Hitachi's Smart City Solutions for New Era of Urban Development

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NEW TRENDS IN URBAN DEVELOPMENT

THE 21st century has brought with it three new global trends in urban development. The first trend, which has emerged against the background of an international consensus on the need to adopt low-carbon lifestyles on a global basis in response to the threat of global warming, is toward "low-carbon cities" that reduce the amount of CO_2 (carbon dioxide) emitted by urban activity[(1)]. The second, a consequence of the economic progress happening in the emerging markets of Asia, particularly China, as well as in South America and elsewhere, is the concentration of population in cities and the associated new construction of large cities[(2)]. The third is the trend toward health-focused urban development in response to the aging of urban populations in Japan and other developed economies which emphasizes medical and welfare considerations and seeks to eliminate intergenerational disparities[(3)].

Hitachi sees these new urban developments and upgrades to existing cities in different parts of the world as an ideal business opportunity to utilize its strengths. To respond to the needs of this new urban era, Hitachi established a Smart City Business Management Division reporting directly to the company President in April 2010 to provide smart city solutions that combine Hitachi's wide range of products and solutions with its extensive past experience.

This article analyzes these new trends in urban development around the world and gives an overview of the smart city concept that Hitachi is proposing in response along with the technologies, products, and solutions that support it (see Fig. 1).

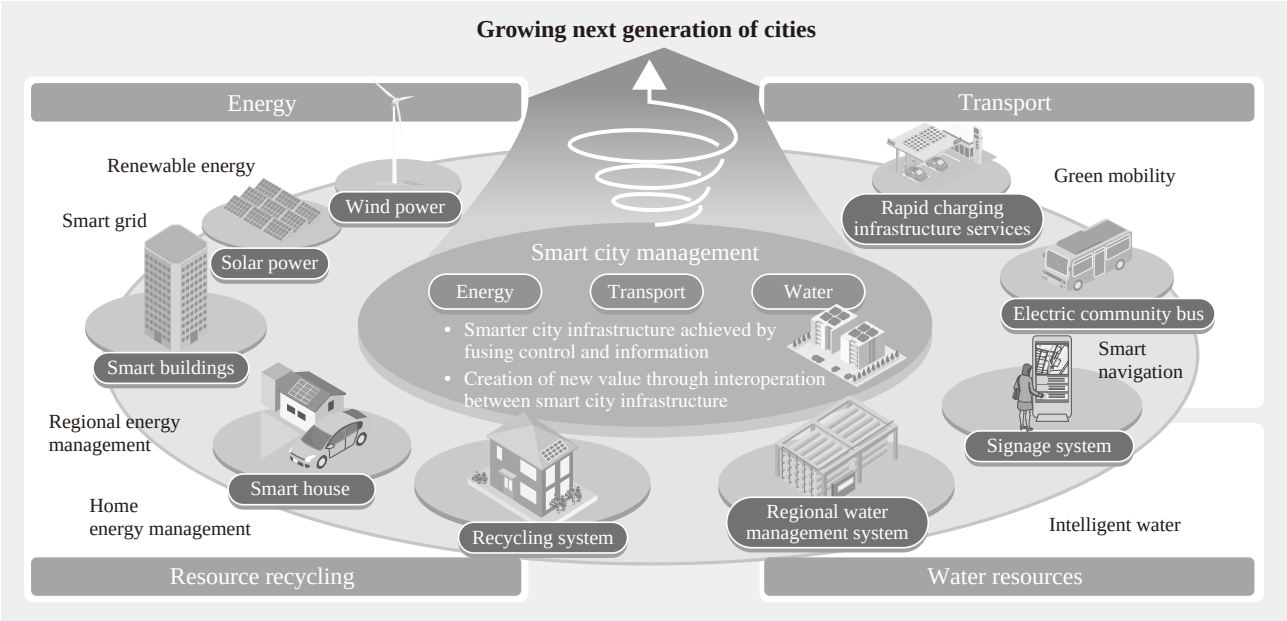


Fig. 1—Smart Infrastructure that Supports Growing Next Generation of Cities.
Urban development is entering a new era against a background of aging urban populations in developed economies, the concentration of emerging economies' populations in cities, and calls for cities to reduce their carbon footprints. Hitachi is seeking to meet this challenge with smart city solutions that fuse information and control by utilizing its experience and advanced technologies in the field of infrastructure.

RESPONSE TO NEW TRENDS

Activities Aimed at Creating Low-carbon Cities

The international response to the problem of global warming had its beginnings at the United Nations Conference on the Human Environment held in Stockholm in 1972. This was followed by the United Nations Conference on Environment and Development (also known as the "Earth Summit") held in Rio de Janeiro in 1992 and the establishment of an international consensus on the need to create a low-carbon society at a global level which was expressed by the signing of the Kyoto Protocol in 1997. Japan passed its "Law Concerning the Promotion of Measures to Cope with Global Warming[(a)]" in 1998 and a 2008 amendment to this law obliged cities with large populations (including "government-decreed cities," "core cities," and "special cities") to introduce measures for reducing emissions of greenhouse gases by their greater urban regions. In response, the Ministry of the Environment formulated and published a "Regional Government Activity Plan for Responding to Global Warming (Regional Policy) Planning Manual[(4)]" in June 2009 and the Ministry of Land, Infrastructure, Transport and Tourism produced the "Guidelines for Low-carbon Urban Development[(b)]"[(5)] in August 2010. Currently, all of Japan's major cities are working actively to formulate action plans for preventing global warming.

