Supplementary Explanation for Development of PCS with Output Control Function (5th Edition)

1st Edition: September 12, 2016

2nd Edition: November 12, 2018

(Addition of ECHONET Lite-compliant PCS with output control function)

3rd Edition: March 7, 2019

(Addition of (5) to "Technical Specifications for PCS with Output Control Function")

4th Edition: December 24, 2021

(Added examples of improvements made during development/operation and extended capacity conversion function)

5th Edition: April 19, 2024

(Addition of revised technical specifications for PCS with output control function in 2023/6)

Japan Electrical Manufacturers' Association

Table of Contents

1. Position of this document

This document is an explanatory document that supplements the following documents proposed at the March 4, 2015 (Heisei 27) Grid Working Group (METI) and the March 19, 2015 (Heisei 27) New Energy Subcommittee (New Energy Subcommittee), and describes more detailed contents for developing "PCS with Output Control Function":

- Technical specifications proposed in "Technical Specifications for PCS with Output Control Function
- Broadly defined PCS test method proposal" published on the JEMA website on September 9, 2015 (2015)

- Addition of additional specifications in Chapter 6 that "ECHONET Lite control-enabled PCS with output control function" should have to support the "ECHONET property proposal for making photovoltaic power generation systems VPP resources" reported by the ECHONET Lite WG at the 8th ERAB study meeting held in September 2018.
- At the Grid Working Group (METI) meeting held on February 28, 2023, revisions to the technical specifications for output control equipment associated with non-firm type connections were proposed.
- Additional specifications were added in Chapter 7 when corresponding to the revised technical specifications.
- Additional specifications were added to Chapter 7 in case of corresponding to the revised technical specifications of general transmission and distribution companies in June 2023.

(2) Related regulations and explanatory materials

Agency for Natural Resources and Energy Website

https://www.enecho.meti.go.jp/category/saving_and_new/saiene/grid/08_syuturyokuseigyo.html

Grid WG on 2/28/2023 Document 1-2 "Specifications of output control equipment for non-firm type connection."

https://www.meti.go.jp/shingikai/enecho/shoene_shinene/shin_energy/keito_wg/pdf/044_01_02.pdf

TEPCO Power Grid Homepage

Revision of Technical Specifications for PCS with Output Control Function, etc. (under 66kV) on June 30, 2023

https://www.tepco.co.jp/pg/consignment/access/outputcontrol.html#under66kv

*Technical specifications and transmission specifications for output control systems are published by each general transmission and distribution company.

JPEA/JEMA Home Page

Technical Specifications of Power Conditioner with Output Control (PCS)

JEMA： http://www.jema-net.or.jp/Japanese/res/dispersed/050.html#052

1. Partial control/increase/decrease in output

The expected behavior is to clip the upper limit of power generation in Figure 1. When the predetermined command fluctuation time (0 min, 30 min) arrives, the control command will change as shown in the blue dotted line.

The amount of power generated by the PCS at this time can be considered for two types of operation: the red line in Figure 1 and the green line in Figure 2.

Figure 2 generates less power than Figure 1 by the red shaded line.

Therefore, the operation of the red line in Figure 1 is the maximum amount of power generation and is the expected operation.

(This does not prohibit the operation in Fig. 2.)

