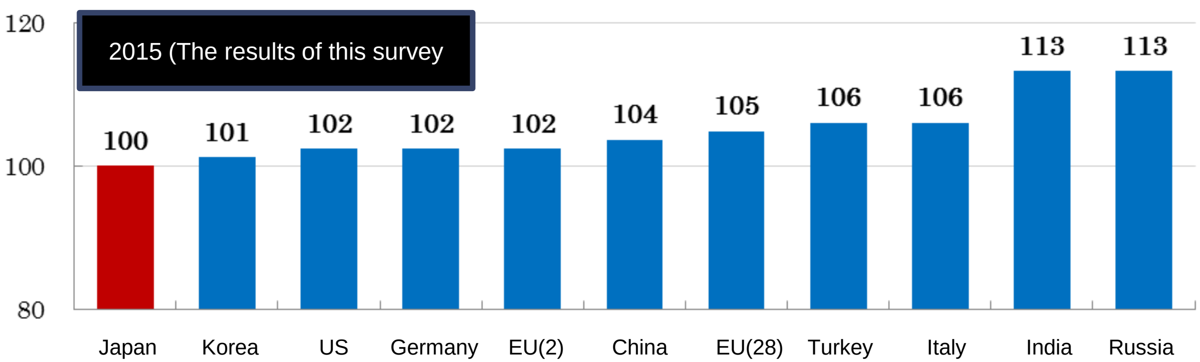
Source: The Japan Iron and Steel Federation

Japan's steel industry (BF-BOF・EAF) maintains the world's highest energy efficiency

- The Research Institute of Innovative Technology for the Earth (RITE) issued an report in 2018 on international comparison of energy efficiency level in steel industry (BF-BOF*). The report revealed that Japan maintains the world's highest energy efficiency in 2015, as in 2005 and 2010.

Estimate of Steel Industry (BF-BOF) Energy Efficiency (2015, Japan=100)





Why is Japan's steel industry the most efficient?

- The **penetration rate of energy-saving technologies** is very high in Japan's steel industry.
- All steelmakers are working on achieving the goals of the JISF's Commitment to Low Carbon Society and **sharing best-practice knowledge** among themselves.

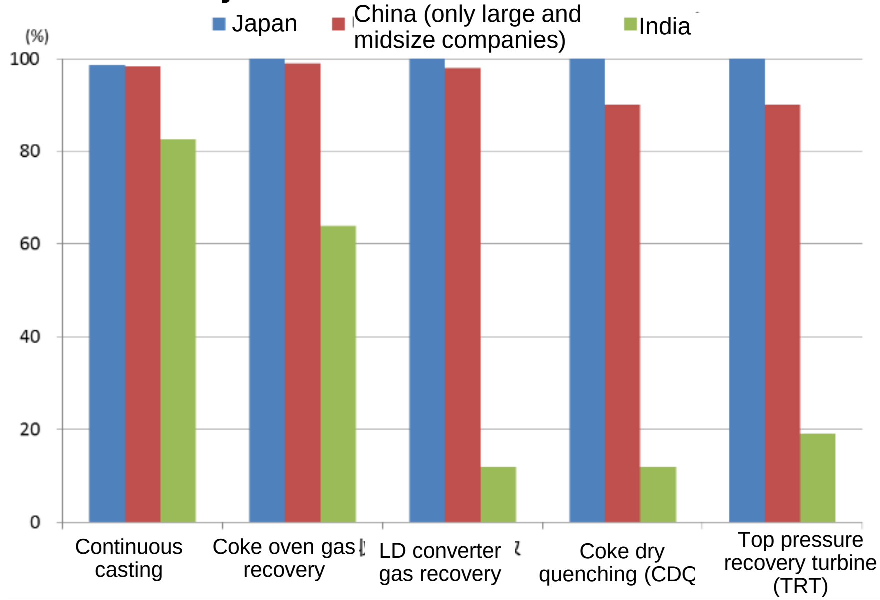
In addition to actions in Japan, increasing the use of energy-saving measures and technologies worldwide will be an effective way to further lower CO_2 emissions in the steel industry.

2. Eco Solution

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 63 million tons.

Utilization Rates of Major Energy Conservation Equipment by Blast Furnace Steelmakers



Emission Reductions in Other Countries from Japanese Energy-conserving Equipment (FY2017)

(Mt/year)

	No. of units	Reduction
Coke dry quenching (CDQ)	96	19.69
Top-pressure recovery turbines (TRT)	62	11.02
Byproduct gas combustion (GTCC)	52	21.90
Basic oxygen furnace OG gas recovery	21	8.21
Basic oxygen furnace sensible heat recovery	7	0.90
Sintering exhaust heat recovery	6	0.88
Total emission reduction		62.59Mt

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

Ref: Total emission reduction in FY2016 was 60.01Mt - CO_2/year

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 FY2014 in Japan, 20134for 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 Collaboration for the Support of Eco Solutions

- Under certain circumstances, energy-conservation equipment supplied to users worldwide by Japanese engineering companies has the potential to reduce annual CO_2 emissions by 70 million tons in 2020 and 80 million tons in 2030. This is equivalent to more than 40% of all CO_2 emissions of the Japanese steel industry.
- In India and other emerging countries where steel production will continue to climb, the use of energy-conservation facilities as standard equipment at newly constructed steel mills could prevent discharging annual CO_2 emissions of approximately 10 million tons. Consequently, eco solutions can be an extremely effective way to fight against global warming.

2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018

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 (2014~)

Multilateral Activities

APP Steel TF (2006~2010)
APP: Asia Pacific Partnership

GSEP Steel WG(2010~2015)
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~)
Versions for integrated steel plants and EAF issued in 2013, version for DRI-EAF in 2017
*International standard for the calculation of CO_2 emission from steel plants

Global Warming Activity Information Sent to Talanoa Dialogue about JISF Report and Japanese Government Report

* Talanoa is Fiji language word that means "an all-inclusive, participatory transparent dialogue process. Fiji chairs COP23. The Talanoa Dialogue was created for the purpose of sharing examples of highly effective initiatives for reducing greenhouse gas emissions worldwide. The goal is to increase the commitment of countries to achieve emission reduction goals.

A story was posted on the Talanoa Japan website to explain activities of the JISF to fight global warming in order to contribute to the Talanoa Dialogue.

Story | Business

Japan's iron and steel sector initiatives to tackle global warming - Contributing to mitigation and adaptation in accordance with the Paris Agreement -

Japan's iron and steel sector has carried out voluntary initiatives on global warming based on the three pillars of environmental action, as well as the fourth pillar of innovative technology development. Under these four pillars, the industry has aligned with the Paris Agreement to take the following actions for climate mitigation and adaption, thereby contributing to tackling global warming on a global scale.

1. Providing steel essential to maintain disaster-resilient social infrastructure designed to prevent and reduce future predicted damage as an adaptation measure.
2. Further improving the functionality of steel to contribute to improving the energy conservation of next-generation industrial products.
3. Ensuring low-carbon manufacturing processes in the steel sector worldwide and developing innovative technologies for drastic long-term reductions to accomplish these actions

Organisation	The Japan Iron and Steel Federation
Detail	20181004-015.pdf（Japanese only, PDF, 1.15MB）
Date	04 October 2018

A document submitted to the Talanoa Dialogue by the Japanese government on October 31, 2018 includes activities by the Japanese steel industry.

○ Iron and steel

Japan's iron and steel sector is working on development of innovative technologies that will be a key to drastic CO_2 emission reductions in the future, such as COURSE50 (※1) and ferro-coke (※2). The sector has been conducting steel plant diagnosis mainly in emerging economies in the steel industry such as India and ASEAN countries, and promoting technology transfer such as the most effective energy saving and environmental protection technologies that are suitable for each of these countries and regions. In addition, Japan's iron and steel sector cooperates with partner countries' steel companies to utilize the energy management tool whereby they could sustainably conduct energy efficiency improvement and CO_2 emission reductions through trends in energy consumption and CO_2 emissions.

※1 COURSE50 aims at CO_2 emission reductions from production processes of about 30% by using hydrogen for iron ore reduction and collecting CO_2 from blast furnace gas. It is scheduled to establish the technologies by ca. 2030 with the final goal of industrializing and transferring the developed technologies by 2050.

※2 Ferro-coke can cut about 10% of energy consumption in the blast furnace operation process by using innovative coke deoxidizing material for the blast furnace (ferro-coke) made from low-grade coal and low-grade iron ore and speeding up and lowering the temperature of the reduction reaction inside the blast furnace.

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**

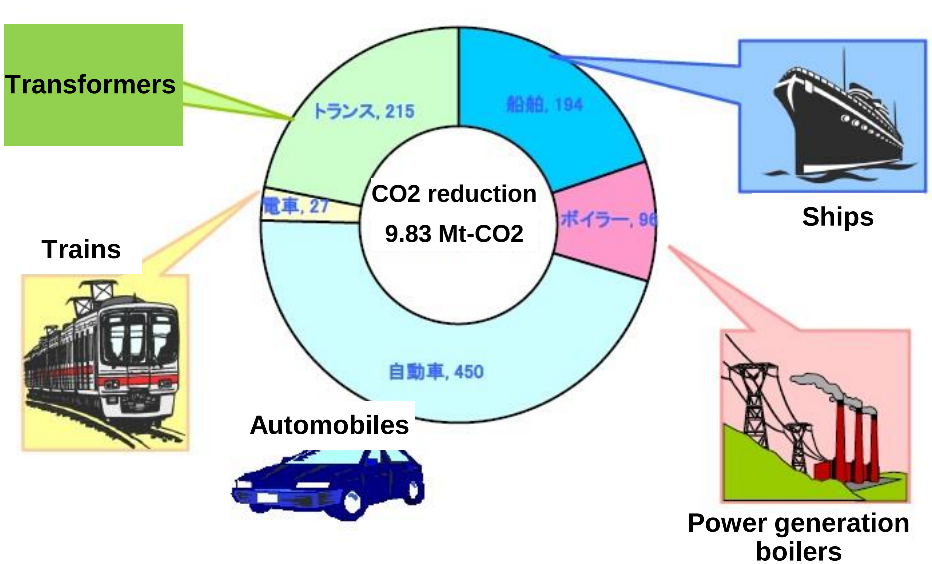
Steel for high-efficiency power plant turbines can withstand high temperatures and high rotation speeds

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

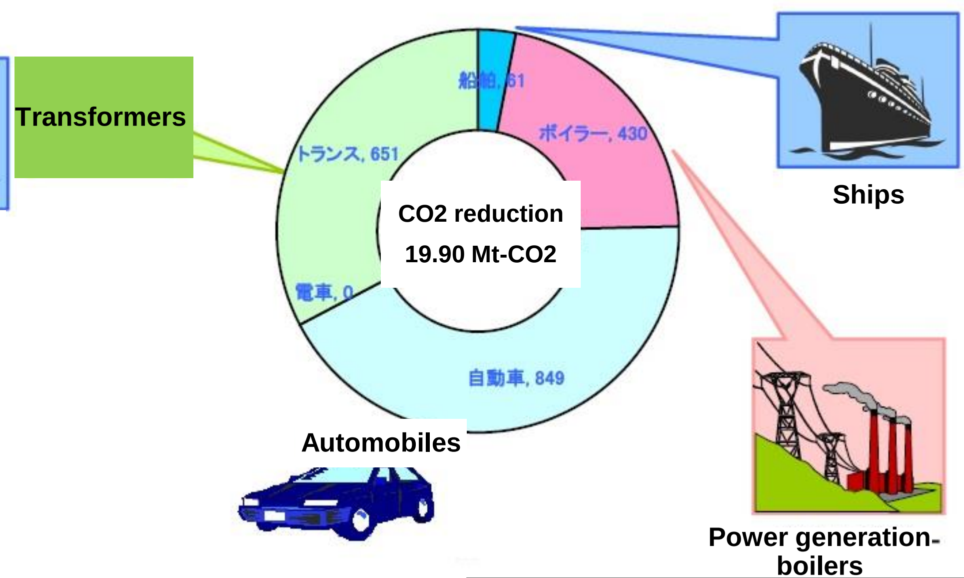
- To establish a method to determine the quantitative contribution of high-performance steel, JISF established in FY2001 a committee with the participation of associations of steel-consuming industries, The Institute of Energy Economics, Japan and the Japanese government. The committee has been monitoring contributions every year since then.
- Statistics are for the five major types of high-performance steel for which quantitative data are available (FY2017 production of 6.95 million tons, 6.6% of Japan's total crude steel output). The use of finished products made of high-performance steel cut FY2017 CO_2 emissions by 9.83 million tons for steel used in Japan and 19.90 million tons for exported steel, a total of 29.73 million tons of CO_2.

CO_2 Emission Reductions by the five major types of high-performance steel (FY2016)

1. Domestic



2. Export



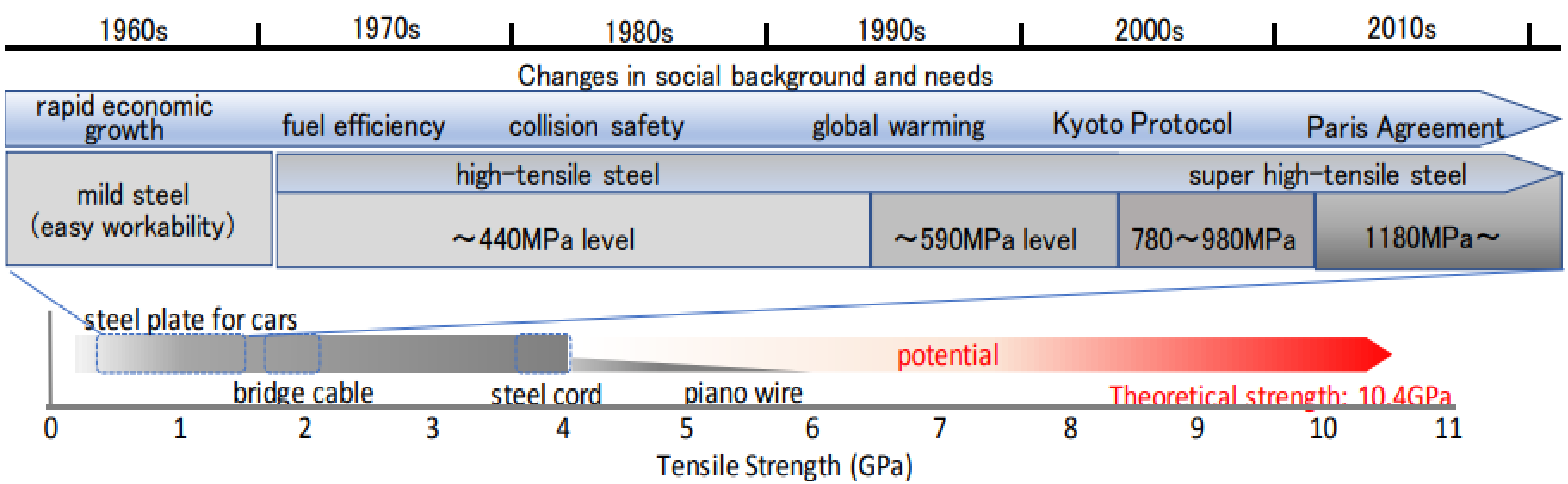
CO_2 Emission Reductions: 29.73 million tons CO_2 in total
(6.95 million tons of high-performance steel)

Ref:
CO_2 Emission Reductions: 28.47 million tons CO_2 by the end of FY2016
(7.36 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 FY2017, use of the five categories of steel products in Japan was 3.18 million tons and exports were 3.77 million tons for a total of 6.95 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.

