The background features a light beige grid pattern. Overlaid on the left side are several thick, semi-transparent, colorful lines that swirl and curve, creating a sense of motion and depth. The colors include shades of orange, yellow, green, and purple. A semi-transparent dark olive-green rectangular box is positioned in the center-right, containing the title and subtitle text.

# Power Systems

Nuclear Power  
Thermal and Hydraulic Power  
Electric Power Distribution

# ABWR-900 as Medium-sized Nuclear Power Plant

The ABWR-900 (960 MWe) as the medium-sized nuclear power plant with outstanding economical efficiency was developed based on the technology of ABWR (1,350 MWe class), which is the world's first—and only—3rd generation advanced light water reactor.

[Main features]

### (1) High power density reactor core

The ABWR-900 core achieved an increase in power density, maintaining a suitable reactor core performance by using a fuel bundle of  $10 \times 10$  fuel, and making the lattice pitch (channel gap) of the fuel bundle expand. A reactor core with high power density is the key technology for the miniaturization of RPV (reactor pressure vessel), and contributed also to rationalization of the reactor building arrangement.

### (2) Safety system with dynamic and passive systems combined

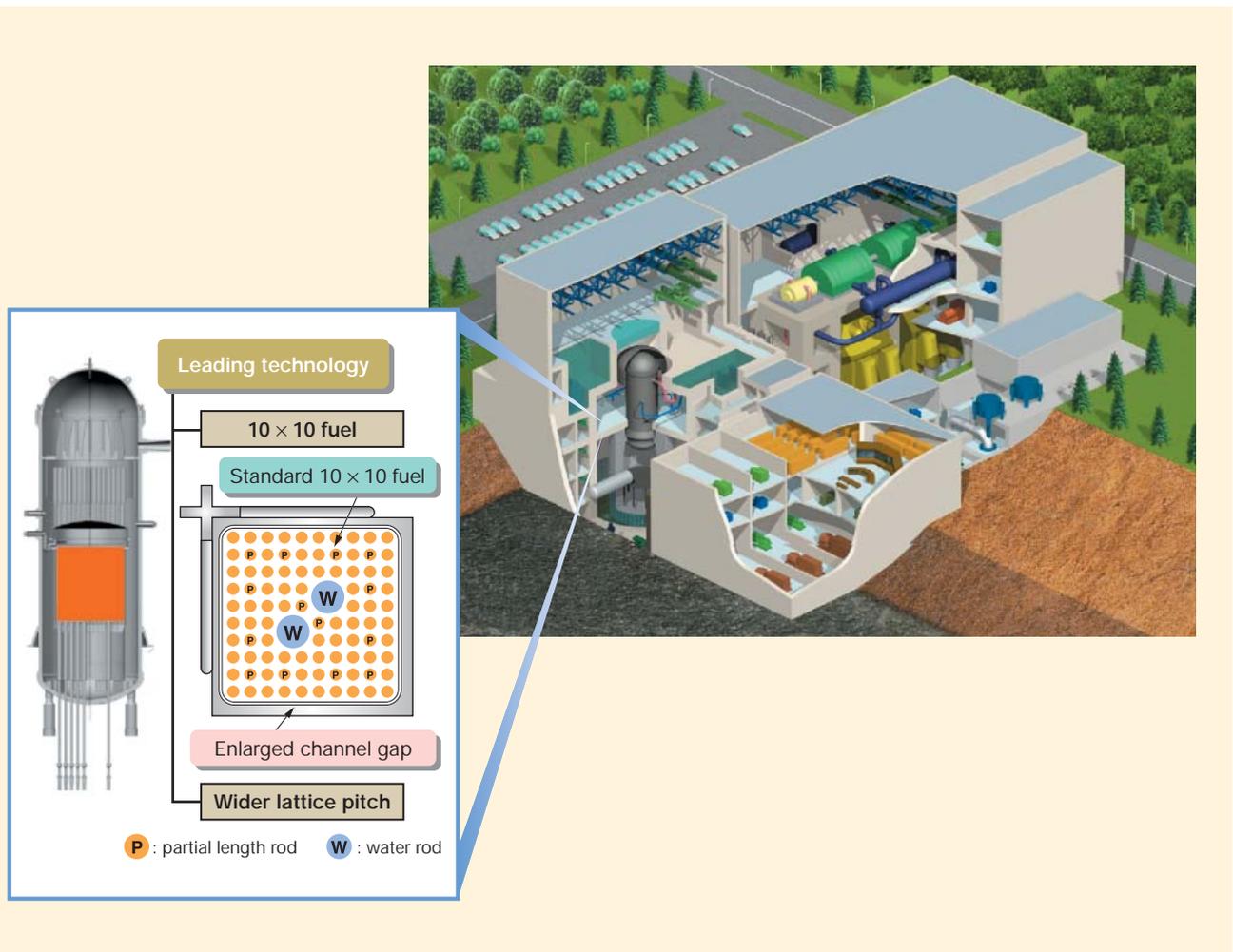
Based on the next-generation reactor design trends, the passive systems (IC: isolation condenser and PCCS: passive containment cooling system) were added to the ABWR-900 safety system, and it was diversified from the viewpoint of driving force and heat

