Social and Industrial Systems that Meet Global Needs for Social Infrastructure

Kazunori Fujiwara
Rick C. H. Lee
Toshihiko Ito
Atsushi Takita
Mitsuo Takayama
Kazuhiro Oyama
Kazuhiko Yamaguchi
Kiyoshi Kinugawa

CHALLENGES IN MOVING TO LOW-CARBON SOCIETY AND NEED FOR SOCIAL INNOVATION

EMERGING economies that continue to enjoy rapid economic growth face a trade-off between ongoing growth and environmental measures such as reducing CO_2 (carbon dioxide) emissions. The requirements for the quantity and quality of energy, water, railways, and other key aspects of social infrastructure are expanding rapidly in step with population growth and economic progress, and in addition to making effective use of resources including recycling, multi-dimensional needs for innovation including safety, security, and high reliability are rapidly coming to the fore. The topics described below characterize some of the major issues. Hitachi will utilize its comprehensive strengths that include technology, products, engineering, and development capabilities to respond to these global needs (see Fig. 1).

CHALLENGES IN MOVING TO LOW-CARBON SOCIETY

Global Warming

One international challenge is how to combat global warming but meanwhile the world's energy consumption continues to rise and is expected to

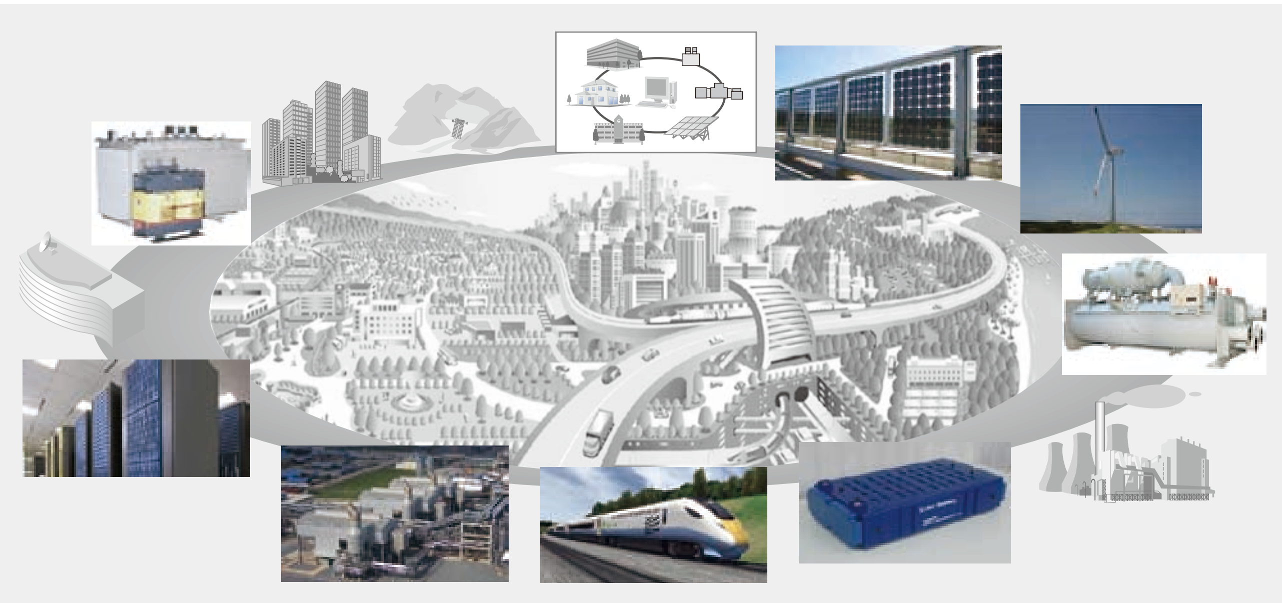
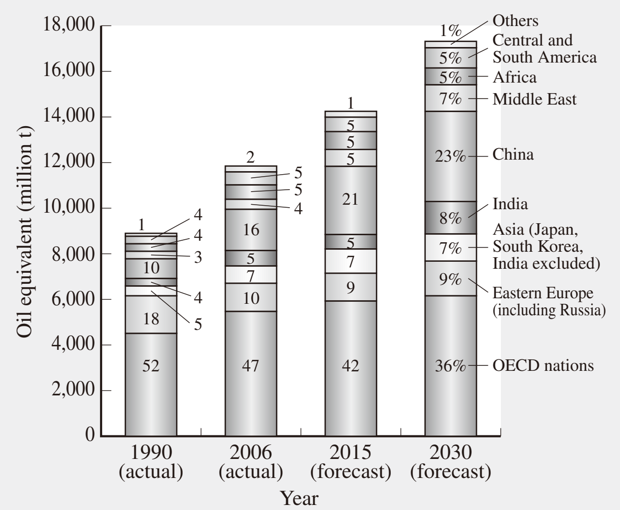


Fig. 1—Hitachi's Social Innovation Businesses.
The global needs for social infrastructure are shifting toward multi-dimensional innovation needs including safety, security, and high reliability. Hitachi can meet these needs with comprehensive strength.



Source: OECD/IEA, “World Energy Outlook 2008”

OECD: Organisation for Economic Co-operation and Development
IEA: International Energy Agency

Fig. 2—Trend in Global Energy Consumption.
Global energy consumption continues to increase and is expected to have reached roughly twice the 1990 level in 2030.

reach roughly twice the 1990 level by 2030 (see Fig. 2). Particularly fast growth is forecasted for the emerging economies of China and India. Given these circumstances, in the move toward a low-carbon society, attention is being focused not only on new technological innovations in a wide range of fields, but also on broad-based environmental businesses that are not limited to specific technologies or products.

Water Shortages

Water shortages are caused not only by the uneven geographical distribution of rainfall due to climate variation, but also as a consequence of a complex combination of different factors including economic growth and population increase in emerging economies.

Currently, approximately 1.1 billion people lack access to safe water supplies, of which 70% live in Asia. The United Nations has predicted that two-thirds of the world’s population will face water stress by 2050(1). The water business in emerging economies is expected to grow rapidly and a report from the Ministry of Economy, Trade and Industry estimated that the market size in 2025 will grow to 100 trillion yen(2).