Eco Product Contribution: Future Potential of Iron and Steel Materials

- Iron and steel materials have greatly improved their mechanical and electromagnetic properties. However, , the characteristic level we put into practical use is only 1/10-1/3 (in the case of strength) with respect to the theoretical limit value.
- Japan Iron and Steel Industry will contribute to the reduction of CO2 in the entire life cycle, while supporting the foundation of the future society, through not only further strengthening steel products but also developing next-generation steel products for hydrogen infrastructure to be expected in the future.



Eco Product Contribution:Quantitative Evaluation of Contribution of High Strength Sheets for Automobiles

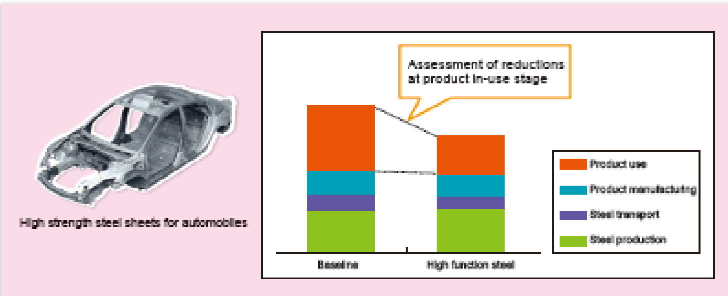
High Strength Sheets for Automobiles

The Japan Iron and Steel Federation

Raw materials/materials → Manufacturing → Sales/Distribution → Use → Disposal/recycling

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. High strength steel sheets for automobiles are steel sheets that can be thinned out while maintaining high strength (and thus reducing steel product weight). Automobiles using this material are lighter than those using conventional steel sheets without such features, thus leading to fuel efficiency improvements that enable CO_2 emission reductions during operation.



Quantification results of avoided emissions

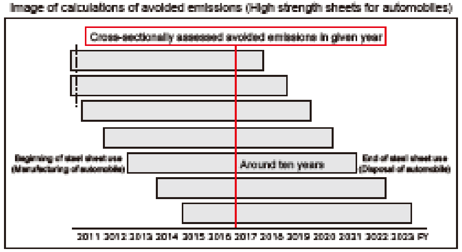
Avoided emissions at the in-use stage of high-strength steel sheets for automobiles in FY2017 were as provided below:

Domestic use	4.5 million t-CO_2
Exports	8.49 million t-CO_2
Total	12.99 million t-CO_2

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Number of new cars manufactured × Average travel distance × Fuel efficiency improvement rate / Average fuel efficiency of new cars × Average years in use

Image of calculations of avoided emissions (High strength sheets for automobiles)



(1) Baseline scenario and assumptions

①Baseline scenario

The case study assessed CO_2 emission reductions from improving fuel efficiency at the in-use stage of automobiles by replacing steel sheets without special functions (normal steel), which serve as the baseline, with high strength steel sheets up to the current share.

	Baseline	Assessed steel sheets	Assessed results
Automobiles	Normal steel	High strength steel sheets (YP340)	Energy savings due to reducing steel sheet weight

②Assumptions

High strength steel sheets can be made thinner than baseline normal steel while maintaining high strength; and therefore, automobiles using this material are lighter than those using conventional steel sheets without such properties, thus leading to fuel efficiency improvements that enable CO_2 emission reductions during operation. (Quantifications are estimates based on actual data.)

(2) Scope of quantification

①Target steel sheets

Steel sheets used domestically and exported steel. (Steel exports from 2009)

The case study covered only steel manufactured in Japan, and excluded overseas manufacture.

(Japanese steel manufacturers do not possess integrated steelworks overseas.)

②Target stages

The case study assessed CO_2 emission reductions due to fuel efficiency improvements at the in-use stage of automobiles.

As raw material mining and transport account for a minuscule percentage of the entire life cycle of iron and steel, and also because the assessment involves replacing steel products, little change is seen at the manufacturing stage.

When assessing the effect of reducing the weight of steel, CO_2 emissions from raw material mining and transport become less than the baseline in accordance with the reduced amount of steel used, but the Federation includes only the in-use stage in its quantifications.

(3) Assessment period

From the viewpoint of comparing CO_2 emissions from a manufacturing process during one fiscal year, the case study performed a cross-sectional assessment of stock.

(4) References

Papers on the method of analysis have been published on the Institute of Energy Economics, Japan website:

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Overview (Japanese) https://eneken.ieej.or.jp/data/pdf/462.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Study 3. Automobiles (high strength steel sheets) (Japanese) https://eneken.ieej.or.jp/data/pdf/465.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (English) https://eneken.ieej.or.jp/data/en/data/pdf/165.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (English) https://eneken.ieej.or.jp/en/data/pdf/172.pdf

Source：Japan Business Federation, “*Contributing to Avoided Emissions through the Global Value Chain*”

Eco Product Contribution: Quantitative Evaluation of Contribution of High Tensile Strength Plates for Vessels

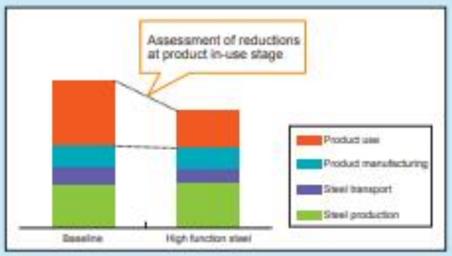
High Tensile Plates for Vessels — The Japan Iron and Steel Federation

Raw materials/materials > Manufacturing > Sales/Distribution > Use > Disposal/recycling

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. High tensile plates for vessels are steel plates that can be thinned out while maintaining high strength (and thus reducing steel product weight). Vessels using this material are lighter than those using conventional steel sheets without such features, thus leading to fuel efficiency improvements that enable CO_2 emission reductions during operation.

High tensile plates for vessels



Quantification results of avoided emissions

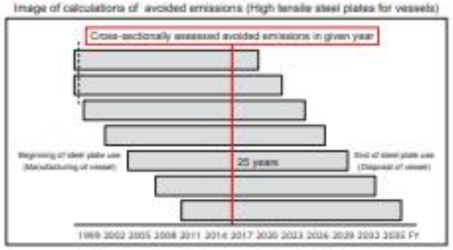
Avoided emissions at the in-use stage of high tensile plates for vessels in FY2017 were as provided below:

Domestic use	1.94 million t-CO_2
Exports	0.61 million t-CO_2
Total	2.55 million t-CO_2

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Fuel consumed by vessels / (1-Weight reduction rate of operating vessels × Contribution ratio to fuel savings) × (Weight reduction rate of operating vessels × Rate of contribution to fuel savings) × Calorific value of fuels

Image of calculations of avoided emissions (High tensile steel plates for vessels)



(1) Baseline scenario and assumptions

① Baseline scenario

The case study assessed CO_2 emission reductions from improving fuel efficiency at the in-use stage of vessels by replacing steel plates without special functions (normal steel), which serve as the baseline, with high tensile steel plates up to the current share.

	Baseline	Assessed steel sheets	Assessed results
Vessels	Normal steel	High tensile steel plates (YP315/YP355)	Energy savings due to reducing steel plate weight

② Assumptions

High tensile plates can be made thinner than baseline normal steel while maintaining high strength; and therefore, vessels using this material are lighter than those using conventional steel sheets without such properties, thus leading to fuel efficiency improvements that enable CO_2 emission reductions during operation. (Quantifications are estimates based on actual data.)

(2) Scope of quantification

① Target steel plates

Steel plates used domestically and exported steel. (Steel exports from 2009)
The case study covered only steel manufactured in Japan, and excluded overseas manufacture.
(Japanese steel manufacturers do not possess integrated steelworks overseas.)

② Target stages

The case study assessed CO_2 emission reductions due to fuel efficiency improvements at the in-use stage of vessels. As raw material mining and transport account for a minuscule percentage of the entire life cycle of iron and steel, and also because the assessment involves replacing steel products, little change is seen at the manufacturing stage. When assessing the effect of reducing the weight of steel, CO_2 emissions from raw material mining and transport become less than the baseline in accordance with the reduced amount of steel used, but the Federation includes only the in-use stage in its quantifications.

(3) Assessment period

From the viewpoint of comparing CO_2 emissions from a manufacturing process during one fiscal year, the case study performed a cross-sectional assessment of stock.

(4) References

Papers on the method of analysis have been published on the Institute of Energy Economics, Japan website:

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Overview (Japanese) https://eneken.ieej.or.jp/data/pdf/462.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Study 4. Vessels (high tensile steel plates) (Japanese) https://eneken.ieej.or.jp/data/pdf/466.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (1) (English) https://eneken.ieej.or.jp/data/en/data/pdf/165.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (2) (English) https://eneken.ieej.or.jp/en/data/pdf/172.pdf

Source: Japan Business Federation, "*Contributing to Avoided Emissions through the Global Value Chain*"

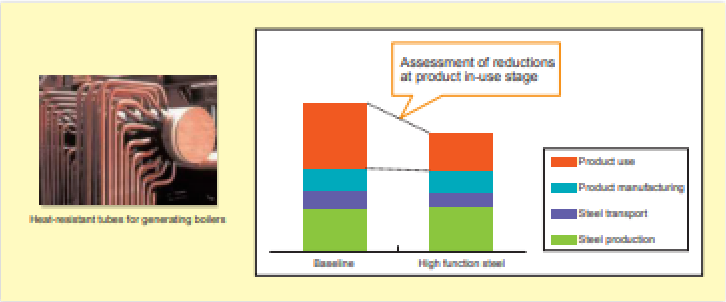
Eco Product Contribution: Quantitative Evaluation of Contribution of High Strength, Heat-resistant Tubes for Boilers

Generating Boiler (Heat-resistant Tubes) — **The Japan Iron and Steel Federation**

Raw materials/materials > Manufacturing > Sales/Distribution > **Use** > Disposal/recycling

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. Heat-resistant high strength steel tubes for generating boilers can resist higher temperatures than conventional heat-resistant steel tubes, and can thus improve the power generation efficiency of steam power plants. This leads to CO_2 emission reductions from fuel consumption savings.



Quantification results of avoided emissions

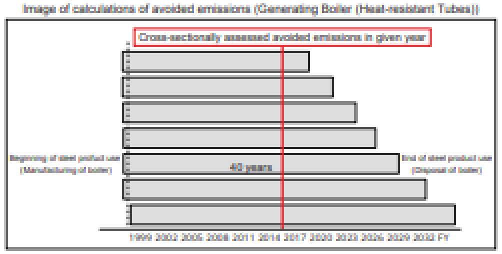
Avoided emissions at the in-use stage of heat-resistant tubes for generating boilers in FY2017 were as provided below:

Domestic use	0.96 million t-CO_2
Exports	4.30 million t-CO_2
Total	5.26 million t-CO_2

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Fuel savings due to efficiency improvements achieved at 593°C – 600°C-class steam power plants as a result of shifting from 566°C-class steam power plants × Rate of contribution of high-performance heat-resistant tubes, or 25% × Number of years power plants are in service

Image of calculations of avoided emissions (Generating Boiler (Heat-resistant Tubes))



(1) Baseline scenario and assumptions

① Baseline scenario

The case study assessed CO_2 emission reductions attributable to savings in fuel input due to replacing baseline heat-resistant tubes for supercritical (SC) 566°C-class steam power plants with high alloy steel boiler tubes for ultra-supercritical (USC) 593°C– 600°C-class steam power plants.

	Baseline	Assessed steel sheets	Assessed results
Heat-resistant high strength tubes for boilers	Steel tubes for supercritical (SC) 566C-class steam power plants	High alloy steel tubes (improved steel alloy 9Cr-9Mo/heat-resistant tube)	Energy savings due to enhanced heat-resistance and strength (higher steam temperatures = higher power generation efficiency)

② Assumptions

High alloy steel tubes can resist higher temperatures compared to the baseline steel tubes for supercritical (SC) 566°C-class steam power plants. Therefore, steam power plants equipped with high alloy steel tubes can operate under higher ranges of steam temperature compared with those using steel boiler tubes for supercritical (SC) 566°C-class steam power plants, thus improve power generation efficiency which will result in energy savings. (Quantifications are estimates based on actual data.)

(2) Scope of quantification

① Target steel tubes

Steel tubes used domestically and exported steel. (Steel exports from 2009)
The case study covered only steel manufactured in Japan, and excluded overseas manufacture.
(Japanese steel manufacturers do not possess integrated steelworks overseas.)

② Target stages

The case study assessed CO_2 emission reductions due to improved fuel consumption at the in-use stage of boilers. As raw material mining and transport account for a minuscule percentage of the entire life cycle of iron and steel, and little change is seen at the manufacturing stage because the assessment involves replacing steel products, the Federation includes only the in-use stage in its quantifications.

(3) Assessment period

From the viewpoint of comparing CO_2 emissions from a manufacturing process during one fiscal year, the case study performed a cross-sectional assessment of stock.

