

**Overseas version simulation software that contributes to the prevention of global warming.**

• U.S. Patent No. US 8,396,605 B2

*Energy simulation Software*  
***Enepro21*** ***World Edition***

**Energy Simulation Software of EIE can reduce Carbon Dioxide (CO<sub>2</sub>) emission to air by optimizing energy efficiency.**

**Basic software for building smart energy networks**



**E.I. Engineering Co., Ltd.**

# EIE Core business (consulting and software licensing)

*Enepro21*

EIE provides consulting services and licenses the general purpose simulation software listed below.

Effective system design

Reproduction and analysis  
of the current operation

Optimal operating support

Power Generation

District facilities,  
Computer centers, Factories

Proper distribution of Energy

Effective distribution of unused energy

Renewable energy,  
Solar power, Solar heating

**Energy  
Simulation  
technology**

Software for Licensing

Energy Simulation Software  
*Enepro21*WE  
World Edition

*Enepro21*multi

EPS 21  
Energy Prediction System

Optimal Operation Guide  
*Enepro21*  
EXPERT

Supporting information/material  
Enepro21 data base

Over 8,000 Equipment performance data Enepro21 How-to video

①EIE is currently licensing **Enepro21** to the following customers.

**Construction, Utility, Planning, Supplier and Universities are benefiting from result of Enepro21's analysis and obtained significant savings.**

- Nihon Sekkei.INC. \* • NIKKEN SEKKEI LTD • Kanden Energy Solution Co., Inc.
- International Petroleum Development Co., Ltd. \* • Tokyo Gas Co., Ltd. • Tokyo Gas Engineering Solutions Co., Ltd.,
- Kyudenko \* • Toho Gas Co., Ltd. \* • OSAKA GAS CO.,Ltd. • Daigas energy • Tokyo Heat Supply
- Mitsubishi Electric CO.,Ltd. (Advanced Technology R&D Center) • Takenaka Co., Ltd.
- Shinjuku Minami Energy Service (JR Tokai) • Shibaura Institute of Technology \* • Yokohama National University \*
- Kogakuin University \* Use multiple

## ②Consulting experience

**Power generation equipment**

①CCPP: **1,705,000kW**

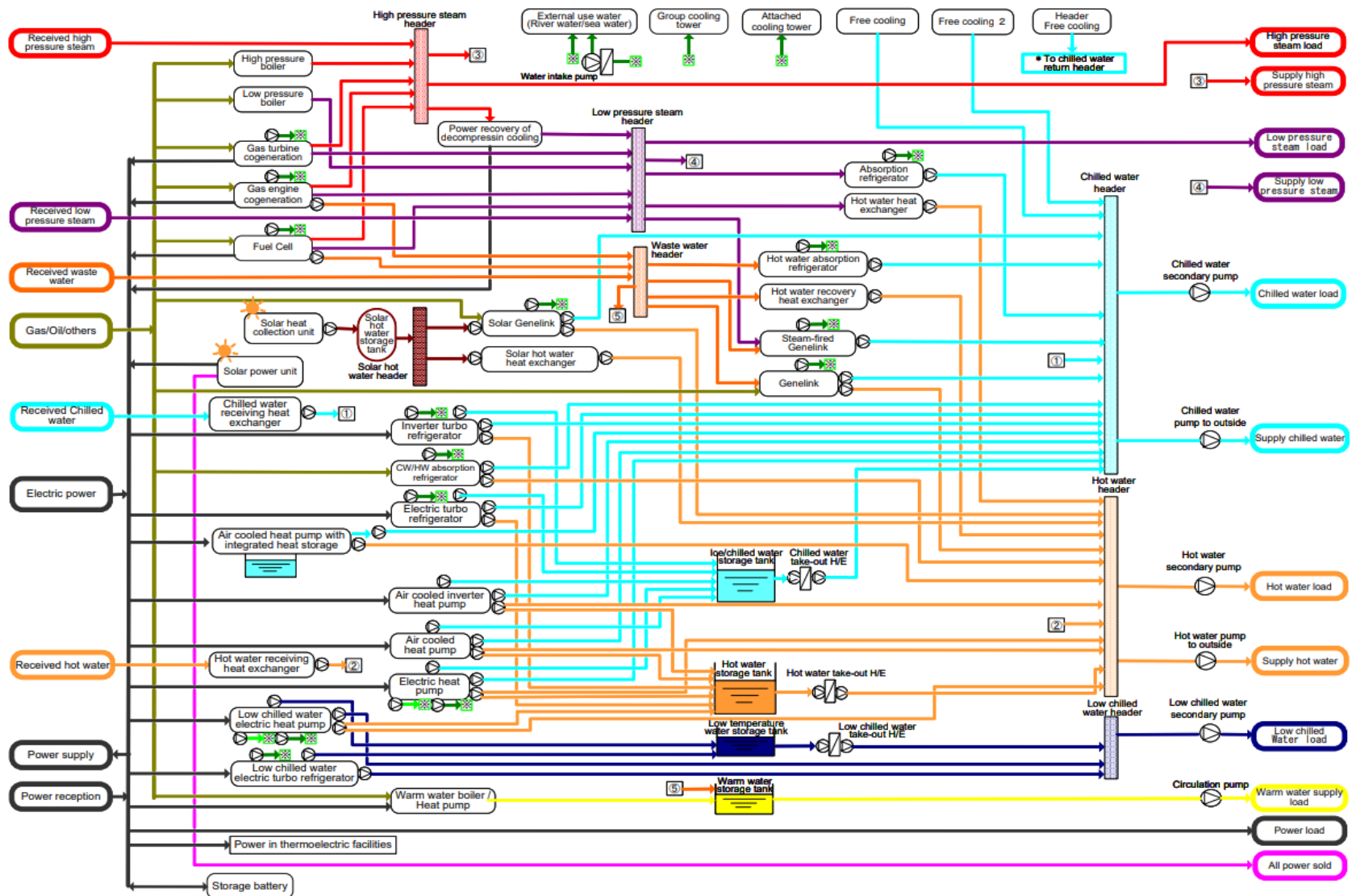
②Gas turbine cogeneration: **441,400kW**

