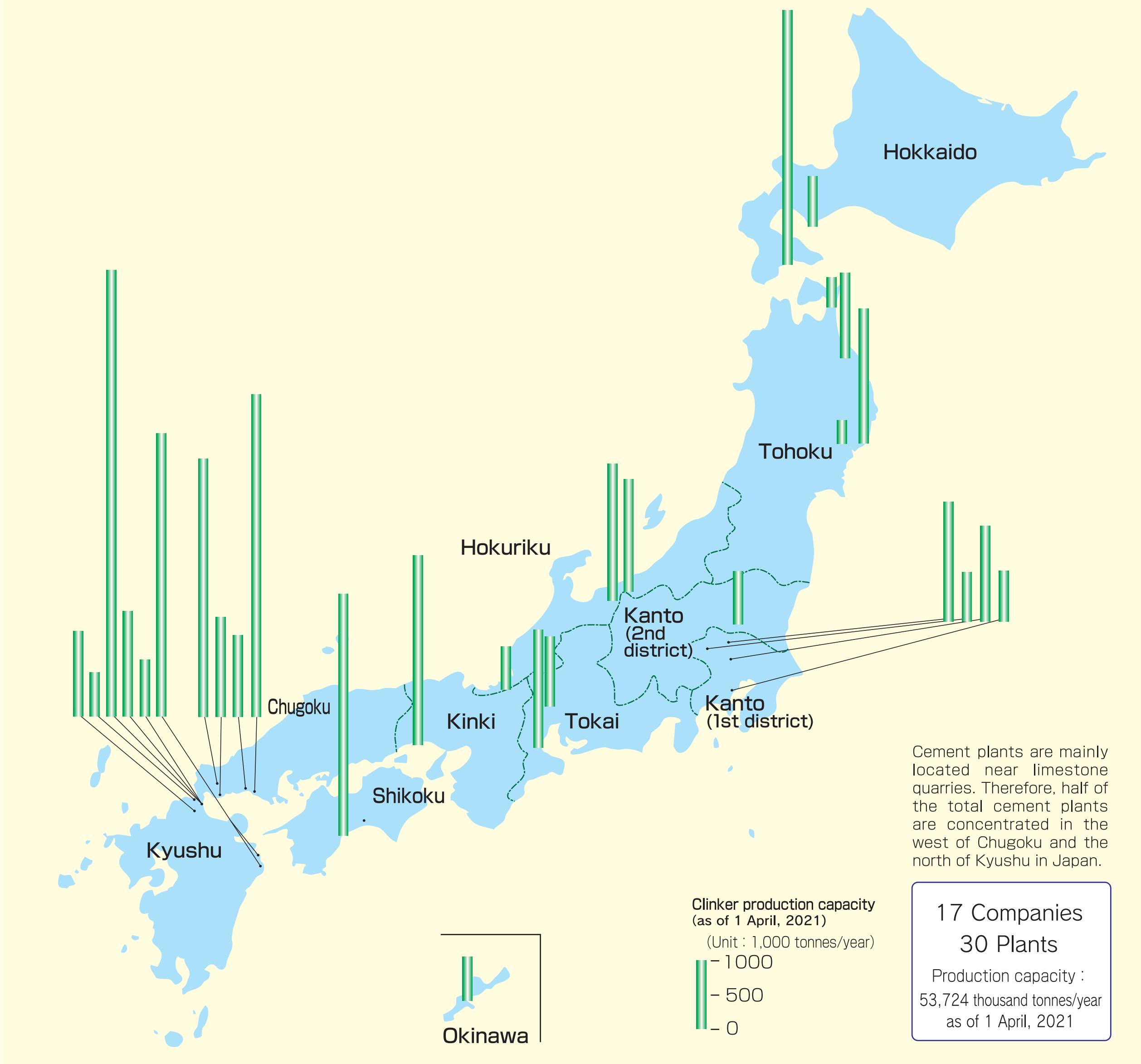
The Cement Industry in JAPAN

2021

JAPAN CEMENT ASSOCIATION

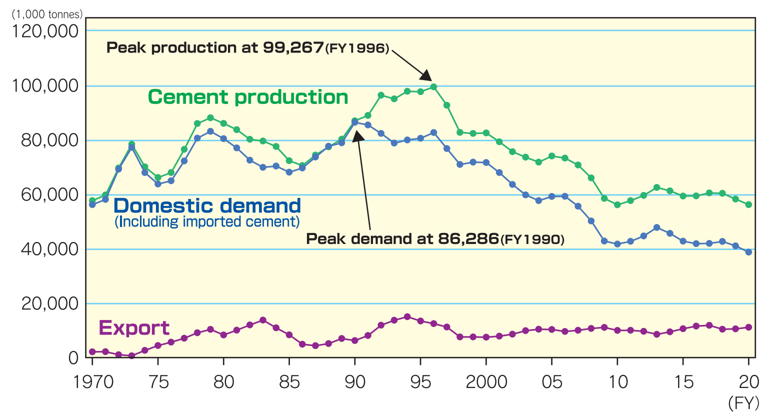
Current state of the cement industry

Locations of cement plants in Japan



Cement plants are mainly located near limestone quarries. Therefore, half of the total cement plants are concentrated in the west of Chugoku and the north of Kyushu in Japan.

