Topics

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Class of 2006

JAPAN : Field Trip

18 - 28 March 2007

What's surprising when you land in Japan is the large part taken up by cities. Almost 80% of the Japanese soil being occupied by mountains. Industrial activities and residential centres were concentrated in the available flatlands and in artificial islands which represent huge conurbations like Osaka and Tokyo. The country is well known for its high technologies and successful industries, which allowed Japan to become a leader in many fields.
Such fantastic economical growth appeared in a society with a lot of respect for its traditions and culture. Shadows from the past of Japan, in the wonderful city of Kyoto for example stood up to the continuous increase in modernity and urbanity. On the other hand, this country has natural riches: Japan has for example a high diversity of plants and flowers. For such discoveries, we must leave the buildings to reach the countryside…

Our field trip was a fantastic occasion to discover these contrasts. Communication (Japanese has 3 different alphabets), habits, urban stress, the crowdy streets of Shibuya in Tokyo, the typical fish markets and the wonderful atmosphere of parks and temples of Kyoto were the surprising sets of our free time between study visits: a 1600 MW power dam in the area of Osaka, the District Heat and Cooling network which supplies Shinjuku business district in Tokyo, a LNG Terminal in Yokohama... All of our visits are summarised in the following pages of this report.
Constitutes of 4 main islands, Honshū, Hokkaidō, Kyūshū and Shikoku, with very scarce energy resources, Japan has to face 3 main challenges: economic growth, energy security and environmental protection. One of the main objective is the improvement of the energy self-sufficiency ratio (4%). Specifically, this involves the development of nuclear energy, the development and use of new energies, such as solar, wind power, and biomass and the development of energy conservation technologies.
Studying how Japan faces these energy issues was very instructive in helping our understanding of global energy issues. The case of Japan illustrated by this trip, was a wonderful chance to learn and to exchange on several topics such as energy efficiency, demand reduction and energy mix diversification, which are also discussed in the European Union. Osaka was the place we chose to confront the results of our study on the theme "Energy Efficiency , the European context" with students of the University of Technology. Big companies in the energy sector welcomed us also for very interesting conferences during this journey.

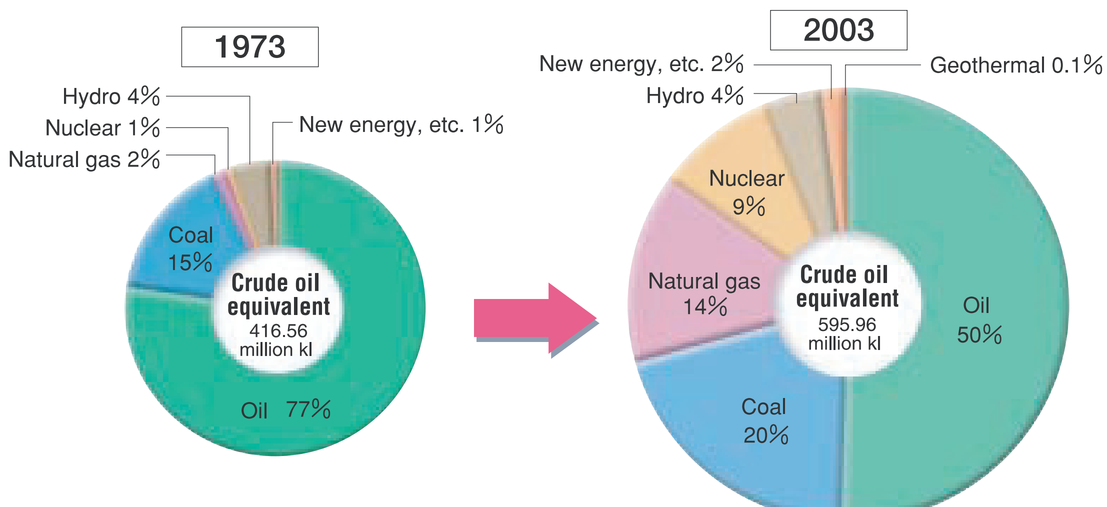
The report that is presented hereunder is a summary of the trip.

JAPAN

Japan Energy Context

Energy Sector

The energy sector in Japan has to deal with a double issue. Indeed, this Asian country is constituted of four main islands, all very poor in energy sources. Japan's energetic self-sufficiency remains at a low level of 4%, 16% if nuclear power is included.
After the Second World War, Japan entered a long but very efficient period of reconstruction based on economic growth, implying a stiff energy consumption increase. Then, in the mid 70's, the Island had to face both oil crise, while oil represented 70% of its energy sources. However, Japan succeeded in conciliating both economic growth and energy demand inflexion thanks to an effective implementation of energy efficiency and its energy sources diversification. Unfortunately, in the middle of the 80's, energy consumption started again to rise up faster due to the Japanese appetite for comfort. Indeed, Japanese families wanted to buy more and more powerful electric appliances dedicated to comfort and the cars engine size increased drastically.
In 2000, total primary energy consumption was around 588 millions kl of oil equivalent. Oil remains the first energy source in the country with more than a 50% share, coal then accounts for 20%, natural gas for 14% and nuclear power for 9%. Hydroelectricity only accounts for 4% and renewable energies for 2%.



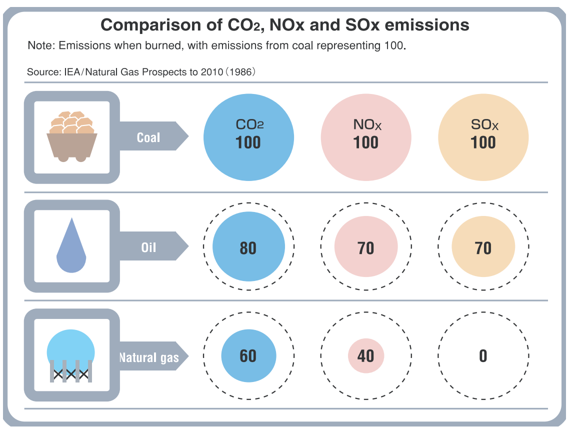
Source: Agency for Natural Resources and Energy, "Energy Balance Chart"

Oil

Despites the efforts made to replace oil by other energy sources after the oil crises that hit Japan in the 1970's, the country still depends on oil for about 50% of its total energy supply.
Japan used to import oil from East Asian nations (mainly China). But these countries became net oil importers because of increasing domestic consumption, with the result that Japan now depends for 90% of its oil imports on the Middle East. To face the geopolitical instability of the exporter countries and ensure an oil supply as stable as possible, Japan has set a specific strategy. The government works to deepen the relationships with the exporters, and is also engaging in joint research projects and technological cooperation in oil-related fields, such as the development of high precision refining technologies. In addition, private companies and the central government stockpile oil to be able to face a sudden interruption in imports. At the end of March 2004, 87 billions litres of oil were stored, with a corresponding supply period of 166 days.

Coal

Before the 1960s, most of the coal came from the domestic mining industry, but low cost imports induced the progressive closing down of nearly all the coal mines in Japan. All the coal is imported now (mainly from Australia). Between the two world wars, coal provided 3/4 of Japan energy but it was replaced by the oil discovered in the Middle East after WW2. After the oil crises, Japan reconsidered coal for its main benefits: coal is abundant (coal resource is assessed to last for about 180 years), coal is wide spread over the world (unlike oil fields mainly concentrated in politically unstable regions), and coal production is more economical than oil.