sink. The safety system of ABWR-900, in which dynamic and passive systems are combined, has been confirmed as having a high safety equivalent to that of ABWR by probabilistic safety assessment.

### (3) Compact plant layout

By equipment simplification and compact arrangement, the building volume and the main components quantities per unit output of the ABWR-900 would be reduced to an equivalent level as compared with those of the ABWR.

In addition to the relative initial investment control effect that a medium-sized one has, the ABWR-900 has outstanding economic efficiency due to the high power density core technology and system simplification, mentioned above. Therefore, it is expected that the ABWR-900 can respond also to the needs of the investment risk reduction accompanying deregulation of the electric power market. Moreover, by adding ABWR-600 (600-MWe class) developed under the same concept as ABWR-900, the output menu of ABWR is expanded and it will surely respond to the various needs of the market.



Outline of ABWR-900 and high power density reactor core



## Phased Array Technique for Coarse Grain Materials

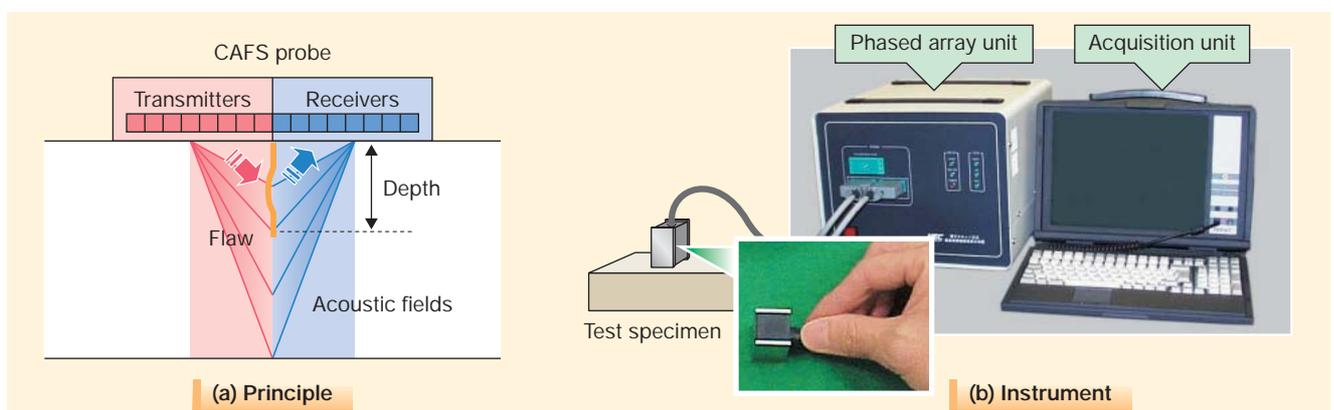
Hitachi has developed a new ultrasonic inspection method called CAFS (crossed active focus scanning) method. This CAFS method is suitable especially for measuring the depth of SCC (stress corrosion cracking) in coarse grain materials such as stainless steel welding and nickel based alloy welding in which an ultrasonic beam is bent and attenuated.

In the CAFS method, an optimized small array probe and a phased array instrument are used. The small array probe is divided into the transmission and receiving areas. The probe

generates the focused ultrasonic beams, and the focal point is scanned along with depth direction of the crack.

The CAFS method uses a focused ultrasonic beam with high energy density and minimizes transmission length in the weld, so that it has high sensitivity to crack tip refraction echo even in the coarse grain materials.

This instrument system gives crack image on display of the acquisition unit in real time.