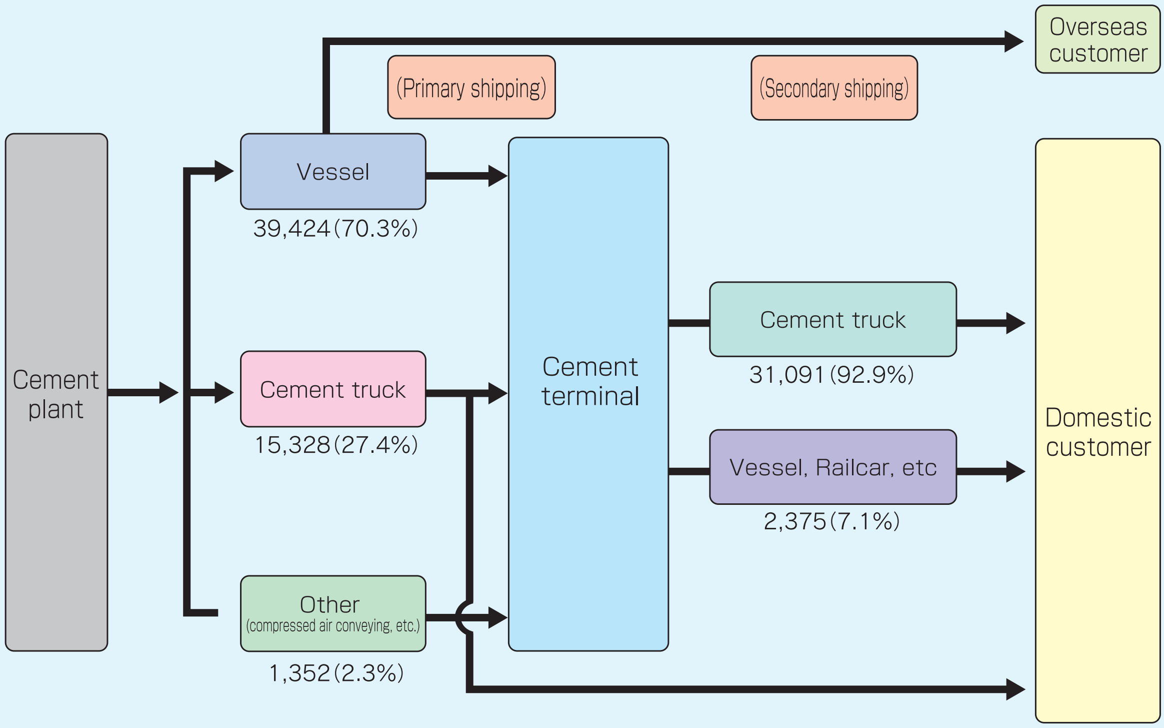
17 Companies
30 Plants
Production capacity : 53,724 thousand tonnes/year as of 1 April, 2021



Supply and demand trend

Distribution system to users in Japan

Most cement is used in "concrete" and 70% of cement is shipped to ready-mixed concrete plants. Because ready-mixed concrete needs to be delivered to a construction site within 90 minutes of mixing, ready-mixed concrete plants are spread all over the country. In order to deliver cement to these users in the most economical as well as effective manner, cement manufacturers have their own service stations (cement terminals).

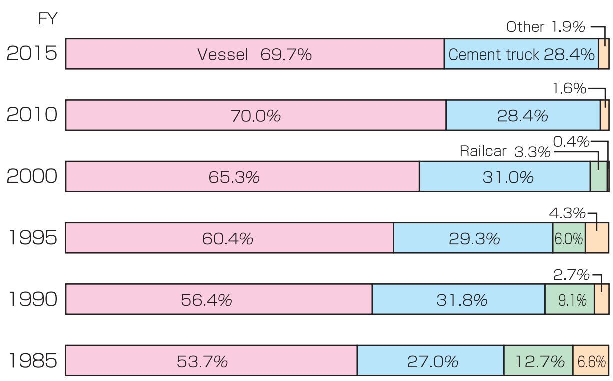


Cement logistics system (FY2020)

(Unit:1,000 tonnes)

Promoting efficiency in distribution costs and reducing environmental impact.