JAPAN

Consequently, Japan doubled its coal consumption in 40 years, with 164 millions of tons in 2003, which currently meets about 20% of Japan's total energy demand. However, a significant drawback of coal is its high CO2 and pollutants emissions (NOx, SOx) during combustion, which makes coal the worst fossil fuel in term of environmental impacts. Japan committed international cooperative programs and works for the development of clean coal technologies (namely high efficiency combustion) in order to promote the use of this abundant and cheap energy source.

Natural gas

Natural gas is one of the energy sources that were increasingly used after the oil crises. Natural gas supplies 14% of Japan's energy demand today. It is the most environmentally friendly fossil energy, since its combustion releases little CO_2, little NOx and no SOx, and is therefore

expected to be more largely used in the future. But Japan's natural gas resources are poor and the nation needs to import 96% of its supplies (58 millions tons). Natural gas, mainly constituted of methane, is cooled to -162°C on the extraction sites and is transported in the liquid state by tankers thermally insulated. Liquefied natural gas (LNG) has the advantage of taking only 1/600th the volume of gas. Once arrived in Japan, LNG is regasified in terminals, and the gas is sent via pipelines to powerplants for electricity generation, or to households. In order to increase the use of this clean and available source, the Japanese government has set up several schemes, such as converting thermal powerplants into gas fired powerplants, replacing oil and coal by natural gas for urban gas supply, and promoting the use of vehicles fuelled with natural gas.

Liquefied Petroleum Gas (LPG)

LPG, mainly constituted by propane and butane (about 60% and 40% in mass respectively), is produced during the refining of crude oil, or extracted from oil and natural gas streams as they

emerge from the ground. Like natural gas, its combustion emits little CO_2 and no SOx, which makes LPG a clean fossil fuel. In Japan, LPG supplies half of the households, and is also used to fuel powerplants, taxis, or is used as a chemical resource. Three fourth of the LPG consumed in Japan is imported, and the rest comes from the refining of the imported crude oil in the Japanese refineries. All included, 80% of the LPG comes from the Middle East, which makes the supply structure fragile. The situation is less critical than oil since LPG can also be extracted from natural gas fields located outside the Middle Eastern region. Japanese law however requires importers to stockpile LPG in order to be able to face a 50-day interruption in imports.

Electricity

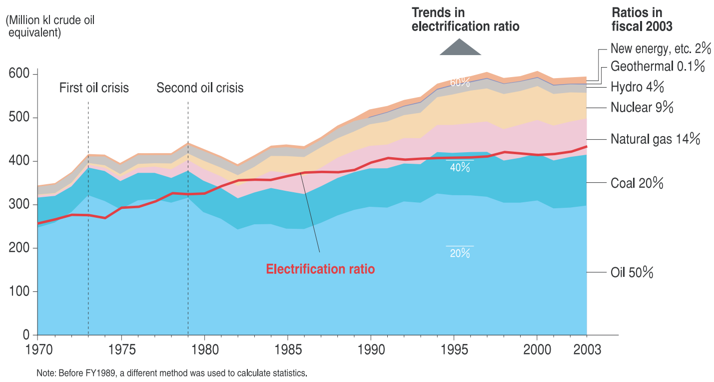
Electricity in Japan

Because of its insularity and for historical reasons, Japan experiences a very unique organisation of its electrical power industry. Japan is divided into nine interconnected districts which are independent in managing their electrical network and their production means. The Okinawa island are the tenth district and is fully isolated. Until 2000 there was only one electrical company for each district. Deregulation has been slowly initiated since.

Electrical consumption

Japan faces important needs in electricity with a 880TWh yearly consumption, fifty percent more than France. The yearly consumption peak happens in summer while it is in winter for France. Daily variations of demand are very sharp which induces numerous peak production means and a higher electricity tariffs than in France. The use of pumped-storage helps reduce the gap between peak and off-peak hours.

The network



JAPAN

When electricity started developping, Tokyo and the eastern districts of Japan bought German generators while western districts bougt US generators. As a result Japan is today divided in two areas, the western being fed with 60Hz current and the easter with 50Hz. Only one gateway of 1.4GW exists. The network is fully monitored by local Electricty Power Companies (EPCO) and by a main dispatching centre in Tokyo. The high voltage network uses 500kV, 275kV, 220kV, 187kV and 132kV. Its length is 166 thousand kilometers.

Deregulation

Since 2000, some consumers have been able to choose their electricity provider, given that they match a minimum power level. The historical provider stays in charge of monitoring and balancing the network. The required level dropped from 2000kW in 2000 to 500kW in 2004 and 50kW in 2005. The possibility to fully deregulate is still under study.

Energy repartition

Japan electrical power production relies on LNG (24¨%), oil (10%), coal (25%), nuclear plants (31%) and hydroelectricity (9%). Renewable electricity, except hydroelectricity and geothermal plants, is not in the scope of historical operators which prefer buying green electricity back from alternative producers.

Renewable Energy:

New energy sources account for only about 1.7 % of the primary energy supply, but the goal is to increase the figure to around 3% by 2010. To achieve this, active support is being offered to local governments, businesses and Non Profits Organisations (NPOs) that are introducing renewable energy sources.

Japan is the number one producer of solar power in the world with an installed capacity of 1132 MW at the end of 2004.

Wind power capacity was 927 MW at the end of 2004, representing an eleven-fold increase compared with 5 years before.

However, there are concerns that the instability of the output of these renewable energies could adversely affect the power grid.

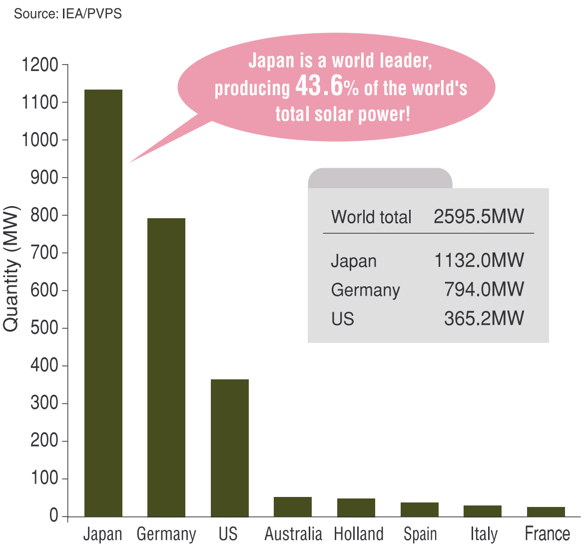
Nuclear Power:

Nuclear power is an important energy source for Japan for a number of reasons, from the wide availability of Uranium to the CO_2 free nuclear power plants.