③ Gas engine cogeneration: **591,400kW**

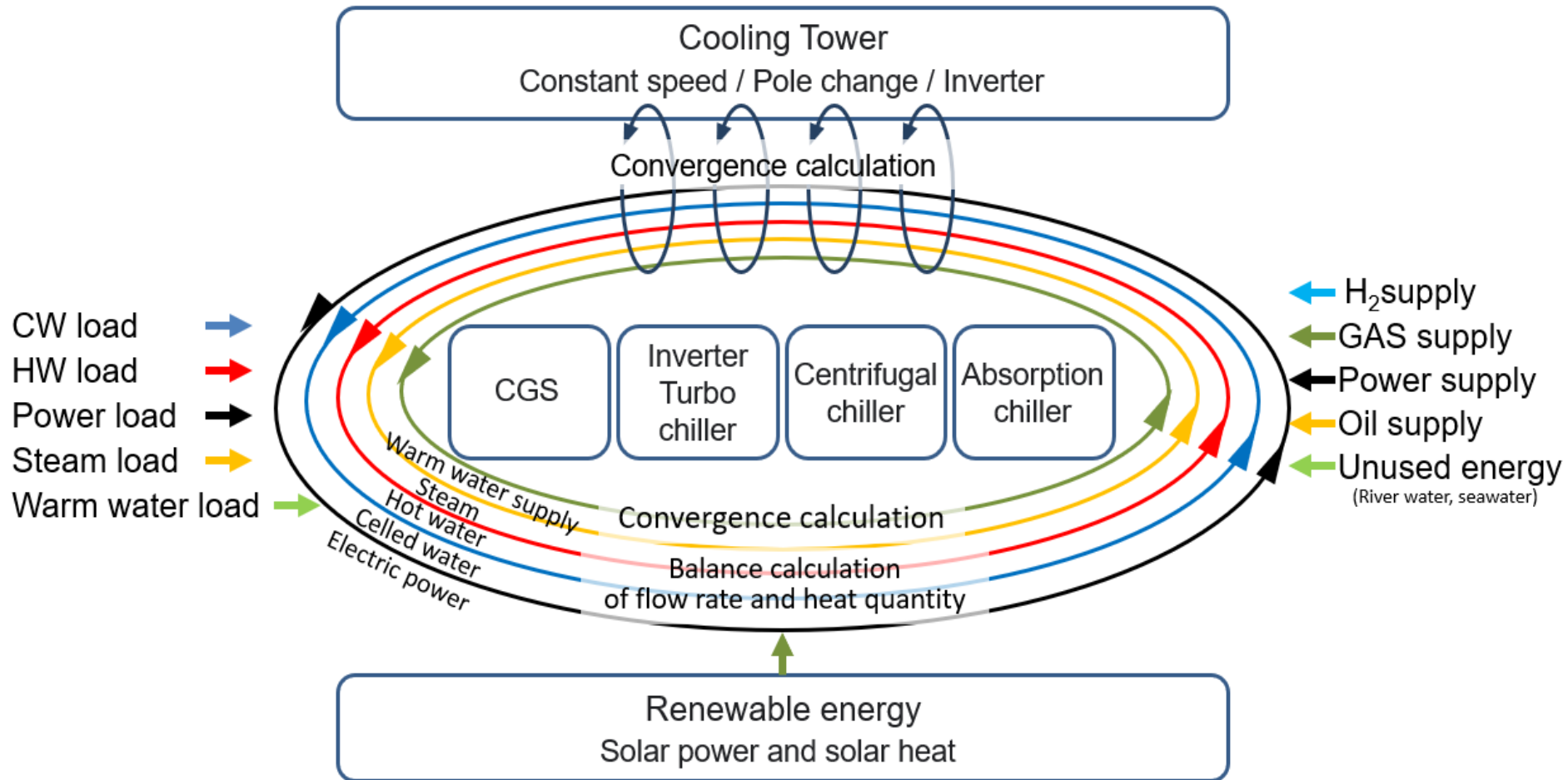
**Energy saving and cost saving for district heating and cooling,  
individual buildings, hospitals, hotels, factories, industrial parks, etc.  
Consulting experience Refrigerated ton base: **681,200RT****