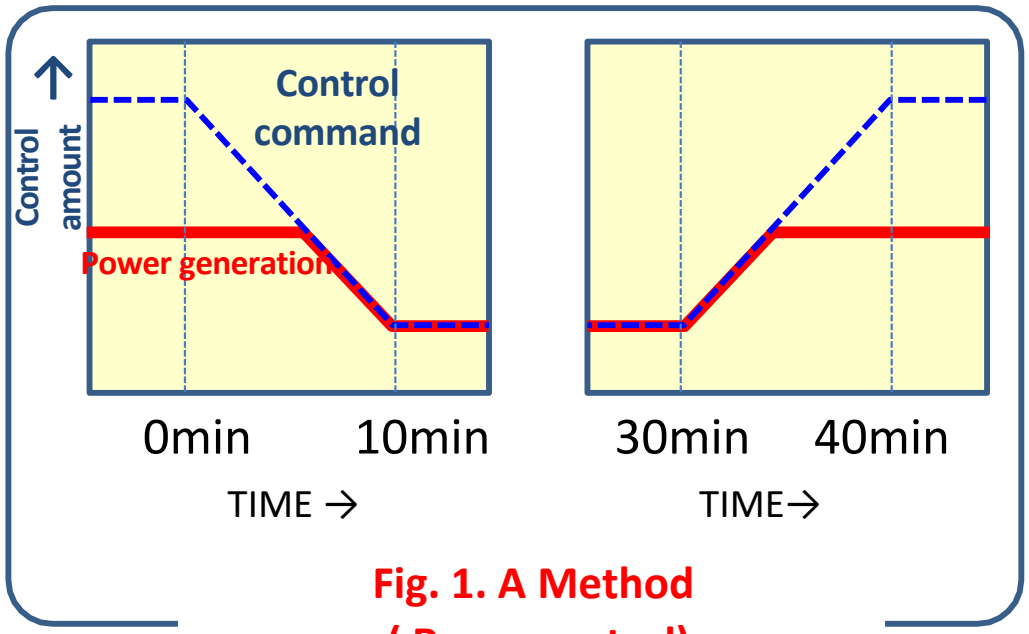


Fig. 1. A Method (Ramp control)

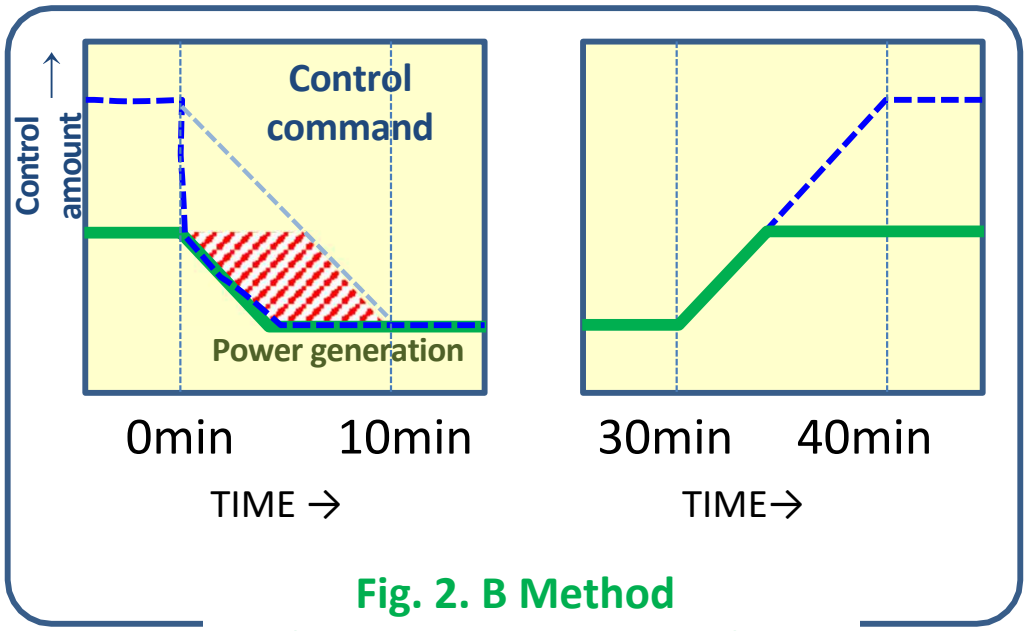


Fig. 2. B Method (Instantaneous control)

2. Partial control/control resolution

The broadly defined PCS receives schedule information in 1% increments.

Here, if the capacity authorized for the facility is smaller than the rated output of the PCS (limited by the rated output of the solar cells), scaling is required (Equation 1) for the control commands sent from the output controller to the narrowly defined PCS.

- Equation 1) Control command = schedule information (= output control value) x facility authorized capacity / PCS rated

In addition, the set values of these conversion factors need to be protected from being changed by end users.

The range of change in control commands from the output controller must be updated in steps finer than 10% of the facility's certified capacity to prevent abrupt changes in power generation.

In other words, the control constraints from the output controller to the narrowly-defined PCS,

(1) The control command update interval should be within 30 s at the maximum.

Or

(2) A control command change slope must be achieved by the narrowly-defined PCS.

is necessary.