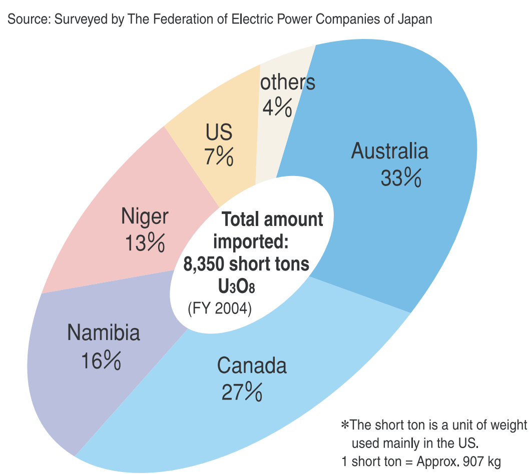
The Guidelines to Nuclear Power Policy adopted by the Cabinet on October 14, 2005 continue to clearly emphasize nuclear power as a basic energy source and affirm that steady development will be pursued. Today, 55 reactors, either PWR or BWR, provide some 30% of the total electricity production of the country with 47,5 GWe of capacity.
Concerning Uranium, its 2007 requirements of 8872 t would be met from Australia (about one third), Canada, Namibia, Niger, US and elsewhere.

Japan has been progressively developing a complete domestic nuclear fuel cycle industry based on imported uranium with the full scale operation of the Rokkasho plant in 2007 which will treat the nuclear waste. In the past, the reprocessing of spent fuel was largely undertaken in Europe. In 1995, Japan's first high-level waste (HLW) interim storage facility opened in Rokkasho-Mura. The first shipment of vitrified HLW from Europe from the reprocessing of Japanese fuel also arrived in that year.

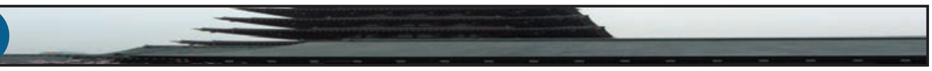
International comparison of rate of solar power generation (end of December, 2004)



Countries from which Japan imports uranium

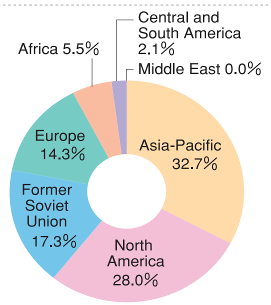
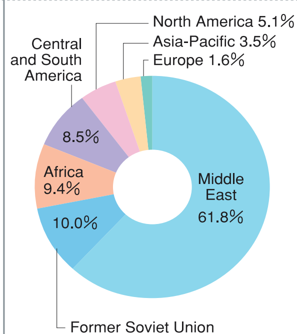
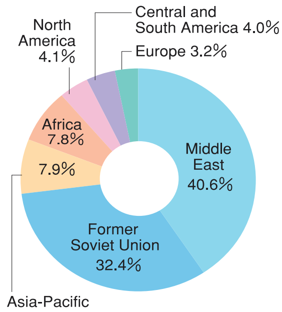
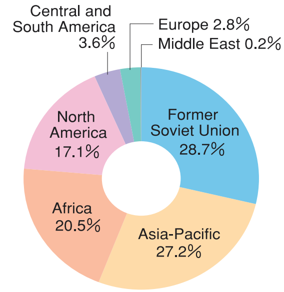
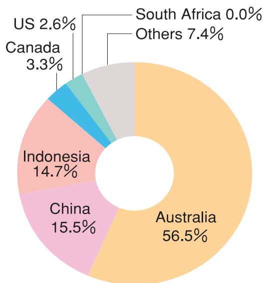
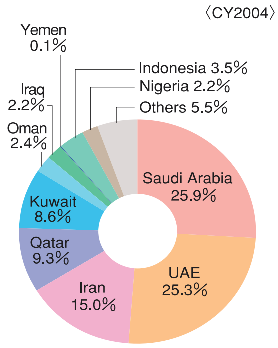
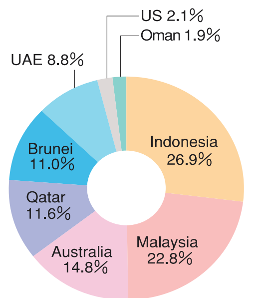
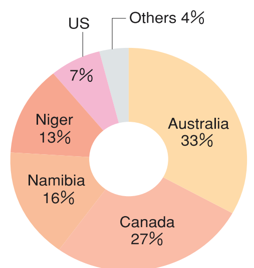


JAPAN



Key Figures (Energy in Japan, METI 2006)

Types of energy source

	Coal	Oil	Natural gas	Uranium
Proven reserves	909.1 billion tons 〈CY2004〉	1,188.6 billion barrels 〈CY2004〉	180 trillion m^3 〈CY2004〉	4.59 million tons Uranium 〈CY2003〉
※Figures are rounded off and may not add up to 100%.				 ※Totals for resource amounts do not include mining losses, etc.
Annual production	2.73 billion tons 〈CY2004〉 "BP Statistics (2005)"	29.29 billion barrels 〈CY2004〉 "BP Statistics (2005)"	2.7 trillion m^3 〈CY2004〉 "BP Statistics (2005)"	36,000 tons 〈CY2003〉 OECD/NEA-IAEA "URANIUM 2003"
Limit of exploitation	164 years 〈CY2004〉 "BP Statistics (2005)"	40.5 years 〈CY2004〉 "BP Statistics (2005)"	66.7 years 〈CY2004〉 "BP Statistics (2005)"	85 years 〈CY2003〉 OECD/NEA-IAEA "URANIUM 2003"
Annual consumption Annual consumption in Japan	2.77820 billion tons 〈CY2004〉 (120.80 million tons) "BP Statistics (2005)"	29.48 billion barrels 〈CY2004〉 (1.93 billion barrels) "BP Statistics (2005)"	2.6893 trillion m^3 〈CY2004〉 (72.2 billion m^3) "BP Statistics (2005)"	67,000 tons 〈CY2003〉 (8,000 tons) OECD/NEA-IAEA "URANIUM 2003"
Japan's dependence on imports	100% 〈FY2003〉 "General Energy Statistics"	99.7% 〈FY2003〉 "General Energy Statistics"	96.5% 〈FY2003〉 "General Energy Statistics"	100% 〈CY2003〉
Amount of fuel needed*1 to operate a 1 million kW power plant for one year	2.21 million tons	1.43 million tons	0.93 million tons	21 tons
Main countries from which Japan imports ※Figures are rounded off and may not add up to 100%.	〈FY2004〉  Source: METI "Mineral Resources and Petroleum Products Statistics"	〈CY2004〉  Source: METI "Mineral Resources and Petroleum Products Statistics"	〈FY2004〉  Source: Ministry of Finance, "Monthly Report of Japanese Trade"	〈FY2004〉  Source: Surveyed by The Federation of Electric Power Companies of Japan

OSAKA UNIVERSITY

Energy Efficiency

Osaka, Monday March 19.

The first visit of the trip to Japan was to Osaka University, at the Division of Sustainable Energy and Environmental Engineering.

This Division is the result of the merger between the former Environmental Engineering department and the Nuclear Energy one. It aims to conduct both engineering classes and research that promote a sustainable development of the human society.

This department provides intensive teaching and training to give students the ability to solve global environmental problems and to develop a sustainable environment. This Division gathers around fifty professors and associates divided into five major groups. The Sustainable Energy System group and the Quantum and Energy Engineering group were hosting us for a scientific exchange.