There are 333 service stations across the country, 81% of which are located in the coastal areas. Large vessels dedicated to cement shipping are widely used for mass transportation. They also transport blast furnace slag or coal ash on the way back, striving to reduce logistic costs. Furthermore, upsizing the capacity of trucks also contributes to streamlining the transportation system. Such rigorous efforts for rationalisation also lead to reducing pressure on the environment.



Rationalization of cement transportation(Primary shipping)

Coastal cement terminal and a cement vessel

Cement production

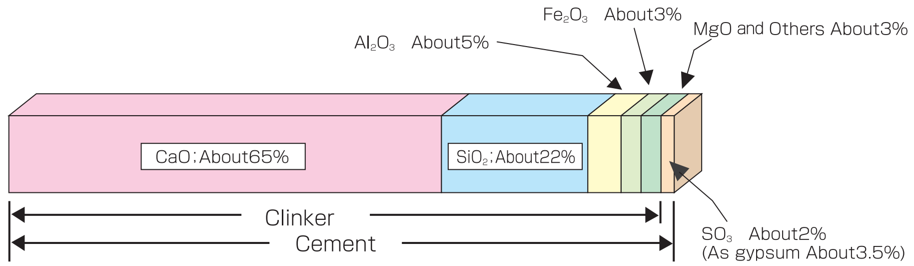
Manufacture of cement consists of the following three processes.

①**Raw materials process** ②**Burning process** ③**Finishing process**

Effective use of the thermal energy in manufacture of cement :

A lot of thermal energy is used in the cement plants. The orange line in the figure of burning process shows the flow of gas. The gases from rotary kiln and cooler are high temperature. When these gases are exhausted, the thermal energy of these gases is not used effectively. Then, the manufacturing processes of cement are designed to use the thermal energy of gases thoroughly. The gases from rotary kiln and cooler are led to the preheater. The gas from rotary kiln and cooler are used for the heating of raw materials including calcination of carbonate. And then, the gas from the preheter is led to the boiler (*) for generating steam of power generation. Finally, the gas from the boiler is led to the raw grinding mill at raw materials process, and the thermal energy of this gas is used for drying raw materials. Overall, the plant operates at over 80% thermal efficiency.

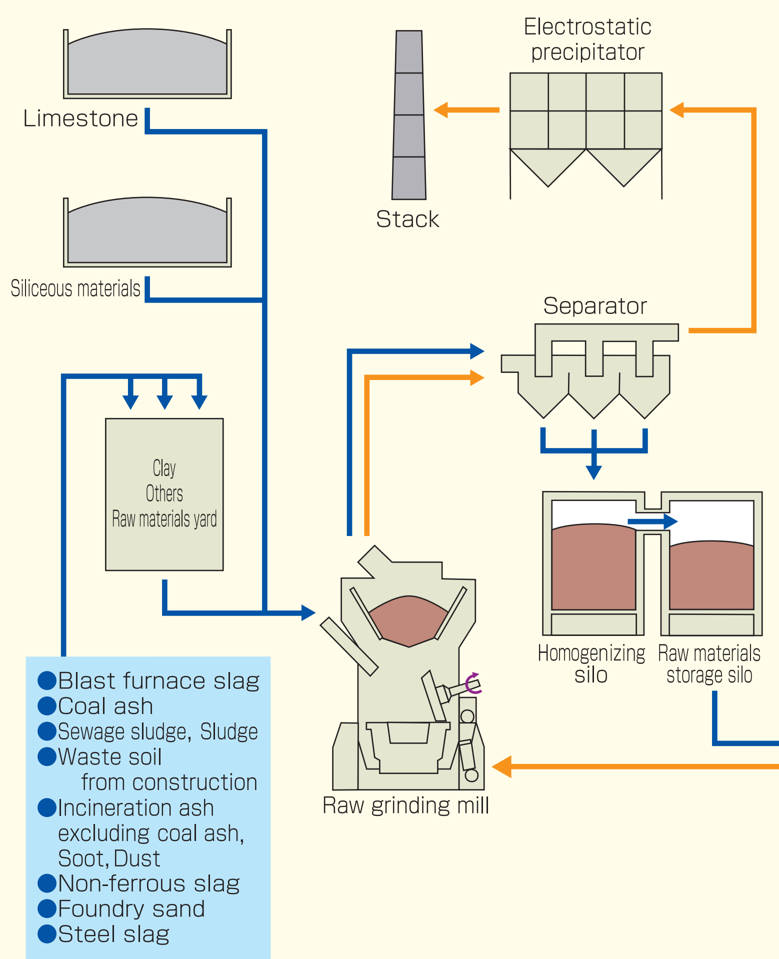
(*) The boiler may not be installed.