3. -1 Partial control / Conversion function to contracted capacity

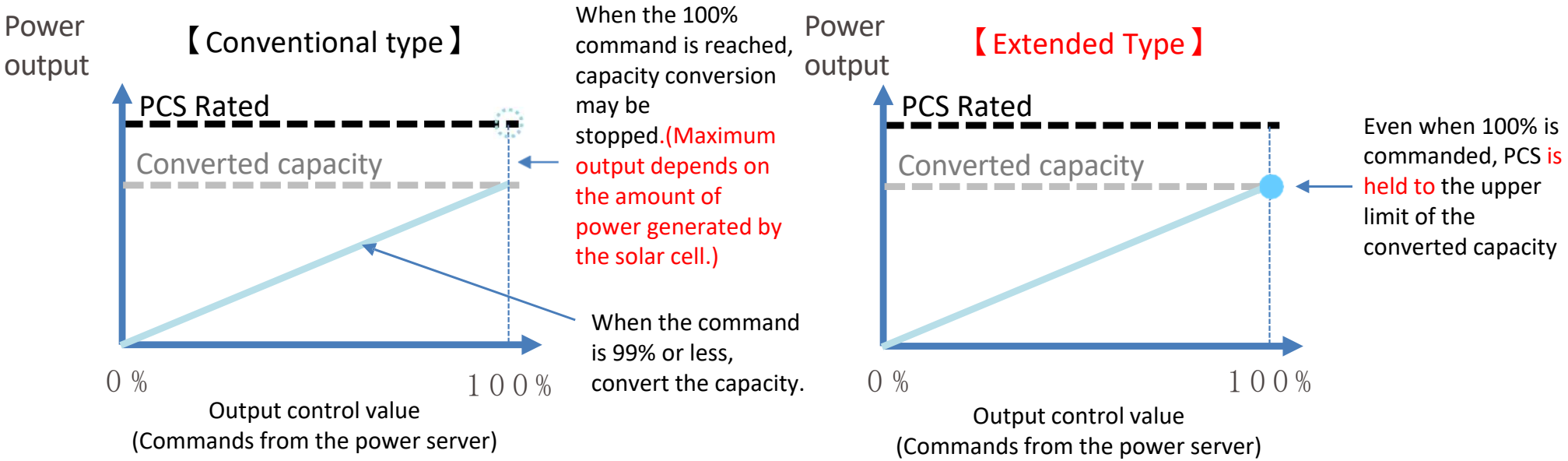
The calculation formula for equipment certification follows the description on the website of the Agency for Natural Resources and Energy.

Note that when a broadly defined PCS supports a power plant consisting of multiple PCSs, the calculation (Equation 2) must be done on a PCS-by-PCS basis as shown below.

- (Equation 2) Facility certified capacity = Σ (PCS rated output or the smaller of the solar cell rated output)

3. -2 Conversion function to contracted capacity Extended type (output limitation even when 100% is commanded)

In the contract capacity conversion function, " Extended type" is defined as the one in which the converted capacity is used as the output limit even when the output control value (= command value from the power server) is at 100%.



Explanation

Since the 100% command means no output control, those with a specification that stops capacity conversion (conventional type) and those with a specification that continues to convert capacity and limit output in any case are defined as "extended type" so that the contracted capacity will not change when the PCS is replaced, etc. This function is not a function to arbitrarily change the rated capacity of the PCS, but is used on a limited basis.

A different function that is often confused with the contract capacity conversion function is the constant clip function included in the upper limit clip function (additional specification: see Chapter 4),This function is a function to save the output of a facility that is not subject to output control and is less than 10 kW, so that when the facility is replaced with a PCS with a larger capacity than the original one, the output is available up to the capacity certified for the facility before the replacement, regardless of the power command.

4. -1 Reverse power flow prevention/prevention accuracy

Some other distributed power sources (fuel cells and products with storage batteries) require reverse power flow prevention control. To prevent interference even when these devices are installed together, a difference in target value settings is provided.