Before introducing the summary of the on-going research themes, it is necessary to understand that the Japanese, concerning the residential field, do not benefit from a very strict thermal insulation regulation, as in France. That's why in this context, the different research projects led in this department intend to go further in energy saving and environmental issues.

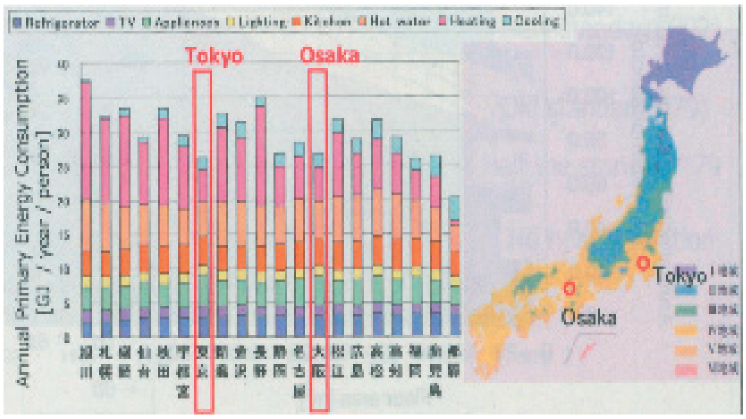
The topics of the given presentations were very close to our concerns about energy savings and environment. Their approach however focused mainly on technical and very specific projects as opposed to our more general comprehensive knowledge of the global energy issues, that we have presented through our presentation of energy efficiency in Europe. These two points of view – their precise one and our global vision – did not make it easy to have a real exchange, though their works and our study are both necessary to implement energy efficiency.

Five short presentations were given about urban energy system issues. Two of them dealt with energy efficiency technologies for the residential and the commercial sectors. Concerning the residential sector, Japan is currently facing an increase in the number of families with few members, and so an enlargement of residential building. An energy end-use model was built to simulate the energy consumption of Osaka city for both electric and gas systems, based on data for heating, cooling and home electric appliances. Thanks to this model, the impact of every efficient technology towards energy reduction was assessed. For the commercial sector, another approach predicted the efficiency of four steps to reduce energy consumption and CO_2 emissions in several districts of Osaka. The last two steps tackled the management of energy generation and distribution planning, and urban model.
Two other presentations focused on issues at a district level. The first was the evaluation of District Heating and Cooling System (DHC) supplied by gas or electricity. This research showed the superiority of DHC compared to individual systems, it pointed out their potential for improvement and predicted their forthcoming progress in energy efficiency.

The investigation of urban heat in Osaka City was then presented. Local climate change was a relatively unknown topic for us, contrary to global climate change. The annual average air temperature in Osaka has gone up continuously for a century. Over the last twenty years, the farmland and forest have decreased by 10% and have changed into artificial surfaces. Since this trend has consequences on the local environment, a model was built to identify the urban energy flows. Indeed, a simulation gave the effect of each anthropogenic waste heat upon air temperature coming from the residential, transportation and industrial sectors. The goal of the study would be to evaluate whether countermeasures against urban heat were necessary.

A more technological aspect was then described with a new technology for semi-transparent photovoltaic panels. They combine electricity generation with both space heating and day-lighting. But overheating, radiative heat loss and glare counterbalances their use. On-site field measurement and residential simulation enabled to assess their performances. Insulation material was needed to obtain an interesting reduction in the simulated heating demand.

At last, the Energy and Environmental Materials Laboratory presented their research on thermoelectric conversion. It is based on the direct conversion from thermal energy to electricity, using semiconductors materials. These materials could be used to recover even a fraction of the wasted heat given off by engines, boilers and other high temperature machines. However, this last idea seems to be attractive mainly because there are no turbines, but the low yield and high cost materials don't make it very competitive today. At the end, they give us a tour of their lab.



OSAKA UNIVERSITY

School / Graduate School of Engineering Osaka University
Division of Sustainable Energy and Environmental Engineering

CONFERENCE given by the Mastère OSE's students at Osaka University

Europe has continuously striven for greater energy independence since the first oil crisis in 1974. Considering that the oil price will continue to follow an upward trend due to oil reserves depletion, this quest has become the European Union's top priority.

However oil dependency is now caught up with unprecedented new challenges, those of global warming and fast energy demand growth. Indeed, EU committed itself to reducing its greenhouse gas emissions by 8 % below the 1990 level before 2012.
Meanwhile, energy demand should increase to 2000 Mtoe in 2030 compared to the 1750 Mtoe current consumption.
Therefore, in addition to the necessary demand reduction and renewable energies development, enhancing energy efficiency remains a key solution to meet Europe's objectives.
Energy efficiency is commonly defined as the ratio between the output service and the input energy used. Improving EE implies saving energy while ensuring the same service.
The EU actually plans to increase it by 20% by 2020 thanks to the implementation of an action plan based only upon existing technologies and behavioral change of final users. As a result, the expected €100 billion of annual savings generated by the plan would be partially reinvested in new innovative technologies to provide for energy efficiency improvements after 2020.
However, actual low energy prices and long payback periods normally used for large EE projects unfortunately limit their wide-spread development.

Going beyond these constraints, the action plan is intended to mobilize the general public, policy makers and market actors to provide EU citizens with the globally most energy-efficient market. It covers all sectors, especially buildings, transportation means and manufacturing industry in which the potential gains are the highest. Finally, the action plan aims at sensitizing people to adopt responsible behavior in using energy in the most rational manner.
First of all, the European action plan's first main goal lies in stimulating the development of energy efficient products sold on the European market.
As an incentive measure, labels, along with price information, inform customers the energy consumption class of each product within a standard class range (typically from A for the most efficient category to G, the least efficient one). These labels are largely adopted for cars, electrical devices and buildings. Such a measure induces manufacturers to design more efficient products and consequently, to enhance their environmentally friendly image.
In addition to label deployment, the EC wants to introduce a minimum energy efficiency norm for each energy-using product in order to classify the average energy efficiency of a product on its market.
For buildings where most of the potential gains occur, the EC introduces a new directive of minimum performance requirements for new and renovated buildings. Actually, the most significant EE improvements are to be found in renovation by insulation. Naturally, the EC supports the development of very low energy buildings.

Improving energy transformation is also a field in which Europe can save energy. In fact, lack of transformation efficiency uses up one-third of all primary energy. Improvements are expected in generating electricity and also in reducing energy transportation losses.
All these energy efficiency enhancements can be achieved only if financial and economic incentives are implemented. For instance, the removal of market barriers such as low energy prices would ease the development of ESCO (Energy Savings COmpany). Small and Medium Enterprises would particularly take advantage of such measures by investing in energy efficiency projects at low risk.
Finally, EU citizens are the most important part of this action plan. Energy efficiency starts at home! Education at school and training of managers are both essential. Large advertising campaigns are also necessary to sensitize the population at large.

France is a special European member state with regards to energy because it has a specific profile: 78% of its power generation is produced by nuclear energy, which is not particularly energy efficient but has the advantage of being a carbon-free industry. The French government has always strongly defended this position in European discussions on the implementation of the action plan.