Various raw materials:

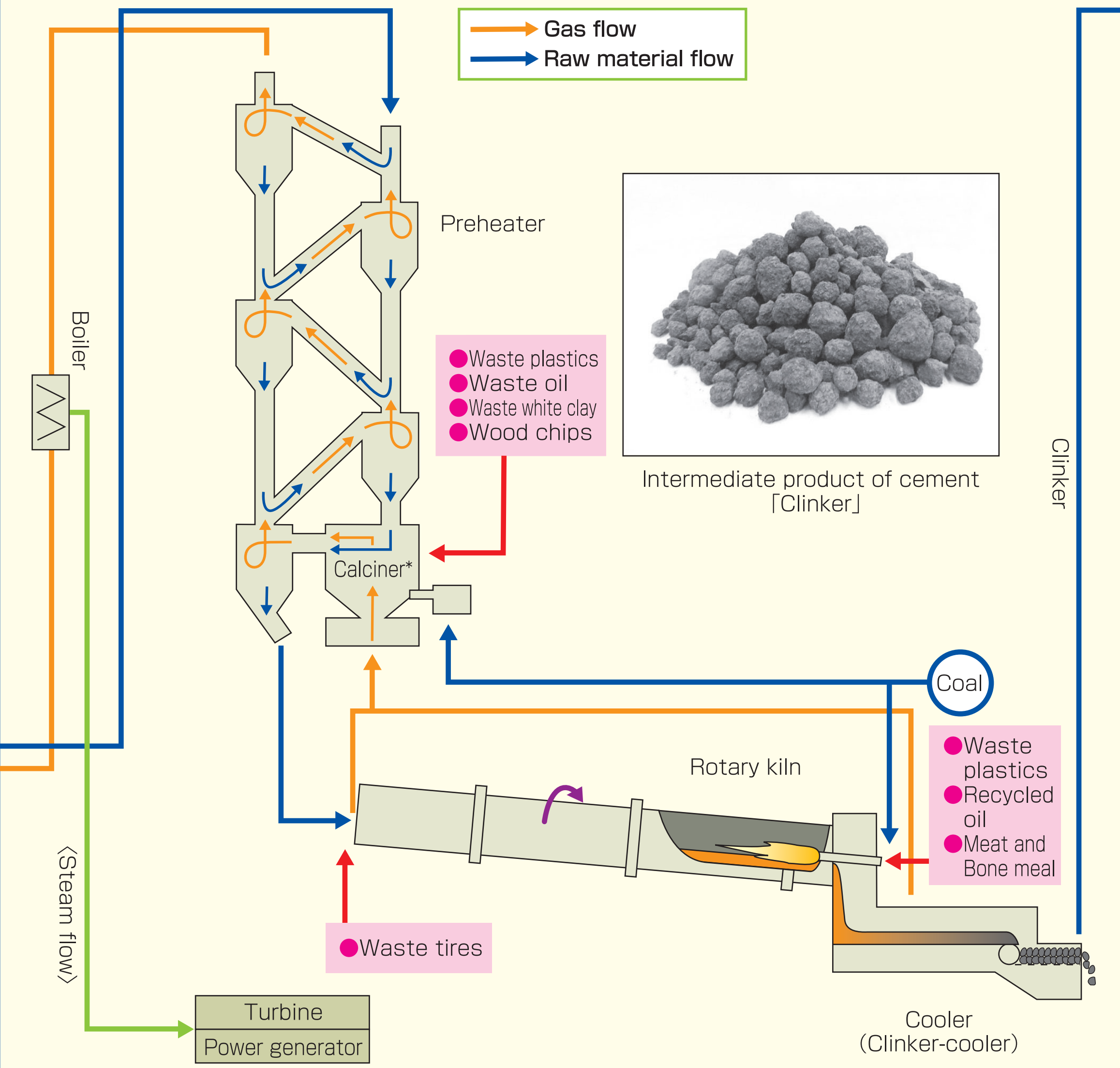
Primal constituents of cement clinker are CaO, SiO_2, Al_2O_3 and Fe_2O_3. The raw materials consist of limestone, clay, silica stones, iron oxide and the others. Since a lot of waste materials and by-products are composed of primal constituents of cement clinker, these are used effectively as some materials.