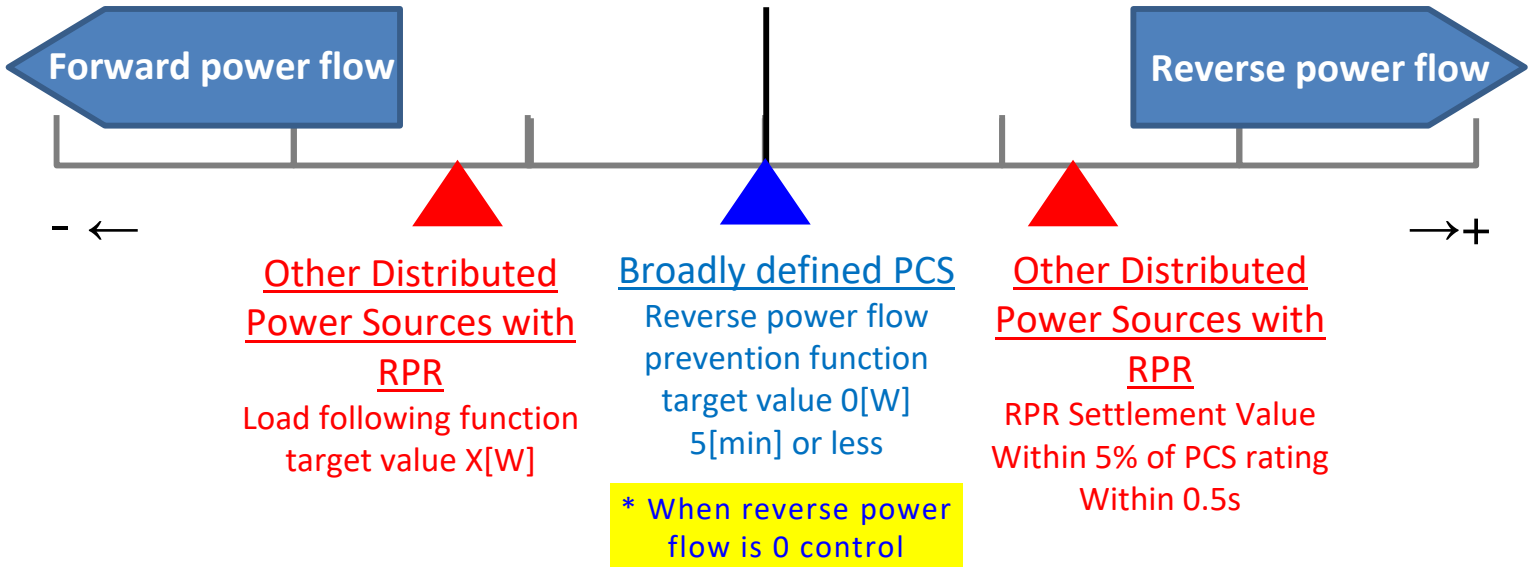
- Broadly defined PCS

Point of power flow 0W *In case of reverse power flow =0 control

- Other distributed power sources

Set on the forward power flow side

Therefore, the system basically expects operation in which solar and other renewable energy sources are prioritized for use. However, each manufacturer must take the utmost care regarding the stable operation of each device in combination. In addition, there may be cases where the amount of power generated among distributed power sources may be biased due to a mixture of operations that control reverse power flow below the output control value and other methods in accordance with the technical specification revision in June 2023. When introducing equipment with multiple specifications, it is necessary to pay attention to avoiding problems after the introduction, for example, by introducing equipment in a configuration that is less likely to cause problems, or by obtaining sufficient understanding from the power generation company.



4. -2 Reverse power flow prevention/prevention accuracy

The control accuracy of narrowly defined PCS is ±5% of the rated output power. This defines the control performance of the output power of the power conditioner. For reverse power flow prevention control, an error of ±5% is also expected. The accuracy of the measurement of the power at the receiving point affects the performance. The following performance is required by JET certification or interconnection agreements, so care must be taken in designing for error accuracy.