(4) References

Papers on the method of analysis have been published on the Institute of Energy Economics, Japan website:

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Overview (Japanese) https://eneken.ieej.or.jp/data/pdf/462.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Study 2. Generating boilers (heat-resistant tubes) (Japanese) https://eneken.ieej.or.jp/data/pdf/464.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (1) (English) https://eneken.ieej.or.jp/data/en/data/pdf/165.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (2) (English) https://eneken.ieej.or.jp/en/data/pdf/172.pdf

Source：Japan Business Federation, “*Contributing to Avoided Emissions through the Global Value Chain*”

Eco Product Contribution: Quantitative Evaluation of Contribution of Grain-oriented Sheets for Transformers

Grain-oriented Silicon Steel Sheets for Transformers

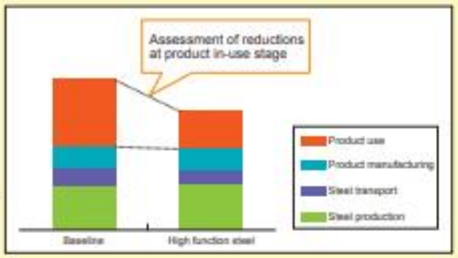
The Japan Iron and Steel Federation

Raw materials/materials → Manufacturing → Sales/Distribution → Use → Disposal/recycling

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. Current grain-oriented silicon steel sheets for transformers can reduce iron loss (energy loss) during transformation; and therefore contribute to efficient electric power transmission, and thus CO_2 emission.

Grain-oriented silicon steel sheets for transformers



Quantification results of avoided emissions

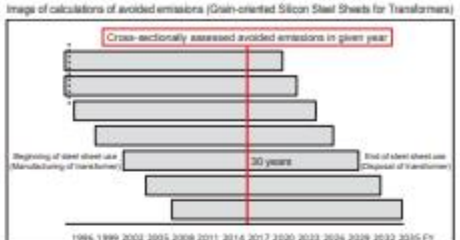
Avoided emissions at the in-use stage of grain-oriented silicon steel sheets for transformers in FY2017 were as provided below:

Domestic use	2.15 million t-CO_2
Exports	6.51 million t-CO_2
Total	8.66 million t-CO_2

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = minimum value*
× (Transformer no-load losses per unit capacity in an assessment year - Transformer no-load losses per capacity 30 years ago)
× Hours of use

Image of calculations of avoided emissions (Grain-oriented Silicon Steel Sheets for Transformers)



*Comparing the amount of transformers produced in the assessment year and that of thirty years ago, if [production in the assessment year] > [production 30 years ago], then was assumed that all transformers produced thirty years ago have been replaced and the minimum value is represented by production 30 years ago. In contrast, if [production 30 years ago] > [production in the assessment year], then it was assumed that transformers produced thirty years ago have not been completely replaced but have only been replaced by those produced in the assessment year, and therefore, the minimum value is represented by production in the assessment year.

(1) Baseline scenario and assumptions

① Baseline scenario

The case study assumed that transformers have a durable life of 30 years, and assessed CO_2 emission reductions attributable to iron loss due to replacing silicon steel sheets for transformers from 30 years ago, which serve as the baseline, with current silicon steel sheets for transformers.

	Baseline	Assessed steel sheets	Assessed results
Transformers	Silicon steel sheets for transformers 30 years ago	Current silicon steel sheets for transformers	Energy savings due to reducing iron loss

② Assumptions

Current silicon steel sheets for transformers can reduce iron loss (energy loss) compared conventional silicon steel sheets for transformers (from thirty years ago), and can thus contribute to efficient electric power transmission and distribution as well as achieving CO_2 emission reductions during operation as a result of improving electric power consumption accompanying iron loss. (Quantifications are estimates based on actual data.)

(2) Scope of quantification

① Target steel sheets

Steel sheets used domestically and exported steel. (Steel exports from 2009)
The case study covered only steel manufactured in Japan, and excluded overseas manufacture.
(Japanese steel manufacturers do not possess integrated steelworks overseas.)

② Target stages

The case study assessed CO_2 emission reductions due to iron loss reductions at the in-use stage of transformers. As raw material mining and transport account for a minuscule percentage of the entire life cycle of iron and steel, and little change is seen at the manufacturing stage because the assessment involves replacing steel products, the Federation includes only the in-use stage in its quantifications.

(3) Assessment period

From the viewpoint of comparing CO_2 emissions from a manufacturing process during one fiscal year, the case study performed a cross-sectional assessment of stock.

(4) References

Papers on the method of analysis have been published on the Institute of Energy Economics, Japan website:

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Overview (Japanese) https://eneken.ieej.or.jp/data/pdf/462.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Study 5 Grain-oriented silicon steel sheets for transformers (Japanese) https://eneken.ieej.or.jp/data/pdf/467.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (1) (English) https://eneken.ieej.or.jp/data/en/data/pdf/165.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (2) (English) https://eneken.ieej.or.jp/en/data/pdf/172.pdf

Source：Japan Business Federation, “*Contributing to Avoided Emissions through the Global Value Chain*”

Eco Product Contribution: Quantitative Evaluation of Contribution of Stainless Steel Sheets for Railway Cars

Stainless Steel Sheets for Railway Cars

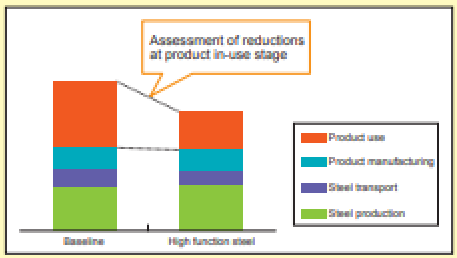
The Japan Iron and Steel Federation

Raw materials/materials › Manufacturing › Sales/Distribution › Use › Disposal/recycling

Summary

Emissions can be effectively reduced at the in-use stage by using high-function steels in components of final products. Stainless steel sheets from railway cars are steel plates that can be thinned out while maintaining high strength (and thus reducing steel product weight). Railway cars using this material are lighter than those using conventional steel sheets without such features, thus leading to fuel efficiency improvements that enable CO_2 emission reductions during operation.


Stainless steel sheets for railway cars



Quantification results of avoided emissions

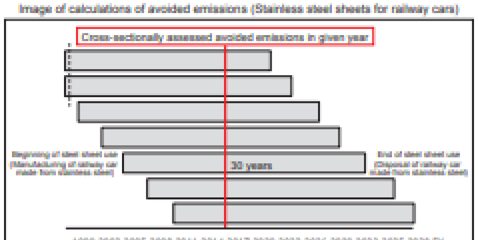
Avoided emissions at the in-use stage of stainless steel sheets for railway cars in FY2017 were as provided below:

Domestic use	0.27 million t-CO_2
Exports	0 t-CO_2
Total	0.27 million t-CO_2

Avoided emissions were calculated using the formula provided below. A cross-sectional assessment was conducted for total stock in a given year to estimate avoided emissions.

Avoided emissions = Energy saved during operation per unit railway car weight reduced per unit distance travelled per car × Weight reduced per car × Annual distance travelled per car × Number of stainless steel railway cars produced annually

Image of calculations of avoided emissions (Stainless steel sheets for railway cars)



(1) Baseline scenario and assumptions

① Baseline scenario

The case study assessed CO_2 emission reductions from improving fuel efficiency at the in-use stage of railway cars by replacing steel sheets without special functions (normal steel), which serve as the baseline, with stainless steel sheets up to the current share.

	Baseline	Assessed steel sheets	Assessed results
Railway cars	Normal steel	Stainless steel sheets	Energy savings due to reducing steel sheet weight

② Assumptions

High strength sheets can be made thinner than baseline normal steel while maintaining high strength; and therefore, railway cars using this material are lighter than those using conventional steel sheets without such properties, thus leading to fuel efficiency improvements that enable CO_2 emission reductions during operation. (Quantifications are estimates based on actual data.)

(2) Scope of quantification

① Target steel sheets

Steel sheets used domestically and exported steel. (Steel exports from 2009)

The case study covered only steel manufactured in Japan, and excluded overseas manufacture.

(Japanese steel manufacturers do not possess integrated steelworks overseas.)

② Target stages

The case study assessed CO_2 emission reductions due to fuel efficiency improvements at the in-use stage of railway cars.

As raw material mining and transport account for a minuscule percentage of the entire life cycle of iron and steel, and also because the assessment involves replacing steel products, little change is seen at the manufacturing stage. When assessing the effect of reducing the weight of steel, CO_2 emissions from raw material mining and transport become less than the baseline in accordance with the reduced amount of steel used, but the Federation includes only the in-use stage in its quantifications.

(3) Assessment period

From the viewpoint of comparing CO_2 emissions from a manufacturing process during one fiscal year, the case study performed a cross-sectional assessment of stock.

(4) References

Papers on the method of analysis have been published on the Institute of Energy Economics, Japan website:

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Overview (Japanese) https://eneken.ieej.or.jp/data/pdf/462.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives: Study 6. Railway cars (stainless steel sheets) (Japanese) https://eneken.ieej.or.jp/data/pdf/468.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (1) (English) https://eneken.ieej.or.jp/data/en/data/pdf/165.pdf

Research on Contribution of Steel Products to Society-wide Energy Conservation from LCA Perspectives (2) (English) https://eneken.ieej.or.jp/en/data/pdf/172.pdf

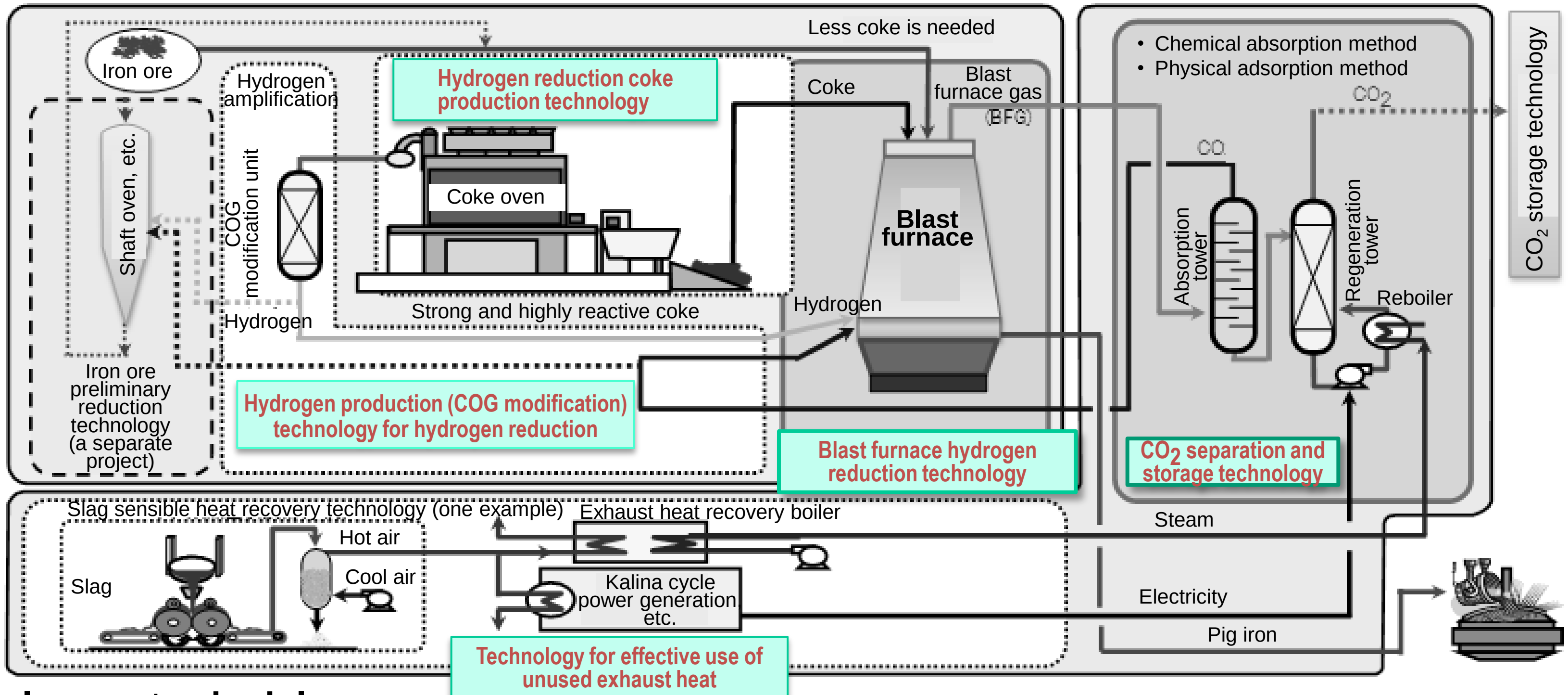
Source：Japan Business Federation, "*Contributing to Avoided Emissions through the Global Value Chain*"

4. Promotion of CO_2 Ultimate Reduction System for Cool Earth 50 Development (COURSE50)

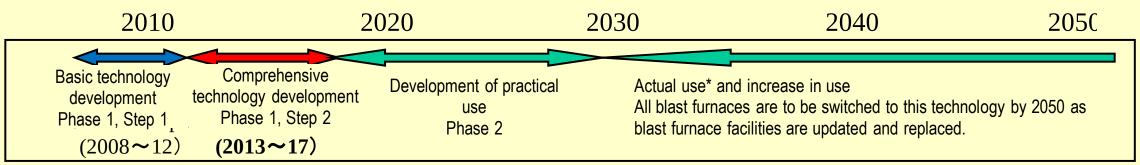
Development of CO2 Ultimate Reduction System for Cool Earth 50 (COURSE50)

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.

5. Reference

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.

JISF Energy Management System

Plan

JISF establishes the highest possible goals based on available technologies

Suitability of the plan is confirmed by providing explanations during the target establishment process to the government advisory council and the Keidanren third-party evaluation committee.