Nevertheless, France has always been involved in energy efficiency, particularly in buildings, with the regularly updated building regulations for energy and fuel conservation set up in 1974. The government has also introduced Tradable Certificates of Energy Savings known as White Certificates.

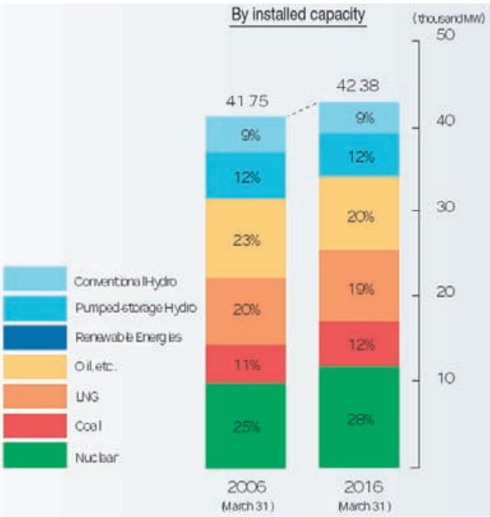
KEPCO

The KANSAI Electric Power Co. Inc.

Osaka, Tuesday March 20.

Kepco outlook

Kepco, which stands for Kansaï Electric Power Company, is one of the ten electric utilities in Japan and the historical provider for the Kansaï district, one of the most industrialised and populated area in Japan. Its supply area includes Osaka, Kyoto, Kobe and Niara. Kepco is the second largest Electricity Provider behind the Tokyo electric power company.
Like all the other Japanese historical utilities, Kepco is a wholly integrated operator, from power generation to transmission, distribution and sales. From the Japanese point of view, it is the only way to ensure a stable supply of electricity at the lowest possible cost in the long term.

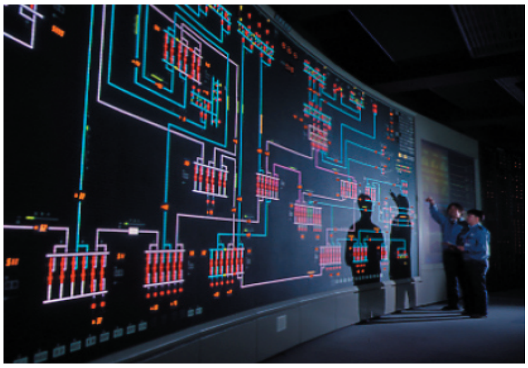


Generation mix

Kepco combines nuclear, thermal and hydro power to try to reach the optimum energy mix. Since the nuclear accident at the Mihama nuclear power plant in 2004, Kepco has to reduced its nuclear capacity to 25% of its total installed capacity (more than 50% before the accident). Nowadays, nuclear power functions as the mainstay, supported by the thermal plants (43%) and the pumped-storage hydro (2%) during peak demand. The rest of the power is provided by conventional hydro.
Due to the lack of surface available, renewable energies such as wind and solar power are limited to 1% of the overall power generation. These capacities are mainly operated by independent providers.

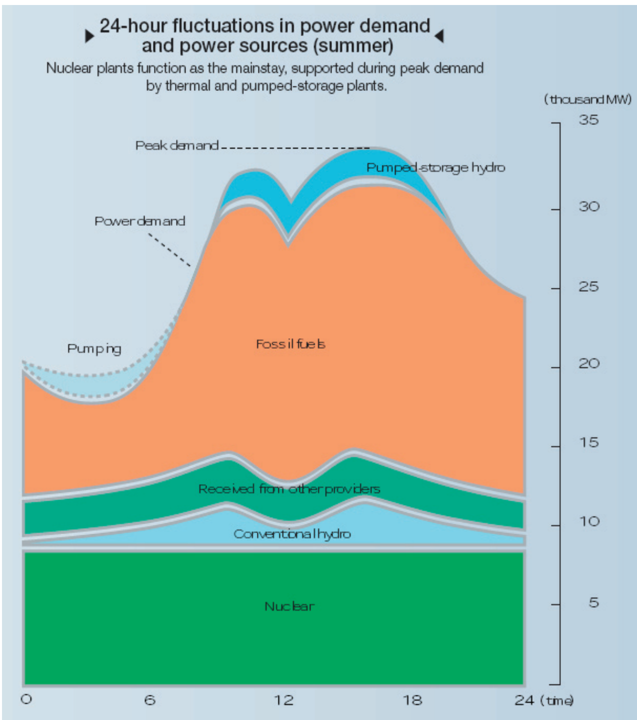
Network management

As an integrated power company, Kepco owns the transmission network and is in charge of its management. This task is completed at their Osaka Central Dispatching Center. One of the benefits of the wholly integrated structure of Kepco is the possibility to optimise the use of their generating capacities. In the French system, the network operator has to use bids to decide which plant should be used. In Japan, based on one day consumption forecast, Kepco uses an economic optimisation program to determine the best allocation of each generating capacity and to use its network rationally.



Market liberalisation

The electricity market has been deregulated in Kansai since 2000. However, the vertical's integrated structure of the historical provider has been kept to insure the reliability of the system. The impact of such a decision on the market opening may be questioned. This hinders the development of a real competition between several power companies. In fact only small independent producers, operating cogenerations or renewable's, are developing.



KEPCO - Hydropower

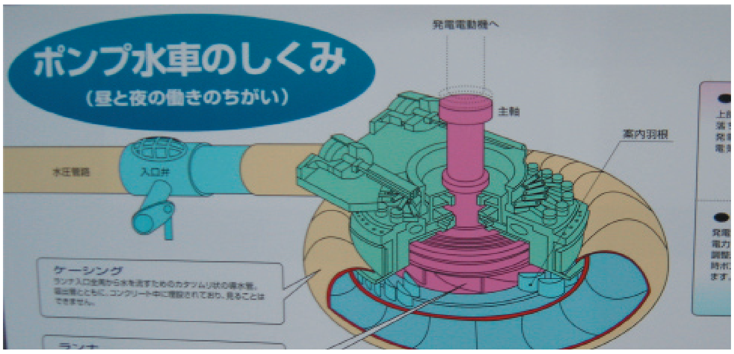
Pump Storage Power Plant

THE KANSAI ELECTRIC POWER CO.,INC OSAKA, JAPAN

Okutataragi, Tuesday March 20.

We visited the pumped storage hydroelectric plant of Okutagari, located in the Kansaï region, where the director welcomed us. This plant belonging to KEPCO (Kansaï Electricity Power Company), was created in 1974, and is composed of 6 generators, the last two having be installed in 1998. The total installed power is 1932 MWe.

This plant, as well as all the pumped storage hydroelectric plants, consists of two reservoirs: an upper and a lower one and a reversible hydroelectric converter between them. The difference in altitude between the two dams of the plant is 400m: the upper dam is located at an altitude of 625 m and the lower one at 225m. Both reservoirs are connected through underground pipes. The digging needed for the station construction produced large amounts of soil, employed for landscaping the surroundings of one of the lakes.



During the storage mode, the plant uses electrical energy to bring the water to the upper reservoir and during the generation mode, the potential gravitational energy is converted into electricity.