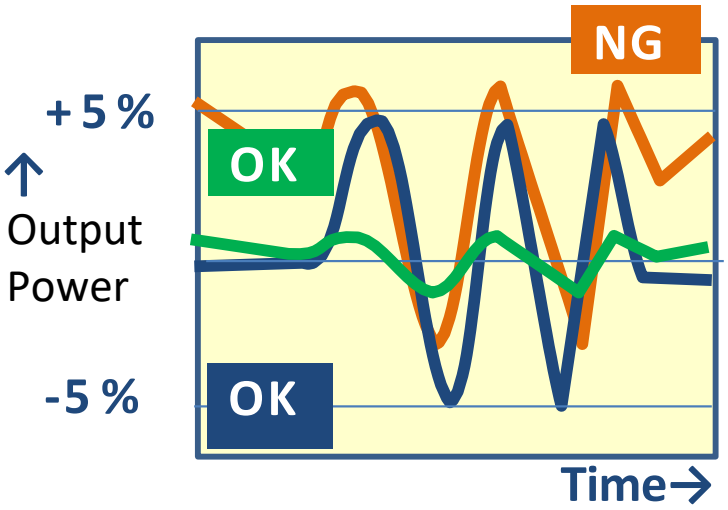


Fig. 1. Operation of narrowly defined PCS

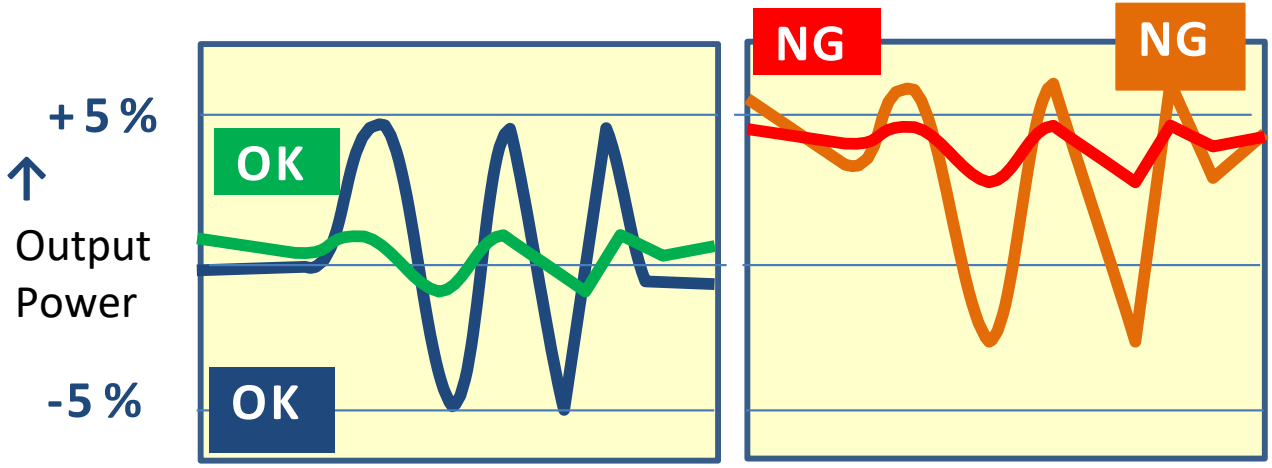


Fig. 2. Control operation of broad-defined PCS.

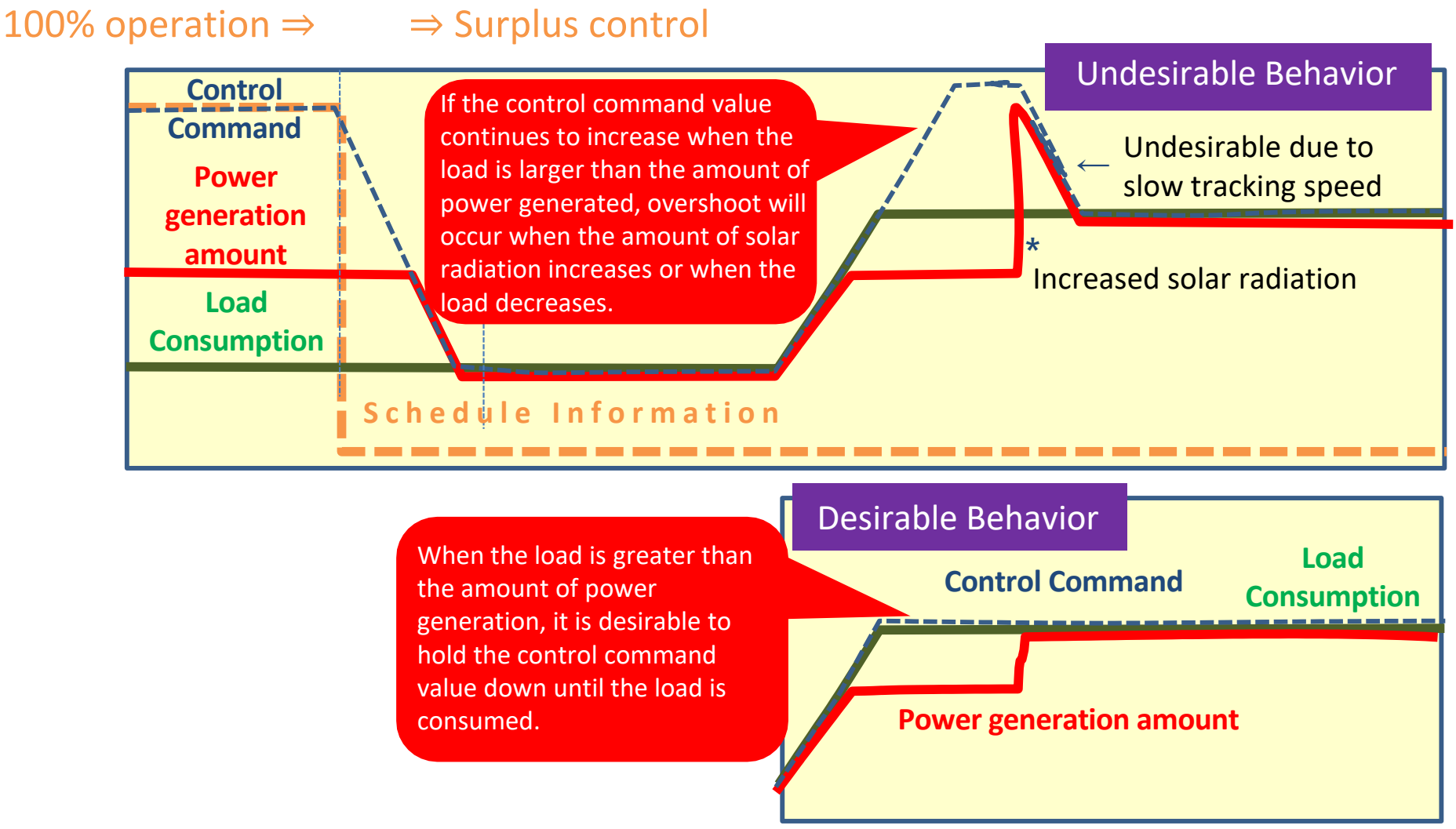
Avoid designing with biased errors.

