Steel Industry Measures to Combat Global Warming
Report of “Commitment to a Low Carbon Society”
January 2016
The Japan Iron and Steel Federation

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6. Promotion of “Commitment to a Low Carbon Society” Phase II
1. Performance report of “Commitment to a Low Carbon Society” (Eco Process)
Japanese steel industry is supporting the Commitment to a Low Carbon Society by fighting global warming with the “three eco’s” created during the Voluntary Action Plan along with COURSE50.

**Eco Process**
Aiming 5 million-tons CO$_2$ reduction vs BAU emission in FY2020 by fully implementing state-of-the-art energy technologies

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

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

**Development of revolutionary steelmaking processes (COURSE50)**
Cut CO$_2$ emissions from production processes about 30% by using hydrogen for iron ore reduction and collecting CO$_2$ from blast furnace gas. The first production unit is to begin operations by about 2030*. Goal is widespread use of these processes by about 2050 in line with timing of updates of existing blast furnace facilities.

* Assumes establishment of economic basis for CO$_2$ storage infrastructure and creation of a practical unit using these processes.
This is a commitment to reach the target based on total crude steel production of 120 million tons in Japan plus or minus 10 million tons. The shaded section of this graph shows the range of production of companies participating in the Commitment to a Low Carbon Society for crude steel production of 110 million to 130 million tons.

The BAU line assumes that steel product mix remains the same as in FY05.

May be outside the anticipated range if there is a big change in production volume. If this happens, suitable levels for BAU and the reduction will have to be examined based on actual conditions.
Annual trend of Energy Consumption and CO₂ Emissions

Total Energy Consumption

Unit Energy Consumption (Based on FY1990)

CO₂ Emissions from Fuel Combustion (Incorporate improvement by emission credit)

Unit CO₂ Emissions (Based on FY1990) (Incorporate improvement by emission credit)

*PJ is a petajoule (10¹⁵ joules). One joule is 0.23889 calories. 1PJ is equivalent to about 2.58 million kiloliters of crude oil.
# Major Initiatives since FY2005

## 1. Next-generation coke oven (SCOPE21)

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Location</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nippon Steel &amp; Sumitomo Metal Oita Works</td>
<td>(2008)</td>
<td></td>
</tr>
<tr>
<td>Nippon Steel &amp; Sumitomo Metal Nagoya Works</td>
<td>(2013)</td>
<td></td>
</tr>
</tbody>
</table>

## 2. More efficient power

<table>
<thead>
<tr>
<th>Initiative</th>
<th>Location</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kobe Steel Kakogawa Station No. 1</td>
<td></td>
<td>Gas turbine combined cycle unit (2011)</td>
</tr>
<tr>
<td>Kimitsu Joint Thermal Station No. 6</td>
<td></td>
<td>Advanced combined cycle unit (2012)</td>
</tr>
<tr>
<td>Kashima Joint Thermal Station No. 5</td>
<td></td>
<td>Advanced combined cycle unit (2013)</td>
</tr>
<tr>
<td>Wakayama Joint Thermal Station No. 1</td>
<td></td>
<td>Advanced combined cycle unit (2014)</td>
</tr>
<tr>
<td>Oita Joint Thermal Station No. 3</td>
<td></td>
<td>Advanced combined cycle unit (2015)</td>
</tr>
<tr>
<td>Kobe Steel Kakogawa Station No. 2</td>
<td></td>
<td>Gas turbine combined cycle unit (2015)</td>
</tr>
<tr>
<td>JFE Steel Chiba Station West-No. 4</td>
<td></td>
<td>Gas turbine combined cycle unit (2015)</td>
</tr>
</tbody>
</table>

Source: Kimitsu Cooperative Thermal Power Company, Inc.
Reuse of Waste Plastics etc.

- Under the Commitment to a Low Carbon Society, the goal is to utilize 1 million tons of waste plastics and other materials based on the premise that the government would create a collection system. But the volume collected in FY14 remained 450,000 tons, which is the same level as FY2005.