Principle of CAFS method and instrument system

## 1,000-MW Output No. 1 Plant of Hitachinaka Thermal Power Station Delivered to Tokyo Electric Power Co., Inc.

In December 2003, Tokyo Electric Power Co., Inc., began operating its first entirely coal-fired thermal power station in 30 years. The Hitachinaka No. 1 Plant has an output of 1,000 MW. Hitachi, Ltd. views thermal power as one of the hopes for electric power plants in the 21st century. In Tokyo Electric Power's new power station, Hitachi was responsible for manufacture, installation, and test operation of the boiler, turbine generator, main and common transformers, 500-kV gas-insulated switchgear, and related facilities and equipment.

[Main features]

- (1) Main steam pressure is 24.5 MPa, and severe conditions were met of withstanding high steam temperatures of 600°C for both the main steam and reheated steam.
- (2) Use of advanced boiler appropriate for 21st century power plant (new boiler construction, latest model burner, etc.)
- (3) Use of type CC4F-41 turbine, used previously in numerous projects
- (4) Use of highly efficient generator
- (5) Digital transmission communications unit used in control unit of switch device's digital relay



Exterior view of No. 1 Plant of Hitachinaka Thermal Power Station and facilities



## No. 8 Type H-25 Gas Turbine Power Generator Delivered to Bahamas Electricity Corporation

The No. 8 gas turbine generator (type H-25) delivered to the Bahamas Electricity Corporation (BEC) of The Bahamas went into commercial operation in July 2003. This H-25 generator

was the second such installation since the No. 4 equipment previously delivered to Central and South Americas. The contract for the No. 8 generator was signed in November 2002 via Sumitomo Corporation. The No. 8 equipment went into operation a month faster than the initially delivered No. 4 generator.

The type H-25 generator in the BEC project replaced an existing gas turbine, and resulted in an enhanced performance. Besides the two gas turbine generators supplied by Hitachi, BEC plans to replace three other existing gas turbines with the type H-25. Hitachi thus expects in the future to replace those three existing gas turbines with type H-25s at the rate of one a year.

[Main features]

- (1) Gas Turbine  
Type: H-25 gas turbine (heavy-duty type)  
Output: 22,360 kW; 7,280 r/min  
Fuel: Diesel oil (gas oil)
- (2) Generator  
Air-cooled  
Capacity: 27,950 kVA, Voltage: 13.8 kV  
Rotational speed: 3,600 r/min



No. 8 type H-25 gas turbine power plant of Bahamas Electricity Corporation



## New Type Digital Generator Excitation System



Exterior view of new type digital generator excitation system

Needs are increasing yearly in the electric power industry for greater economy and easier maintenance of control devices. In response to those needs, Hitachi has commercialized a new type of digital generator excitation system.

Outstanding economy and ease of maintenance have both been realized in this system by developing a specialized board and concentrating all functions on it.

[Main features]

(1) It is possible to apply either the thyristor excitation system or the brushless excitation system from small capacity generators to those with output as large as about 600 MVA

(2) Various functions (signal detection, computing, gate pulse generation circuits, etc.) are united on a single specialized board, making possible high reliability and ease of maintenance.

(3) It is possible to respond to either single or dual control circuits.

(4) Through use of a thyristor switch in the electrical discharge circuit, an AC circuit-breaker is used and economy is realized in the main circuit.

## Efficiency Improvement of Recent Steam Turbine Retrofit in Australia

Many fossil power plants around the world have been in operation for several few decades. Their efficiency is relatively low compared with plants designed contemporarily, which is also an important aspect from the viewpoint of reducing the CO<sub>2</sub> emissions. An Australian utility is undertaking a project to retrofit four existing coal fired steam turbines each with 500 MWe output. The turbines were originally manufactured by GEC and put into service in 1972. The low-pressure turbine retrofit is the first step in this upgrading process and significant performance improvements have been obtained by applying the state-of-the-art turbine technologies developed by Hitachi. These consist of (1) optimized steam flow arrangement, (2) five stages of continuous cover blades (CCB) including a new 33.5" last-stage blade, (3) a new inner casing which enabled the installation of highly efficient nozzle diaphragms, and (4) exhaust hoods with aerodynamically efficient diffusers.

The actual designs and processes result in the outstanding success of the retrofit, e.g., (4.8% relative efficiency improvement compared with the guarantee value of 3%).