Raw materials process



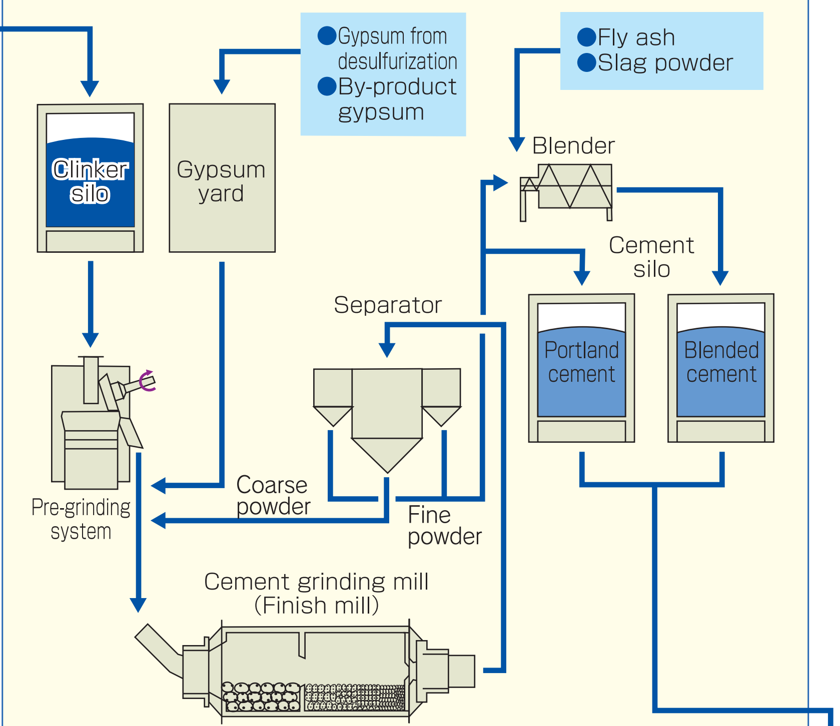
①**Raw materials process :** The raw materials of cement clinker are prepared by granulating the mixture of limestone, clay, silica stones, iron oxide and the others in raw grinding mill. The proportions in mass of each material are carefully controlled so that the chemical compositions of raw materials may be set to the designated compositions.
A lot of waste materials and by-products are used as some materials these days.

Burning process



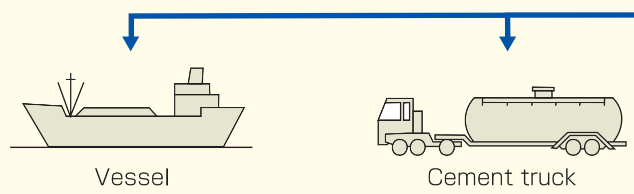
②**Burning process :** Powdered raw materials is heated and sintered in order to produce cement clinker in this process. The temperature of sintering of cement clinker in rotary kiln is 1450℃ or more.
At all plants in Japan, the raw materials are fed to the top of preheater. And, the raw materials passed through preheater are fed to rotary kiln.
This system is adopted in order to raise efficiency of thermal energy. The sintered cement clinker are quickly cooled down in the air quenching cooler.

Finishing process



③**Finishing process :** Portland cements are produced by granulating finely the cement clinker and gypsum in cement grinding mill. And, the blended cements are produced usually by blending Portland cement and admixtures.

Shipping



Long-term Vision for the Cement Industry toward Decarbonized Society

Japan Cement Association made public a "Long-term Vision for the Cement Industry toward Decarbonized Society" (https://www.jcassoc.or.jp/cement/1jpn/200326.html). This vision mainly consists of the following components showing a direction of measures for aiming at establishing the "decarbonized society" as a long-term goal for 2050 or ultimate goal.

1. Background and objective of the vision,
2. Estimated domestic demand in 2050,
3. Roles of the cement industry: "Supply of basic material," "Contribution to an establishment of a recycling-based society," "Contribution to local community," "Cooperation in disaster debris treatments," etc.
4. Direction of measures and issues to be challenged: "Reducing clinker to cement ratio" "Switching to low carbon raw materials and thermal energy" "Improving thermal energy efficiency" "Developing low carbon binding materials and new cement" "Challenging to CCUS" "Taking up CO_2 by cement carbonation" etc.

Our main efforts to build a sound material-cycle society and save energy is introduced as follows.

1. Challenges to the establishment of a recycling-based society as the role of the cement industry

A lot of wastes, by-products and garbage generated from industries and households actually consist of the same constituents as those found in cement. Taking advantage of the fact that no secondary waste, and only a negligible amount of dioxin, is generated in the process of cement manufacturing, the cement industry is striving to recycle waste materials and by-products. Effective use of waste materials and by-products not only contributes to saving natural resources but also helps with extension of a remaining life of final disposal sites for waste materials which is currently a nationwide issue.