- A big CO₂ emission reduction is possible by reexamining associated policies for the use of waste plastics and other materials. At the governmental councils and other occasions, we continuously request to review and revise the current system as soon as possible.

Use of Waste Plastics and Waste Tires

Source: The Japan Iron and Steel Federation
Effective Use of Waste Plastics (Containers and Packaging Recycling)

• Due to priority on recycling materials, purchased 260,000 tons of waste plastics in FY2014 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 CO₂ emissions through the effective use of waste plastics, etc. We hope to see a quick reexamination of recycling systems from the following standpoints.

(1) From the standpoint of efficiently and effectively using waste materials (recycling waste materials that are highly effective at cutting CO₂ 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 CO₂ 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

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

Source: The Japan Containers and Packaging Recycling Association

FY14 unit purchase price for recycled materials was 63,000/ton and ¥44,000/ton for chemicals
Steel Industry Environmental/Energy Conservation Investments

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

Energy Conservation Initiatives of the Steel Industry

1. Performance Report

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Initiatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>’70s</td>
<td>Process innovations (Continuous casting, continuous annealing, etc.)</td>
</tr>
<tr>
<td>’80s</td>
<td>Process improvements (Hot charge rolling, automated combustion control, etc.)</td>
</tr>
<tr>
<td>’90s</td>
<td>Recovery and efficient use of byproduct gases (Gas holder, high-efficiency gas turbine combined cycle, etc.)</td>
</tr>
<tr>
<td>’00s</td>
<td>Exhaust heat recovery (TRT, CDQ, etc.)</td>
</tr>
<tr>
<td>’10s</td>
<td>SCOPE-21 (Constant improvements, Hydrogen amplification, CO₂ recovery)</td>
</tr>
</tbody>
</table>

**Process innovations**
- Continuous casting, continuous annealing, etc.
- Hot charge rolling, automated combustion control, etc.
- Blast furnace coal powder input, coal moisture control, etc.
- Artificial intelligence, supply chain network, etc.

**Process improvements**
- Hot charge rolling, automated combustion control, etc.
- Continuous casting, continuous annealing, etc.
- Artificial intelligence, supply chain network, etc.

**Exhaust heat recovery**
- TRT, (CDQ), etc.
- Regenerative burners, etc.

**Energy Conservation Initiatives**
- Recovery and efficient use of byproduct gases
- Exhaust heat recovery
- Use of waste materials
- Process innovations
- Process improvements
- Byproduct gas use
- Exhaust heat recovery
- Waste material use

**Waste materials use**
- Waste plastics and tires, biomass
- Gasification, etc.
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.
2. Eco Solution
Eco Solution: Global Crude Steel Production (Countries and regions)

- Global crude steel production in 2014 was a record-high 1.67 billion tons. During the 24 years since 1990, production has approximately doubled.
- China is the world’s largest producer of greenhouse gases. China’s steel production has grown more than tenfold since 1990 and the country accounts for almost half of global steel production volume.

Source: worldsteel
Global steel demand is expected to increase, mainly in emerging countries, and steel production will climb with this demand. The RITE forecast for 2050 global crude steel production is 2.2 billion tons. This is about 30% higher than the 1.67 billion tons in 2014.

Technologies are the only way to minimize CO₂ emissions as demand for steel increases. Japan’s steel industry is the most energy-efficient in the world. Sharing energy conservation technologies and increasing their use will become even more important as an effective means of fighting global warming.
Eco Solution: CO₂ 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 CO₂ 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 CO₂ emissions in China, Korea, India, Russia, Ukraine, Brazil and other countries by approximately 50 million tons.