Urbanization

Urbanization is proceeding at an accelerating pace in emerging economies that are sustaining high growth rates and providing the impetus behind the world economy. The level of urbanization in East Asia has grown from 16.8% in 1950 to 38.9% in 2005 and is expected to exceed 50% by 2025. Rapid urbanization brings problems such as atmospheric pollution caused by waste products and other emissions, soil degradation, water contamination, overcrowding caused by high population density, and power shortages, and as a consequence the need to establish social infrastructure which includes water and sewage infrastructure, roads, railways, and power generation is becoming urgent.

Outlook for CO_2 Reduction in Japan

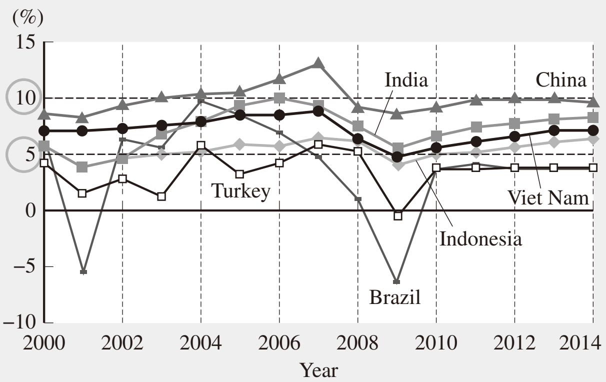
With the Japanese government having announced a target of reducing emissions of CO_2 and other greenhouse gases by 25% (compared to 1990 levels) by 2020 at the United Nations Climate Change Conference, it is anticipated that environmental measures by Japanese corporations will pick up pace from now on. Currently, use of renewable energy in the form of solar and wind power generation is increasing with the encouragement of the government. More companies are considering equipment upgrades that will help reduce CO_2 emissions and it is anticipated that investment in energy-efficiency equipment will expand (see Table 1).

On the other hand, because energy efficiency is already more advanced in Japan than in other nations and this limits the potential for domestic CO_2 reduction measures, a movement towards transferring production sites overseas has commenced. Overseas investment by Japanese corporations is vigorous and is forecast to remain at around 350 billion yen annually up until 2015.

Table 1. Breakdown of Capital Investment by Purpose
The proportion of capital investment accounted for by energy efficiency is growing. (Unit: %)

	Strengthen production capabilities	Upgrades, maintenance and repair	Environment	Rationalization and energy efficiency	Research and development	Others
2008 fiscal year	45.4	18.4	4.1	10.3	9.1	12.6
2009 fiscal year	34.1	25.5	5	12.6	8.8	14.1

Source: Development Bank of Japan Inc., “Survey of Capital Investment Plans”



Source: Produced from IMF data. Figures for 2010 and later are IMF forecasts.

IMF: International Monetary Fund

Fig. 3—Forecasted Trend in Economic Growth by Emerging Economies.
The forecasted trend in economic growth by emerging economies is shown. Growth is expected to continue out beyond 2014 including in China and India.

ECONOMIC GROWTH AND MARKET OUTLOOK IN EMERGING ECONOMIES

Statistical Data on Economic Growth

China is forecasted to continue to achieve GDP (gross domestic product) growth around 10% from 2010 onwards and India, Viet Nam, and Indonesia are also expected to grow at 5% or faster(3) (see Fig. 3). Although economic growth in Brazil and Turkey went backwards in 2009 due to the effects of the recession, growth is expected to recover to around 5% in 2014 and to continue subsequently.

In terms of population, China and India are by far the largest and per capita GDP growth is expected to be strong (see Table 2).

Table 2. Growth Outlook for BRIC Nations and VISTA Nations
Strong growth is expected in China, India, Viet Nam, and Indonesia, even when expressed in per capita GDP.

	Population		Per capita GDP	
	2010 (× 10 million)	Growth (%) 2010 to 2020	Size (× 100 million $US)	Growth (%) 2008 to 2014
China	135	0.5	3,259	10.9
Brazil	20	0.9	8,295	4.5
Russia	14	-0.5	11,807	4.5
India	121	1.5	1,017	6.5
Viet Nam	9	1.1	1,042	7.5
Indonesia	23	1.1	2,239	5.9
Argentina	4	1.0	8,171	0.2
Turkey	8	1.1	10,479	1.5
South Africa	5	0.8	5,685	2.8

BRIC: Brazil, Russia, India, and China
VISTA: Viet Nam, Indonesia, South Africa, Turkey, and Argentina
GDP: gross domestic product

After China and India, Viet Nam and Indonesia are also expected to enjoy strong economic growth because they combine rising populations with increasing per capita GDP.

Market Outlook Based on State of Social Infrastructure Development

Emerging economies are experiencing rapid urbanization driven by strong economic growth. The following section looks at the infrastructure development associated with these changes in terms of the areas being targeted for investment. In China and India, investment is vigorous across all sectors, including water treatment (water and sewage systems, treatment of industrial waste water, industrial water supplies, agricultural water supplies, etc.), energy (electricity generation, oil and gas, etc.), and transport, and growth prospects are strong. In terms of water treatment infrastructure, the proportion of households with a water supply is still low in India, Viet Nam, and Indonesia, even in urban areas and therefore when future growth is taken into account, the prospects are for significant investment in water and sewage infrastructure and therefore the water business is a market that can be expected to grow in the future (see Table 3).

When analyzed from the perspective of GDP and CO_2 emissions, emissions of CO_2 per unit of GDP in emerging economies are seven to 10 times higher than in Japan indicating that Japan's energy-efficiency technologies can also make a contribution in the energy sector and that the business opportunities are significant.

If a comparison is made of overall investment in social infrastructure, the average annual growth rate between 2005 and 2015 in emerging economies such as China (7.2%), India (6.2%), Viet Nam (6.6%),

Table 3. World Water Usage and Share
Considerable investment is anticipated in water supply and sewage systems, particularly in urban areas.

	2000		2025		Growth (%)
	Water intake (km^3/year)	Share (%)	Water intake (km^3/year)	Share (%)	
Agriculture	2,605	66	3,189	61	22.4
Households	384	10	607	12	58.1
Industry	776	20	1,170	22	50.8
Others	208	5	269	5	29.8
Total	3,973	100	5,235	100	31.8

Source: Ministry of Economy, Trade and Industry and other sources

Indonesia (5.2%), and United Arab Emirates (4.6%) is several times higher than that in developed countries such as Japan (1.5%), USA (2.7%), UK (2.4%), and Germany (1.6%).

Hitachi's Social Infrastructure Business

Hitachi has the technologies, products, engineering skills, and development capabilities to meet these global needs.