Design with the aim of having an average error of 0.

The output control device does not shift the control command to the side of increasing power generation.

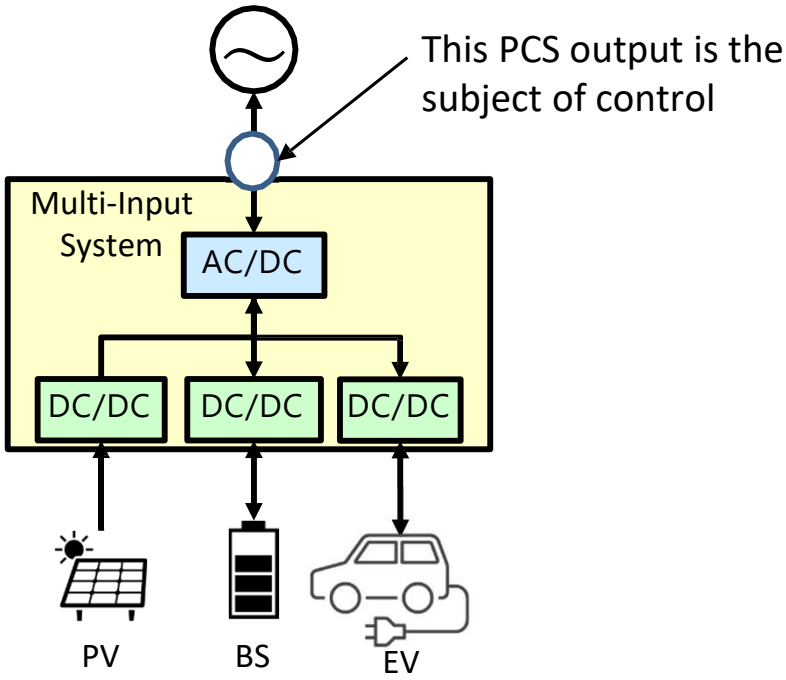
4. -3 Reverse Power Flow Prevention/Prevention Accuracy

The following restrictions occur in the control operation when it is designed simply. Note that the control command value must follow the load consumption or the control speed must operate at a high speed when following the load.



5. Output control in multiple DC input systems and multiple input systems

In multiple DC input systems (PV + BS, PV + EV) and multi-input systems, the PCS outputs a mixture of power generated by PV and discharged power from BS and EV. Therefore, it is necessary to control the PCS output, which is a combination of the power generated by the PV and the discharged power from the BS and EV, according to the power command.