- **Enepro21** is a general-purpose simulation software for heat source facility and can be usable all over the world.
  - The language of the software is written in English.
  - The unit consists of SI units, which are international units common throughout the world.
  - Solar power generation and solar heat simulations can be used in any country by setting the time difference from Universal Time (UTC).
- To meet the complex utility costs around the world, the “Detailed Utility Consumption List” output outputs 365 days of hourly utility consumption in Excel format.  
You can freely calculate the cost and environmental load.
- **Enepro21** can be used to design and analyze various centralized energy facilities such as power generation facilities (CCPP, GT, GE, fuel cells, storage batteries), renewable energy (solar energy, solar heat utilization).
- **Enepro21** can reproduce the actual operation results of the existing facility within error rang of 1to 2 % per year.  
(Accurately reproduce the operating state by making full use of convergence calculation to balance the power, heat and flow rate)

# Standard model flow of Enepro21 World Edition



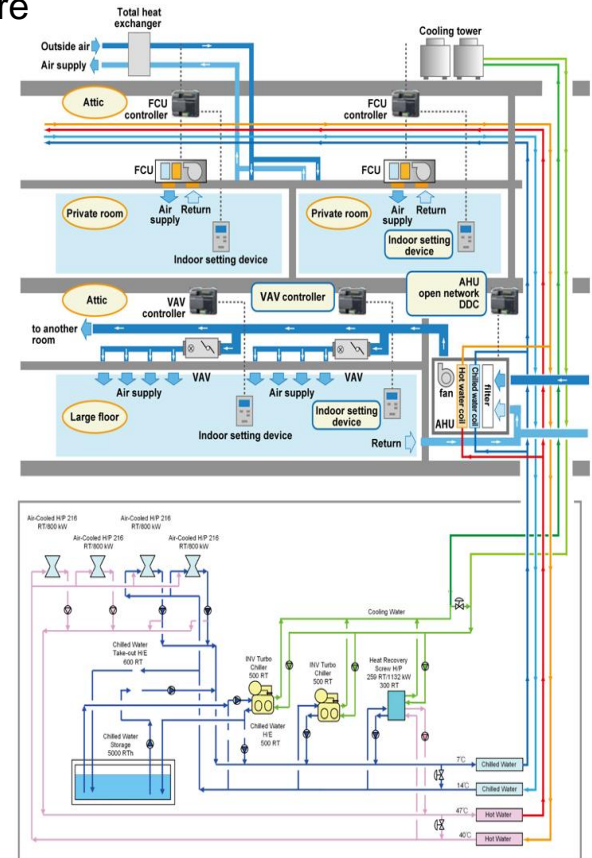
A surplus solar power from the nearby generator can be collected and utilized.



# Relationship between building air-conditioning system and heat source system (HVAC)

- The control results of temperature, humidity and outside air ventilation by the air conditioning system in the building side are summarized in the required energy amount on the building side and the temperature difference of the heat medium.
- After all, under the condition of the linked temperature difference between inlet and outlet of the heat medium, the requirement of energy for the building must be sent by the heat medium to the building side from the heat source as to be less cost and CO<sub>2</sub> minimum.
- Thus, "building side air conditioning system" and "heat source system" can be designed and analyzed separately under the conditions of the heat medium.
- 「EnergyPlus」 software which is used worldwide is recommended for the calculation of the building side for heat load calculation. On the other hand, the energy consumption and carbon dioxide (CO<sub>2</sub>) production of the heat source system are greatly affected by many factors such as the temperature of the cooling water in the cooling tower, the control method of the pump, the supply temperature of the heat medium and the temperature difference of the heat medium. **Enepro21 World Edition**, a general-purpose simulation software, has been successfully used in Japan and is the best simulation software for designing and analyzing heat source facility.

Building air conditioning system



Heat source system



- Accurately reproduce the annual operation status of existing facility (error range of 1to2%)
- Enepro21 World Edition allows you to accurately calculate and compare operating costs and carbon dioxide (CO<sub>2</sub>) emissions when considering how to operate an existing facility or renew an existing facility.

## Step-1

Suggestion of the operation improvement plan by changing the operation conditions.  
(due to changes in operational parameters)

- Calculate the effect of energy saving and cost reduction by changing the various operation parameters, the priority order of operation of equipment and operation time period of cogeneration unit
- Calculate the cost saving and CO<sub>2</sub> reduction by changing the operation load and parameter of equipment

Analysis of equipment performance

Select the optimum case from the comparison table

## Step-2

Study of the countermeasures for energy/cost saving and Carbon Dioxide (CO<sub>2</sub>) reduction by the small investment.

- Introduce the inverter pump, free cooling and pump with excess flow rate etc.

## Step-3

Propose the energy/cost saving and Carbon Dioxide (CO<sub>2</sub>) reduction by adding the equipment and/or optimizing the facility

- Employ the new equipment such as cogeneration + Genelink, heat accumulation equipment and reusable energy
- Propose the optimized renewal plan by considering the future load forecast and energy cost.



## Enepro21 World Edition License Overview

Provision of the reliable information  
and the consulting service

Accurate and fast calculation  
Easy to use



License



Reliable / Provision of information

Web  Utilization data

Equipment performance data

Vast data of over 8,000 units are collected  
from various users

Customer

Accumulation of  
data and know-how



Accurately reproduce  
the annual operation status of the existing facility

Prompt and reliable consulting

Case files



- If you need to consider a newly proposed facility, load the case file for the previously considered facility. By substituting the information and load of the proposed facility and new equipment, you can easily and quickly consider the newly proposed facility.
- Several engineers, proposing their ideas, can construct a system of the new proposed facility together based on the common case file.
- Until the adopted equipment data is obtained, the simulation study can be done in advance by downloading the similar equipment performance data from Enepeo21 data base.
- The hourly calculation is done instantly, and the annual calculation result can be quickly calculated, so you can make various studies under different conditions.
- Creating Reports, graphs, and forms is simple and easy by exporting the data to Excel.
- There is a help function for each open screen, and the calculation formula is also described, so you can easily understand the contents.