Do

Member companies take actions for conserving energy and cutting CO_2 emissions based on JISF targets

JISF checks progress by receiving reports from company presidents at its Executive Board Meeting

Check

Performance is evaluated every year by a government advisory council (steel working group) and Keidanren third-party evaluation committee

Action

The plan is revised as needed based on assessments and instructions from the government advisory council (steel working group) and Keidanren third-party evaluation committee

ISO50001 Certificate

Effective Use of Waste Plastics (Containers and Packaging Recycling)

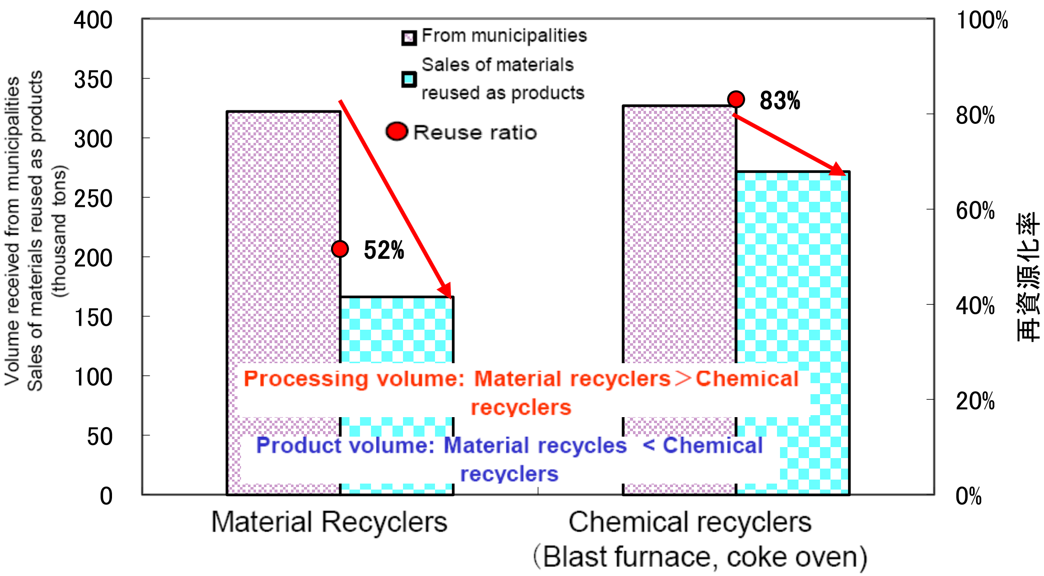
- Due to priority on recycling materials, purchased 250,000 tons of waste plastics in FY2017 under the container and packaging recycling system; current waste plastic processing capacity in the steel industry is about 400,000 tons, leaving significant unused capacity (utilization rate is slightly over 60%)
- A review of policies can produce a big drop in CO_2 emissions through the effective use of waste plastics, etc. JISF hopes 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.

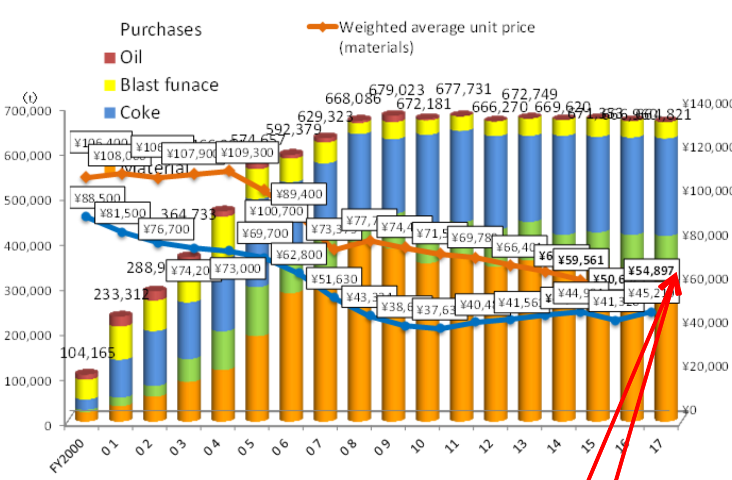
(2) A payment system should be considered to provide incentives to local governments that cut costs below a certain level or make big improvements; this would lower the social cost of recycling by encouraging local governments to improve efficiency of collecting and storing waste materials in separate 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 (FY2017)



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



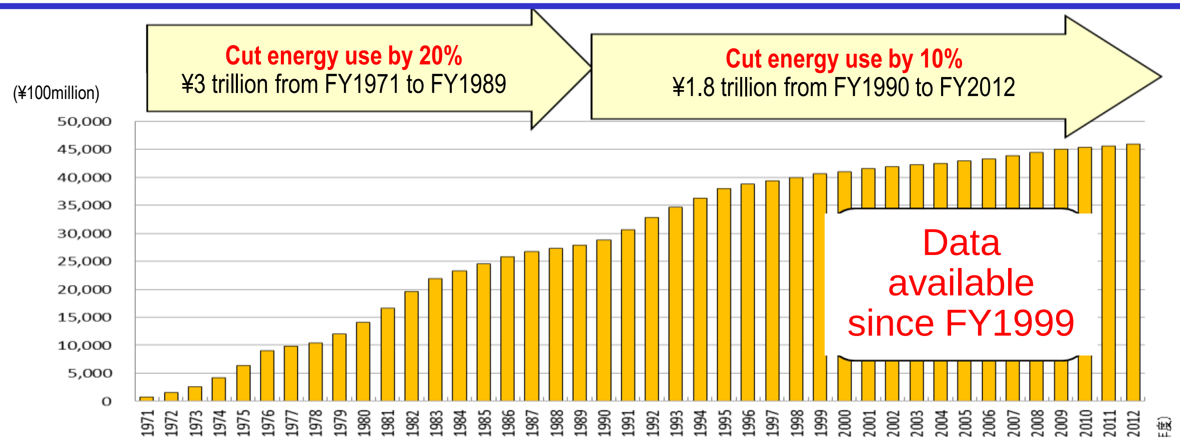
Source: The Japan Containers and Packaging Recycling Association

FY17 unit purchase price for recycled materials was ¥55,000/ton and ¥45,000/ton for chemicals

Investments for Environmental Protection and Energy Conservation

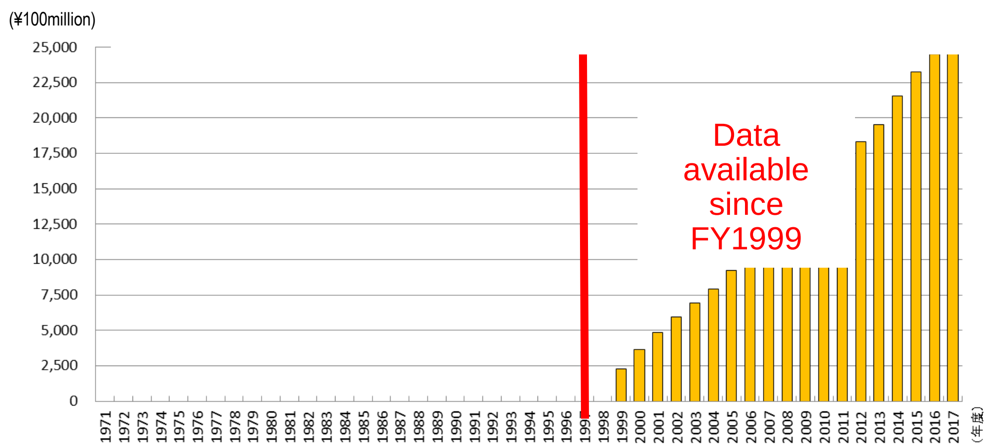
- Japanese steel industry made investments of about ¥3 trillion between FY1971 and FY1989 for environmental protection and energy conservation. These investments totaled about ¥1.8 trillion between FY1990 and FY2012.
- Investments for rationalization and labor-saving totaled about ¥1.8 trillion between FY2005 and FY2017.

Fig. Accumulative investment for environmental facilities since FY1971



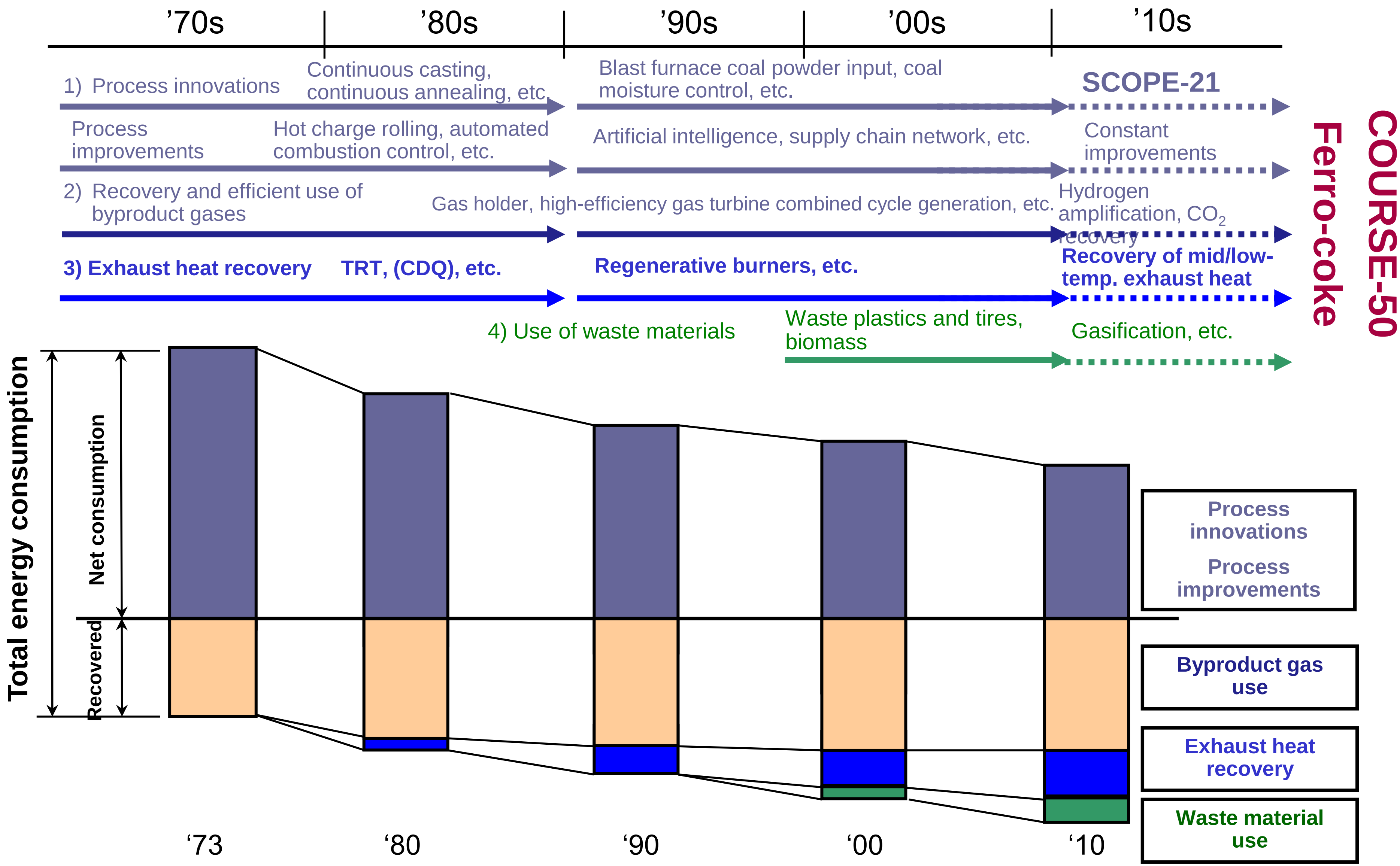
Source: ~FY2011: METI Survey on Capital Investments of Major Industries, FY2002~: METI Survey on Corporate Finance (former Survey on Capital Investments)

Fig. Accumulative investment for rationalization and labor-saving since FY1999



Source: Development Bank of Japan Inc

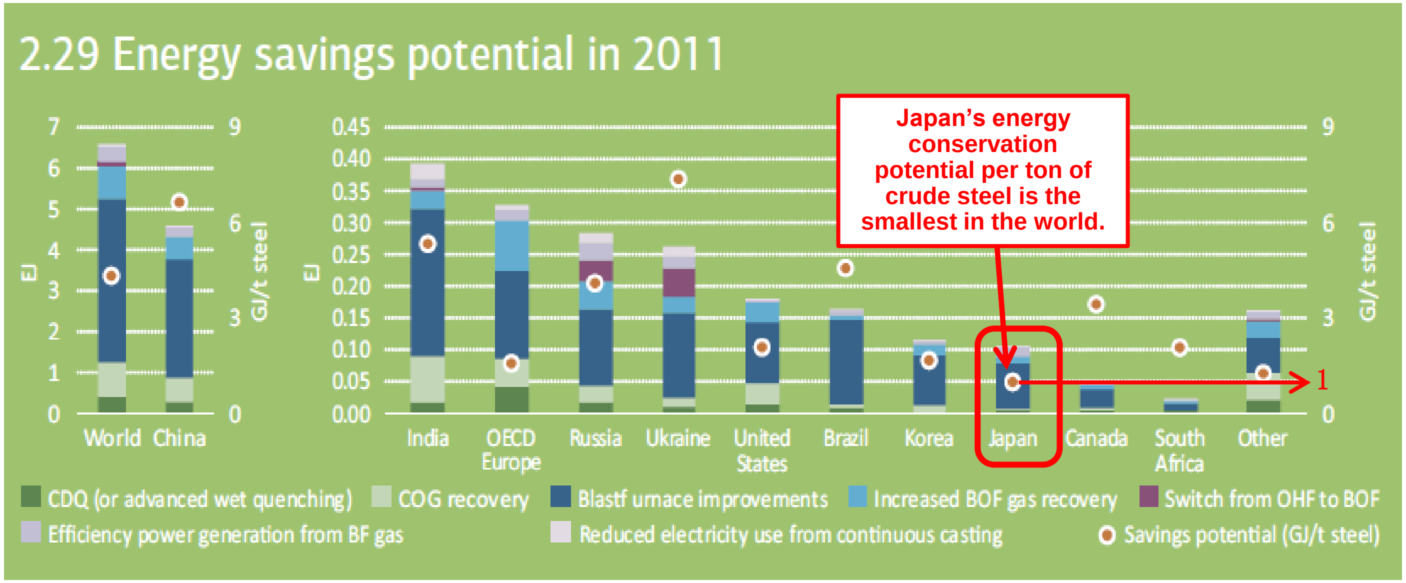
Energy Conservation Initiatives of the Steel Industry



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.