Utilization Rates of Major Energy Conservation Equipment by Blast Furnace Steelmakers

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>No. of units</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke dry quenching (CDQ)</td>
<td>90</td>
<td>1,671</td>
</tr>
<tr>
<td>Top-pressure recovery turbines (TRT)</td>
<td>59</td>
<td>1,071</td>
</tr>
<tr>
<td>Byproduct gas combustion (GTCC)</td>
<td>47</td>
<td>1,634</td>
</tr>
<tr>
<td>Basic oxygen furnace OG gas recovery</td>
<td>21</td>
<td>792</td>
</tr>
<tr>
<td>Basic oxygen furnace sensible heat recovery</td>
<td>7</td>
<td>85</td>
</tr>
<tr>
<td>Sintering exhaust heat recovery</td>
<td>6</td>
<td>88</td>
</tr>
<tr>
<td>Total emission reduction</td>
<td>5,340</td>
<td></td>
</tr>
</tbody>
</table>

Emission Reductions in Other Countries from Japanese Energy-conserving Equipment

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

Note: Continuous casting figures for all three countries include blast furnace and EAF steelmakers (Total continuous casting production/Total crude steel production in 2013). For other equipment, figures are for FY2014 in Japan, 2013 for coke oven gas recovery and LD converter gas recovery and 2010 for CDQ and TRT in China, and 2000 for all other categories in India.

Sources:
Japan: JISF
International cooperation to support Eco Solution


Bilateral Activities

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

The Public and private collaborative meeting between Indian and Japanese Iron and Steel Industry (2011~)

ASEAN-Japan Steel Initiative (2013~)

Multilateral Activities

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

GSEP Steel WG(2010~)
GSEP: Global Superior Energy Performance Partnership

ENCO (~2009)
Environment Committee

EPCO (2010~2013)
Environmental Policy Committee

ECO (2014~)
Environment Committee

“CO₂ Breakthrough Program”: Participating with COURSE50 (2003~)

CO₂ data collection (2007~)

Development of ISO14404* (2009~2013)
Issued as ISO in March 2013
*Standards for the calculation of CO₂ emission from steel plants

worldsteel etc.
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.

**Eco Solution: ISO50001 Certification**

- **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 CO2 emissions based on the JISF targets
  - JISF checks progress by receiving reports from company presidents at its Executive Board Meeting

- **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

- **Check**
  - Performance is evaluated every year by a government advisory council (steel working group) and Keidanren third-party evaluation committee
Eco Solution: Three pillars of the energy management in the steel plant

ISO14404 (issued in March 2013)
• This standard, which incorporates the proposal of the Japanese steel industry, permits comparisons and evaluations using more effective data by establishing uniform global indicators for individual steel mills for energy efficiency (unit CO$_2$ emissions)

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

Energy Management System (ISO50001 certified in Feb. 2014)
• An energy management system ideally suited for conducting energy conservation activities

Accurate measurements and evaluations by using a uniform standard (ISO14404)
Your blood pressure is higher.....

Best energy conservation technologies based on evaluations (Technologies Customized List)
I will give you medication to lower your blood pressure.
You need to exercise regularly.

Energy conservation PDCA (ISO50001)
Take medicine every day and jog on weekends
Measure blood pressure daily to confirm progress and work even harder if there are no benefits!

Higher energy efficiency (Goal achieved)
Meet targets and return to good health!
Global contribution of Japanese steel industry in energy saving field

   - As a foundation of JISF’s international contribution, technology conference is organized periodically after signing MoU in July 2005.
   - The 7th conference was held in October 2015 for the first time in 4 years. With more than 100 participants from both countries, there were active interactions relating to energy saving experiences and latest energy saving facilities etc.

2. India: The Public and Private Collaborative Meeting between Indian and Japanese steel industry (2011~)
   - Collaborative meeting was held 5 times since 2011, with the participation of energy saving experts from public and private sector in India and Japan.
   - Japan supports technology transfer from Japan to India by conducting steel plant diagnosis by using ISO14404, establishing Technologies Customized List and by organizing technology seminars by engineering companies.

3. ASEAN: ASEAN-Japan Steel Initiative (2013~)
   - JISF and AISC (ASEAN Iron and Steel Council) signed MoU in order to enhance interaction in the field of environment, standardization and trade.
   - In the environmental field, Japan conducted steel plant diagnosis, established Technologies Customized List and organized public and private workshop etc under the public and private cooperation.
3. Eco Product
Eco Product: Japanese Industrial Products that Conserve Energy and Cut CO₂ 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 CO₂ emissions in Japan and worldwide.