For example, Hitachi develops and supplies products and systems for sectors such as water treatment (water supply, sewage, desalination, etc.), electric power (nuclear power, gas turbines, solar power, wind power, amorphous transformers, etc.), transport (vehicles, signaling equipment, operation management systems, etc.), and oil and gas, and also lithium-ion batteries, data centers, and smart community technologies that improve the convenience, energy efficiency, and other features of social infrastructure.

For the future, Hitachi intends to expand its social infrastructure business globally by utilizing its comprehensive strengths and by working in collaboration with the customer to deploy total solutions that contribute to customers' business operations.

The following sections provide some representative examples from Hitachi's social infrastructure businesses, including in particular Hitachi's involvement in CO_2 reduction based on energy analysis, leading-edge technologies that give priority to environmental considerations (steel industry, transport, electric power, etc.), and measures aimed at realizing a sustainable society that seeks to make effective use of limited resources.

HITACHI'S INVOLVEMENT IN CO_2 REDUCTION BASED ON ENERGY ANALYSIS

Optimum Energy-efficient Systems for Manufacturing Industry

Hitachi's operations in the industrial sector are based around the three axes of business (comprehensive strength, global-scale operations, etc.), research (optimization of equipment functions, simulation, etc.), and products (performance, price, etc.) and its environmental measures prioritize the following three points.

(1) Energy-efficiency and optimum solutions for industrial equipment

Measures for energy efficiency in industrial equipment need to consider approaches such as improving the efficiency of energy use, implementing energy-efficient operating practices, energy balancing, reducing CO_2 emissions, and reducing the cost of investment. Hitachi conducts surveys and simulations aimed at determining the current situation that cover three points (usage of each form of energy, the operating conditions for utilities equipment, and the specifications and systems used for utilities equipment), and offers optimum proposals to customers about how they should use their equipment based on the results.

For existing low-temperature heat source equipment, for example, Hitachi's approach is to implement energy-efficient systems by performing simulations of optimum energy consumption and offering total proposals that include options such as absorption heat pumps[(a)] that use heat sources such as on-site power generators or compressor cooling water, various types of waste heat recovery equipment, and absorption water chillers.

(2) Installation of ECSs

Regarding the equipment associated with energy efficiency, the more complex the system, the more essential it is to perform a deep investigation of optimum energy-efficient operating practices. In situations like this, Hitachi proposes the installation of an ECS (energy control system) based on demand forecasting and operation planning to achieve energy efficiency in a planned manner. A typical example of a demand forecasting technique is MBR (model-based reasoning). This technique is particularly effective when monitoring equipment or other systems have collected actual data on past operation. An ECS like this that is based on the operating conditions of the actual equipment can forecast the process steam and heating or cooling load required for each day's production volume and determine the optimum energy-efficient operating practice by selecting the mix of cooling and heat source equipment that will minimize CO_2 emissions.

(3) CO_2 emissions reduction in petrochemicals and chemicals industry

When CO_2 emissions are classified by industry,

(a) Heat pump
A heat transfer system that works on the principle that increasing the pressure of a gas increases its temperature whereas decreasing its pressure decreases the temperature. In addition to air conditioning and other refrigeration systems that have conventionally used this system, in more recent times it has also been used for water heaters. In applications such as heaters or water heating in particular, by concentrating heat from the air so that it can be used as a heat source, the system can make available heat energy equivalent to more than three times the electrical energy used to operate the heat pump.

the proportion accounted for by the petrochemicals and chemicals industry reaches about 14% which is the second highest after the steel industry which accounts for approximately 39%. In addition to changes in the balance of its use of electricity and heat (steam) associated with factors such as revisions to its product mix or plant consolidation, the manufacturing part of the petrochemicals and chemicals industry is also reviewing its use of utilities generally due to the rise in the price of fuel over recent years. Pumps and compressors driven by steam turbines that use process steam are widely used in the petrochemicals and chemicals industry. When investigating efficiency improvements to existing compressors, steam turbine upgrades, and changes to the balance between electricity and heat energy, Hitachi actively promotes the option of considering whether to convert from steam turbine drive to electric drive. Hitachi is also working actively on the development of new technologies such as operational control that reduce CO_2 emissions over the overall customer plant including production equipment and utilities and carbon traceability[(b)] that allows dynamic management of CO_2.

Hitachi also has an extensive range of services that provide support from a customer viewpoint, including an ESCO[(c)] business that provides consulting including on financing considerations such as how to reduce up-front investment and an O&M (operations and maintenance) business that provides consulting on operation and maintenance.

Use of Power Electronics to Reduce CO_2 Emissions

Power sources and the electric machinery driven by these power sources form the basis of the social infrastructure for electricity and industry. Power electronics[(d)] is a key component for reducing CO_2 emissions in general industry and also in the electric power industry which includes renewable energy. Hitachi supplies a wide range of systems and other products that combine CO_2 reduction and convenience by combining technologies such as power electronics,

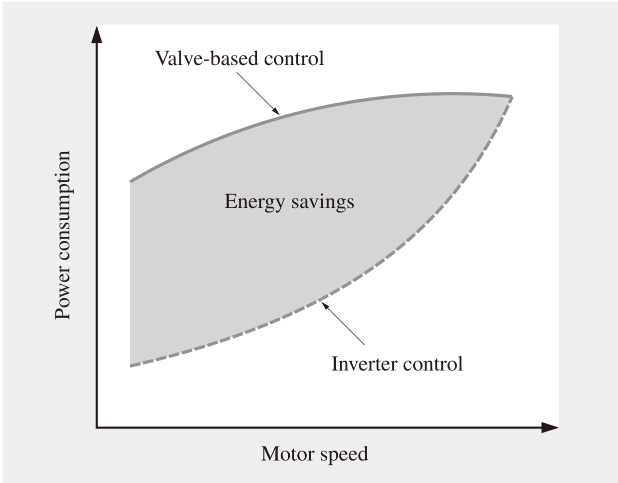


Fig. 4—Example Energy Savings for Pumps and Fans.
The energy savings available when using an inverter to control the operation of equipment such as pumps and fans compared to valve-based control are shown.

control techniques, and the power devices used in these applications in a wide range of fields including electric power, industry, transport, and home appliances.