The amount of wastes and by-products used for cement production

(Unit: 1,000 tonnes)

Type	Used for	FY1990	FY2000	FY2010	FY2015	FY2018	FY2019	FY2020
Coal ash	Raw materials, Admixture	2,031	5,145	6,631	7,600	7,681	7,593	7,286
Blast furnace slag	Raw materials, Admixture	12,213	12,162	7,408	7,301	7,852	7,430	6,981
Sludge	Raw materials	341	1,906	2,627	2,933	3,267	3,091	2,950
By-product gypsum	Raw materials(Additive)	2,300	2,643	2,037	2,225	2,229	2,091	2,032
Incineration ash(excluding coal ash),Soot, Dust	Raw materials	468	734	1,307	1,442	1,530	1,554	1,482
Waste soil from construction	Raw materials	–	–	1,934	2,278	1,531	1,214	1,241
Waste plastic	Heat energy	0	102	445	576	718	746	746
Non-ferrous slag	Raw materials	1,559	1,500	682	722	811	740	725
Woodchips	Heat energy	7	2	574	705	517	450	437
Steel slag	Raw materials	779	795	400	395	387	441	364
Foundry sand	Raw materials	169	477	517	429	455	407	336
Recycled oil	Heat energy	51	239	195	179	223	236	282
Waste white clay	Raw materials, Heat energy	40	106	238	311	264	260	260
Waste oil	Heat energy	90	120	275	293	335	322	245
Cullet	Raw materials	0	151	111	129	152	165	154
Meat and Bone meal	Raw materials, Heat energy	0	0	68	57	60	63	71
Waste tire	Raw materials, Heat energy	101	323	89	57	70	65	69
RDF, RPF	Heat energy	0	27	48	37	40	46	46
Coal mining waste	Raw materials, Heat energy	1,600	675	0	0	0	0	0
Others	–	14	253	408	382	459	506	447
Total	–	21,763	27,359	25,995	28,053	28,583	27,422	26,155
Cement production		86,849	82,373	55,903	59,074	60,074	57,978	55,894
Consumption per ton of cement (kg/t)		251	332	465	475	476	473	468

Note 1) "Sludge" includes sewage sludge from waste water treatment plants.
Note 2) "Coal ash" includes not only coal ash from power plants, but also coal ash from other industries.

On the other hand, the cement industry supports the recovery and reconstruction of disaster areas by using disaster waste as a raw material and energy for cement production.

Examples of the disaster wastes : Tatami mats wet with muddy water (left) and rice straw mixed with sediment (right)

Disasters and their disaster wastes utilized for cement production since 2004

Date	Type of Disaster (Location)	Main Disaster Wastes
2004.Oct.	Earthquake (Niigata-Chuetsu)	Wood chips
2007 Mar.	Earthquake (Noto peninsula)	Wood chips
2007 Jul	Earthquake (off the coast of Chuetsu)	Wood chips
2011 Mar.	Great East Japan Earthquake	Wood chips, Mixed disaster debris etc.
2014 Aug.	Sediment disaster due to heavy rain (Hiroshima)	Wood chips
2015 Sep.	Heavy rain and flood (Kanto/ Tohoku area)	Tatami mat
2015 Sep.	JCA joined in the D.Waste-Net (Disaster Waste Treatment Support Network) managed by the Ministry of the Environment	
2016 Apr.	Earthquake (Kumamoto)	Wood chips, Tiles, Mixed disaster debris
2016 Dec.	Large-scale fire (Itoigawa city)	Fire wastes
2017 Jul.	Heavy rain and flood (northern Kyushu)	Wood chips, Tiles, Mixed disaster debris.
2018 Jul.	Heavy rain and flood (western Japan)	Sediment, Sludge, Wood chips
2019 Apr.	Heavy rain and flood (northern Kyushu)	Sludge
2019 Oct.	Heavy rain and flood due to the Typhoon (Eastern Japan)	Sediment, Rice straw, Wood chips
Total amount of treatment (2004~2019)		1.57million tonnes

2. Challenges to the establishment of a decarbonized society as the final goal

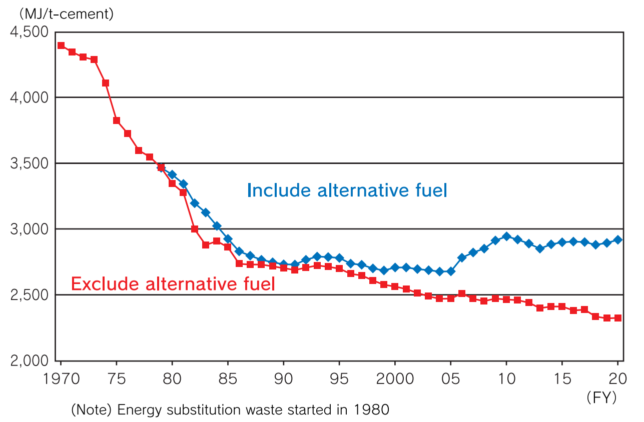
the cement industry continuously reduces thermal energy consumption by installing state-of-the-art energy conservation equipment. Furthermore, consumption of fossil-originated energy is proactively replaced by alternative thermal energy from combustible wastes.