Indoor view of Macquarie Generation Liddell No. 2, Australia

## 121-MW Steam Turbine Generator and Waste Heat Recovery Boiler Delivered to Dominican Republic

For the combined cycle power plant built in the Dominican Republic by AES Corporation, an IPP (independent power producer) in the U.S., Hitachi, Ltd. won a CIF contract from CTE (Caribbean Thermal Electric), a joint venture between Fluor Daniel of the U.S. and ICA of Mexico, for delivery of one steam turbine generator and one waste heat recovery boiler. Following successful performance tests, the generator and boiler went into operation in October 2003.

[Main features]

(1) Multi-shaft combined cycle STG (steam turbine generator) and HRSG (heat recovery steam generator) combined equipment package.

(2) Steam turbine: 121 MW, reheat mixed pressure type, with the largest axial flow exhaust, and maximum blade length of 40 inches (101.6 cm)

(3) HRSG: Reheat, triple pressure, natural circulation type; first unit in actual operation with combustion through a duct burner

(4) Plant start-up through own steam (no auxiliary boiler); middle pressure start-up used for turbine. Substantial shortening of start-up time realized.



Overall view of AES Corporation's combined cycle plant

## Japan's First WAN-interconnected PC-based SCADA System Supplied to Kansai Electric Power, Co., Inc.

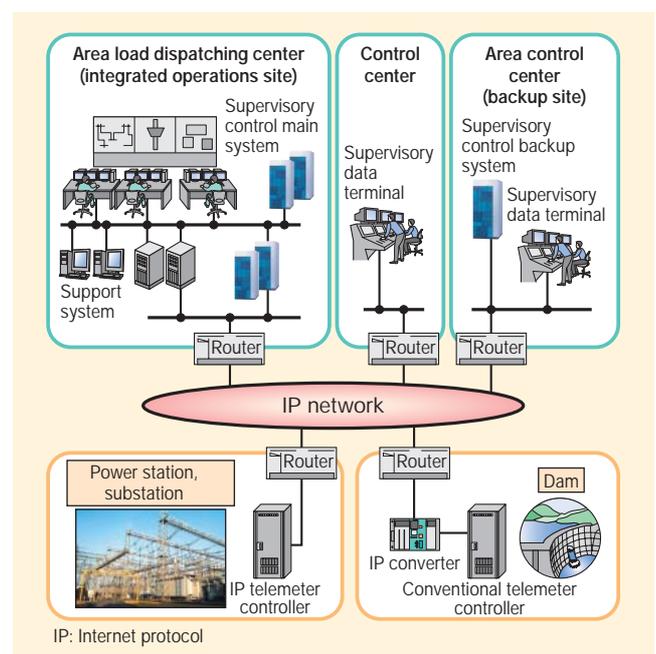
Needs have increased in the electric power industry for introducing systems to reduce operating costs for power transmission facilities such as by integrating them and also for responding flexibly to changes in the systems for operating power facilities. To satisfy those needs, Hitachi has developed Japan's first WAN (wide area network) interconnected SCADA (supervisory control and data acquisition) system using PCs for Tokai Area Load Control Center. The system utilizes PC servers and remote supervisory control devices with IP connections.

[Main features]

(1) An IP network is applied to the data transmission to realize a WAN interconnected distributed system. This system makes it possible to share supervisory control information commonly among multiple locations, thus easing the former limitations about where systems could be located.

(2) This is the first time for an online real-time system to use PC architecture (Linux server) throughout. While assuring reliability and performance, development costs were reduced.

(3) An IP conversion device was developed to allow ready connection of conventional type telemeter controllers to networks. (Operations began in June 2004.)



Outline configuration of supervisory control system linked to IP network



## Data Management Middleware Developed for Dispatching/Control Center Systems of Chubu Electric Power, Co., Inc.

On the occasion of renewing the dispatching/control center systems that conduct concentrated supervisory control of its substations, Chubu Electric Power, Co., Inc. developed a system that emphasizes commonality of its application software in order to secure stable provision of electric power and greater development efficiency.