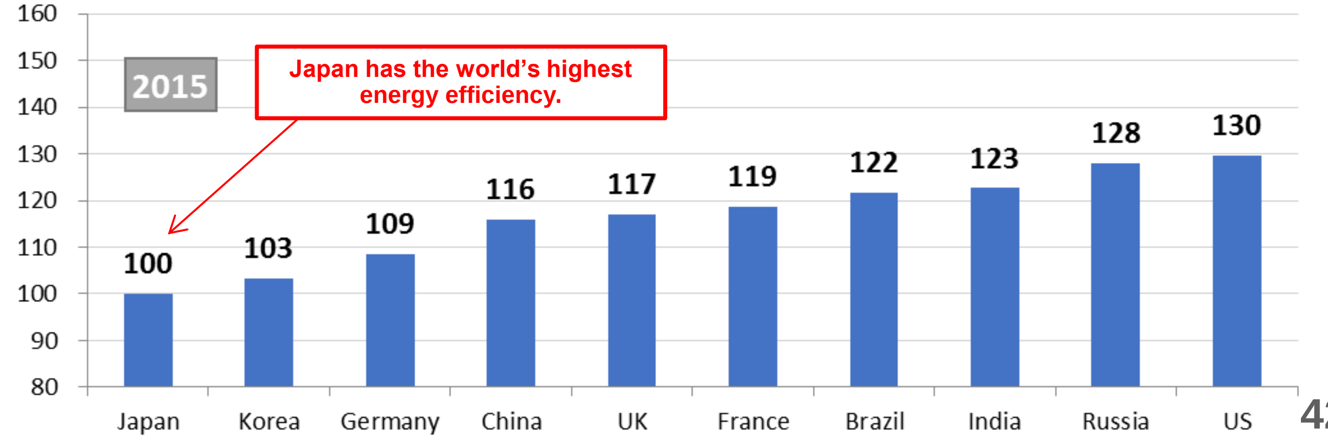
Energy Saving Potential from Transferring and Promoting Energy Conservation Technologies (2011)



Source: IEA "Energy Technology Perspective 2014"

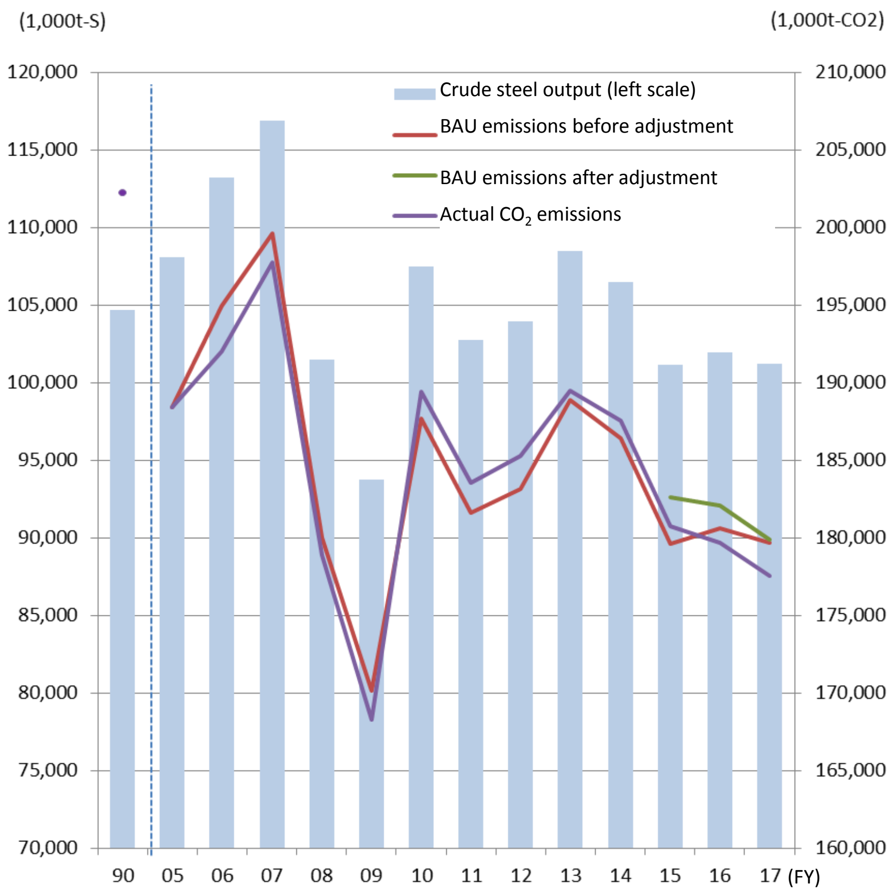
Estimate of Steel Industry (BF-BOF) Energy Efficiency

(2015, Japan=100)

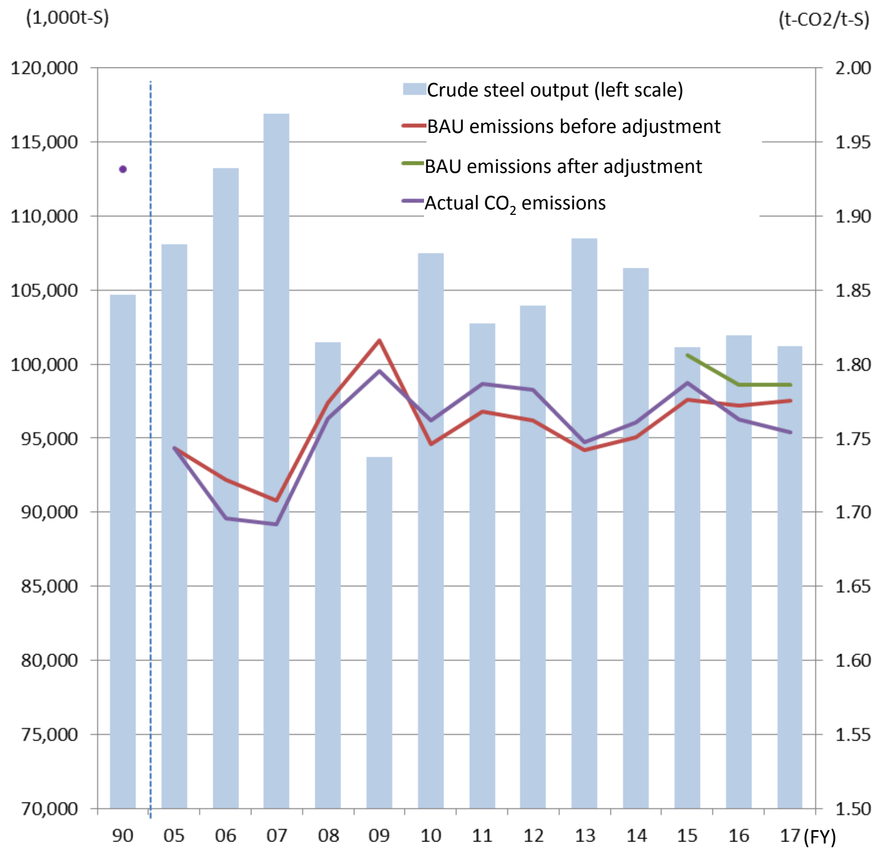


Source: RITE "Estimated Energy Unit Consumption in 2015"

Crude Steel Output and Total and Unit CO_2 Emissions



Crude Steel Output and CO_2 Emissions
(constant FY2005 electric power emission coefficient)



Crude Steel Output and Unit CO_2 Emissions
(constant FY2005 electric power emission coefficient)

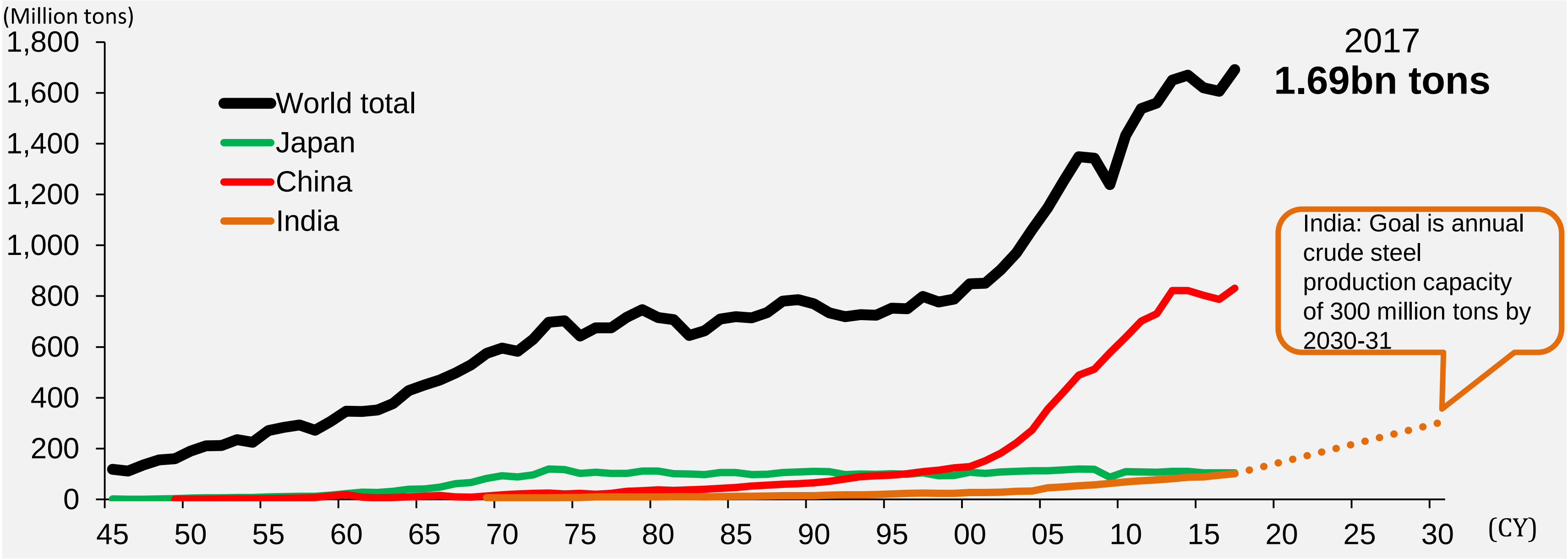
Eco Solution: Growth of Global Crude Steel Output

- As of end of 2015, the per capita steel stock in Japan was 10.7 tons compared with 4.0 tons worldwide.
- Steel stock per capita is an indicator of the penetration of social infrastructure and industrial products, which are a measure of prosperity. The steel stock is expected to grow steadily in emerging countries as these countries become more prosperous and accomplish Sustainable Development Goals (SDGs).

Global crude steel output will increase for many more years

India's steel industry plans to approximately triple crude steel output to 300 million tons by 2030.

Global Crude Steel Output



Source: worldsteel

The Japanese Steel Industry's Overseas Contributions to Energy Conservation

1. China: Japan-China Steel Industry Environmental Protection and Energy Conservation Technology Conference (2005~)

- This conference has been held periodically since steel industry leaders of the two countries signed an MoU in July 2005. Providing a forum for exchanges of information about steel technologies, this conference plays a key role in international steel industry cooperation.
- The tenth conference was held in October 2018 at the city of Tomakomai in Hokkaido. Now in its tenth year, the China steel mill environmental and energy conservation countermeasure has made significant progress. Conference participants confirmed the contributions of this program. Participants also discussed life cycle assessments and other new themes in addition to conventional environmental and energy conservation measures.

2. India: Public and Private Collaborative Meeting between the Indian and Japanese Steel industries (2011~)

- Started in 2011, this meeting has been held eight times, bringing together public and private-sector energy conservation experts in the two countries.
- The Japanese steel industry has provided assistance concerning the introduction of its energy conservation technologies in India. Activities include steel plant diagnosis using ISO14404, the establishment of a Technologies Customized List containing energy conservation technologies suitable for India, and technology seminars held by Japanese manufacturers of energy conservation equipment.

3. ASEAN: ASEAN-Japan Steel Initiative (2014~)

- Started in February 2014, this initiative brings together steel industry energy conservation professionals from Japan and six ASEAN countries. Since the start of this initiative, workshops for specific themes have been held for the ASEAN region and individual countries to support energy conservation measures in the ASEAN steel industry.
- There have been steel plant diagnosis at 14 ASEAN steel mills in order to provide advice for improving operations and using new technologies.

Technologies Customized List

The Technologies Customized List contains information about technologies involving energy conservation and protecting the environment that are recommended for specific countries and regions. These lists have been prepared for India and the ASEAN region.

The Technologies Customized List for India

35 recommended technologies

(19 energy and 16 environmental technologies)

Energy conservation benefits, technology suppliers and other information

No.	Title of Technology	A ; Effect of Technologies Introduction: Electricity Savings (kWh/t of product)	Fuel Savings (GJ/t of product)	CO2 Reduction (kg-CO2/t of product)	Co-benefits	B ; Proficiency Level of Technology in Japan [*1]	C ; Conditions in India [*2]: Diffusion Rate of Technology in 7 Major Steel Companies % [*4]	Needs: Electricity Saving	CO2 Reduction	Productivity	Quality	Water Saving	Barrier: Financial	Technical	Remodeling	Counter measures: Financial	Technical
	Sintering																
1	Sinter Plant Heat Recovery (Steam Recovery from Sinter Cooler Waste Heat)	-	0.251 /t-sinter	23.9 /t-sinter	SOx, NOx, Dust	A	34	2	NA	NA	NA	NA	2	NA	1	2	1
2	Sinter Plant Heat Recovery (Power Generation from Sinter Cooler Waste Heat)	22.1 kWh/t-sinter	-	19.9 /t-sinter	-	F	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3	High Efficient (COG) Burner in Ignition Furnace for Sinter Plant	-	0.021 /t-sinter	0.50 /t-sinter	-	F	45	1	1	NA	NA	NA	NA	1	1	1	1
	Cokemaking																
4	Coke Dry Quenching (CDQ)	- / 150 kWh/t-coke	1.9 /t-coke / -	135 /t-coke / 74.9 /t-coke	-	A	35	1	NA	NA	1	1	NA	1	1	1	1
5	Coal Moisture Control (CMC)	-	0.3 /t-coke	27.6 /t-coke	-	F	10	1	NA	1	NA	NA	1	1	NA	1	1
	Ironmaking																
6	Top Pressure Recovery Turbine (TRT)	50 kWh/t-pig iron	-	45.0 /t-pig iron	-	A	28	2	NA	NA	NA	NA	2	NA	1	2	1
7	Pulverized Coal Injection (PCI) System	-	1.66 /t-pig iron (at 123kg coal inj.)	147 /t-pig iron	-	A	66	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
8	Hot Stove Waste Heat Recovery	-	0.08 /t-pig iron	7.8 /t-pig iron	-	A	25	2	1	NA	NA	NA	2	1	NA	2	2
	Steelmaking																
9	Converter Gas Recovery Device	-	0.84 /t-steel	79.8 /t-steel	-	A	63 [*2]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
10	Converter Gas Sensible Heat Recovery Device	-	0.126 /t-steel	12.0 /t-steel	-	A [*6]	No data	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
11	Ecological and Economical Arc Furnace	150 kWh/t-steel	-	136 /t-steel	DXN, Dust, Noise	F	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	Waste Heat Recovery from EAF	87.7 kWh/t-steel	-	78.9 /t-steel	-	F	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Technology Explanation Sheets

Thorough explanations of individual technologies

India Technology Customized List: http://www.jisf.or.jp/business/ondanka/eco/documents/TechnologiesCustomizedListIndiav3.pdf
ASEAN Technology Customized List: http://www.jisf.or.jp/business/ondanka/eco/documents/ASEANTechnologiesCustomizedListv2.pdf

Steel Plant Diagnosis

Objective

1. Evaluate energy efficiency level of the steel plant using ISO14404*.
2. Recommend energy saving technologies from Technologies Customized List (TCL) based on the equipment diagnosis to encourage technology transfer from Japan

*ISO14404 is an international standard for calculating CO2 emissions from a steel plant .