(1) Industry, transport, and facilities sectors

In a typical factory, approximately 60% of electricity use is accounted for by the electric motors used to drive pumps, fans, and other machinery. The energy efficiency of electric motors can be significantly improved by using inverter control for adjustable-speed operation (see Fig. 4). Hitachi contributes to energy efficiency in industry through an extensive range of inverter models extending from small-capacity general-purpose inverters up to large 60-MVA mega-drives.

Also, as typified by the steel industry, production equipment itself is becoming more diverse and achieving higher precision in response to the need for product improvements such as to quality, functionality, weight, and energy efficiency. In response, Hitachi produces converters that achieve higher efficiency, higher density, and reduced harmonics and supplies total drive solutions tested using electromechanical simulation and simulators.

(b) Carbon traceability
A system that can track the CO_2 emissions associated with a product through every step of its life from development to manufacturing, distribution, and disposal.

(c) ESCO
Abbreviation of energy service company. A business that contributes to the customer's profitability and the protection of the global environment by providing comprehensive energy-efficiency services. The ESCO earns a portion of the customer's energy cost savings (merits) by, for example, providing a guarantee for the benefits of energy efficiency.

(d) Power electronics
Equipment that controls electric power using power semiconductors and the associated application system technologies. Representative examples include rectifiers that convert electric current from AC (alternating current) to DC (direct current), inverters that convert from DC to AC, and power conditioners. Power electronics is used in a wide variety of products from home appliances such as lighting, air conditioning, and refrigerators to eco-cars, railway rolling stock, electrical converters, industrial machinery, and power generation and transmission equipment where it contributes to energy-efficiency and other performance improvements.

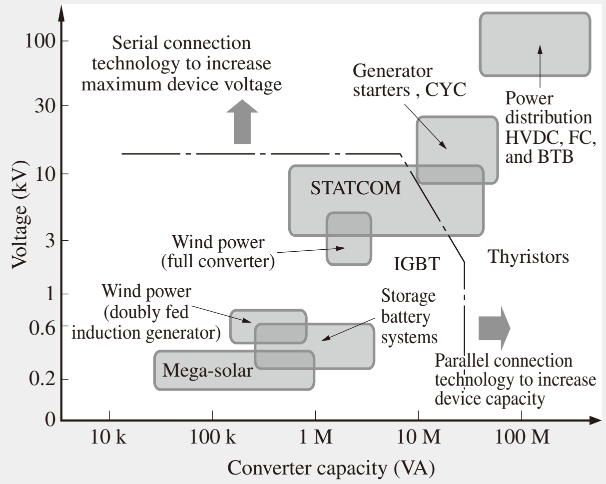
In the transport field, Hitachi is working on initiatives for the railway industry including the commercialization of storage battery systems for making effective use of regenerative energy and the introduction of hybrid drive systems. Hitachi is also working on improving energy efficiency using systems such as electric drives for large dump trucks and other construction machinery and for ships.

In the facilities field, the number of IT (information technology) devices has increased explosively with advances in information processing and communication technology and their wider adoption, and power consumption at data centers is growing dramatically. Hitachi is proceeding with its eco-friendly data center project which has set a target of reducing data center power consumption by up to 50% by 2012. Power electronics technology plays an important role in the installation of a transformer-less UPS[(e)] which is a representative UPS product and in overall optimization including air conditioning.

(2) Electric power industry

Hitachi power electronics systems are utilized in a wide range of areas within the electric power industry, including PCSs (power conditioning systems) for wind and solar power generation and voltage stabilization equipment that stabilizes and suppresses the fluctuations in grid voltage and frequency associated with the connection of a large quantity of wind or solar power generation capacity to the grid, and extend to ultra-high-voltage, large-capacity electricity distribution equipment (see Fig. 5).

Hitachi is also working on development of the power semiconductors that are the key devices in this power electronics equipment with the aims of improving equipment efficiency, enhancing functionality, and extending operating life. A representative example is the IGBT[(f)] for which Hitachi is developing technologies to improve characteristics such as current capacity (3,600 A), voltage (6.5 kV), and maximum junction temperature (150°C) and to reduce thermal resistance in order to supply devices that can help increase the capacity and decrease the size of conversion equipment. In addition to increasing the capacity of individual devices, Hitachi is also making it possible to reduce CO_2 emissions further and improve performance simultaneously by using serial and parallel circuit techniques to achieve even higher capacity in future electrical conversion equipment that uses IGBTs.



Source: OECD/IEA, "World Energy Outlook 2008"

CYC: cycloconverter HVDC: high voltage direct current
FC: frequency changer
BTB: back to back (asynchronous link between grids)
STATCOM: static synchronous compensator
IGBT: insulated gate bipolar transistor

Fig. 5—Example Applications of Power Electronics in Power Industry.
Example applications for Hitachi power electronics products in the power industry are shown.

LEADING-EDGE TECHNOLOGIES THAT TAKE ACCOUNT OF ENVIRONMENT: OIL AND GAS INDUSTRY

Outlook for Oil and Gas Market and Hitachi's Involvement

The environment surrounding oil and gas resources is changing rapidly against the backdrop of our current predicament in which we are faced simultaneously with the long-term rising trend in energy consumption evident in global markets and the problem of the global environment.

On the demand side, vigorous activity in the area of resource diplomacy aimed at securing oil and natural gas resources is happening along with growth in energy consumption caused by population increase

(e) UPS
Abbreviation of uninterruptible power system. A system for storing electric power in a battery to provide backup power in case an outage occurs on the commercial power supply. UPSs have a particularly important role at data centers because an unstable power supply, such as transient voltage drops or other voltage fluctuations occurring on the commercial power supply, can cause faults on servers and telecommunications equipment such as misoperation or shutdown.

(f) IGBT
Abbreviation of insulated gate bipolar transistor. A semiconductor device that combines a bipolar transistor and MOSFET (metal-oxide-semiconductor-field-effect transistor). IGBTs have become the predominant device used in high-capacity inverters because they have lower conduction losses while still being able to withstand high voltages.

and by economic progress in emerging economies in particular. On the supply side, numerous initiatives are being actively pursued including maximizing the value of limited oil and gas resources and make effective use of it in a sustainable way, expanding investment and the exploitation of previously undeveloped prospects, and the development of new sources of energy that can act as alternatives to fossil fuel.

On the other hand, the need to prevent global warming and reduce the burden on the environment is making CO_2 emissions reduction and energy-efficiency measures matters of urgency throughout the oil and gas value chain which extends from upstream resource development all the way to the consumption of the final product.