- Warnings to prevent erroneous calculations:
  - Outlet temperature of the equipment
  - Duplicated equipment
  - The variance of the temperature of the equipment
- Useful functions
  - Enthalpy input (pressure input MPaG)
  - Calculation of pump capacity and pump efficiency
- The equipment data can be shared among the users.
- For setting priority equipment:  
the balance calculation is performed with consideration of the flow rate and the amount of heat to start only the number of equipment required.
- Enepro21 automatically calculates the number of equipment to drive.  
And you can make accurate corrections from the saved records.

## Content

### [4.3 Gas Engine cogenerator](#)

#### [4.3.1 Model System diagram](#)

#### [4.3.2 Related devices](#)

#### [4.3.3 Data input- "Performance · Capacity · number · Fuel etc."](#)

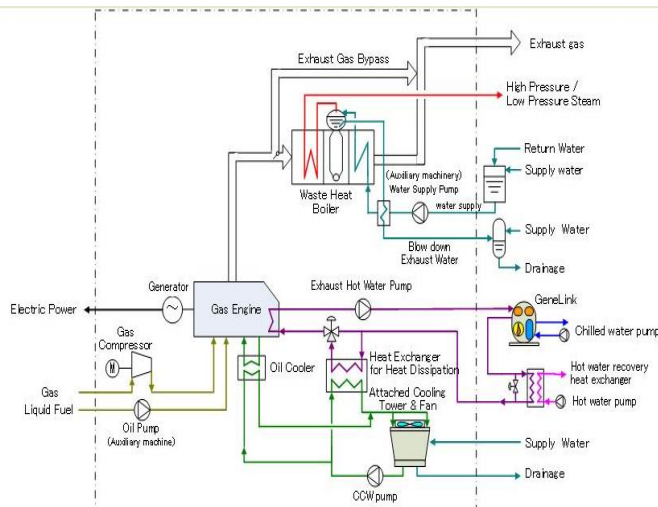
#### [4.3.4 Data input- "Auxiliary power consumption"](#)

#### [4.3.5 Data input- "Cooling tower, etc."](#)

#### [4.3.6 Calculation expression](#)

## 4.3 Gas Engine cogenerator

### 4.3.1 Model System diagram



#### 4.3.6 Calculation expression

##### 1) Fuel consumption

From Expression 4.3.2

$$\text{Fuel consumption [Nm}^3\text{/h]} = \frac{\text{kW [kW]} \times 3.6 \text{ [MJ/kWh]}}{\text{Lower fuel heating value [MJ/Nm}^3\text{]} \times \text{kW [\%]}} \times 100$$

Expression 4.3.9

##### 2) Actual vaporization amount of waste heat boiler

Combining Expression 4.3.2, Expression 4.3.3, and Expression 4.3.6, the rated actual vaporization amount of the waste heat boiler can be obtained as follows:

$$\begin{aligned} \text{Actual vaporization amount [kg/h]} &= \frac{\text{kW [kW]} \times 3600 \text{ [s/kWh]}}{\Delta H_g \text{ [kJ/kg]} + \Delta H_b \text{ [kJ/kg]} \times \text{Blow rate [\%]} / 100} \\ &\times \frac{\text{Steam heat recovery rate [\%]}}{\text{kW [\%]}} \end{aligned}$$

Expression 4.3.10

where

$$\Delta H_g \text{ [kJ/kg]} = \text{Steam enthalpy [kJ/kg]} - \text{water supply enthalpy [kJ/kg]}$$

$$\Delta H_b \text{ [kJ/kg]} = \text{Blowdown water enthalpy [kJ/kg]} - \text{water supply enthalpy [kJ/kg]}$$

At a certain electricity generation output (kW), the power generation efficiency and the waste hot water heat recovery ratio can be determined from the load factor and the performance data.

##### 3) First, the fuel consumption (Nm<sup>3</sup>/h) is determined by Expression 4.3.9, and the amount of heat recovery from waste hot water is calculated by the following expression.

Amount of heat recovery from waste hot water First, the fuel consumption (Nm<sup>3</sup>/h) is determined by Expression 4.3.9, and the amount of heat recovery from waste hot water is calculated by the following expression.

$$\begin{aligned} \text{First, the fuel consumption (Nm}^3\text{/h)} &\text{ is determined by Expression 4.3.9, and the amount of heat recovery from waste hot water is calculated by the following expression. [MJ/h]} \\ &= \text{Lower fuel heating value [MJ/Nm}^3\text{]} \times \text{Fuel consumption [Nm}^3\text{/h]} \\ &\times \frac{\text{Waste HW heat recovery ratio [\%]}}{100} \end{aligned}$$

Expression 4.3.11

##### 4) Waste heat

The waste heat has to be calculated to determine the flow rate of the cooling water pump and the power consumption of the cooling tower fan.

Gas engine waste heat can be calculated by Expression 4.3.11 as follows:

- Enhancement of learning function by using the operation video with sample case of Enepro21  
The operation videos as listed below have been prepared for the users to use the simulation function of Enepro21 effectively.