- The Japanese steel industry has established a close relationship with these manufacturers by developing and supplying steel that has a variety of characteristics. This high-performance steel is a vital to achieving the outstanding functions of advanced products and has earned a reputation for reliability among manufacturers.

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

➢ Motors for hybrid/electric cars
   High-efficiency non-oriented electrical sheets for higher fuel efficiency, more power, smaller size and lower weight

➢ Automotive and industrial machinery parts
   Strong gear steel increases gears and reduces size and weight – higher fuel efficiency

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

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

➢ Generator parts
   Steel for high-efficiency power plant turbines can withstand high temperatures and high rotation speeds
The Importance of Increasing the Use of Eco Products

- High-performance steel generally has higher CO₂ emissions than ordinary steel does during the manufacturing stage. But high-performance steel is an eco product because it greatly lowers CO₂ 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 CO₂ 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

Source: The Institute of Energy Economics, 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.
Eco Product: The global competitive edge of the Japanese steel industry, mainly for high-performance steel

- Steel from other countries cannot match Japan’s high-performance steel in terms of performance, quality, supply and other attributes. This steel is the core element of the international competitive edge of the Japanese steel industry.

- China, the world’s largest steel producer, became a net exporter of steel in 2006. Only Japan is still a net exporter of steel to China.

Source: Customs statistics China
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 (FY2014 production of 7.30 million tons, 6.6% of Japan’s total crude steel output). The use of finished products made of high-performance steel cut FY2014 CO\(_2\) emissions by 9.90 million tons for steel used in Japan and 16.76 million tons for exported steel, a total of 26.66 million tons of CO\(_2\).

**CO\(_2\) Emission Reductions by the five major types of high-performance steel (FY14)**

### 1. Domestic

<table>
<thead>
<tr>
<th>Category</th>
<th>CO(_2) Emission Reductions (FY14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ships</td>
<td>196 million tons</td>
</tr>
<tr>
<td>Power generation boilers</td>
<td>190 million tons</td>
</tr>
<tr>
<td>Trains</td>
<td>96 million tons</td>
</tr>
<tr>
<td>Automobiles</td>
<td>483 million tons</td>
</tr>
</tbody>
</table>

**CO\(_2\) Emission Reduction: 9.90 million tons**

### 2. Export

<table>
<thead>
<tr>
<th>Category</th>
<th>CO(_2) Emission Reductions (FY14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ships</td>
<td>605 million tons</td>
</tr>
<tr>
<td>Power generation boilers</td>
<td>311 million tons</td>
</tr>
<tr>
<td>Trains</td>
<td>700 million tons</td>
</tr>
<tr>
<td>Automobiles</td>
<td>25 million tons</td>
</tr>
</tbody>
</table>

**CO\(_2\) Emission Reduction: 16.76 million tons**

**CO\(_2\) Emission Reductions: 26.66 million tons CO\(_2\) in total (7.30 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 FY2014, use of the five categories of steel products in Japan was 3.766 million tons and exports were 3.534 million tons for a total of 7.299 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.
**CO₂ Emission Reduction from Blast Furnace Slag Used in Cement**

- Mixed cement (mainly slag cement) is one way to lower CO₂ 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 CO₂ emissions.

Replacing conventional cement (Portland cement), which generates CO₂ during the firing of raw materials, with slag cement, which does not generate CO₂ during production, reduced annual CO₂ emissions by 10.88 million tons/year (FY14).

- **Japan:** Annual reduction of 3.82 mn tons of CO₂
- **Exports:** Annual reduction of 7.06 mn tons of CO₂

**Assumptions for emission reduction contribution**
- Conversion to volume of cement: 450kg of slag/Ton of cement
- CO₂ emission reduction: 312kg of CO₂/Ton of cement

**Source:** Japan Cement Association, Nippon Slag Association
4. Initiatives commercial/residential sector and transport sector
Initiatives in transportation

- CO₂ emissions per unit of cargo transport decreased to 42.5kg of CO₂/k ton-km in FY14 from 44.0kg of CO₂/k ton-km in FY06.
- In FY13, the steel industry modal shift (ships + rail) was 78% for primary transportation and 97% for cargo transported more than 500km. This is far higher than the average modal shift rate of 38.1% for all industries in Japan (Ministry of Land, Infrastructure and Transport FY05 data for more than 500km).
- Steelmakers are taking other actions too, such as improving cargo transport efficiency by using a higher pct. of cargo space on ships, utilizing shore-based electric power supplies for ships and using eco-tires on trucks and using eco-friendly driving methods.