Against this background, measures such as improvements in production efficiency, utilization, ease of maintenance, and similar along with further reductions in the cost of equipment installation are also needed for the main equipment and other systems that Hitachi supplies to oil and gas plants.

Compressors Designed for Lower Life Cycle Cost

In addition to high reliability, reducing life cycle costs is a priority for the centrifugal compressors(g) used in the oil and gas industry which are required to cover a wide operating range while maintaining their efficiency over long use. To meet these needs, Hitachi has focused on the impeller to improve its efficiency and achieve a wide operating range while also making structural improvements to the inlet guide vane to achieve a wide operating range that permits variations in load. These technologies are also ideal for CCS(h) which requires a wide operating range.

Use of Gas Turbines in the Oil and Gas Market

The H-25 gas turbine is a heavy-duty 30-MW-class model of which more than 120 units have been delivered since first entering service in 1989.

Characteristics of the oil and gas market include custom specifications and harsh operating conditions. Examples include the environment, quality of the air-fuel gas, high performance, integrated control with motors, adjustable-speed inverters, compressors and other equipment, and an optimum design that depends on the scale of the system. To meet the stringent demands of this market, the H-25 gas turbine provides the following features.

(1) High reliability
(2) Consideration for the environment [use of LNC (low-nitrogen oxide combustor)]
(3) Fuel flexibility
(4) Engineering capabilities with a high level of technical skills
(5) High-performance

With a high level of readiness for a market subject to a large number of different stringent standards and other requirements including the American Petroleum Institute (API) standards, the H-25 has built up a large number of sales globally.

Total Solution for Compact LNG Plant

Oil and gas plants have considerable scope for improving energy efficiency and reducing CO_2 emissions, including in existing production equipment. Hitachi can propose improvements that utilize high-voltage inverters and supply high-quality solutions that cover the total process, extending from specific proposals on how to save energy through to evaluating system implementation. One example of a total solution is a proposed LNG (liquefied natural gas) plant for the development of small- to medium-sized gas fields, an area that has attracted attention in recent years.

Proposal features include: (1) use of a highly efficient cooling process different to that used for large gas fields, (2) reduced equipment installation costs, (3) optimization of the entire system from electricity generation to the liquefaction process, and (4) establishment of a business organization that coordinates with and complements the engineering company to make the most of both parties' strengths.

In addition to what it is doing with individual products, Hitachi is expanding the scope of its contribution to the oil and gas industry by supplying total solutions that draw on its strengths in both mechanical and electrical equipment and expanding its business in collaboration with global partners.

(g) Centrifugal compressor
A machine that uses centrifugal force to compress a gas. Air, natural gas, or other gas fed into an impeller that rotates at high speed is compressed in the direction perpendicular to the axis of rotation. Centrifugal compressors are critical items of equipment at oil refineries, petrochemicals, fertilizer production, natural gas, steelmaking, and other plants where they are used in a wide variety of applications.

(h) CCS
Abbreviation of carbon dioxide capture and storage. A technology for separating and capturing the CO_2 produced by thermal power plants, natural gas production sites, etc. and then storing it in a stable geological formation or sequestering it in the ocean. Methods being developed to separate and capture CO_2 include chemical absorption in which the CO_2 is dissolved in an alkaline solvent, physical absorption that applies pressure to absorb the CO_2 into a solvent, and membrane separation using a gas permeation membrane.

LEADING-EDGE TECHNOLOGIES THAT TAKE ACCOUNT OF ENVIRONMENT: STEEL INDUSTRY

New rolling(i) mills are being constructed around the world as demand for steel products grows. Steel industry systems are large and complex combining components that include mechanical systems made up of rolling stands and their associated machinery, high-capacity drive systems, PLCs (programmable logic controllers), process computers, and backbone control LANs (local area networks). Steel industry control systems that require high-speed and high-precision control techniques always use the best available computing and control technology to achieve the μm control accuracy demanded for steel strip.

On the other hand, in addition to producing high-quality steel strip reliably, factors such as rising raw material prices and concern for the global environment are driving growing demands in recent years for improvements in areas such as energy efficiency and product yield through greater rolling efficiency.

To meet these needs, Hitachi has worked jointly with rolling equipment manufacturer Mitsubishi-Hitachi Metals Machinery, Inc. (MHMM) to supply numerous large steel industry systems that seek to achieve highly efficient rolling and higher product quality across the entire system and treat mechanical equipment and electrical control as a single unit. In particular, Hitachi has enjoyed a large share of the international market for continuous PL-TCM (pickling line and tandem cold rolling mill) systems. PL-TCMs achieve high product quality and high production capacity in the order of 1.5 million t/year by linking a pickling line and rolling mill in continuous operation and Hitachi and MHMM have supplied more than 15 new PL-TCMs to sites around the world since 2000.

Hitachi has strengthened its involvement in hot rolling in recent years, working with MHMM on joint research and developing systems that combine know-how in machinery and electrical control. A representative example of the results of this work is the hot rolling equipment supplied to Dongbu Steel in South Korea that commenced commercial operation in 2009. This tandem rolling mill consisted of two roughing mill stands and a five-stand finishing mill and was the first time that Hitachi had been involved in the construction of a new hot rolling system outside Japan. The mill was designed not only to facilitate greater efficiency at the equipment level through the use of the latest motor drives but also to achieve higher steel strip yield through use of the latest jointly developed strip thickness control, temperature control, and other control systems. Also, the overall production process constitutes a recycling system in which scrap is reused as raw material by melting in an arc furnace, and a high level of energy efficiency is achieved by rolling high-temperature steel slabs immediately after they exit the continuous casting machine.

LEADING-EDGE TECHNOLOGIES THAT TAKE ACCOUNT OF ENVIRONMENT: RAILWAYS

Hitachi is working energetically to develop technologies to improve the environmental performance of rail transport. From among these developments, this section looks at the development of technologies for reducing energy consumption and for recycling of rolling stock (see Fig. 6).

Representative examples of technologies for reducing energy consumption are systems that make effective use of regenerative energy and energy savings achieved by the adoption of aluminum carbodies to reduce weight, and in the area of rolling stock recycling Hitachi is also working on improving the reusability of aluminum materials.