Initiatives such as trials of low-carbon measures for cities and model urban developments are in progress in various locations with support from government subsidies. In April 2010, the Ministry of Economy, Trade and Industry selected Yokohama-shi, Toyota-shi, Kansai Science City (located in Kyoto and informally known as Keihanna Science City), and Kitakyushu-shi to be "Next-generation Energy and Social System Demonstration Areas." As part of this initiative, Hitachi is working on the Yokohama Smart City Project and has been selected to participate in a project to "develop technology for establishing compound electric power storage systems" run by the New Energy and Industrial Technology Development Organization (NEDO).

The adoption of low-carbon practices is also the key concept for future urban development outside Japan. As described later in this article, environmentally conscious cities such as the Tianjin Eco-city are being constructed in various parts of China. At the direction of its government, Singapore has embarked on a program of trials that use the city state as a test bed for low-carbon urban technologies with the aim of deploying the results internationally. Singapore published a Sustainable Development Blueprint[(6)] in April 2009 which lists the numeric targets for its low-carbon city plan and the Economic Development Board (EDB), Singapore's economic development agency, is working on the government-sponsored Urban Solutions initiative which deals with proposals from foreign countries. Hitachi has established a Centre of Excellence (CoE) at Hitachi Asia Ltd. and is seeking out business opportunities while participating in this program in partnership with the EDB.

Large Urban Developments in Emerging Markets

The urbanization of populations is proceeding at a rapid pace in emerging markets, including China, India, and other Asian Belt nations and the nations of Central and South America (see Fig. 2).

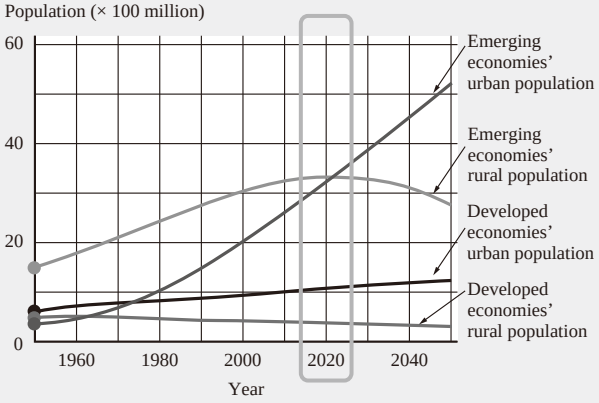


Fig. 2—Concentration of Population in Cities.
The urban population in emerging economies is forecast to overtake the rural population in 2020 and reach 5 billion by 2050.

(a) Law Concerning the Promotion of Measures to Cope with Global Warming
Based on the Kyoto Protocol adopted at The 3rd Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP3) Kyoto Protocol Climate Conference, this law stipulates the responsibilities and roles of national and regional government agencies, businesses, and citizens in achieving Japan's obligation under the protocol of reducing greenhouse gas emissions between 2008 and 2012 by 6% relative to 1990 levels. The law was passed by the House of Councillors on October 2, 1998 and came into effect on October 9 of the same year.

(b) Guidelines for Low-carbon Urban Development
Guidelines which present the base concepts behind low-carbon urban development and potential specific measures in a systematic way as well as simulation methods for estimating the overall change in CO_2 emissions over an entire city.

In response, the construction of major new cities is planned in China, India, and elsewhere. The plans in China include the eco-cities mentioned earlier and their main aim is to accommodate the influx of people into major cities and also to encourage the establishment of nearby industries that can provide them with employment.

For example, the development plan for the Binhai New Area running from Tianjin to Bohai Bay is being undertaken based on the three pillars of promoting high-technology industry, promoting maritime industry, and the "three eco-cities." This development plan for the greater urban area includes an advanced manufacturing industry zone, aeronautical industry zone, Binhai high-technology industry zone, harbor-side industry zone, commercial business zone, and port logistics zone.

In India, the Delhi-Mumbai Industrial Corridor Project linking the capital Delhi with the international trading center of Mumbai is being undertaken based on an agreement between the governments of Japan and India. This plan includes the development of a backbone distribution network between Delhi and Mumbai together with associated industrial cities. Hitachi has received funding from the Ministry of Economy, Trade and Industry to participate in a feasibility study for part of this region.

These urban developments share a number of features. The first is that, because they involve the development of cities on undeveloped land (reclaimed or other previously unused land), energy, water, transport and other infrastructure needs to be provided either independently or as an integrated package. The second is that these developments are being undertaken as PPPs (public-private partnerships) which in many cases are based on the BOT (build-operate-transfer) model whereby private-sector businesses undertake to build infrastructure and operate it for a fixed period of time before handing it over to the local government or other agency. The third is the creation of SPCs (special-purpose companies) to operate urban services which often means that capital needs to be invested in the SPC to participate in the urban infrastructure.