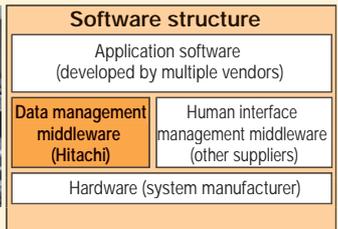
Previously, the application software differed by dispatching/control center system and by software vendor. The new software is common to all dispatching/control center systems. Multi-vendors were used, with each vendor assigned a development task. Based on its cumulative experience to date with the design and application of distributed type supervisory control systems, Hitachi was tasked with developing the "data management middleware" (basic software for distributed database management), the foundation of the middleware contributing greatly toward realizing high performance, high reliability, and expandability. Hitachi contributed much to the system being up and running on schedule, and operating stably afterward.

Plans call for this product to be used in the future in all the dispatching/control center systems of Chubu Electric Power, Co., Inc.

(The first location Chubu Electric Power, Co., Inc. used this new system in was the Gifu dispatching/control center system.)



Control room of Gifu dispatching/control center



### Special features of data management middleware

Special features	Functions
Integrated data model for dispatching/control center system	<ul style="list-style-type: none"> <li>Electric power facilities (power station, transmission, maintenance, river water related facilities) model</li> <li>Data transmission format model</li> <li>Data model for ties with other systems</li> </ul>
Data management functions specifically for use with each application specification	<ul style="list-style-type: none"> <li>Management of chronological records and data for event history records</li> <li>Store and restore management of snapshot data</li> </ul>
Database access functions for high performance, high reliability, and expandability	<ul style="list-style-type: none"> <li>Control functions such as database reference, update, and deletion</li> <li>Distributed data access and replication function</li> <li>Program trigger function when update data</li> <li>Data view function for ensuring independence of data</li> <li>Function for copying data between dual systems</li> </ul>
Data switching function for flexible response to data changes	<ul style="list-style-type: none"> <li>Deployment and delivery functions when conducting data maintenance</li> <li>Function for switching database versions</li> </ul>

## Energy Analysis System for Bulk Electric Power Consumers

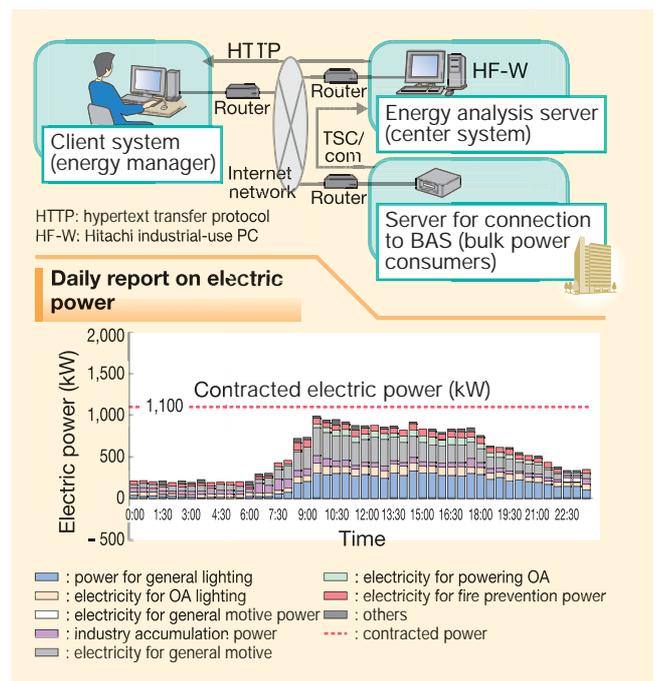
Together with revisions to Japan's Energy Conservation Law, bulk consumers of electric power are being asked to tighten up their management of energy. In that backdrop, Hitachi has developed an energy analysis system which provides easy-to-understand guidance information to bulk consumers of electric power by collecting and analyzing data needed in energy management and applying it to reducing management costs and conserving energy.

### [Main features]

(1) For collecting data, the TSC/com (tool of solution and communication for building and energy management system) protocol, the de facto industry standard, is used, allowing data measured by existing BAS (building automation systems) to be collected and displayed at low cost.

(2) A web-based system is used for achieving flexibility without depending on the configuration of the client system hardware or installation location.

By using this system, bulk consumers of electric power: (1) reduce expenses related to measuring the amount of energy consumed by their facilities; (2) realize greater efficiency and labor savings in energy management operations; (3) can introduce equipment for reducing energy costs based on simulation for introducing heat accumulator equipment such as "Eco-ice (ice thermal-storage)."