Effective use of regenerative energy was achieved by developing hybrid drive systems for diesel trains that run on non-electrified sections and a system for making effective use of energy generated by a regenerative brake on electrified sections. In the field of carbody technology, Hitachi has for some time been advocating the A-train concept. The "A" in "A-train" stands collectively for "Advance," "Amenity," "Ability," and "Aluminum" and the concept seeks to "lighten the environmental burden," "reduce life cycle costs," and provide "comfort." The A-train concept has been involved with the developments such as reducing the noise level inside and outside the train with the objective of comfort. To reduce the burden on the environment further, Hitachi was among the first to start work on hybrid drive systems and it set out to achieve small size, lighter weight, and improved performance by making advances in circuit technology for the traction inverter and integrated control technology that uses its own

(i) Rolling
A process used in the production of steel products in which a semi-finished slab with a specific shape produced by refining and then casting steel is rolled into the steel strip end-product. Rolling is divided into hot rolling in which the steel is rolled at a temperature above its recrystallization temperature and the subsequent process of cold rolling which is performed at room temperature.

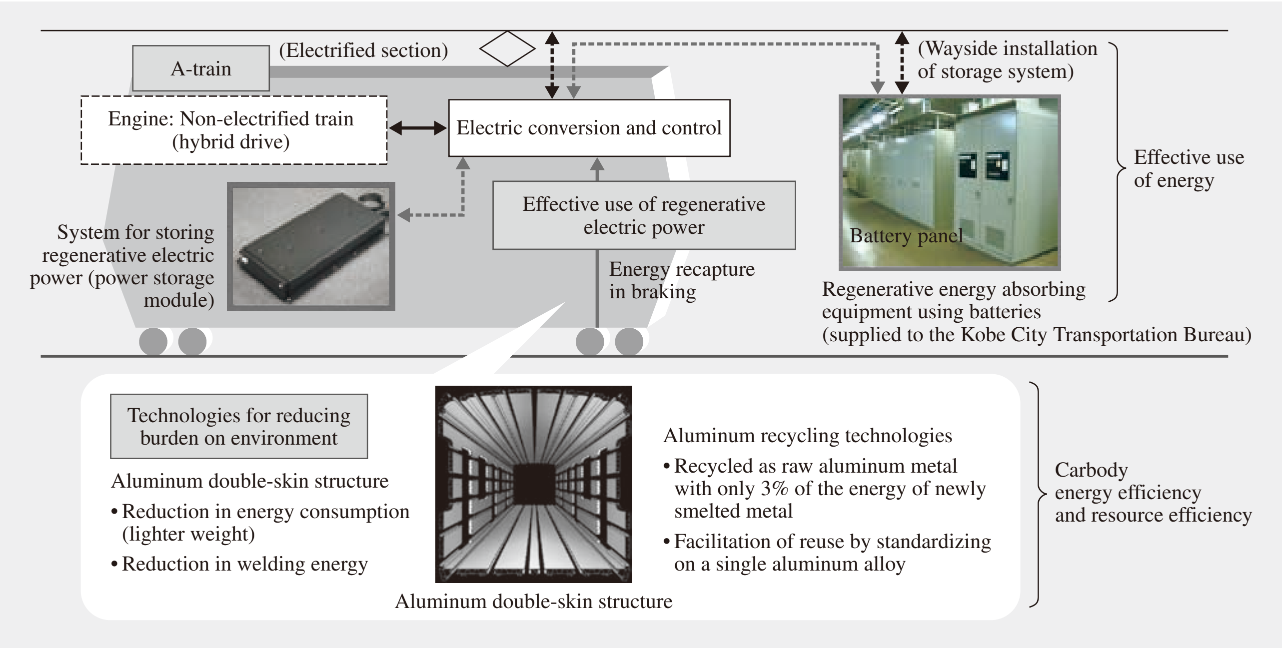


Fig. 6—Leading-edge Technologies for Railways that Take Account of Environment.
Hitachi's leading-edge technologies have reduced the burden on the environment and achieved effective use of regenerative energy.

lithium-ion batteries. The simple structural design using a lightweight aluminum double-skin structure also helps reduce the energy consumed to drive the train. Hitachi also undertook comprehensive work at a part-by-part level to apply technology for reusing the aluminum material used to produce the lightweight carbodies and it utilizes this as raw aluminum metal that can be reused with only 3% of the energy of newly smelted metal.

Hitachi is actively expanding overseas based on these technologies and its rolling stock is in use in the Class 395, the UK's first high-speed train, as well as in Taiwan, South Korea and elsewhere where Hitachi trains enjoy a good reputation.

LEADING-EDGE TECHNOLOGIES THAT TAKE ACCOUNT OF ENVIRONMENT: WATER SOLUTIONS

Supplying Safe and Fresh-tasting Water in a Way that Takes Account of Environment

Over nearly a century, Hitachi has supplied a large number of solutions that deliver safe and fresh-tasting drinking water in and outside Japan based on its advanced technology and product reliability.

The water supply industry is in the process of changing from an emphasis on quantity to an emphasis on quality, which is to say an era of "safe and fresh-tasting drinking water." Preempting the Guidelines for Establishing Plans for Safe Water Supplies promulgated by the Ministry of Health, Labour and Welfare in May 2008, Hitachi developed a safe water supply management system (water supply HACCP[j]) utilizing the HACCP methodology to provide an environment that supports the establishment of plans for safe water supplies by water supply agencies.

In the area of technology development, Hitachi has been an active participant in joint projects between industry, government, and academia and from 2005 to 2007 was part of the e-Water II project run by the Japan Water Research Center. Through this project, Hitachi set out to achieve objectives including reducing operation and management costs and reducing the burden on the environment by developing technology for water systems subject to wide variations in water quality which consisted of control technology that uses advanced simulation techniques and safety assurance technology based on a proprietary membrane impairment detection method.

To reduce the burden placed on the water-related environment by waste discharge which is a global issue, Hitachi has developed and is currently testing

(j) HACCP
Abbreviation of hazard analysis and critical control point. A hygiene management methodology for food manufacturing processes in which the potential hazards in all processes from raw materials reception through to manufacturing and dispatch are identified in advance and the critical control points needed to prevent these from occurring are continuously monitored and recorded.

control technology for performing water treatment with low emissions that reduces the emissions of CO_2 and NO_2 (nitrogen dioxide) by using operational control to optimize the environmental burden imposed by sewage treatment plants and their water quality targets and operating costs. To help encourage water recycling, Hitachi has also developed a sewage recycling system that uses ozone micro-bubbles[(k)] and has plans to supply it globally.