Aging of Urban Populations in Developed Economies

In contrast to emerging markets where populations are growing and becoming increasingly concentrated in cities, developed economies are experiencing falling birth rates and aging populations. The aging of urban populations in particular is evident in developed economies with Japan acting as a "bellwether nation" at the forefront of this trend.

Large commercial facilities were constructed in the suburbs of Japan's regional cities during the 1980s and 1990s with results that included the ongoing decline and depopulation of city centers. In response, Japan passed amendments to the "three urban development laws" in 1998 with the aim of undertaking urban development in a way that reduces dependence on automobiles and makes it practical for even the elderly to do their shopping by foot. However, even if residents could be persuaded back to city centers, this would not hold back the aging of city populations. Accordingly, recent years have seen growing research activity investigating urban developments that place an emphasis on the elderly, health, and similar[7].

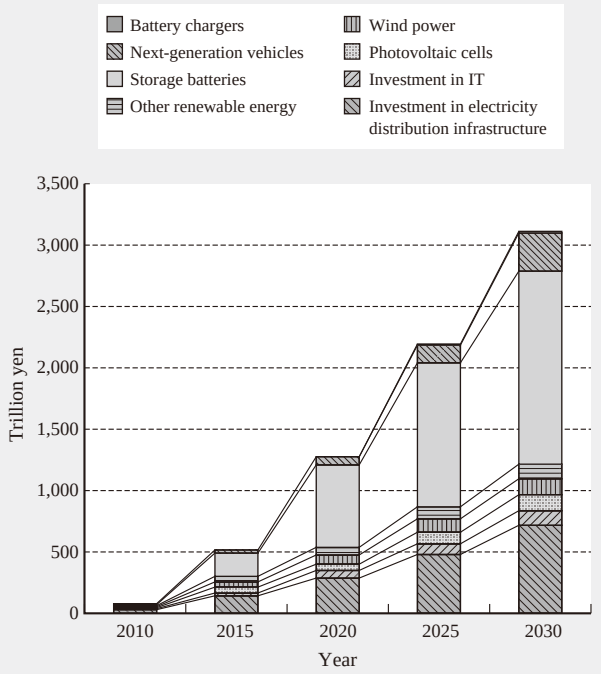
In April 2009, The University of Tokyo established an Institute of Gerontology and formed the Gerontology Consortium, a joint academia/industry initiative of which Hitachi is a member, to investigate what form cities should take to make them good places for the elderly to live.

Emergence of New Players

Two other interesting changes are apparent in urban development trends. The first is the involvement of various different funds. Whereas urban development in the past was treated as a form of public works handled by national, regional, or other government agencies, recent years have seen more urban developments undertaken as investments, particularly in emerging markets. The Tianjin Eco-city mentioned earlier is a joint investment in urban development by a Singaporean government-run fund and the Chinese government. Although the process has been slowed by the 2008 financial crisis, Dubai in the United Arab Emirates has utilized its extensive oil money for city construction and created a business model in which the money raised when assets are sold is invested in the next round of development. Malaysia is also proceeding with plans for the construction of a new city as an investment for the national pension fund.

This trend has led to the construction and operation of entire cities being viewed as a commercial enterprise creating a need for the efficiency of urban development and city management to be considered from the early planning stages.

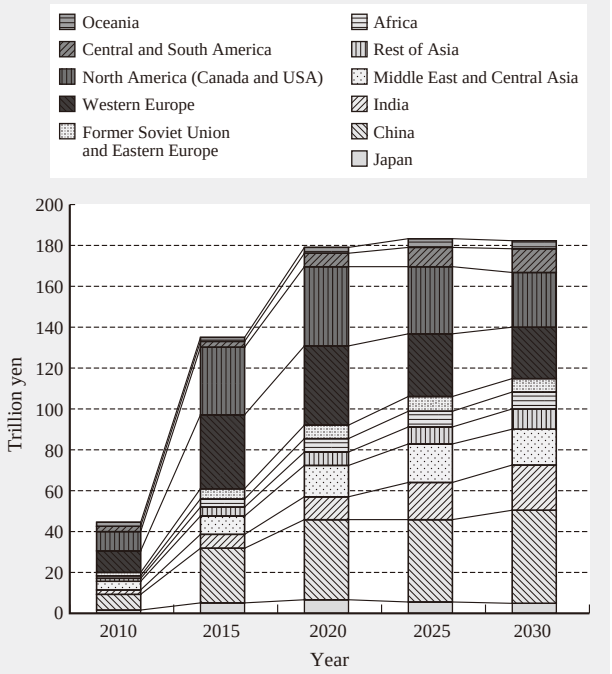
The second change is the involvement of IT (information technology) companies. Around the world, International Business Machines Corporation (IBM) of the USA, service providers and IT consultancies



Source: World Smart City Digest, Nikkei BP Cleantech Institute (Sep. 2010)

IT: information technology

Fig. 3—Forecast for Smart City Market (Broken Down by Technology).
The global market for smart city technologies is forecast to exceed 1,000 trillion yen in 2020 and reach 3,000 trillion yen by 2030.