The steel plant diagnosis has been performed at 24 locations.

- ✓ 10 plants in India
- ✓ 14 plants in the ASEAN region in 6 countries*

*Indonesia, Singapore, Thailand, Philippines, Vietnam, Malaysia

Day1~3

1. **Operation observation** of BF-BOF, EAF, reheating furnace and other facilities

2. **Energy data collection** by using ISO14404

Day4

3. **Reporting session**

Based on ISO14404, Japanese experts

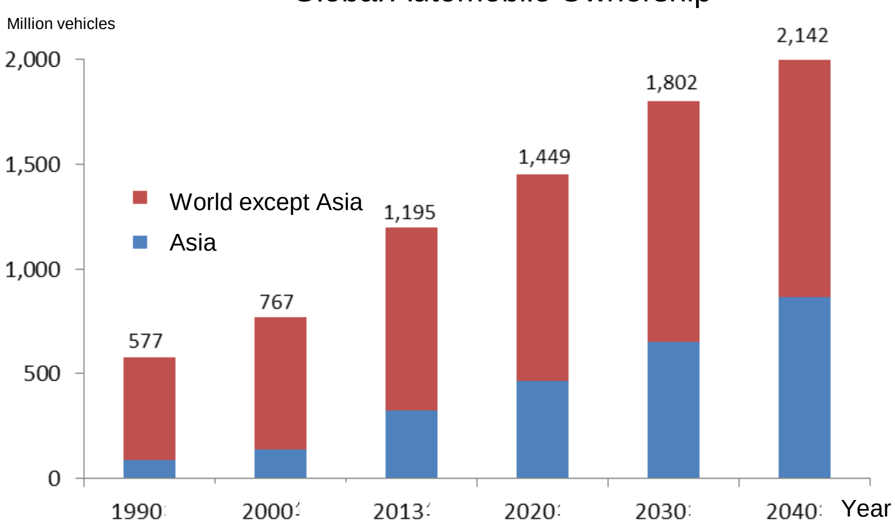
1. *analyze energy consumption trend*
2. *recommend suitable energy saving technologies mainly from TCL*
3. *provide advice for operational improvement*

The Importance of Increasing the Use of Eco Product

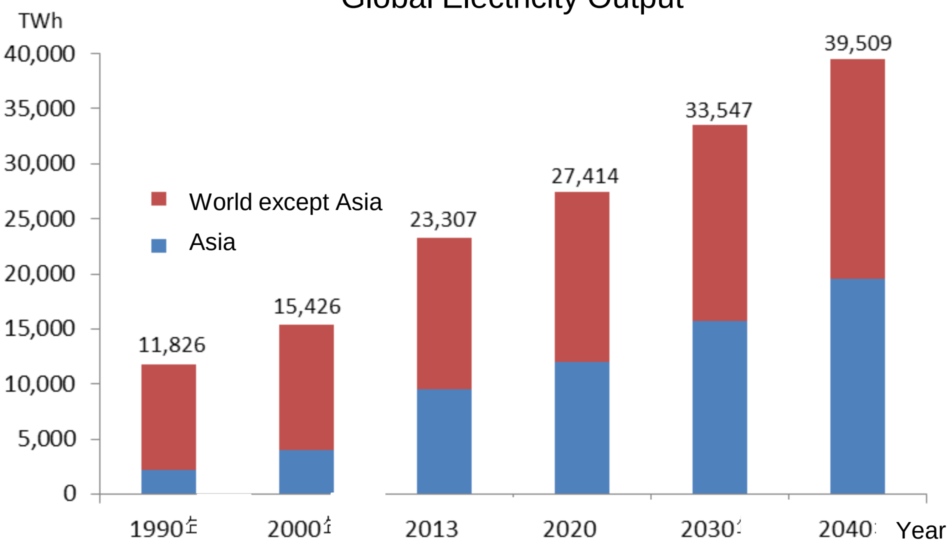
- High-performance steel generally has higher CO_2 emissions than ordinary steel does during the manufacturing stage. But high-performance steel is an eco product because it greatly lowers CO_2 emissions when used by making finished products more energy efficient.
- By supplying high-performance steel, 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 2015 by The Institute of Energy Economics, Japan

Global Automobile Ownership



Global Electricity Output

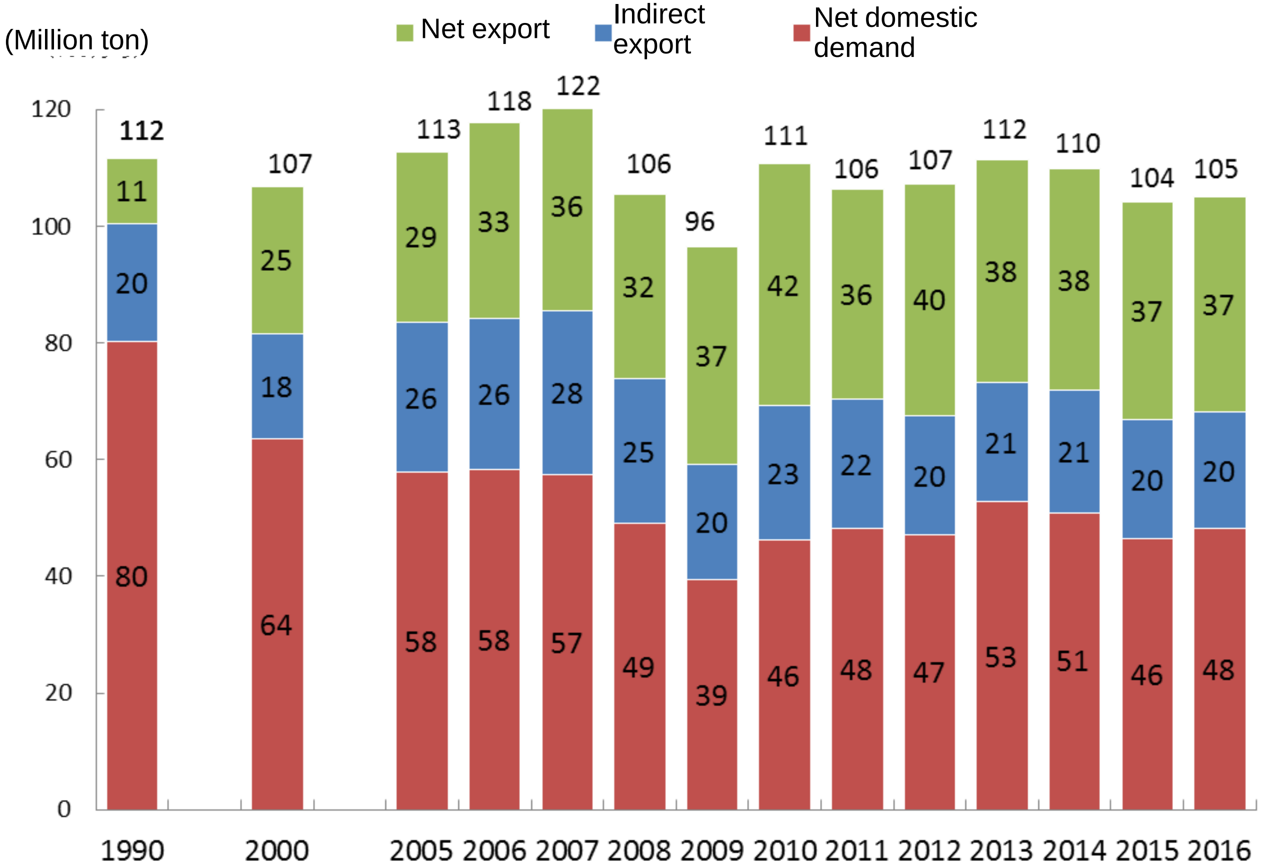


Source: The Institute of Energy Economics, Japan

Crude steel production trend per demand in Japan

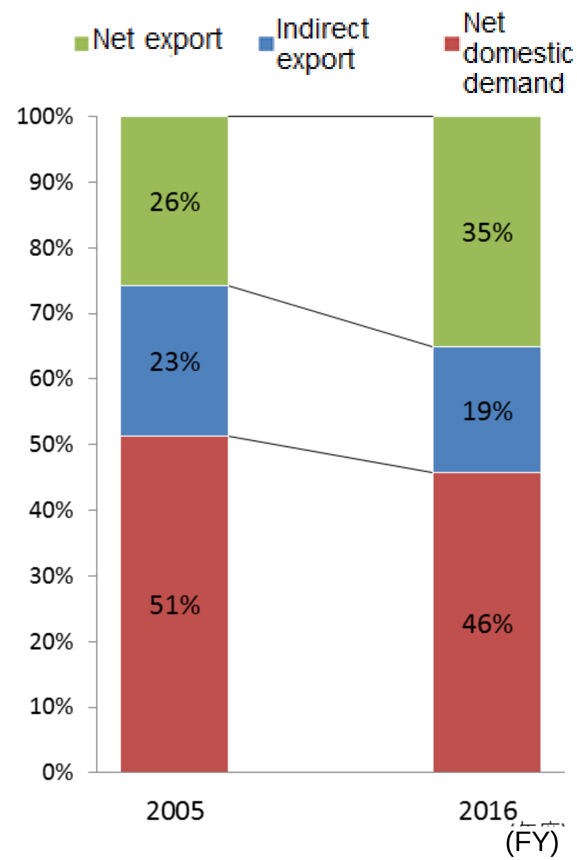
- Steel exports from Japan have been increasing. The main reason is strong demand overseas for high-performance steel backed by global economic growth, primarily in Asia.
- In recent years, external demand (direct and indirect exports) has accounted for more than half of Japan's crude steel production.