Approximately 70% of the thermal energy required for cement production is consumed during burning process. Therefore, the cement industry has mainly challenged to reduce the thermal energy consumption of clinker production. Particularly all cement plants in Japan installed high efficiency modern kilns equipped with a suspension preheater (SP) together with a precalciner (new suspension preheaters; NSP) by 1997. Furthermore, the thermal energy intensity is reduced by installing many of energy conservation facilities such as high performance clinker cooler into existing plants and therefore Japan is maintaining the highest energy conservation level in the world.

Also, an increase of alternative thermal energy from combustible wastes results in a further reduction of fossil-originated energy

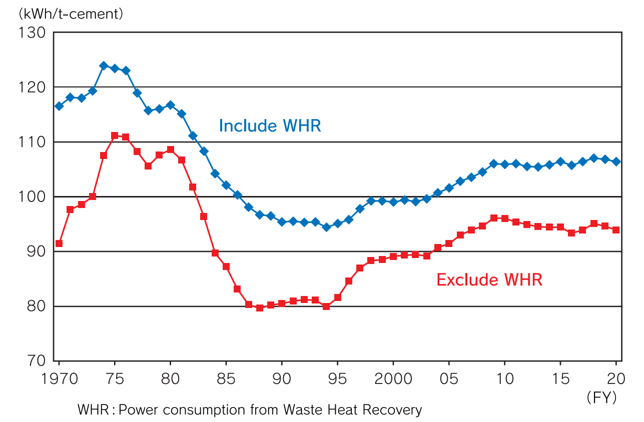
For electrical power energy as well, power consumption is reduced by installing energy conservation equipment such as waste heat recovery and vertical mill.

Specific thermal energy consumption



(Note) Energy substitution waste started in 1980

Specific electric power consumption



WHR : Power consumption from Waste Heat Recovery

Two performance indicators of thermal and power are used to asses an energy efficiency of the cement production.

●Specific Thermal Energy consumption

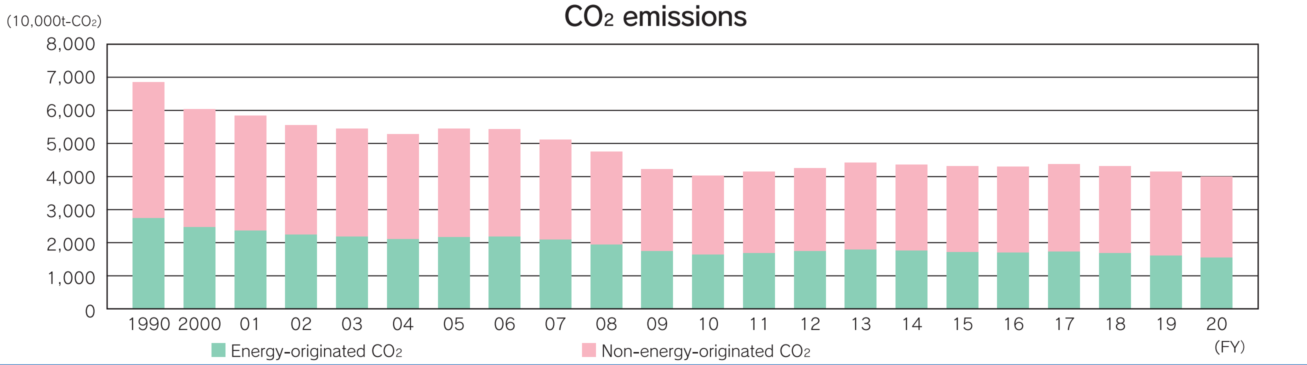
Thermal energy required for one tonne of cement production is used as unit of indicators which are (1) including alternative energy (Gross); and (2) excluding alternative energy (fossil-originated energy only = Net).

●Specific electric power consumption

Electrical power energy required for one tonne of cement production is used as unit of indicators which are (1) including a power consumption generated from waste heat recovery (Gross); and (2) excluding the power consumption generated from waste heat recovery (Net). One of typical energy conservation facilities is the waste heat recovery which reuses the waste heat after cooling the clinker to generate an electric power.

The “Net” is defined as an important performance indicator to aim at assessing an energy-saving performance.

CO_2 emissions



The figure shows the change of CO_2 emissions from the cement industry. Improvement of thermal energy conservation can reduce the energy-originated CO_2 emissions, and increase of utilization of waste containing CaO as alternative raw materials can reduce the non energy-originated CO_2 emissions. The amount is equivalent to a saving about 1.7 million tons of limestone.(FY 2019 results)

The Carbon Neutrality Action Plan (Former "Commitment to a Low Carbon Society")

The cement industry is continuously challenging an improvement of the energy efficiency by developing "The Carbon Neutrality Action Plan"

1) Pledge of Sector Target by 2030: Reduce an specific overall energy consumption of cement production (*1) (*2) 355 MJ/ton-cem. in FY 2030 from the FY 2010 level.