The users can learn by the videos over and over again at any time. time.

- From startup / load creation to calculation execution for those who use Enepro21 for the first time

- Basics: 16 thematic training videos

- |  |  |
|--|--|
| ① Program Configuration and Project File   | ② Example of Creating Thermoelectric Loads Based on the Heat Load Basic Unit |
| ③ Example of Creating Thermoelectric Loads Based on the Measured Data (Excel)    |  |
| ④ Importing / Modifying / Enabling Thermoelectric Load Data                      | ⑤ Basic Condition Setting  |
| ⑥ Creating System Configuration and Use of Equipment Performance Data Collection |  |
| ⑦ Pump Power Calculation and Control Method Setting                              | ⑧ Equipment Model Setting for a System with CGS                              |
| ⑨ Equipment Model Setting for a System with Heat Storage                         | ⑩ Operation Plan Setting and Convenient Functions                            |
| ⑪ Calculation Execution and Output of the System with CGS                        | ⑫ Calculation Execution and Output of the system with Heat Storage           |
| ⑬ Example of Comparative Study of Operating Methods of the Systems with CGS      |  |
| ⑭ Secondary Pump System Setting  | ⑮ Summary of Convenient Functions  |
| ⑯ Basic Concept of Chilled Water Balance   |  |

- Advanced version: Video of simulation example incorporating Know-How of EIE

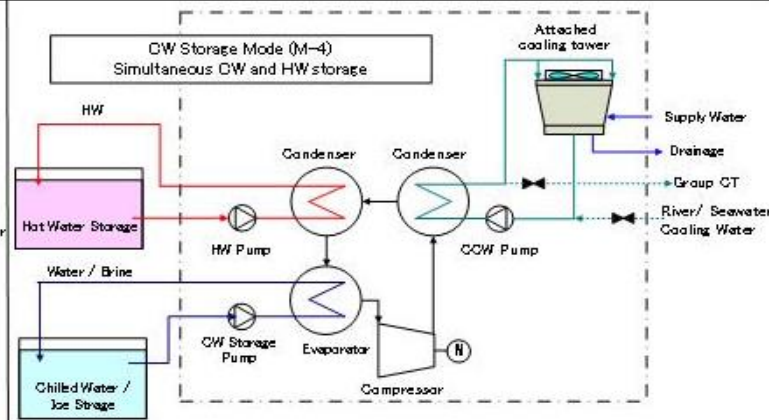
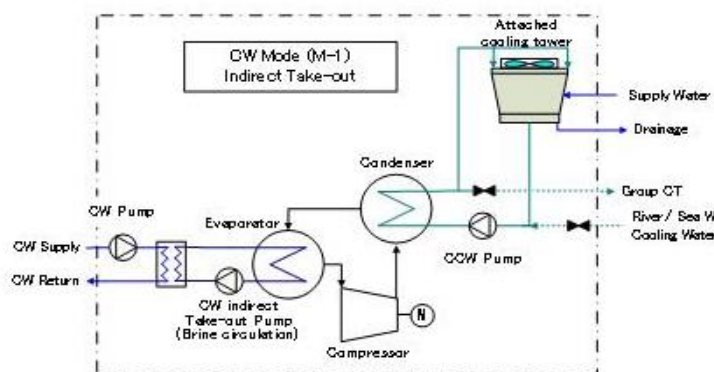
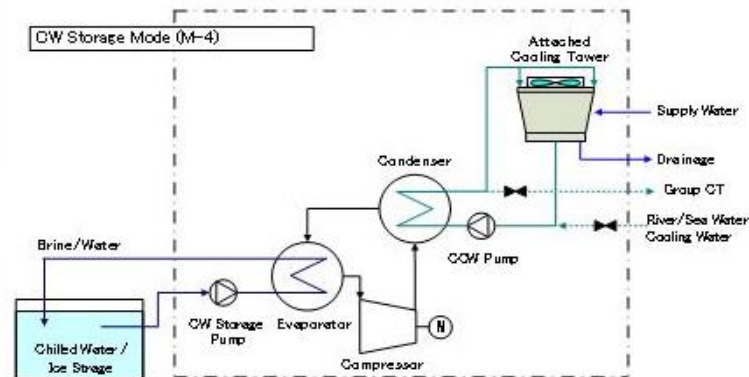
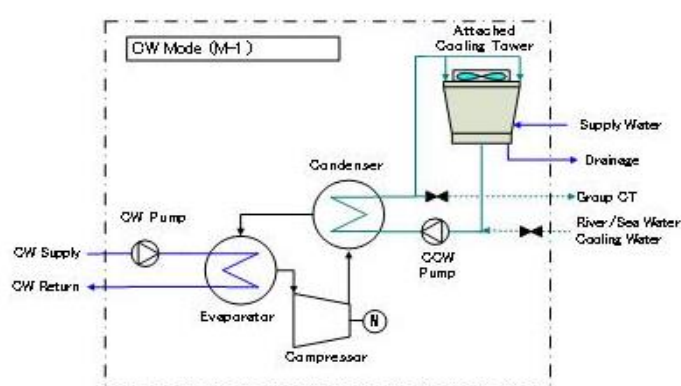
- |   |   |
|---|---|
| ① Settings of Solar Power Generation System   | ② Settings of Solar Heat Utilization System |
| ③ Settings of Tandem Type Turbo Chiller   | ④ Settings of Free Cooling System           |
| ⑤ Trial Calculation of the Primary Energy Conversion Coefficient for Cold and Hot                                       |   |
| ⑥ Trial calculation of the Primary Energy Conversion Coefficient for Cold and Hot for the System Using CGS Exhaust Heat |   |

# Automatic connection of device data related to the main equipment *Enepro21*

## Equipment data

The related equipment within the dotted line are automatically connected.