Crude steel production trend per demand in Japan



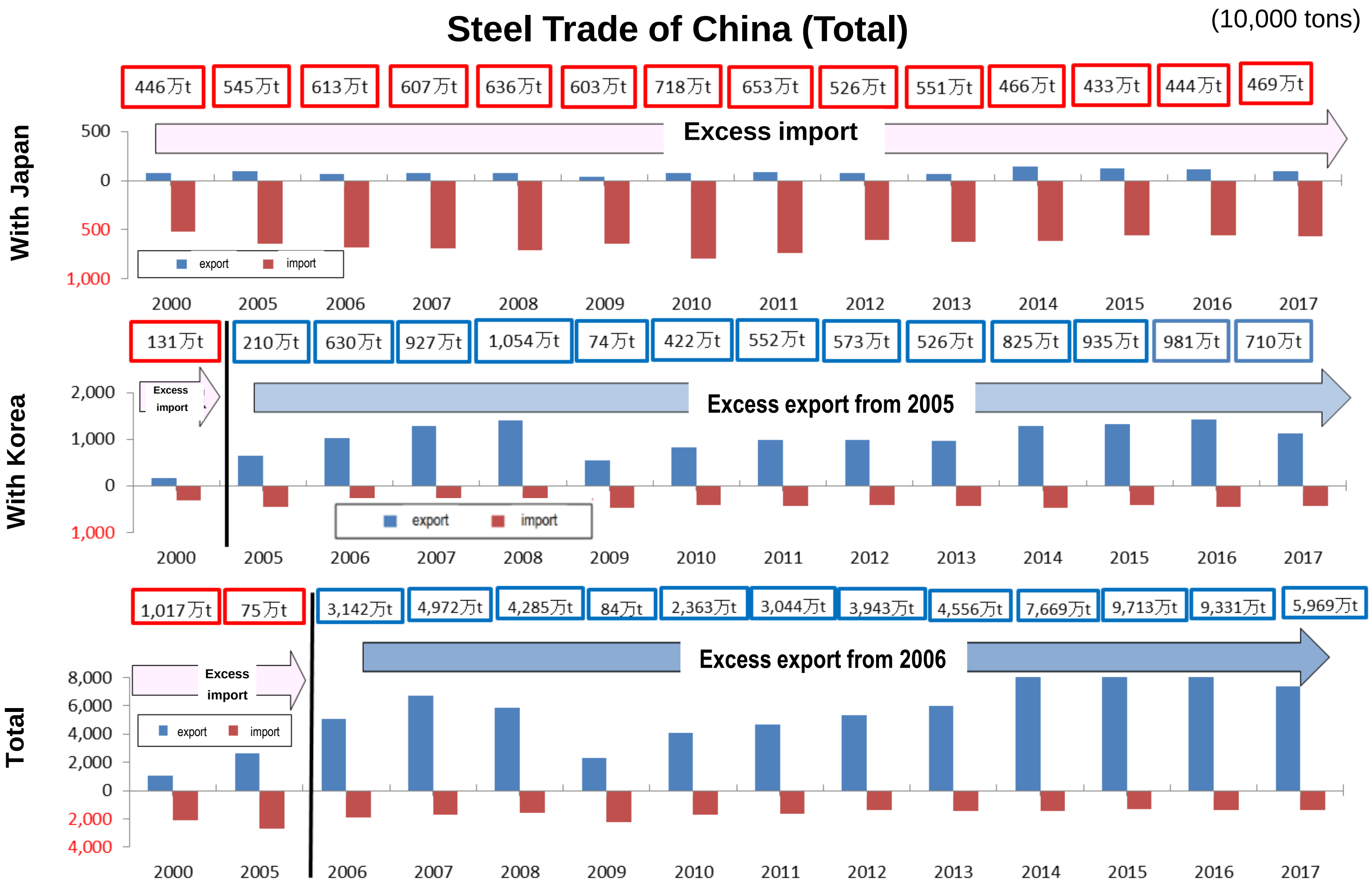
Source: JISF

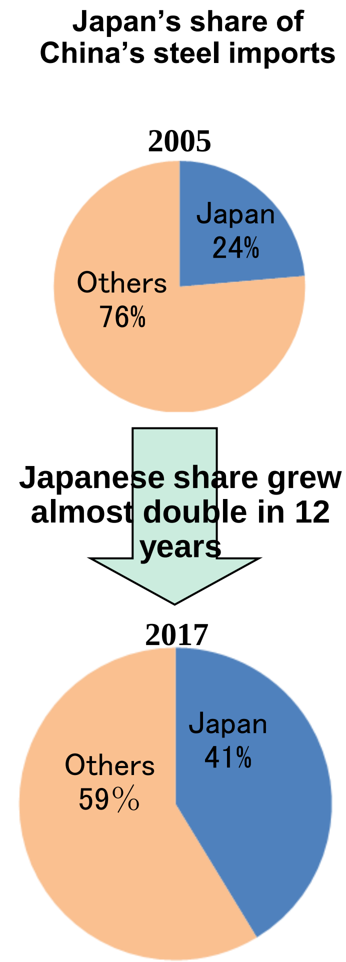
Composition ratio (%)



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. High-performance 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 the only net exporter of steel to China now.





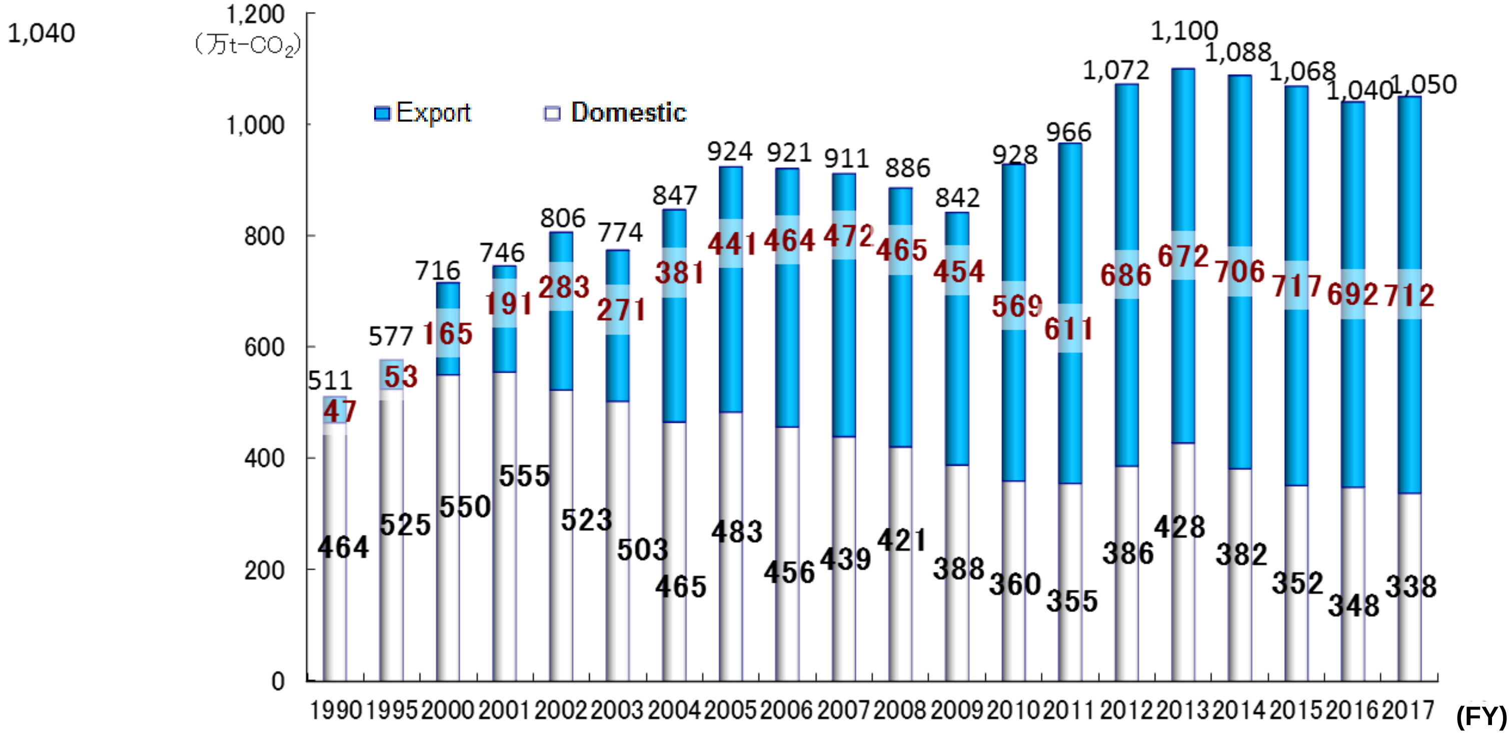
出所：中国通関統計

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 10.50 million tons/year (FY17).

- **Japan: Annual reduction of 3.38 mn tons of CO_2**
- **Exports: Annual reduction of 7.12 mn tons of CO_2**



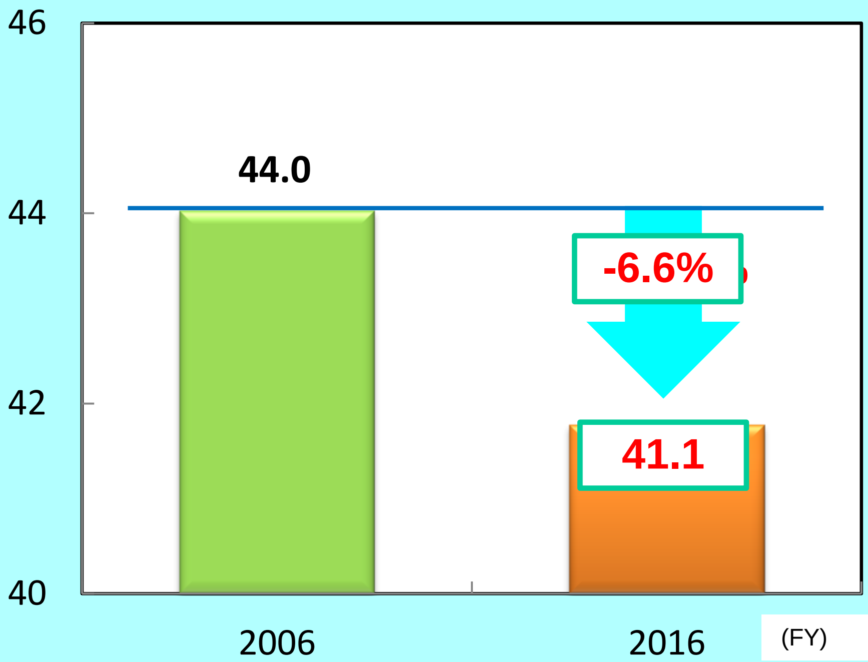
Assumptions for emission reduction contribution Conversion to volume of cement: 450kg of slag/ Ton of cement CO_2 emission reduction: 312kg of CO_2/Ton of cement

Source: Japan Cement Association, Nippon Slag Association

Initiatives in the cargo transport sector

- CO_2 emissions per unit of cargo transport decreased to 41.1kg of CO_2/k ton-km in FY17 from 44.0kg of CO_2/k ton-km in FY06.
- In FY17, the steel industry modal shift (ships + rail) was 75% for primary transportation and 95% 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 45 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

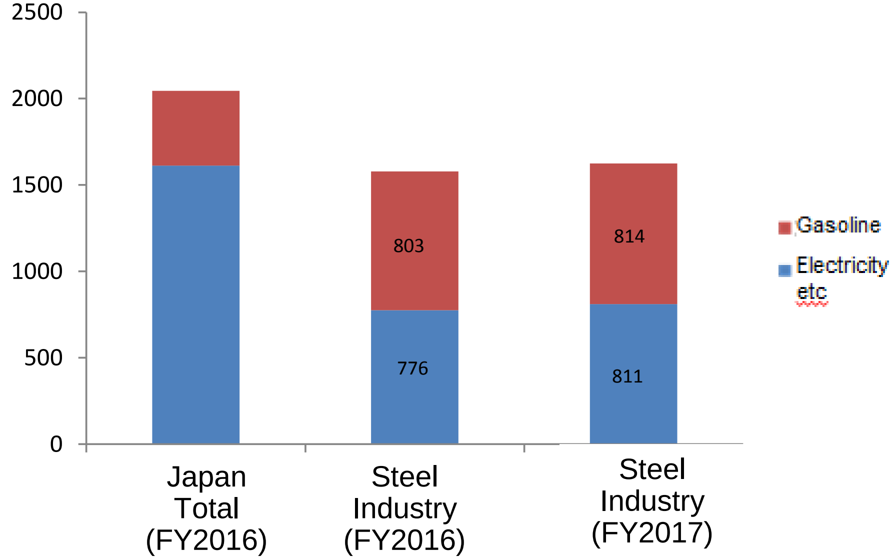
	No. of units
Steel mills	**218**
Junction port	**41**

(Totals for 4 blast furnace and 2 EAF steelmakers as of the end of FY17)

Initiatives in commercial/residential sector

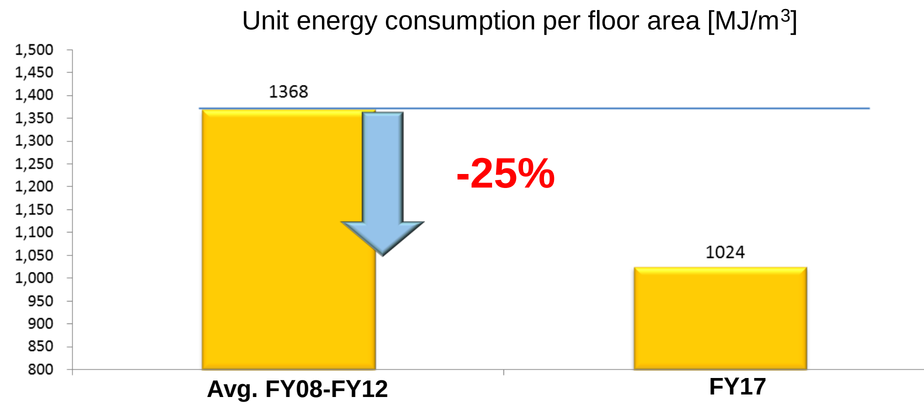
- In FY2005, Japan's steelmakers started energy conservation programs using environmental ledgers for residential sector. Steelmakers started education programs that included all employees, including at group companies, promotion of use of household environmental ledgers, and other actions. There are around 18,000 households participating in this program in FY2017.
- Steel industry is taking actions to reduce energy consumption and CO_2 emission from offices. Unit energy consumption in offices in 2017 were down 25% compared to FY 2008-2012.

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 307 business sites of 69 companies in FY2017

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

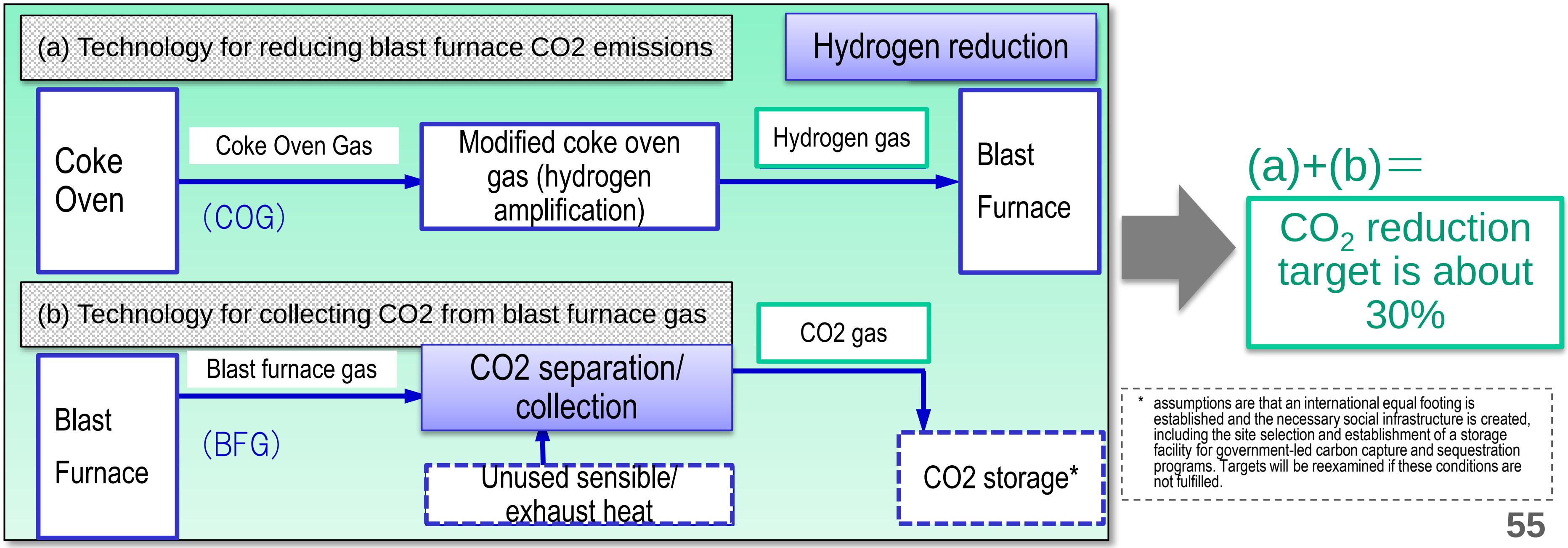
Phase 1, Step 2 (FY13-17) Initiatives

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

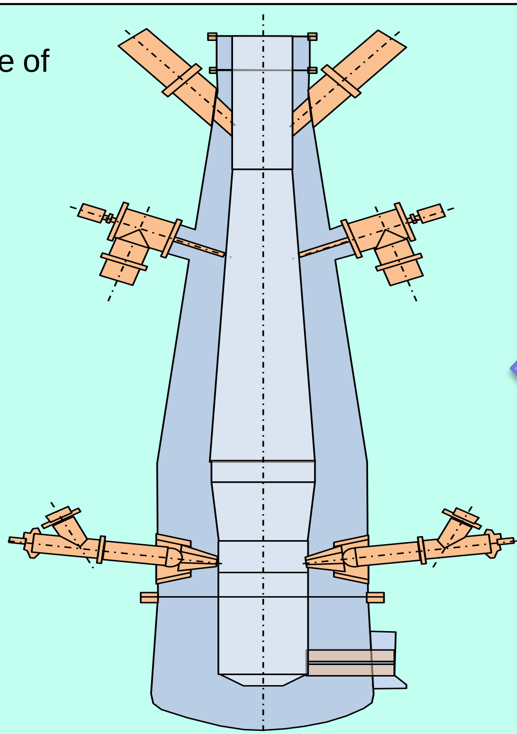
The goal is to develop a technology that makes it possible to collect CO_2 at a cost of ¥2,000 per ton of CO_2, which is the cost that matches the requirements of the demonstration test blast furnace. This will require developing a high-performance chemical absorption liquid and other substances, creating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



Construction of Trial Blast Furnace

- In Phase 1, Step 2, a 10m^3 blast furnace for testing was 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.
- Trial operations were performed four times during FY2016 and FY2017.