Source: World Smart City Digest, Nikkei BP Cleantech Institute (Sep. 2010)

Fig. 4—Forecast for Smart City Market (Broken Down by Region).
It is forecast that the global market for smart city technologies will be driven by North America, Western Europe, and China until around 2020, with growth in India and Central and South America emerging subsequently.

are offering proposals for collecting and analyzing the huge volumes of data generated by urban activity to improve the efficiency and quality of urban life while also seeking to achieve highly efficient operation of energy, water, and other city infrastructure by combining both supply- and demand-side data.

For Hitachi, which operates both infrastructure and IT businesses, these moves toward creating greater added-value in cities through information processing and improvements to the efficiency of city operations represent a new business opportunity in the field of urban development (see Fig. 3 and Fig. 4).

HITACHI'S SMART CITY CONCEPT

Extensive Experience in Urban Development and City Management

Hitachi has been contributing to urban activity through the supply of a wide range of technologies, products, and solutions for each of the three layers that make up a city since before the emergence of the new trends in urban development described in the previous section. Products supplied by Hitachi for the urban infrastructure layer that underpins urban activity include electric power systems (power generation and distribution), water supply and sewage, and telecommunications systems, while for the urban services layer that makes urban activity possible, Hitachi supplies building services such as elevators, escalators, and air conditioning as well as vehicles, operation management systems, and associated components for road, rail, and other forms of transport. Similarly, for the urban lifestyle layer that lies on top of these other two layers, Hitachi's products include information services that make life more convenient and comfortable and security systems that provide safety and peace of mind in cities (see Fig. 5).

For the urban infrastructure layer, Hitachi has also built up a considerable track record in information solutions such as billing and customer management systems as well as in equipment (hardware and its associated control systems). Meanwhile, IT solutions for various different business models used by public and private sector organizations involved in urban activities have also become one of the major pillars of Hitachi's business.

The smart city concept proposed by Hitachi seeks to combine these elements to create new value in cities. The following gives an overview.

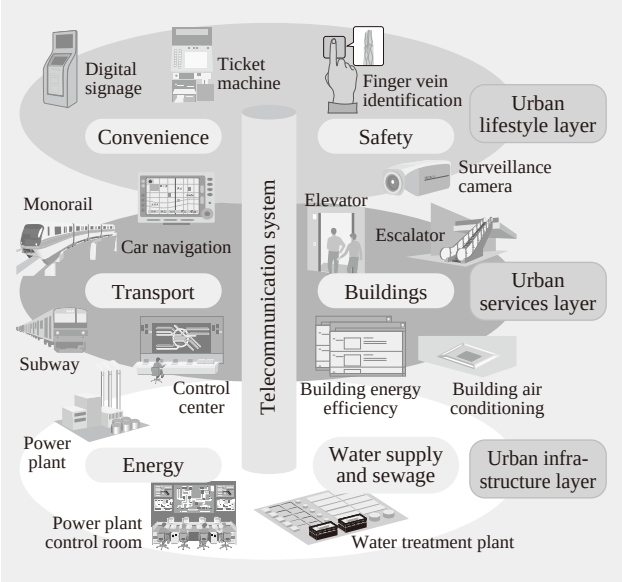


Fig. 5—Hitachi's Extensive Experience in Urban Systems. Hitachi has extensive experience at every level of urban living including energy, water supply, sewage, and other aspects of city infrastructures; urban services including transport and buildings (elevators, escalators, and air conditioning); and solutions that enhance the convenience and safety of residents.

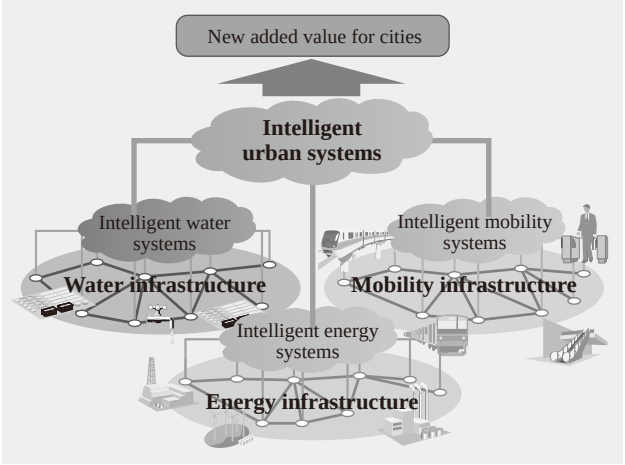


Fig. 6—Hitachi's Smart City Concept. New value is created by making the infrastructure that supports cities more intelligent through the application of information and communications technology and by coordinating the operation of this smart infrastructure.

Smart City Overview

(1) Integrating urban infrastructure and making it smarter

Making cities smart involves adding intelligence to the infrastructure that supports urban activity and creating new value by integrating the operation of this smart infrastructure (see Fig. 6). Here, the term "smart" means providing functions that optimize the operation of infrastructure equipped with knowledge capabilities and information processing capabilities to maximize the value created by its operation.

Meanwhile, "creating value" includes things like reducing cities' carbon footprints in accordance with their respective city visions and the provision of urban services that are kind to the elderly. Similarly, the expectation for the organizations that manage entire cities as a commercial enterprise is that the value created by the adoption of smarter practices will include a better return on investment and greater operational efficiency across the entire city.

(2) Fusing control and information

Utilities like energy and water are produced at large plants and supplied to cities via distribution networks. Hitachi has extensive experience and know-how in the control of these plants, networks, and other utilities infrastructure.