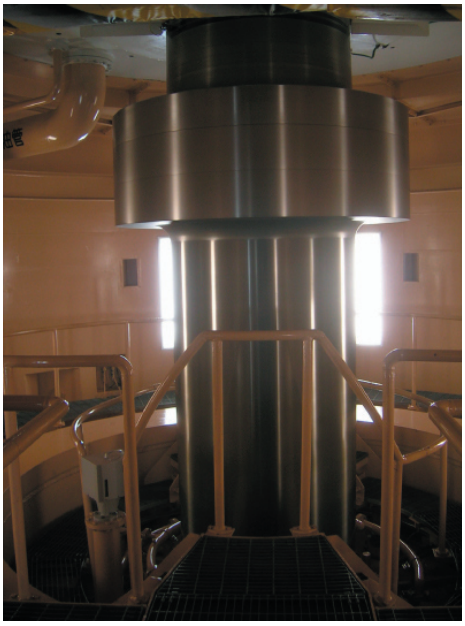
The interest of such a plant is the operational flexibility and the capacity to optimise the load curve. At pumped storage plants, electricity (taken from the national grid) is used during periods of low demand (usually at night) to pump water into reservoirs for release during times of peak electricity demand when the marginal cost of electricity generation is higher. Less electricity is produced than is used to pump the water to the higher reservoir. However, the procedure is economical when the costs avoided by not using less efficient thermal power stations to generate a similar amount of electricity exceed the cost of the pumped storage procedure.

According to the plant director, almost 70% of the electricity consumed to pump the water to the upper reservoir can be recovered by the turbine in the electricity production mode. The electricity used for pumping is nuclear electricity. In Japan, especially in the Kansaï region, the peak in electricity demand is in summer time, because of the extensive use of air conditioning and cooling systems. Pumped storage is a means to meet demand. In Japan the hydroelectricity production was 103147 GWh in 2004, of which 9 084 GWh from pumped storage.

We visited one of the two blocks of the plant, composed of two generators of 18kV at 60 Hz. This underground plant is placed between the two reservoirs.

The power generated varies between 295 MW and 370 MW for each generator, depending on the water level in the reservoir and the water flow rate (which varies between 100 m^3/sec and 103 m^3/sec).

The constant rotational speed of the turbine is 360 rpm. Only three minutes are needed to stop the turbine from the pumping mode and switch to electricity production mode. The voltage is then increased - from 18 kV at the output of the turbine - to 500kV through transformer stations to be transported to the network.



JHFC Park

Japan Hydrogen & Fuel Cell

財団法人 日本自動車研究所 Japan Automobile Research Institute

Tokyo, Wednesday March 21.

JHFC stands for Japan Hydrogen and Fuel Cell Demonstration Project. Organized by the Ministry of Economy, Trade and Industry, it involves a wide range of activities related to the use of fuel cell vehicles.

The JHFC Demonstration Project consists of the Fuel Cell Vehicle (FCV) and the Hydrogen Infrastructures Demonstration Study.

The JHFC project aims to gather and share fundamental data on the methods for hydrogen generation from various sources and FCVs performance, environmental impacts, total energy efficiency, and safety under actual usage conditions in order to develop a roadmap for the full-scale mass production and widespread use of FCVs.

The project has been divided into two steps:

JHFC 1: 2002 – 2006

☐ Demonstrate high energy efficiency in FCV.

☐ Demonstrate "Well to wheel" efficiency by using demonstration data of FCV and hydrogen stations.
Today, only 60 FHC are running in Japan (350 worldwide)

JHFC 2: 2006 – 2010

The future project aims to:
☐ Clarify the remaining problems of FCVs and hydrogen Infrastructures in tests simulating their actual usage conditions more faithfully.

☐ Collect data to develop regulations, codes and standards concerning FCVs and Hydrogen Infrastructures.

☐ Formulate and implement public relation and education strategies to propagate and promote FCVs and Hydrogen Infrastructures.

☐ Ascertain the effect of FCVs and Hydrogen Infrastructures on energy conservation and environmental impact mitigation.

☐ Identify technology and policy trends concerning FCVs and hydrogen Infrastructures.

JHFC Park description:

Located on the Yokohama bay 40km from Tokyo, the place includes:

- 1 Hydrogen Manufacturing Station (Desulfurised-gasoline reforming process)
- 1 Hydrogen station for FCV supplying (including H_2 storage at 40Mpa)
- 1 FCV garage with several models (Toyota FCHV, Nissan X-Trail, Honda, Mercedes Class A F-Cell, GM Hydrogen3, Toyota-Hino Bus, Suzuki MRWagon, Mazda RX-8 Hydrogen RE)
- 1 showroom (engines demonstrations, Fuel Cell Prototype, conference room…)
- 1 SOFC 1kW.

The efficiency of the actual hydrogen process on site is at 60%, the future goal is to rich 70%.

Visits for individuals, schools and technicians are organized.

The students of the Mastère OSE spend a whole afternoon at the JHFC Park to take part a conference, visit the Hydrogen Manufacturing Station and also have a short Tour in a Nissan FHC (see the picture on the left). We could appreciate how flexible, powerful and silent the model was.

TOKYO Metropolitan Government

Solar Energy Promotion

Tokyo, Thursday March 22.

Tokyo city and its neighbourhood form the world largest megalopolis with 36 million inhabitants. In such a huge area, energetic issues are at the forefront in terms of economic growth but also raise important questions of pollution and gas emission for its government, the Tokyo Metropolitan Government (TMG).

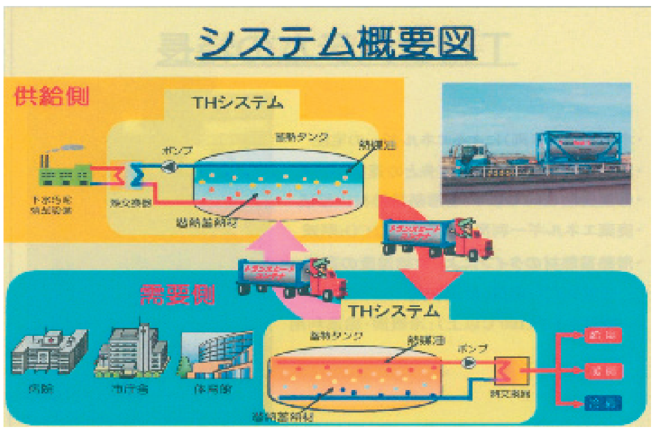
Therefore, to prevent global warming , this political institution has set the ambitious goal to increase the percentage of renewable energy by up to 20% by 2020.

In order to reach this target, TMG has set an intermediary objective of 5% of renewable energy purchase for its own use, whereas the Japanese government imposes only 1,63% of renewable energy to energy producers in their production mix. The city doesn't limit its action to that percentage, but also wants to push other cities to adopt this objective and also to encourage private enterprises to use renewable energies. To do so, it organises a national conference on this topic, gathering 230 attendees, among which 150 are private companies and 50 are cities. Investment in renewable energy projects and consumption is actually difficult as the price of this green energy is up to three times higher than conventional energy. Nevertheless, TMG involves banks in this business, by inciting them to develop innovative financial products dedicated to renewable energy investments.