### CO₂ Emissions per Unit of Cargo Transport

<table>
<thead>
<tr>
<th>Year</th>
<th>Emission (kg of CO₂/k tons-km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>44.0</td>
</tr>
<tr>
<td>2014</td>
<td>42.5</td>
</tr>
</tbody>
</table>

Note: Total CO₂ emissions from use of gasoline, light oil and heavy oil at 49 companies surveyed divided by total ton-kilometers of cargo transported

### Fuel saving by using electricity from shore-based sources

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

<table>
<thead>
<tr>
<th>No. of units</th>
<th>Steel mills</th>
<th>Junction port</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel mills</td>
<td>218</td>
<td></td>
</tr>
<tr>
<td>Junction port</td>
<td>41</td>
<td></td>
</tr>
</tbody>
</table>

(Totals for 4 blast furnace and 2 EAF steelmakers as of the end of FY14)
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 FY2014.
- Steel industry is taking actions to reduce energy consumption and CO\textsubscript{2} emission from offices. Unit energy consumption in offices in 2014 were down 20% compared to FY 2008-2012. Energy consumption also fell below the reference year.

### Household CO\textsubscript{2} Emissions

<table>
<thead>
<tr>
<th></th>
<th>(CO\textsubscript{2} emissions per individual: kg of CO\textsubscript{2}/person-year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan Total</td>
<td></td>
</tr>
<tr>
<td>(FY2012)</td>
<td></td>
</tr>
<tr>
<td>Japan Total</td>
<td>1,599</td>
</tr>
<tr>
<td>Steel Industry</td>
<td>908</td>
</tr>
<tr>
<td>Steel Industry</td>
<td>835</td>
</tr>
</tbody>
</table>

### Unit energy consumption in offices

- Unit energy consumption per floor area [MJ/m\textsuperscript{3}]

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

Data for 330 business sites of 74 companies in FY2014
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

<table>
<thead>
<tr>
<th>Steam generators</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam generation:</td>
<td>40 tons/hour</td>
</tr>
<tr>
<td>Heating capacity:</td>
<td>29.5GJ</td>
</tr>
<tr>
<td>Thermal transmission area:</td>
<td>382m²</td>
</tr>
<tr>
<td>Primary steam pressure:</td>
<td>1.01MPa (saturation temperature)</td>
</tr>
<tr>
<td>Secondary steam pressure:</td>
<td>0.837MPa (saturation temperature)</td>
</tr>
</tbody>
</table>

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

Project summary
Work is under way on developing a technology for using hydrogen for the reduction of iron ore (method for lowering blast furnace CO₂ 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 CO₂ from blast furnace gas (BFG), a revolutionary CO₂ separation and collection technology (technology for separating and collecting CO₂ 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 CO₂ emissions by about 30%. (a project for NEDO)

Development schedule

<table>
<thead>
<tr>
<th>Phase 1, Step 1</th>
<th>Phase 1, Step 2</th>
<th>Phase 2</th>
<th>Actual use* and increase in use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic technology development</td>
<td>Comprehensive technology development</td>
<td>Development of practical use</td>
<td>All blast furnaces are to be switched to this technology by 2050 as blast furnace facilities are updated and replaced.</td>
</tr>
<tr>
<td>(2008～12)</td>
<td>(2013～17)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 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. COURSE50
Phase 1, Step 2 (FY13-17) Initiatives

Development item (a): Technology for reducing blast furnace CO₂ 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 CO₂ from blast furnace gas
The goal is to develop a technology that makes it possible to collect CO₂ at a cost of ¥2,000 per ton of CO₂, which is the cost that matches the requirements of the demonstration test blast furnace. This will require developing a high-performance chemical absorption liquid and other substances, creating a more efficient physical adsorption method, performing applied research for technologies for utilizing exhaust heat, and creating technologies for more cost reductions.