The supply of energy and water to consumers is a one-way process and the usage at each household provides the basis for calculating charges. In a smart city, information collected from households, buildings, and other end-users as well as from various points across the distribution network is used as feedback for operational control (see Fig. 7). If this information is supplied to users as well as to suppliers it can help improve lifestyles.

Interconnecting different infrastructural information systems and performing integrated management can also help reduce carbon emissions by allowing overall optimization. Whereas the electric power system keeps supply and demand in continuous balance, the interaction between supply and demand in the water supply system is less tightly coupled and the loading on the transport infrastructure varies in response to resident behavior. By coordinating these, it is possible, for example, to maintain the balance of electricity supply and demand in realtime by slowing the operation of water treatment plants during times when the railway system is operating at peak load. Similarly, information from IC (integrated circuit) card ticketing can be used to predict the behavior of passengers and perform predictive control of transport systems and other forms of mobility such as elevators and escalators.

(3) Cities with their own sensory nervous systems

In addition to making infrastructure smarter as described above, collecting various different types of information that impact directly on residents' lives and supplying it to them or using it as feedback for infrastructure control can help reduce city carbon emissions and improve convenience and safety for

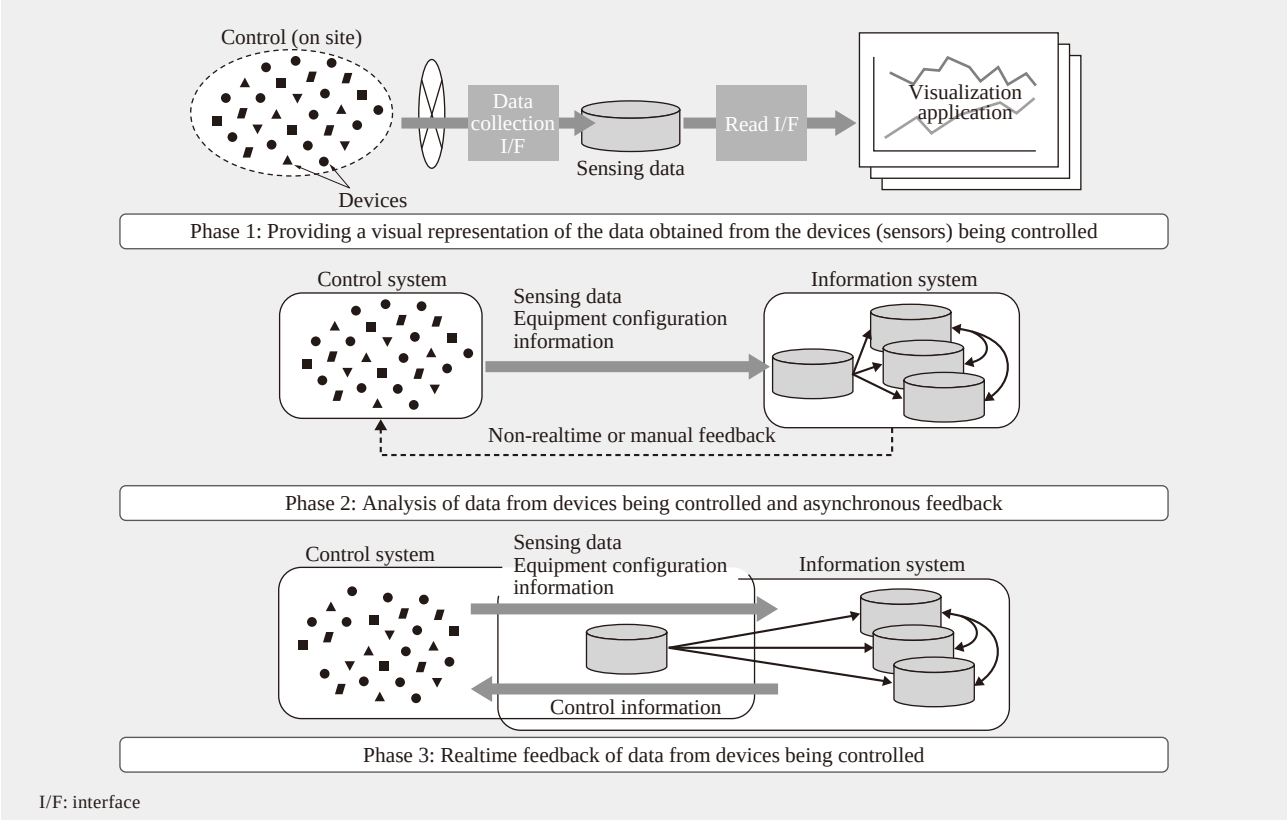


Fig. 7—Fusion of Information and Control.
Fusion of information and control goes through three phases resulting, in the third phase, in a smart city equipped with intelligent infrastructure.

residents. For example, the information obtained from large-scale surveillance camera systems installed in cities is currently used to determine what happened after a crime or other incident has occurred, but because it can also be used for purposes such as determining people's movements, traffic conditions, and the weather, it will become possible to determine circumstances with a much greater level of detail than is provided by the current surveillance mesh.