Among its global warming countermeasures (* with a budget of 50 billion yen), TMG has focused on thermal solar and photovoltaic systems development in Tokyo: TMG's objective is to implement 1 million kWh of solar energy systems including between 60 to 70% of thermal solar systems. This would lead to an increase of 10 times the current installed solar systems in the city.

TMG also aims to recover waste energy, especially that produced in the outer-urban zones. For example, TMG is the third CO_2 emitter in town and one third of its CO_2 emissions are due to waste water treatment and sewer systems. Thermal waste energy from this process can be used for other applications: when possible, it is sent to hospitals or other establishments though heat pipes.

TMG has further developed an innovative process for transporting this energy: the system consists in recovering heat thanks to an exchanger, and then in storing it in a heat transfer fluid. So, the fluid is carried in a tank truck and used in an other place such as a swimming pool or any requesting company. This system is profitable only if the distance between production and consumption doesn't exceed 10 km. Finally, TMG is aware that improvements remain to be made and intends to extend this system to cooling applications in the future.



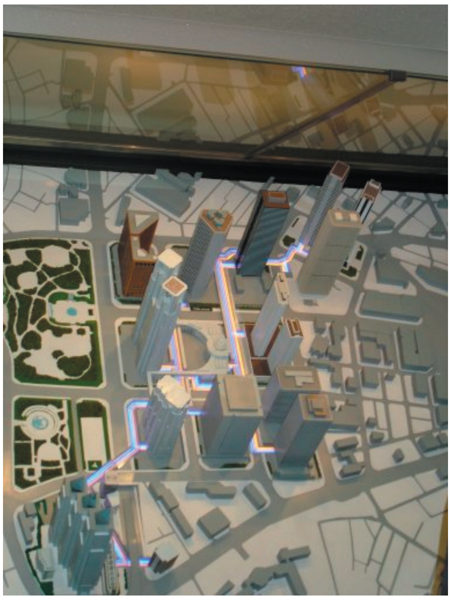
TOKYO Metropolitan Government

District Heating and Coling

Tokyo, Thursday March 22.

Second network created in Japan, the Shinjuku DHC (District Heating and Cooling Centre) was constructed in 1971 in the Shinjuku area, the new centre of Tokyo. This centre had in 2005 a turnover of 6.5 billions of yens, which correspond to 45 millions of euros. The system uses natural gas and cogeneration systems, thus protecting urban environment and reducing energy consumption. It has a cooling capacity of 59,000 RT (refrigerating ton; 1 kW = 0.284 RT) and a heating capacity of 173,139 kW.

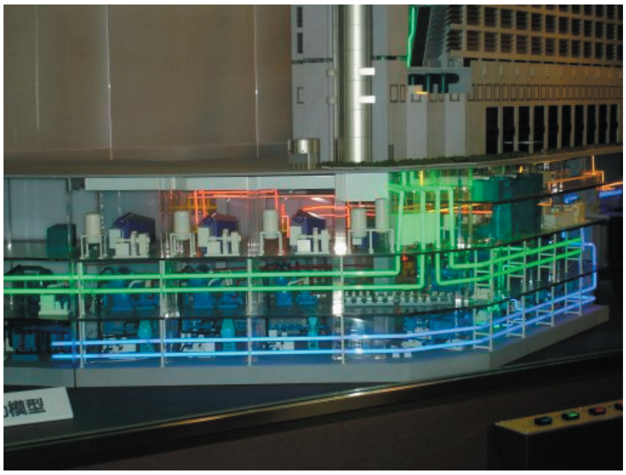
This DHC is one of the world largest systems and the first in Japan. With 2km of pipes, it serves 2,200,000 m^2, which is more



than 15 skyscrapers in the Shinjuku area, where the City Hall Towers of Tokyo are.

The Shinjuku DHC is supplied by two cogeneration systems of respective electric power 4,500 and 4,000 kW. Electric generators provide respectively 50% and 40% of the annual consumption of the buildings supplied. For cooling generation, topping sys-

tems are used. The topping system consists of a back-pressure turbine-turbo chiller and a steam absorption chiller, for a COP(Performance coefficient) of 2.3. Water boilers send 4MPa and 400°C high-pressure steam. This steam is used to drive turbo chillers and is also used as a heat source for the district (1MPa and 200°C steam). Water in pipes comes in at 90°C. Cold water leaves the system at 4°C and comes back at 12°C. This temperature differential, measured at the consumer's, has to be respected



as it is linked to the flow in pipes, and thus to the customer's invoice ($P = \alpha * Q * \Delta T$).

Topping systems and boilers are put together on four floors (see figure below). Eight cooling towers 22 m high cool burning gases, which are first treated against NOx and SOx.

To manage this system, 40 people are employed. Supply is adapted day by day, based on weather forecasts, which estimate the heating and cooling capacity to be provided.

TEPCO

LNG & Electricity

TOKYO ELECTRIC POWER COMPANY

Tokyo, Friday March 23.

TEPCO is one of the biggest energy companies in the world and is in charge of production, transport and delivery of electricity in Tokyo, Yokohama and the rest of Kanto's area. TEPCO also owns 45% of Kandeko (electrical engineering company), but also 33% of Tokyo Telecommunication Network, and even holds shares of several electric powerplants in China.
TEPCO was created on the 1st of May 1951. The hydroelectric energy then represented 80% of the TEPCO energy mix. The growing demand in electricity has required the use of thermal power stations. The increase in coal and oil prices due to the oil crisis created a need to diversify the energy mix of TEPCO. The 62 800 MW of installed power are allocated as follow: 14% hydroelectric, 28% nuclear, 42% natural gas, 13 % coal and 3% oil.
The goal of TEPCO is to satisfy and harmonize the « 3 E » : economic growth, environmental protection and energy security. Regarding more specifically supply stability, TEPCO has built up a « triple circuit » constituted of 3 electric lines in parallel. In case of an incident on a line, it allows redirecting power into the two other lines during the repair, which avoids disconnecting consumers. Nowadays, a Japanese sees on the average a power cut only every 10 years for a period of 2 minutes. To draw a parallel, the average duration of electric breakdowns in France is about 45 minutes.

Japan ratified the Kyoto protocol and therefore has to reduce its greenhouse gases emissions by 6% below its 1990 level. Because of the demand growth, this objective requires reducing by 20% the emissions per kWh produced, which is TEPCO's commitment.
Since it started using LNG for electricity production in 1970, TEPCO has increased the consumption of this energy resource : in 2003, its importations of LNG represented 32.9% of the global Japanese importations and 15% of the volume of LNG exchanged in the world. In 2004, the LNG power plants represented 73% of the total thermal capacity of TEPCO, which keeps on promoting LNG use by building new powerplants and new pipelines. TEPCO owns 10 thermal powerplants supplied with gas, placed around the bay of Tokyo and connected to each other by two gas pipelines. One is on the east side of the bay, and the other on the west side. An 18 km-long undersea pipeline is under construction and will cross the bay from east to west to connect both sides.
TEPCO also owns 4 LNG terminals around Tokyo bay. Two of them are commonly held with Tokyo Gas. The overall capacity of these terminals represents 2 982 billions liters, in other words 21.4% of the Japanese storage capacity. LNG is transferred from the ship to ground tanks (buried or not), at atmospheric pressure and −160°C. Each ship brings 60.000 tones of LNG, which represents three days of consumption. LNG is then sent to a vaporization unit to be heated and then vaporized into natural gas. The pipes containing the LNG are plunged either in sea water or in a water tank heated by combustion gases. The natural gas is then sent to the power plant to be burnt and generate electricity.