Global Response for "Water Century"

Along with issues such as water pollution and increasing demand for water in emerging economies in particular, it is anticipated that the needs associated with water resources will intensify further in the future in countries around the world. The 21st century has been called the "water century" and securing water resources has become an important issue.

Hitachi has been contributing globally such as the construction of the Mubarak Pumping Station as part of a desert greening project in Egypt and the operation of a water recycling project in Dubai in the United Arab Emirates. Hitachi is also building operational and management know-how through activities such as participating in the running of water and sewage systems in the Republic of Maldives to supply total solutions.

At the core of this work is the "intelligent water" concept. This concept seeks to improve the efficiency of water circulation at a regional level by combining advanced information and control technology with Hitachi's sophisticated water treatment systems. Through this concept, Hitachi intends to contribute to solving the issues of the global water environment.

INVOLVEMENT IN BUSINESSES FOR THE ASIAN BELT ZONE[(l)]

Joint Project with National Development and Reform Commission in People's Republic of China

Based on the policies in China's 11th Five Year Plan which included ten large environmental projects and a target of reducing annual energy consumption by an amount equivalent to 240 million t of coal (target for 2010 fiscal year) with the aim of transitioning to a society with a sustainable economy, Hitachi (China) Ltd. established a China Energy Conservation and Environmental Protection Promotion Project Team in April 2006 (see Table 4).

In September 2007 in one of the first projects to be undertaken under the Japan-China Energy Conservation and Environmental Business Promotion

Table 4. Key Actions in Joint Project in China

Since 2006, Hitachi has been developing an energy-saving model project together with China's National Development and Reform Commission and Yunnan Province, making notable achievements and receiving high praise.

Date	Main Activity
April 2006	China Energy Conservation and Environmental Protection Promotion Project Team established by Hitachi (China) Ltd.
January 2007	Environment Experts Mission, invitation of Chinese media Energy conservation and environmental protection links between Hitachi, National Development and Reform Commission, and China Center for Business Cooperation and Coordination Hitachi Energy Conservation and Environmental Protection Technology Exchange Conference organized jointly (in May 2007 and January 2008)
September	Second Japan-China Energy Conservation and Environment Forum held Hitachi, National Development and Reform Commission, Energy Conservation Office of The People's Government of Yunnan Province Model Project for Energy Conservation and Waste Heat and Pressure Recovery for Electrical Machinery Systems in the Steel and Chemical Industries of Yunnan Province signed
April 2008	Inverter system installed at Kunming Iron & Steel Group Co. Ltd.
May	Hitachi and National Development and Reform Commission agree on Model Project for Energy Conservation and Pollution Reduction in Small and Medium-sized Chinese Businesses Agreement on Ningbo industrial city on the coast of Zhejiang Province as the model city (November 2008) Third Japan-China Energy Conservation and Environment Forum held Japan-China Energy Conservation and Environmental Business Promotion Model Project signed
July	Inverter system installed at Yunnan Tianda Chemical Industrial Co., Ltd.
September	Inverter system installed at Yunnan Three Circles Chemical Co., Ltd., Yuntianhua Group Co., Ltd.
November 2009	Fourth Japan-China Energy Conservation and Environment Forum held Hitachi and National Development and Reform Commission sign memorandum of understanding on "Good Will Joint Project for Building a Low-carbon Society and Resource and Environment Sector"
March 2010	National Development and Reform Commission —Hitachi Green Economic Technology Exchange Meeting held.

(k) Ozone micro-bubbles
Micro-bubbles are air bubbles with a diameter of 10 to 40 μm that have special properties including persisting in the liquid for longer than conventional air bubbles and not combining with other bubbles. Ozone micro-bubbles are seen as potentially providing an advanced form of water treatment because, by forming micro-bubbles from ozone, a substance that does not dissolve easily in water, they can disperse in the water and achieve a high level of efficacy for antimicrobial, virus inactivation, and other antiseptic effects.

(l) Asian Belt Zone
The 24 countries and regions extending from Japan to the Arabian Peninsula and including China, the Association of Southeast Asian Nations (ASEAN) nations, India, and the Middle East.

Model Project run by the governments of Japan and China, Hitachi together with the National Development and Reform Commission and the Energy Conservation Office of The People's Government of Yunnan Province agreed to participate in the Model Project for Energy Conservation and Waste Heat and Pressure Recovery for Electrical Machinery Systems in the Steel and Chemical Industries of Yunnan Province and supplied two high-voltage inverter system sets for energy-efficiency applications to the Kunming Iron & Steel Group Co. Ltd. and Yuntianhua Group Co., Ltd. in Yunnan Province. The project was very well received with improvements to on-site operating practices being achieved through the adoption of an energy-efficiency monitoring system resulting in a reduction in energy consumption that exceeded the 20% target.

These initiatives earned a good reputation and led in November 2009 to Hitachi signing a memorandum of understanding with the National Development and Reform Commission to proceed with joint projects on an all-encompassing basis. Hitachi will pursue these joint projects based around the axes of highly efficient energy systems and smart grids, water treatment systems for securing safe water resources, home appliance recycling and reuse, and the provision of urban transport systems that have a low impact on the environment.

This work will provide an opportunity to introduce partner companies and other agencies in China to a wide range of the latest technologies, products, and solutions and contribute further to interaction and cooperation between the two countries aimed at establishing a low-carbon society.

Strengthening Social Innovation Business with Singapore EDB

As part of Hitachi's strengthening of its social innovation businesses in the Asian Belt Zone, Hitachi Asia Ltd. entered into an agreement in cooperation with the Economic Development Board (EDB), a government agency of Singapore, to establish a Centre of Excellence (CoE) at its Singapore headquarters on April 1, 2010 (see Fig. 7).

This organization intends to work energetically to expand social innovation businesses in the Asian Belt Zone in cooperation with Singapore government agencies, government-linked corporations, and private enterprises.

To respond to the problems of urbanization that include traffic congestion and emissions of greenhouse gases and other atmospheric pollutants, Singapore government is proceeding with its Urban Solutions programme to establish cooperative relationships with companies that possess advanced technologies in fields such as clean energy, water and the environment, urban development, information technology, urban transport, and security.