In the future, it has been suggested that data will be able to be collected from street intersections and vehicles via a sensor network(c) and used to assist with the running of the city.

Another requirement for smart cities will be to unify the provision of common information (such as map or weather data) that is used in a wide variety of different city operations to improve operational efficiency and data accuracy. An integrated authentication platform that standardizes the personal identification functions used by different systems will also be needed.

Whereas cities in the past only had "motor nerves" in which all information flowed in the same upstream to downstream direction, smart cities will be equipped with "sensory nerves" in the form of smart metering(d) and other sensor networks so that city operations can respond to the situation on the ground in realtime.

Hitachi is building up a portfolio of the individual technologies that will be required to achieve this.

HITACHI'S SMART CITY SOLUTIONS

Energy Sector Solutions

For smart cities' energy needs, wind, solar, and other renewable energy will provide distributed power sources to complement the large centralized power sources provided by conventional power plants. Also, the need to handle the fluctuation in output that

(c) Sensor network
A way of collecting realtime information about people, objects, and the environment by linking various sensors for parameters such as temperature, humidity, and vibration via a telecommunication network.

(d) Smart metering
A system that incorporates sophisticated power meters able to measure the amount of electric power used by households, buildings, and other consumers and automatically transmit this data to the supplier at regular intervals. In addition to encouraging consumers to reduce their power consumption by providing a visual representation of their usage, the system allows power companies to perform tasks such as managing the operation of appliances via the network.

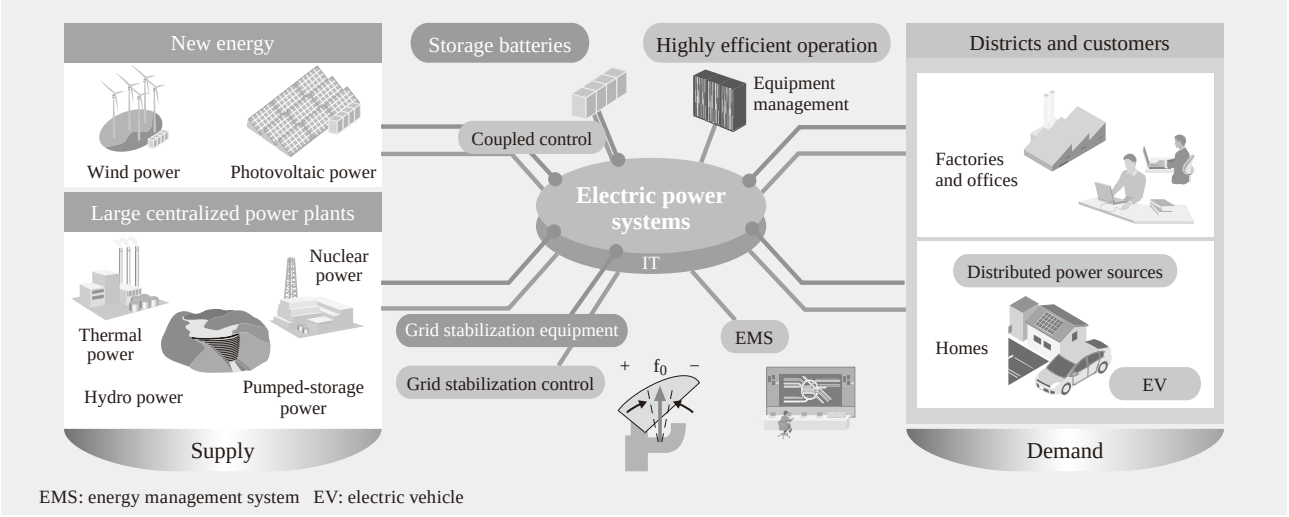


Fig. 8—Energy Solutions.
The electric power infrastructure in the next-generation cities will use smart grids to supply power economically with low carbon emissions and high quality.

is a characteristic of these new power sources will mean that batteries will play an important role. It is also anticipated that new demand-side equipment including EVs (electric vehicles) and HEVs (hybrid electric vehicles) will become more widely adopted and maintaining the stability and reducing the carbon emissions of electricity grids that incorporate such equipment will become issues of concern (see Fig. 8).

Hitachi is collaborating with Japanese power utilities to implement electricity supplies with world-class levels of power quality and reliability while also building up its know-how through the construction of power plants outside Japan.

Hitachi is drawing on this knowledge to develop and commercialize products such as the next generation of smart grid technologies; energy management systems for homes, buildings, and districts; and the automated meter reading using AMI (advanced metering infrastructure) that underpins these systems.

Solutions for Water Resources

Progress is being made on incorporating more intelligence into water infrastructure for smart cities and, in addition to management of water sources and water distribution, resource recycling which includes reuse of waste water is also an essential requirement. Many emerging markets in particular suffer from a shortage of water and are placing high hopes on the technologies and systems collectively known as “intelligent water” that incorporate IT into the water cycle.

Hitachi has long been a supplier of equipment and processing systems to water treatment plants and sewage treatment plants run by local governments and other agencies around Japan and has contributed to establishing Japan’s high-quality water supply and sewage infrastructure. Internationally, the scope of Hitachi’s business includes the purchase of local water treatment companies and encompasses both the operation of water treatment businesses and the supply of equipment, systems, and other products for applications such as purification of drinking water, processing and reuse of industrial and domestic waste water, and seawater desalination.