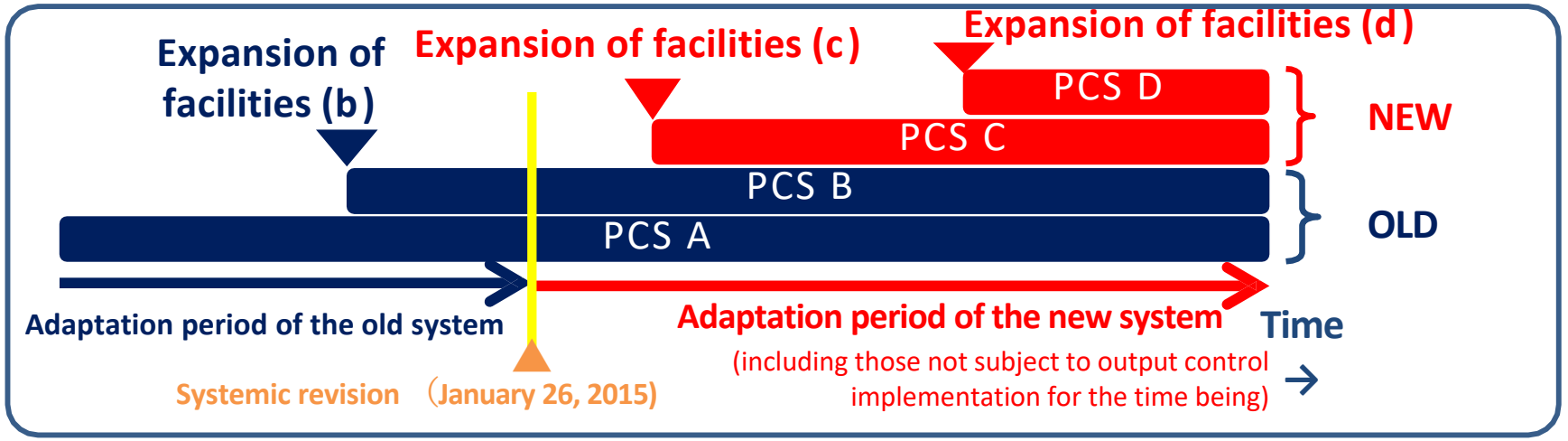


6. Output Control for Power Generation Systems other than PV

The technical specifications for output control issued by general transmission and distribution companies have been revised (June 2023), and the scope of output control has also been revised regardless of the type of power source. For example, power generation systems that exclusively use storage batteries will be able to use reverse power flow, and the installation of output control devices will also be subject to the new specifications. Therefore, the scope of output control is likely to change in the future as regulations and operational practices are developed.

■ Adding to an existing system

(1) Basic concept of output control targets when adding equipment



Subject to output control

Expansion of facilities (b) : The expansion of facilities (PCS B) to which the old system is applied is not subject to output control.

Expansion of facilities (c/d): The installation (PCS A/B) to which the old system is applied is not subject to output control, and the expansion (PCS C/D) is under the new system and subject to output control.

※ PCS : Power Conditioner

※ Conditions and systems for adaptive regulations at the time of installation of additional equipment are subject to change from time to time, so please confirm the latest information based on the latest information when changing equipment.

※ The "old system" here refers to the system before the installation of output control equipment became mandatory (before January 26, 2015).

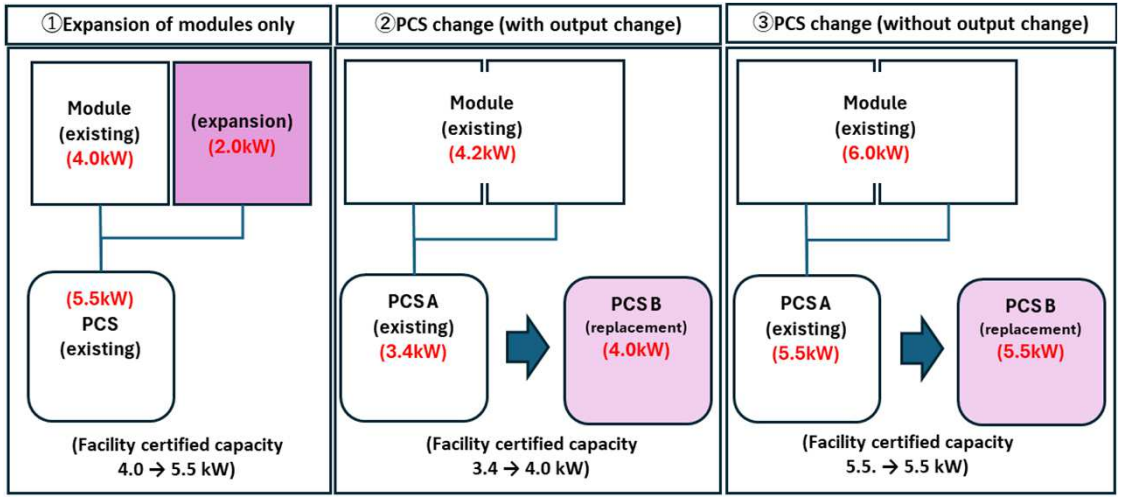
※ Refer to the figure on the right for the classification of output control rules. The output control for less than 10 kW will not be implemented "for the time being," but may be subject to output control in the future.