- Related pumps ( Chilled water pump, cooling water pump, heat storage pump, hot water pump, etc.)
- Attached cooling tower • Heat storage tank • Heat exchanger



# Equipment performance data

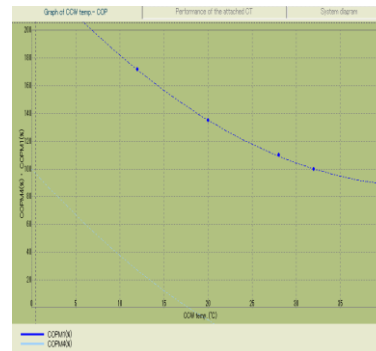
(Data is automatically entered by downloading from the equipment database)

## Equipment performance data

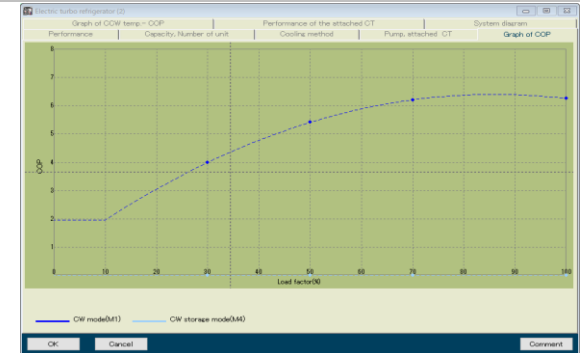
- ① The equipment characteristics (COP) are created by a regression equation by inputting the numerical values of four load factors at the reference cooling water temperature and the reference chilled water outlet temperature.
- ② Equipment characteristics are automatically corrected by cooling water temperature correction, chilled water outlet temperature correction, cooling water flow rate correction, and aging correction. (To accurately reproduce the actual operation)

$$COP(E) = COP \times \frac{COP\%}{100} \times \frac{COP\%2}{100} \times \frac{COP\%3}{100} \times \frac{COP\%4}{100}$$

COP (E) Corrected COP used for energy calculation  
 COP COP determined by load factor(cooling water reference temperature)  
 COP% [%] COP correction by cooling water temperature  
 COP% 2 [%] COP correction by chilled water outlet temperature  
 COP% 3 [%] COP correction due to aging  
 COP% 4 [%] COP correction by cooling water flow rate



Cooling water temperature correction curve



☒ Correct COP based on the CW outlet temp.

COP%2(%) 100 115  
 Outlet temp. of CW(°C) 7 (Base temp.) 12  
 Correctable lower limit of temp.(°C) 5 12  
 ※ It is considered that COP%2 does not change out of the applicable temp. range.

☒ Correct COP based on the CCW flow rate

COP%4(%) [Arbitrary point] [Rated point]  
 94.5 100  
 CCW flow rate(%) 70 100  
 Correctable lower limit of CCW flow rate(%) 50