For the future, Hitachi will continue to strive to

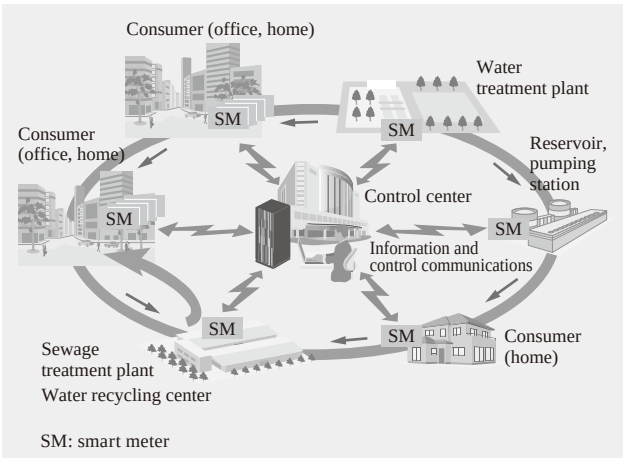


Fig. 9—Water Management Solutions.
Installing smart meters in the water distribution system allows for automatic metering and can reduce operating costs, optimize equipment management, and smooth water demand.

build the next generation of urban water systems that incorporate features such as fusion with IT, use of geographical information processing, and the use of smart meters for sophisticated water usage management (see Fig. 9).

Emerging markets are seeing the appearance of integrated infrastructure companies that supply water and sewage services as well as power, gas, and other energy infrastructure all through the same company. Working with these companies on the next generation of urban development represents a major business opportunity for Hitachi with its experience in the energy, water, and information businesses.

Mobility Solutions

One of the major services that a city provides for its residents is mobility. Work is proceeding on the development of charging stations and other EV infrastructure with the aim of creating a low-carbon city by reducing dependence on vehicles powered by internal combustion engines and an approach to road transport based primarily on EVs and HEVs. Because railways have a growing role in providing public transport and reducing reliance on automobiles, the development of energy-saving technologies is important.

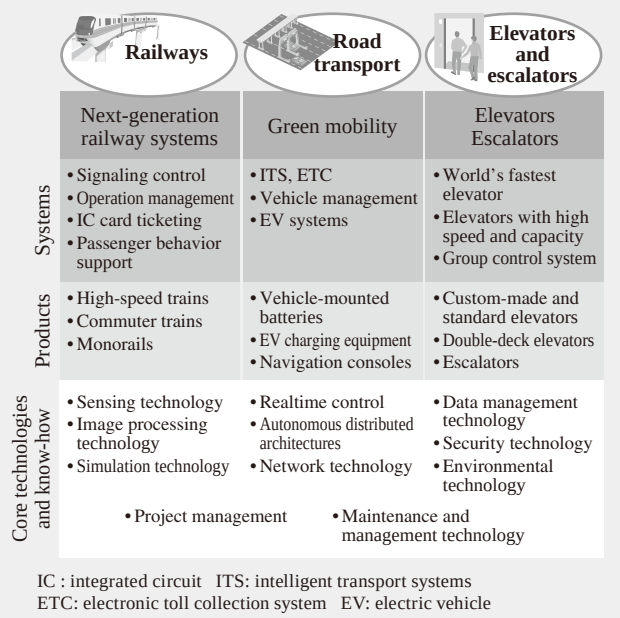


Fig. 10—Mobility Solutions.
Hitachi's capabilities cover both horizontal forms of transport such as railways and roads and vertical transport including elevators and escalators. It is working on research and development of advanced technologies for both these forms of mobility.

Meanwhile, the use of personal mobility to help people move about their neighborhoods is attracting attention bearing in mind the aging of society.

Hitachi can supply a comprehensive range of both horizontal and vertical modes of transport, with horizontal mobility solutions including railway systems, ITSs (intelligent transport systems) for road transport, and electric carts for use on golf courses and elsewhere. Meanwhile, elevators, escalators, and other forms of vertical transport are also an important area of business.

Against this background, Hitachi is working on research and development in a wide range of fields aimed at producing the next generation of mobility products. In the field of railways, these include energy-saving technologies such as making rolling stock lighter, technologies for making effective use of regenerative power produced when trains decelerate, and the development of hybrid rolling stock. Hitachi is also developing charging stations and other EV infrastructure technologies in the area of road transport and technologies for elevators with high speed and capacity in the area of vertical transport (see Fig. 10).

Information Technology Solutions

All sorts of different information is used in urban living and daily urban activities in turn produce huge amounts of data. Hitachi supplies solutions for the public, industrial, and other sectors that collect, process, and deliver this information together with data centers and platforms such as servers and storage systems. Hitachi also supplies digital signage(e) and security solutions that help provide city residents with a more comfortable and secure way of life. For example, this issue also covers firefighting systems which are essential to keeping the city safe.

