

Research on the use of public cloud

- Implementing a customer facility operation planning tool on the cloud -



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1. Construction of customer service tool for utility company on public cloud

- Use of a public cloud seems to be a valuable measure to build a system for information services provided to a large number of customers **AT LOW COST**.
 - There are not a lot of public information on the performance and cost of the cloud to consider the business use of the cloud.
- ➔ We tried constructing a web-based optimal operation planning tool (OPT-ADOPT) on a public cloud as a case study.

- Information we want to collect about use of public cloud system
- ✓ **HOW** and **HOW MUCH** we can operate
 - ✓ **HOW FAST** we can calculate optimal problems

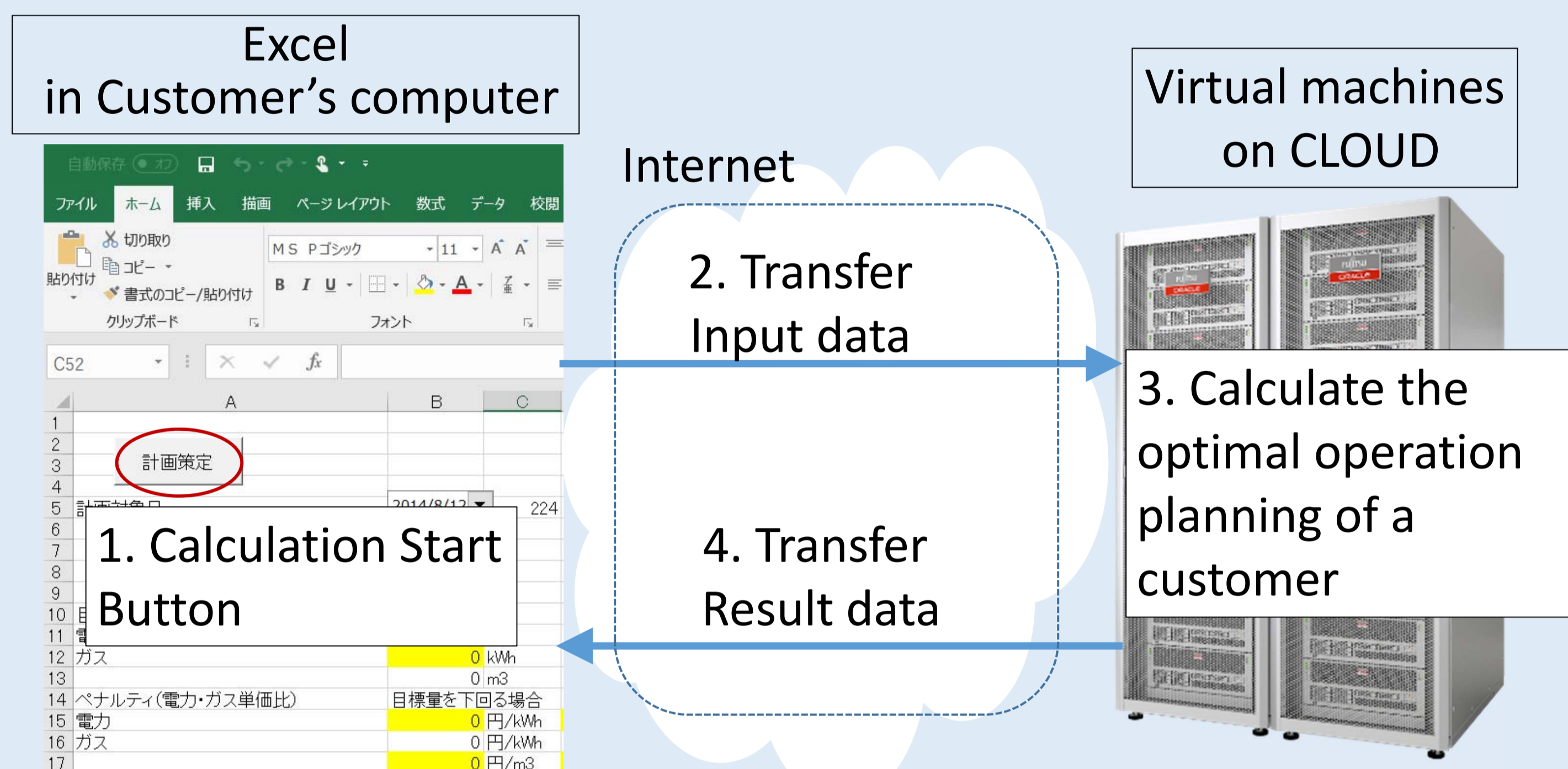


Fig.1 Procedure of signal and data transfer on Opt-adopt on cloud system

2. Benefits of use of cloud

- Flexible performance system
Utilization fee of this public cloud is proportional to the number of calculation of optimal operation planning.
- ➔ By using monitoring program of public cloud operator, we developed **flexible system** that can **adjust the number of virtual machines according to the number of calculation requests**.
- ➔ More than 1000 requests of optimal operation planning can be calculated in parallel.
- “Managed services” by cloud operator company are available.
 - Operation management of cloud system (response to OS vulnerability, etc.)
 - Automatic implementation of measures against hardware errors. (Redundant, backup, automatic recovery, etc.)