Volume of 10m^3



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

Commitment to JISF's 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 processes (COURSE50)

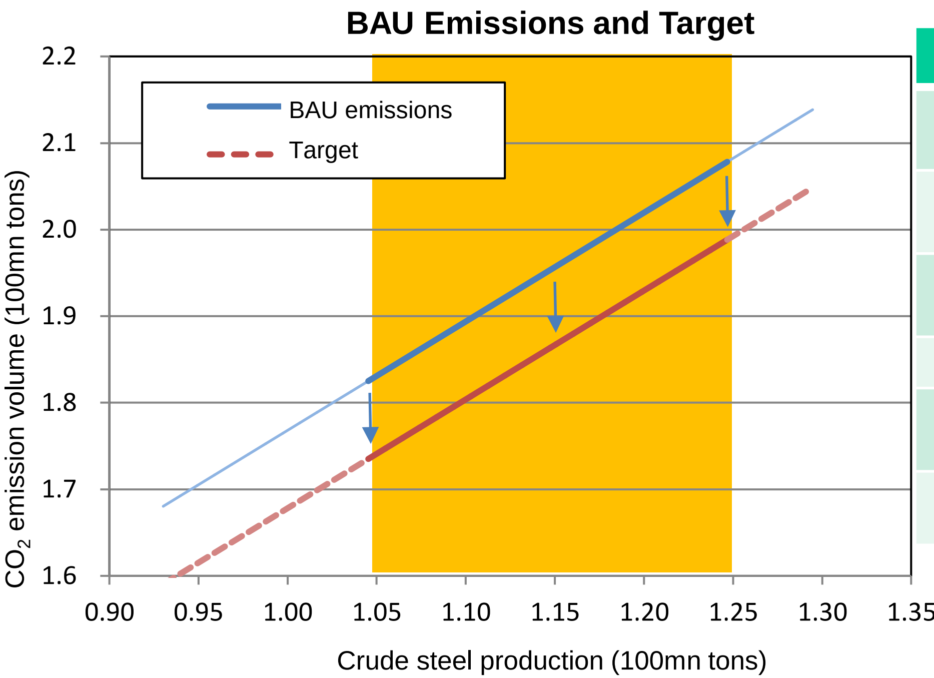
Cut CO_2 emissions from production processes about 30% by using hydrogen for iron ore reduction and collecting CO_2 from blast furnace gas. The first production unit is to begin operations by about 2030*. Goal is widespread use of these processes by about 2050 in line with timing of updates of existing 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	–
(5) Develop and use revolutionary technologies[*3]	About 2.6mn tons of CO_2	–
Total	9mn tons of CO_2	3mn tons of CO_2 + Waste plastics[*4]

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	19,733	18,833

*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

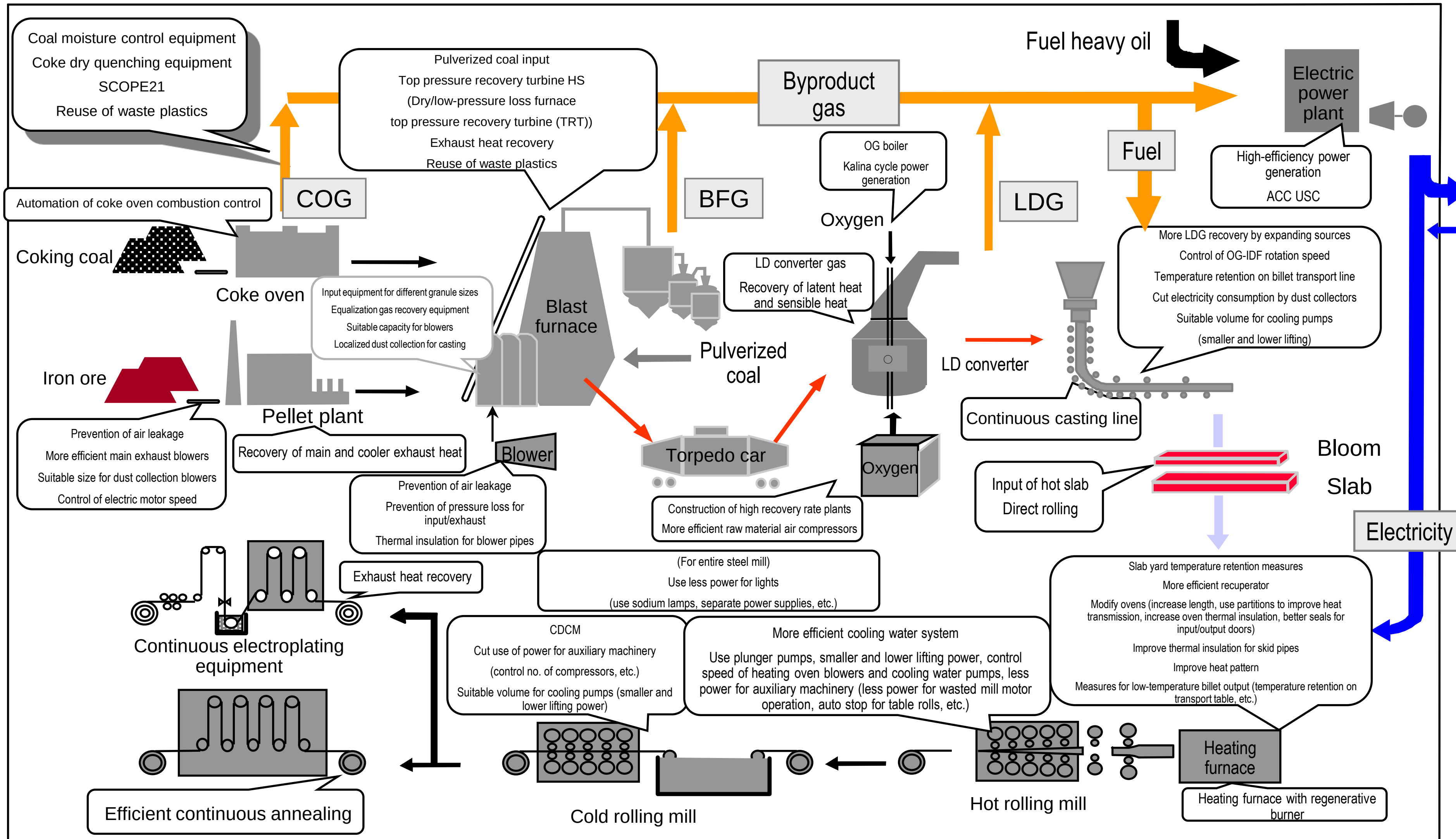
a. Awaiting results of studies concerning a Japanese government review of the container, packaging and plastic recycling system and other related items; may be reviewed (target reduced) if there is no outlook for growth in the waste materials handling capacity of the steel industry by FY2030 in relation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

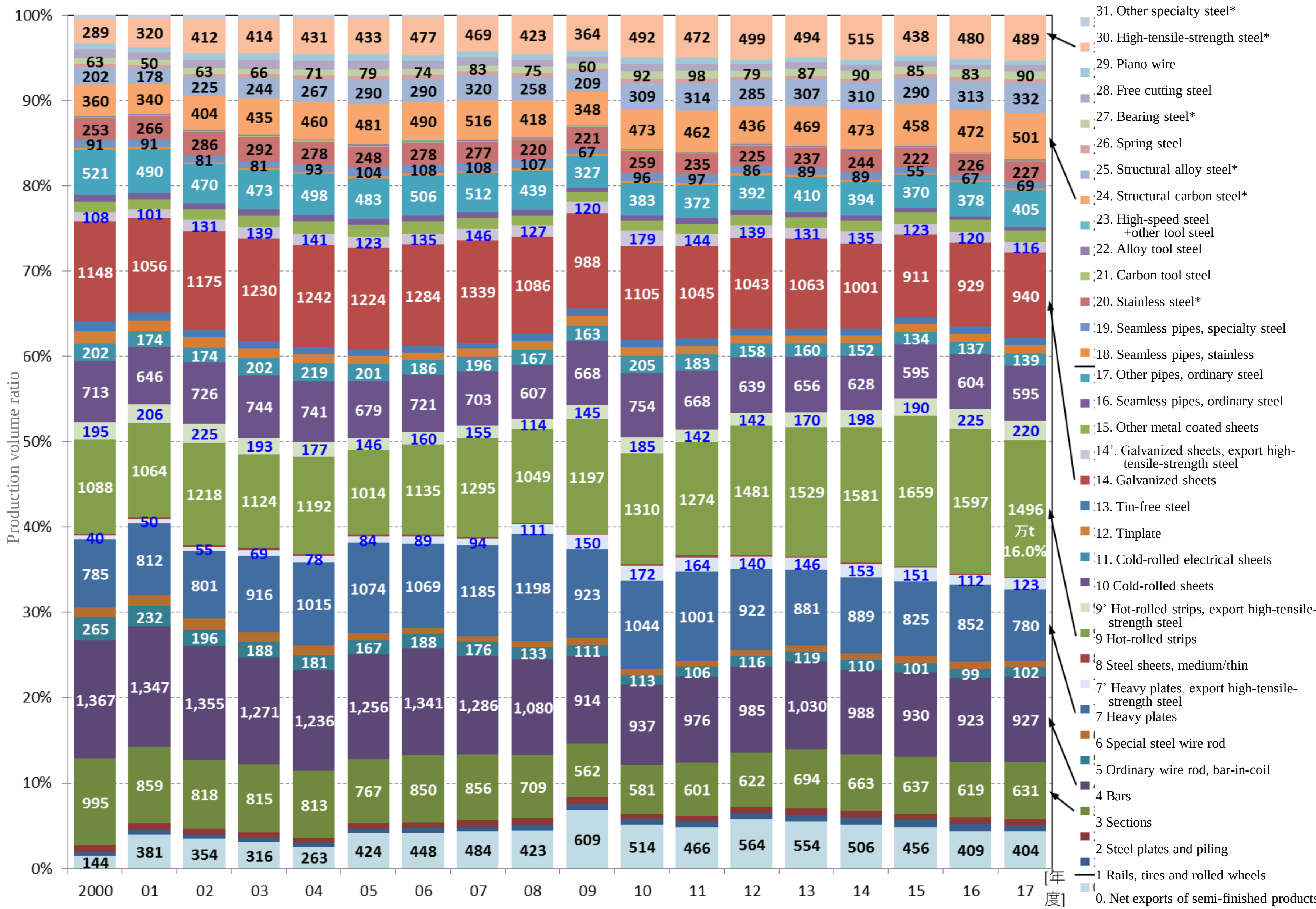
*3 For the development and use of revolutionary technologies, assumptions are that (a) technologies will be in use in FY2030 and (b) the use of these technologies is economically feasible. In addition, for COURSE50, assumptions are that an international equal footing is established and the necessary 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.

*4 Within the target for the 5 million ton reduction in CO2 emissions in FY2020, the primary focus is on a 3 million ton reduction in CO2 emissions by steelmakers' own initiatives for efficient use of energy and other ways. Concerning collection of waste plastics and other ways, only an increase in the collected volume compared to FY2005 is counted as the amount of reduction in emissions

Steel Production Processes and Development and Use of Energy Conservation Technologies



(Reference) Change in Product Mix for Downstream Evaluations



Life Cycle Environmental Impact of Steel Products

Issuance of ISO 20915 (International standard for life cycle inventory calculation methodology for steel products)

- This is a method for calculating the environmental impact of steel products. One example is the impact per kilogram of hot rolled sheets.
- This method can be used by steel users to calculate the environmental impact from steel when evaluating a LCA of finished products.
- Japan submitted the draft of this standard in July 2015 and, after discussions with many countries by using worldsteel's expert meeting and other channels, the standard was issued on November 12, 2018 from ISO.
- ISO 20915 has the following features.
  - This is the world's first standard for evaluating the environmental impact of steel products that covers the entire life cycle, including recycling of end-of-life products.
  - The standard places emphasis on the ratio of scrap recovery instead of the scrap utilization ratio for the reduction of the environmental impact of steel products.
  - By visualizing of the effects of recycling, this standard makes possible the more widespread use of environmental impact evaluations that cover the entire life cycle. This will increase the recycling of basic materials on a global scale and contribute to lowering the environmental burden of these materials.