Example of energy analysis system configuration

# Overview of Hitachi Energy Solution Service Business

According to Kyoto Protocol developed at the Kyoto Conference, the third session of the Conference of the United Nations Framework Convention on Climate Change, Japan has to reduce 6% of its emission of global warming gases between 2008 and 2012, compared to that of 1990. To meet this goal, the Japanese government is implementing several regulations for energy conservation, environment tax, emissions trading of carbon dioxide, and so on.

In this background, most companies and municipalities are required to dramatically reduce CO<sub>2</sub> emission, energy costs, and capital assets.

Recently, the business for ESCO (energy service companies) has been growing providing customers with comprehensive services for energy savings. Hitachi started the ESCO business in April 1999. The ESCO offers comprehensive services for energy savings to customers, and includes costs required for repairing energy saving equipment; their fees paid by savings in energy costs. The service includes energy saving diagnosis, energy saving proposal, equipment installation, finance, and maintenance. Hitachi promotes a totally supporting energy saving business, for instance, air conditioning, lighting, power generation, and optimization of systems.

There is an advantage of energy cost savings after ESCO projects have been completed. Some advantages include increased customer profit, and also financing of the expenses of ESCO project and operation cost. The contract term is usually a ten-year term, because of the need to recover initial investment costs.

The following advantages can be obtained by customers.

- (1) Total execution of energy saving modifications
- (2) Reliable improvements without financing from the first year
- (3) Effective investment for core business to improve ROA (return on assets), through capital asset reduction

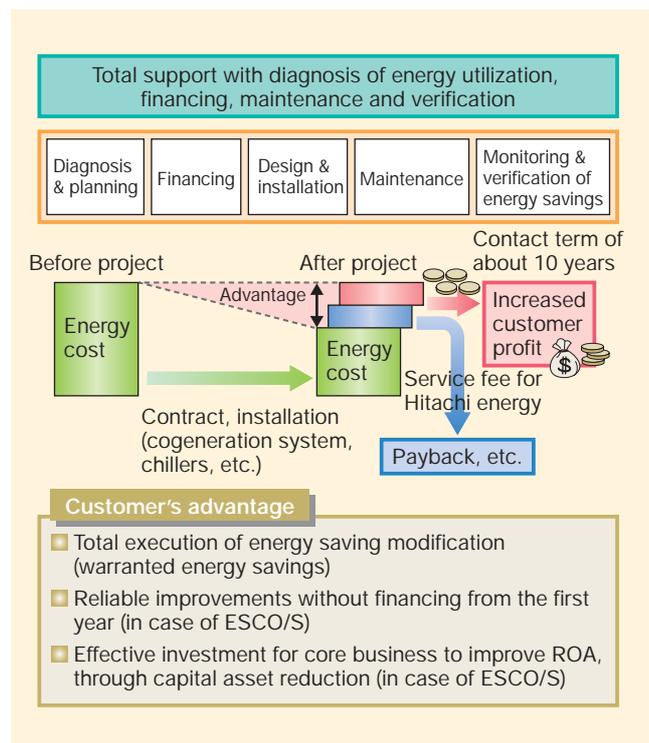
One of the ESCO service projects enables energy savings through displacement air conditioning and utilization system of exhaust gas from gas turbine generation system.

The ESCO introduces energy saving equipment at no cost to the customer, applying a shared savings contract according to which the energy saving effects obtained by the new equipment are shared between the ESCO and a cooperating company. In addition to installing energy saving equipment at the production sites of its business partners, Hitachi provides a complete range of services, such as guarantee of energy saving values and post-installation maintenance.

At the plant, introduction of a displacement air conditioning system has resulted in a comfortable operation space and an estimated 90% reduction in the amount of power required for existing air conditioning systems.

Furthermore, a process for installing the steam turbines a flexible heat and power supply system is established to suit the requirements from the plant's utilities (electricity and steam) to match the climate and production planning, resulting in more efficient production.

It is expected that the plant's total volume of energy consumption is expected to decrease by approximately 9.3%



Concept of shared savings ESCO business

**Gas turbine cogeneration system**

Gas turbine package   Exhaust gas boiler

**Displacement air conditioning system**

Ordinary air conditioning fans   New fans

**Results**

- Annual saving amount of energy consumption about 2,280 kL/year of crude oil (9%)
- Annual reduction of CO<sub>2</sub> emission about 4,650 ton-CO<sub>2</sub>/year (6%)

Examples of ESCO project