☒ Correct COP by arbitrary ratio

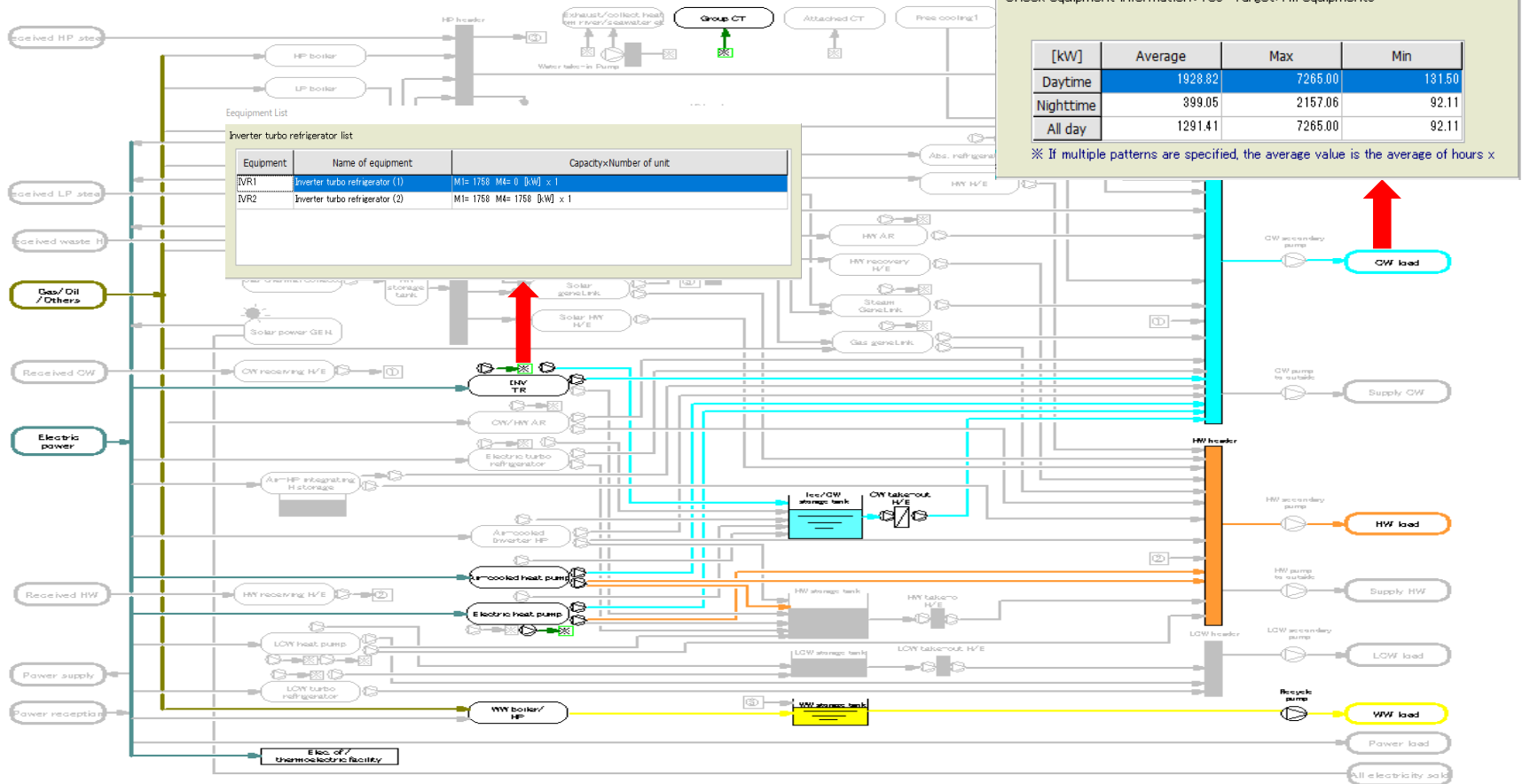
COP%3(%) 100

**【Note】**  
 Corrected-COP = COP × COP%1/100 × COP%2/100 × COP%3/100 × COP%4/100  
 COP : COP determined by load factor.  
 COP%1 : COP correction based on the temp. of CCW (outside air)  
 COP%2 : COP correction based on the CW outlet temp.  
 COP%3 : COP correction by arbitrary ratio  
 COP%4 : COP correction based on the CCW flow rate



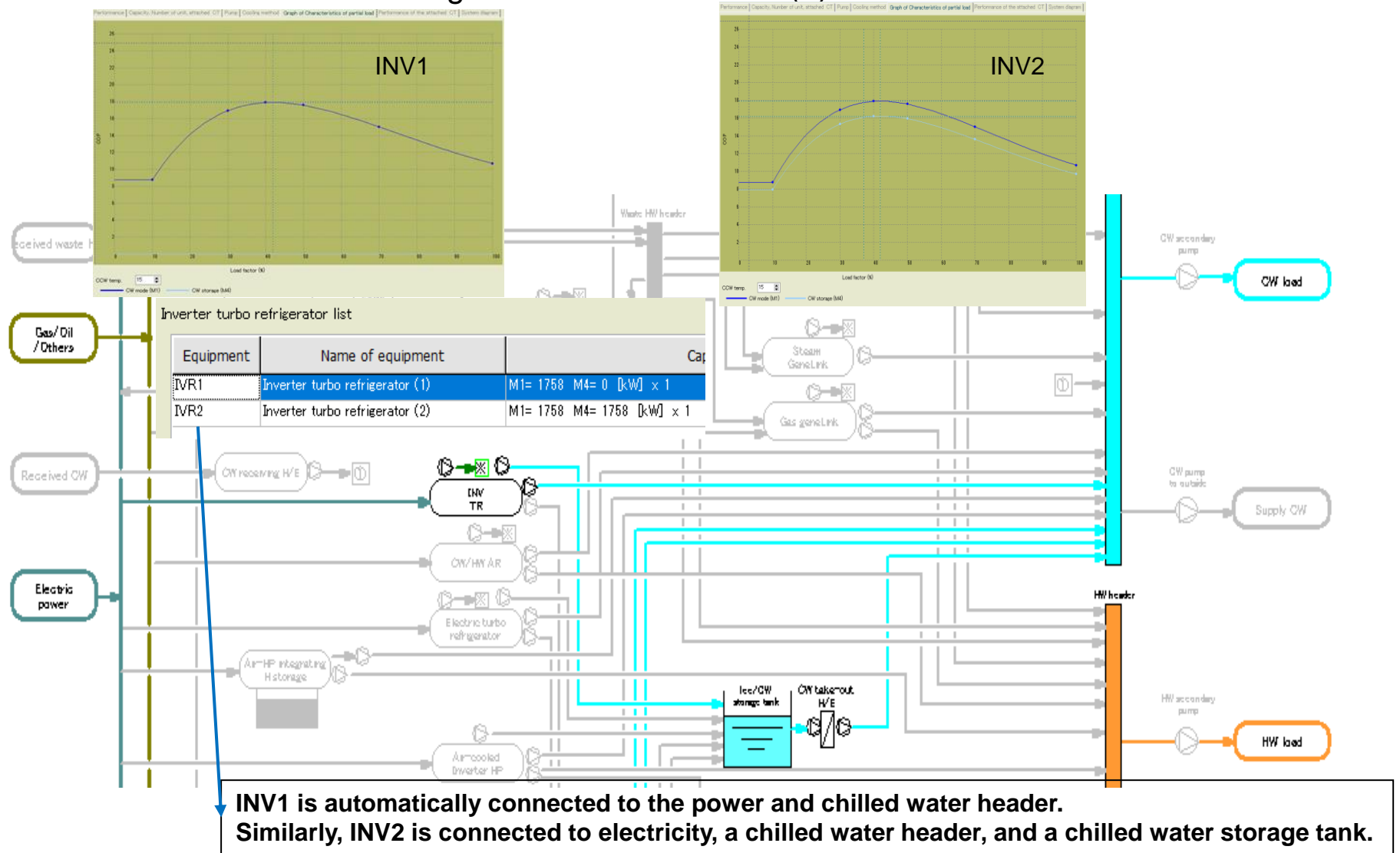
# System construction procedure (with heat load connected)