(*1) "Specific overall energy consumption of cement production" is calculated as the summation of "Specific thermal energy consumption of cement production", "Specific thermal energy consumption for on-site power generation" and "Specific electrical power energy purchased from the grid" divided by "Cement production volume", where alternative thermal energy from combustible wastes is excluded.

(*2) "Specific overall energy consumption of cement production measured for the fiscal assessment year" is slightly compensated by taking into account of fluctuations of "cement production volume" and "cement/clinker ratio" from the base year (FY2010) levels as "specific overall energy consumption of cement production".

2) Other Actions on Energy-Saving Products and Services

① Encouragement of diffusion of concrete pavement : CO_2 emitted from a heavy vehicle to drive on concrete pavement is reduced due to an improvement of mileage on a point of view of a life cycle assessment (LCA).

② Contributions to the establishment of the recycling-based society: Utilization of many types of combustible wastes and by-products from other industries for cement production results in extension of a remaining life capacity of existing landfill sites.

3) Contributions to the global mitigation: Statistical national information on energy consumption, diffusion rate of energy conservation technologies (equipment) and utilization of alternative fuels has been published to the public in order to contribute both to the reduction of an energy consumption to produce cement and the establishment of the recycled-based society globally.

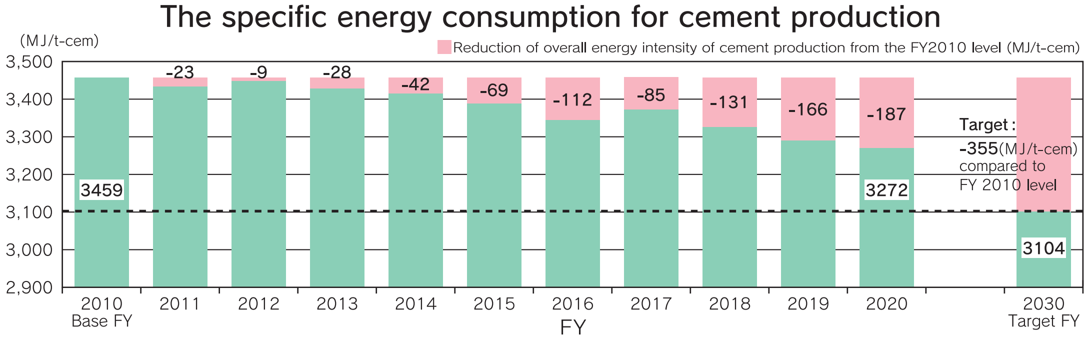
4) Development of technologies (Plan after FY 2021) (*3)

① Specific thermal energy consumption of cement production can be reduced by using mineralizer which decrease the burning temperature of clinker.

② Specific thermal energy consumption of cement production can be reduced by increasing the amount of C_3A in the clinker and clinker substitutions in cement.

(*3) Under the right conditions of expected circumstances and technique such as availability of material containing fluorine, optimized clinker production conditions and quality control method for the aimed clinker, a feasible study for the clinker production would be carried out in an appropriate plant for the pilot test.

The specific energy consumption for cement production



JCA MEMBER COMPANIES

- Aso Cement Co., Ltd. https://www.aso-cement.jp
- DC Co., Ltd. http://www.dccorp.jp
- Denka Co., Ltd. https://www.denka.co.jp
- Hachinohe Cement Co., Ltd. https://hachi-ceme.jp
- Hitachi Cement Co., Ltd. http://www.hitachi-cement.co.jp
- Kanda Cement Co., Ltd. https://www.aso-cement.jp/about/overview_kanda.html
- Mitsubishi Materials Corporation https://www.mmc.co.jp
- Myojo Cement Co., Ltd. https://www.myojyo-cement.co.jp
- Nippon Steel Blast Furnace Slag Cement Co., Ltd. https://www.kourocement.co.jp
- Nippon Steel Cement Co., Ltd. https://cement.nipponsteel.com
- Ryukyu Cement Co., Ltd. https://ryukyucement.co.jp
- Sumitomo Osaka Cement Co., Ltd. https://www.soc.co.jp
- Taiheiyo Cement Corporation https://www.taiheiyo-cement.co.jp
- Tokuyama Corporation https://www.tokuyama.co.jp
- Tosoh Corporation https://www.tosoh.co.jp
- Tsuruga Cement Co., Ltd. https://www.tsuruga-cement.co.jp
- Ube Industries, Ltd. https://www.ube-ind.co.jp

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(2021.12)