JFE Engineering

Building Cooling

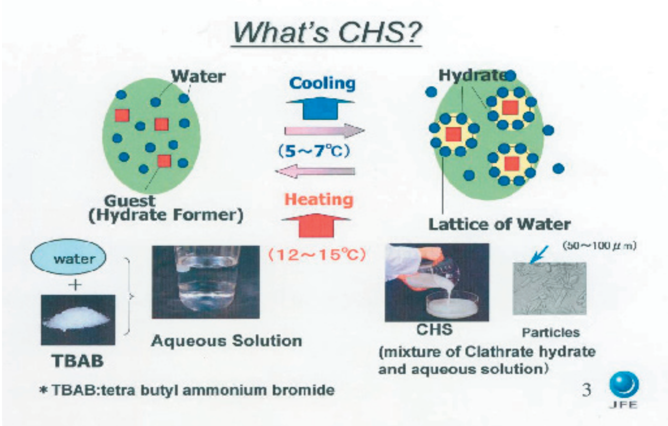
JFE Engineering Corporation

Tokyo, Friday March 23.

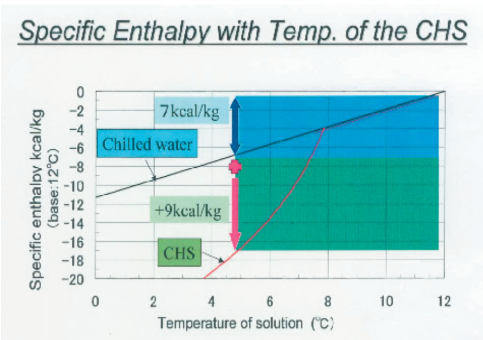
JFE (Japan Fe (stands for the symbol of iron) Engineering) and the NEDO (New Energy and Industrial Technology Organization) have jointly developed a cooling system based on the management of a new heatcarrier fluid. JFE has obtained the Japan's industrial technology first prize and the congratulations of the Japanese government for this invention.

JFE gathers extremely diverse activities through all its business units. Some of them deal with steel exploitation (pipelines, construction…), energy and environment (cogeneration systems, electricity production through biogas …) or logistics in many processes.
NEDO is a public organism and aims to promote R&D in energy projects by establishing partnerships between industrial, private or public actors.

The innovative part of this process is based on the unique properties of a new liquid substance : the Clathrate Hydrate Slurry (CHS). This fluid is obtained when cooling to 5-8°C a mix of tetra-butyle ammonium bromide (TBAB) and water.
The air-conditioning system works as follows : once the CHS is created, it is circulated in a closed-circuit. It is stored in a tank then released when needed. The fluid motion is managed through a pump system. When the heat of the fluid has been delivered, it is cooled (via a chiller) and sent back to the tank.

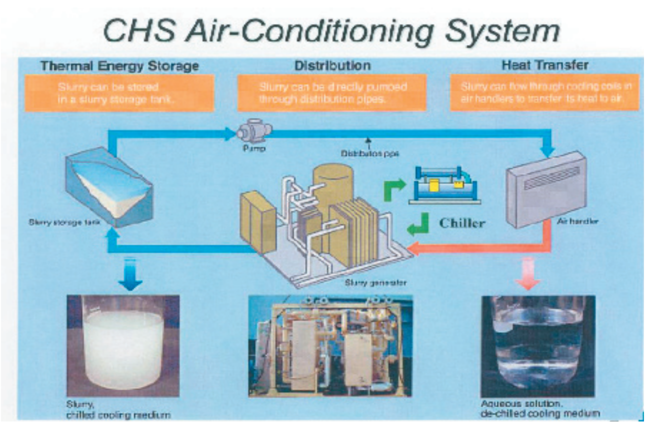


The main part of the energy savings is due to the high heat storage capacity which allows processing the CHS during the night. Thus it enables the chillers to work with a higher coefficient of performance (COP) thanks to the low external temperatures. Moreover this storage is economically very interesting. Indeed the price of electricity is very low during the night period, so that it is efficient to process the chilling operations which are very energy demanding.



CHS heat capacity is 2 or 3 times larger than chilled water. Even if the viscosity of CHS is a bit high, the required flow rate and differential pressure are divided by 2 compared to typical chilled water air-conditioning with the same level of performance. The heat storage capacity can also be downsized which leads to a reduction in both the heat engines size and the volume of the storage capacities. Energy consumption is also reduced a lot compared to a chilled water system.

Although this technological innovation is now available on the market and is compatible with existing technologies, only 7 buildings in the world are using such a system (including the JFE Engineering building in Japan). Compared to a typical air-conditioning system, a CHS-based system costs about 20 to 30% more. Theoretically this extra cost would be paid off in 5 to 10 years thanks to the chill-generation during the night, when the price of electricity is low. So this technology is economically sustainable and is just waiting for customers.



Partners

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We have been very impressed with the high level of the presentations and the speakers who have been most competent and made themselves available.

OSE
Optimisation des Systèmes Energétiques

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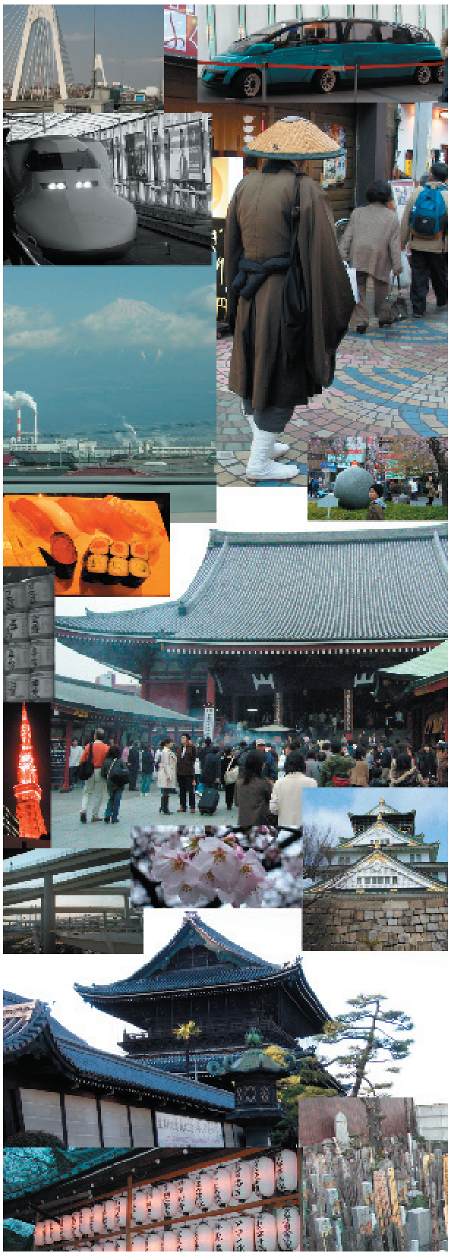

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