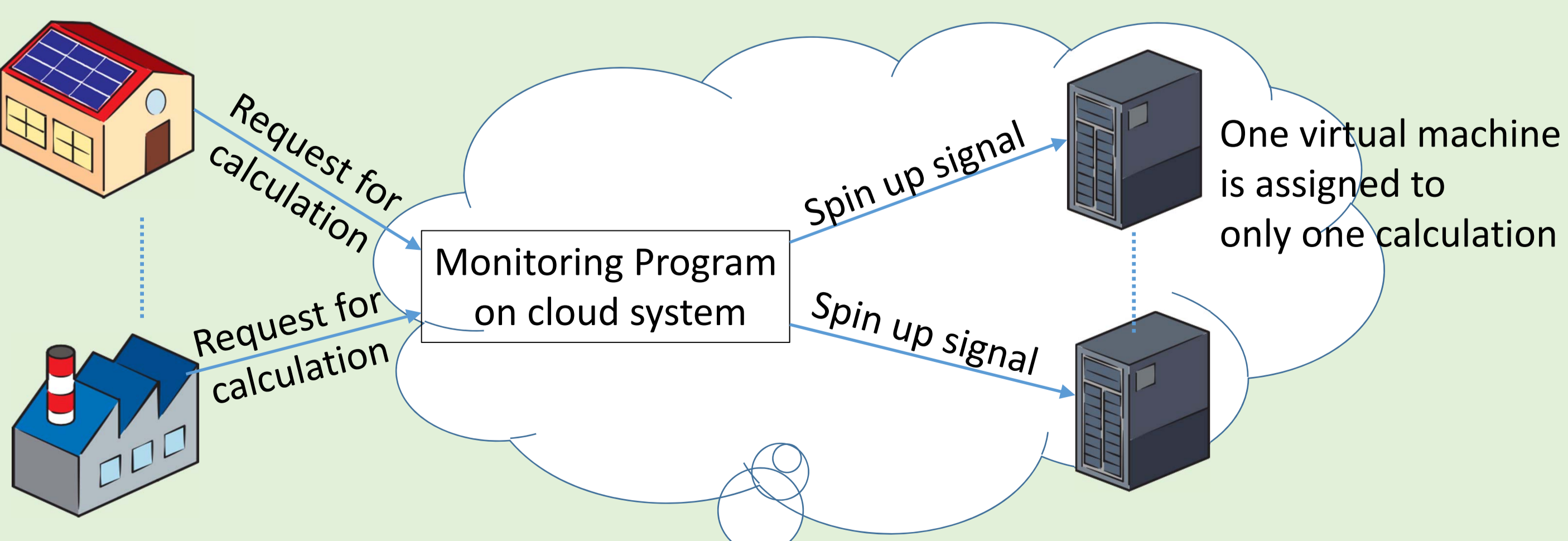


Fig.2 Monitoring program automatically spins up a virtual machine of cloud system in response to a request of calculation from an OPT-ADOPT user

3. Function of OPT-ADOPT

OPT-ADOPT is an optimal operation planning tool for customer energy facilities.

- Target of OPT-ADOPT

- ✓ Consumers who have their Combined Heat & Power (CHP), air conditioners using exhausted heat from CHP, and electric refrigerators
- ✓ Operators of microgrids

- Function

- ✓ Supply daily and annual solution about optimal operation planning of energy system and facilities

Facility	Electric Power consumption [kW]	Daily freq.	Time of facility available																							
			0	1	2	3	4	5	...	19	20	21	22	23												
A	800⇒800⇒500	3	0	0	0	1	1	1	...	1	1	1	0	0												
B	400⇒200	...	1	1	1	1	1	1	...	1	1	1	1	1												
I	120⇒100	...	1	1	1	1	1	1	...	1	1	1	1	0												
J	100⇒100	...	1	1	1	1	1	1	...	1	1	1	1	1												
E	120	1	5	0	0	1	1	1	1	1	1	1	1	1	0	0										
F	100	2	3	0	1	1	1	1	0	1	1	1	1	1	1	0										