- The data of the download device can be read into the system flow, and multiple system that matches the load can be built. The optimum solution can be easily obtained by comparing the systems.

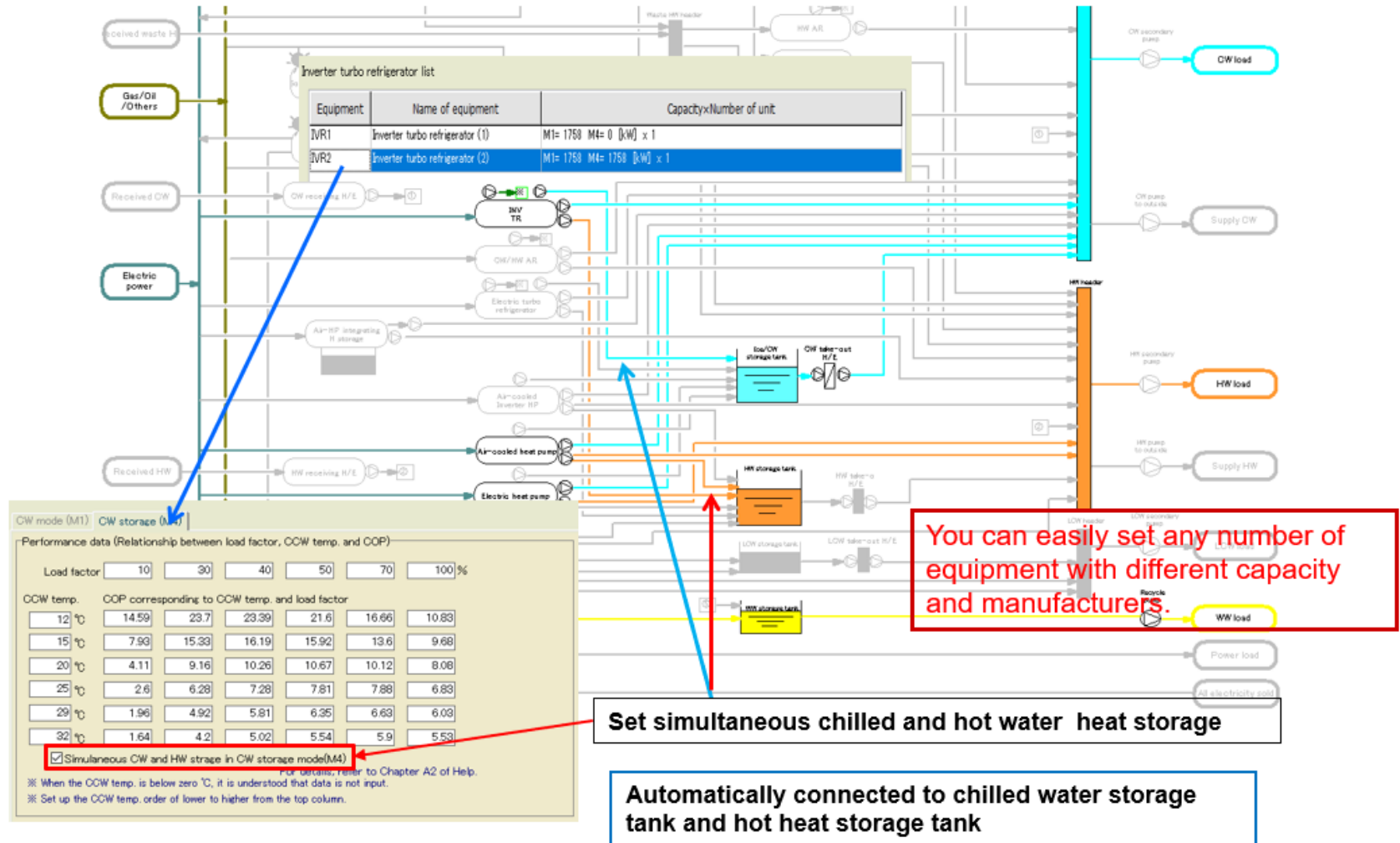


# Example of reading the INV turbo chiller from the database into the system *Enepro21*

- Reading the chilled water dedicated inverter turbo chiller (1) and chilled water heat storage inverter turbo chiller (2)



# Setting of simultaneous chilled and hot heat storage of inverter turbo chiller *Enepro21*



# *Engineering for Tomorrow*

with Enepro21World Edition



**E.I. Engineering Co., Ltd.**