In addition to these solutions, Hitachi is also working toward the creation of smart cities by fusing control and information to develop new technologies and solutions including technologies that utilize the data generated by the city as feedback to control the infrastructure that supports urban activity, and systems that provide this control information to residents. As

(e) Digital signage
Electronic signage systems that display information on digital screens using equipment such as displays or projectors in place of conventional printed signs. It is anticipated that the technology will be used to implement new functions such as updating the displayed information in realtime via data communication networks; using sensors, image recognition, or other techniques to convey information bi-directionally; and exchanging information with mobile phones.

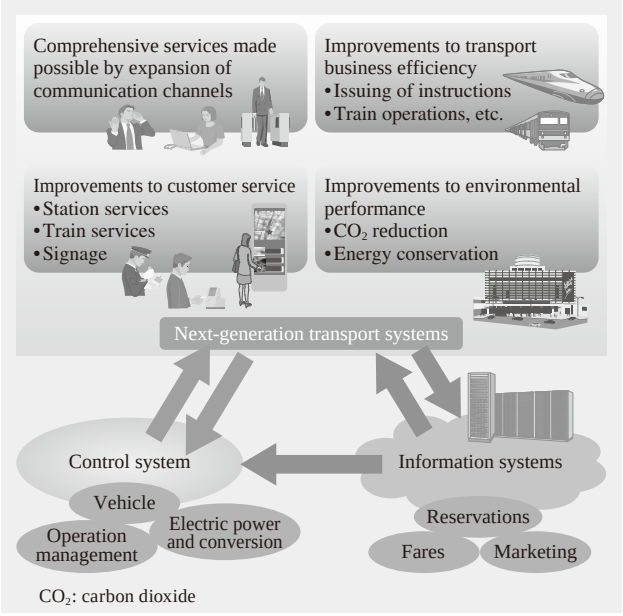


Fig. 11—Information Technology Solutions (Railway Example). In addition to integrating control systems that handle train operation with information systems such as those used to manage reservations, next-generation transport systems seek to provide better and more comprehensive customer services by, for example, utilizing information from IC card ticketing.

an example, this issue includes an article describing systems that utilize positioning information.

Along with smart grids for the energy sector and intelligent water for the water infrastructure, Hitachi is also aiming to implement solutions that use the information produced by the IC (integrated circuit) card ticketing systems used by railways (see Fig. 11).

Hitachi's Involvement in Urban Development

In response to a new urban era in which large urban developments are being undertaken, especially in emerging markets, Hitachi with its solutions for different sectors described above is participating actively from the upstream processes of urban development. In addition to its activities in China and India described in this issue, it is also actively participating in model urban developments and demonstrations in Japan in collaboration with developers and infrastructure operators.

Meanwhile, in the field of health-focused urban development in response to the aging of urban populations, Hitachi is working with the relevant authorities in Hitachinaka-shi in the Ibaraki Prefecture of Japan on the "Kenko Ikiiki" (healthy living) urban development project which is based around a company-run hospital. You can find out more about this project in a special report in this issue.

These examples show how manufacturers who in the past have concentrated on supplying equipment have a new role in urban development and are being presented with a new role and fresh business opportunities as we enter a new urban era.

Along with the development of eco-cities and smart cities all over the world, a new movement toward the standardization of indicators for evaluating smart cities and their certification has emerged. Hitachi, backed by the Ministry of Economy, Trade and Industry, is leading the standardization activities both in Japan and in the international arena. Hitachi is advocating its framework of standards to the Japan Smart Community Alliance, which acts as a national parent organization for this movement, as well as advocating its proposals to the World Business Council for Sustainable Development (WBCSD) and Pacific Area Standards Congress (PASC) in order to coordinate the diversity of views on a global basis and to assemble allies for Hitachi's proposals.

BRINGING ABOUT NEXT GENERATION OF CITIES

Urban development around the world is entering a new era against a background of three mega-trends; namely the emergence of a low-carbon society, the urbanization of populations in emerging markets, and the aging of populations in developed economies.

Hitachi supplies smart city solutions for this new urban era based on the key concepts of "making urban infrastructure smarter" and the "fusion of information and control" by combining information technology, one of the pillars of its business, with its extensive experience with the infrastructure on which cities are built, including energy, water treatment, and transport. As one of the few companies anywhere in the world that combines both an infrastructure equipment business and an information technology business, Hitachi sees the new urban era as a major business opportunity and it is focusing on research and development of the individual technologies and other solutions that will be needed.

Just as the benefits of new urban technologies are incurred over a long period in the order of 20 or 30 years, it also takes a long time for their success or failure to become apparent. Hitachi will continue to strive toward the realization of the next generation of cities while proposing its own ideas about what forms these should take.

The recent earthquake and Tsunami which devastated a wide area of the Tohoku region of Japan

has highlighted new problems in urban development and management. People have been reminded of the fact that different parts of the infrastructure are mutually dependent on one another, and that a breakdown in one area can trigger a chain of collapse across the entire infrastructure in many cities, towns, and villages. Hitachi established the Hitachi Group Headquarters for Post-earthquake Reconstruction and Redevelopment to lead the company's activities aimed at supporting the recovery of devastated cities and infrastructure as well as the recovery of Hitachi's own disaster-affected factories and offices.

Hitachi is expanding its activities in the field of smart cities to encompass the rehabilitation of devastated cities by focusing the organizations assembled to promote smart cities on this task and is contributing by establishing ever more sustainable and disaster-proof cities.

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