(a) Technology for reducing blast furnace CO₂ emissions
(b) Technology for collecting CO₂ from blast furnace gas

\[(a)+(b) = \text{CO₂ reduction target is about 30\%}\]
Construction of Trial Blast Furnace

- In Phase 1, Step 2, a $10^3$ blast furnace for testing will be constructed at the Kimitsu Works, which has a trial CO$_2$ separation and collection system (CAT1, CAT30) that can be used for tests with this blast furnace.
- Construction of testing furnace is completed in September 2015 and test operation is ongoing towards the experiment in 2016.
6. Promotion of “Commitment to a Low Carbon Society” Phase II
Commitment to a Low Carbon Society Phase II

**Eco Process**
Aiming 9 million-tons CO$_2$ reduction vs BAU emission in FY2030 by fully implementing state-of-the-art energy technologies

**Eco Solution**
Contribute worldwide by transferring the world’s most advanced energy-saving technologies to other countries (especially to developing countries) and increasing the use of these technologies. (Ca. 50 million ton of CO$_2$ reduction contribution in FY2013. Ca. 80 million tons of estimated CO$_2$ emission reduction contribution in FY2030)

**Eco Product**
By supplying the high-performance steel that is essential to create a low-carbon society, contribute to lowering emissions when finished products using this steel are used. (Ca. 26 million tons of CO$_2$ emission reduction contribution in FY2013. Ca. 42 million tons of estimated CO$_2$ emission reduction contribution in FY2030.)

**Development of revolutionary steelmaking processes (COURSE50)**
Cut CO$_2$ emissions from production processes about 30% by using hydrogen for iron ore reduction and collecting CO$_2$ from blast furnace gas. The first production unit is to begin operations by about 2030*. Goal is widespread use of these processes by about 2050 in line with timing of updates of existing blast furnace facilities.

**Development of innovative ironmaking process (Ferro Coke)**
Develop ferro-coke that can speed up and lower the temperature of the reduction reaction inside a blast furnace and create the associated operating process. Develop revolutionary technologies that can reduce energy consumption for pig iron production and permit the greater use of low-grade raw materials.
Eco Process (Reduction targets in Japan for production processes)

The 2030 goal for steel production processes is to use advanced technologies as much as possible to lower CO₂ 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

<table>
<thead>
<tr>
<th></th>
<th>Phase II 2030</th>
<th>Phase I 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Improve coke oven efficiency</td>
<td>About 1.3mn tons of CO₂</td>
<td>About 0.9mn tons of CO₂</td>
</tr>
<tr>
<td>(2) More efficient electricity generation</td>
<td>About 1.6mn tons of CO₂</td>
<td>About 1.1mn tons of CO₂</td>
</tr>
<tr>
<td>(3) More energy conservation</td>
<td>About 1.5mn tons of CO₂</td>
<td>About 1.0mn tons of CO₂</td>
</tr>
<tr>
<td>(4) Waste plastics²</td>
<td>2.0mn tons of CO₂</td>
<td>2.0mn tons of CO₂</td>
</tr>
<tr>
<td>(5) Develop and use revolutionary technologies³</td>
<td>About 2.6mn tons of CO₂</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>9mn tons of CO₂</td>
<td>5mn tons of CO₂</td>
</tr>
</tbody>
</table>

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

### Fiscal 2030 Assumption

<table>
<thead>
<tr>
<th>Crude steel output in Japan (10,000 tons)</th>
<th>Participants' Crude steel output (10,000 tons)</th>
<th>BAU emissions (tons of CO₂)</th>
<th>Emissions after target is reached (tons of CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12,000</td>
<td>11,508</td>
<td>19,675</td>
<td>18,775</td>
</tr>
</tbody>
</table>

*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.