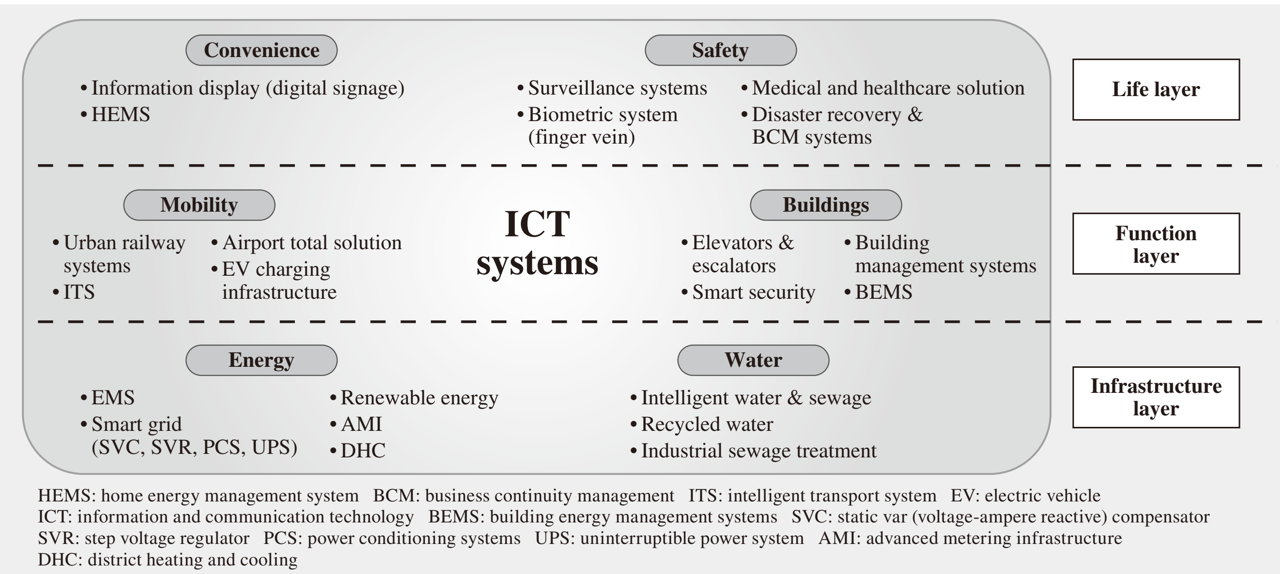


Fig. 7—CoE Business Activity.
Established on April 1 2010, the purpose of Centre of Excellence (CoE) is to develop and expand social innovation business in the Asian Belt Zone by cooperation with government agencies, government-linked corporations and private enterprises. By harnessing Hitachi's advanced information technology systems in strategic power and industrial businesses, the CoE strives to offer cutting-edge solutions in urban development, transportation, water treatment, energy, and the environment for a safe, comfortable, intelligent, and sustainable society.

Hitachi is strengthening the global deployment of its social innovation businesses which supply social infrastructure systems that are enhanced by the use of ICT (information and communication system technologies) and intends to utilize these links to expand these businesses, which include its urban development business and an energy-efficiency solutions business that uses smart grids, not only in Singapore but also elsewhere in the Asian Belt Zone, with the CoE playing a central role.

Contribution to Social Infrastructure Innovation Businesses

In an era in which many issues such as the environment, economy, and resources are shared globally, the past requirements for social infrastructure have changed considerably. In response, Hitachi has adopted a strategy of focusing on social infrastructure innovation businesses in which water, industry, and transportation constitute one core element.

Hitachi celebrates its centenary this year and intends to use it as an opportunity to bring together the technologies and knowledge of the entire group to continue contributing to social infrastructure from a global perspective by supporting many different countries and regions, particularly emerging economies, so that they can develop in harmony with the world.

REFERENCES

(1) World Health Organization, "Millennium Development Goals" (Sep. 2000).

(2) Ministry of Economy, Trade and Industry, "Toward Global Deployment of Japanese Water Businesses and Water-related Technologies—Summary of Water Resource Policy Study Committee" (July 2008) in Japanese.
http://www.meti.go.jp/policy/economy/gijutsu_kakushin/innovation_policy/pdf/mizuhoukokusyo.pdf

(3) IMF, "World Economic Outlook Database" (Oct. 2009).

ABOUT THE AUTHORS

Kazunori Fujiwara

Joined Hitachi, Ltd. in 1981, and now works as the General Manager of the Industrial Infrastructure Systems Division, Industrial & Social Infrastructure Systems Company. He is currently engaged in the management of the industrial systems business. Mr. Fujiwara is a member of The Institute of Electrical Engineers of Japan.

Toshihiko Ito

Joined Hitachi, Ltd. in 1975, and now works as the Chief Strategy Officer, Industrial & Social Infrastructure Systems Company. He is a professional Engineer (Electrics & Electronics) and a member of The Institution of Professional Engineers, Japan.

Mitsuo Takayama

Joined Hitachi, Ltd. in 1978, and now works as the General Manager of the Total Solutions Division. He is currently engaged in the coordination of solution businesses across the Hitachi Group. Mr. Takayama is a member of The Japan Society of Mechanical Engineers.

Kazuhiko Yamaguchi

Joined Hitachi, Ltd. in 1970, and after serving as CMO for the automotive equipment group, he has since 2006 worked as Vice President and Director, and Group Executive Manager of Hitachi Plant Technologies, Ltd. He is currently engaged in management of the industrial plant systems business.

Rick C. H. Lee

Joined Hitachi Asia Ltd. (formerly Hitachi South East Asia Pte. Ltd.) in 1988, and now works at the Centre of Excellence. He is currently promoting the Social Innovation Business in the Asian Belt Zone by cooperation with government agencies, government-linked corporations, and private enterprises.

Atsushi Takita

Joined Hitachi, Ltd. in 1977, and now works as the General Manager of the Social Infrastructure Systems Division, Industrial & Social Infrastructure Systems Company. He is currently engaged in the management of marketing and business development for social systems business.

Kazuhiro Oyama

Joined Hitachi, Ltd. in 1980, and now works as the General Manager of the Power & Industrial Systems Division, Power Systems Company. He is currently engaged in the management of the large generator, motor, electricity distribution, and power device businesses.

Kiyoshi Kinugawa

Joined Hitachi, Ltd. in 1975, and now works as the General Manager of the Sales & Marketing Division, Industrial & Social Infrastructure Systems Company. He is currently engaged in the management of sales and new business development for social and industrial infrastructure systems.