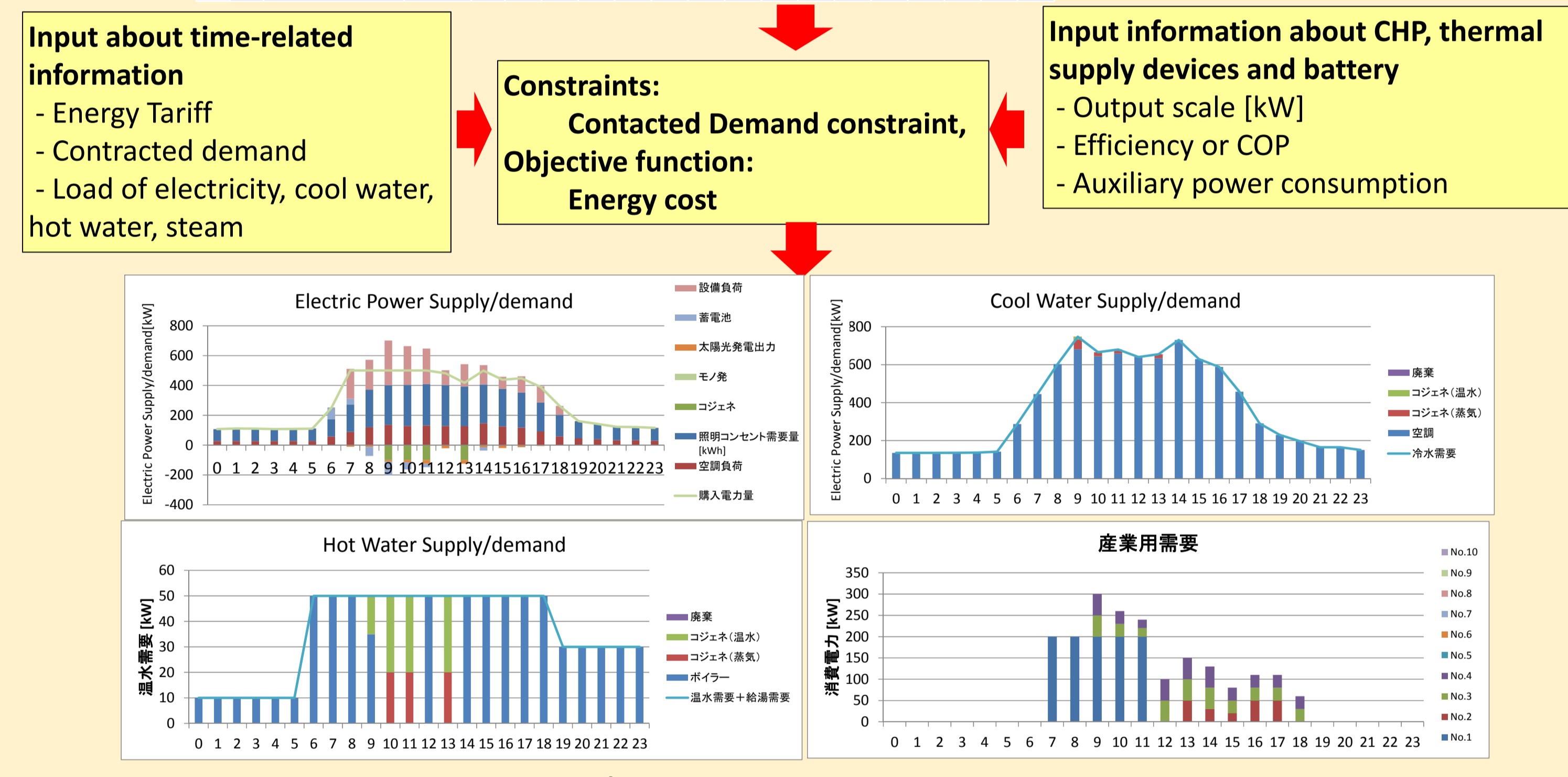


Fig.3 Input/Output example of OPT-ADOPT

4. Cost and performance test

Assumption:

- 1000 users send requests of calculation to cloud version OPT-ADOPT at the same time.
- 1000 users request same burden of calculation: daily operation planning of the same line-up of energy facilities.(Table 1)

Result:

- Average calculation time is 30 seconds. The differences of execution time depend on CPU spec differences of virtual machines.
- The cost of 1000 calculations is about 27 cents. Almost all cost is for the utilization of a virtual machine.(Table 2)

Table 1 Line-up of energy facilities

Facility	The number of units
CHP system	1 unit
Turbo refrigerators driven by electricity	3 units
Refrigerators driven by gas	3 units

Table 2 Breakdown of cost of 1000 calculations

Breakdown of cost	Qty.	Cost*
Utilization of virtual machines	30 sec	27 cent
spin up of virtual machine	1000 times	0.022 Cent
Input data upload to Server	2000 times	1.04 Cent
Result data download from Server	2000 times	0.08 Cent
Communication to cloud	10MB	0.13cent

* 1 JPY nearly equals 1 cent.

5. Concluded remarks

- Cloud-based optimal operation calculation tool for electric demand management of small scale industrial, commercial customers and microgrids was developed.
- The tool can calculate daily and annual optimal operation planning of energy system including CHP and thermal supply systems.
- We conducted performance test in the assumption that 1000 users send requests in parallel. Calculation time is about 30 seconds for daily operation planning (24 time-zones) of 7 units of energy facilities and it costs 27 cents.