https://www.enecho.meti.go.jp/category/saving_and_new/saiene/grid/08_syuturyokuseigyo.html

Output control category		Old Rule	New Rule	Unlimited no compensation rules
Upper limit of output control without compensation	500kW or more	30 days per year	360 hours per year	Unlimited no compensation
	50kW or more but less than 500kW	Not subject to output control for the time being → Output control will be implemented from 2022		
	10kW or more but less than 50kW			
	Less than 10kW	Not subject to output control for the time being		

Modification of existing system

(2) When the capacity authorized for the system after expansion or modification is less than 10 kW



Note: This pattern is a representative example of a basic expansion or modification target. Patterns with different configurations should be checked against the system.

※The number of kW in parentheses ( ) is an example.

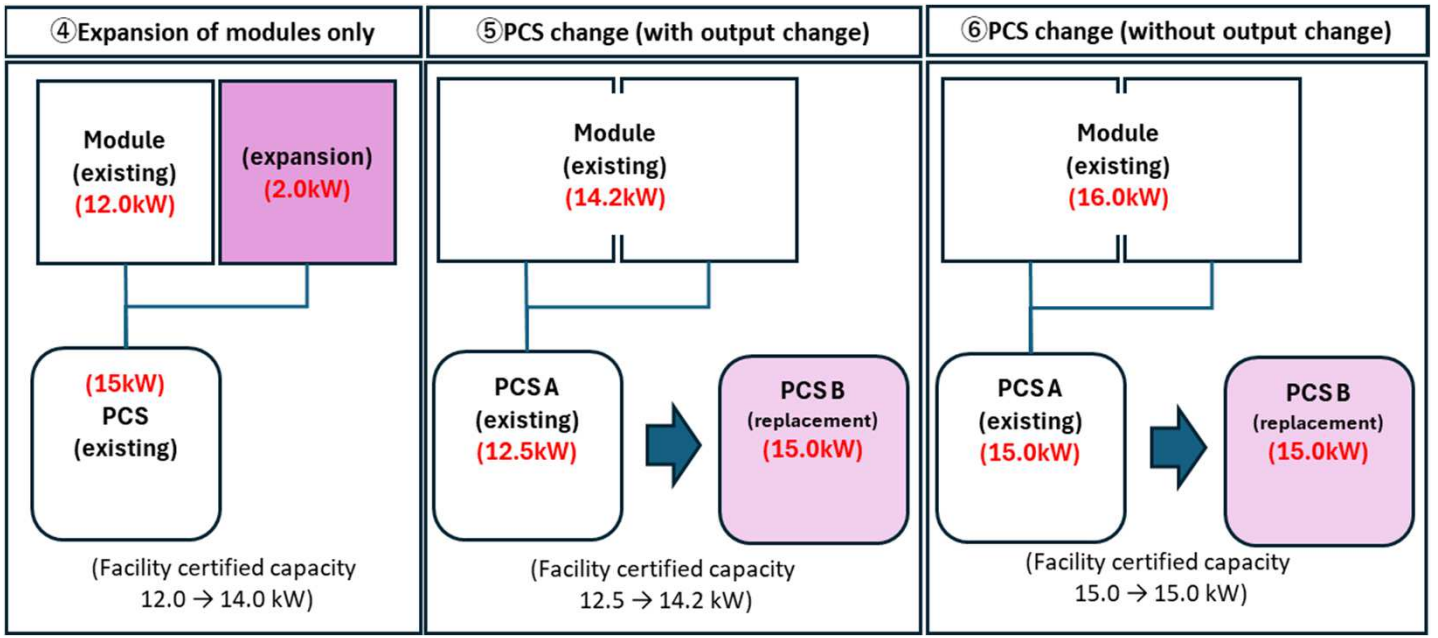
		Output control (subject/not subject)
①Expansion of modules only	Existing	Not subject ⇒ Subject
	Expansion	Not subject
②PCS change (output increase)		Not subject ⇒ Subject※1.
③PCS change (no output change)		Not subject ⇒ Not subject

For the time being, output control is not implemented for facilities below 10 kW (as of January 2024). However, since output control devices may be required in the future, therefore, the requirements are listed here.

※1. During control operation: Output is not controlled up to the capacity certified for the existing installation (3.4kW), and clipping operation is possible with the existing capacity. In the case of a facility that was not subject to output control before the expansion or modification, if there is no module expansion, the output of the power conditioner has increased, and the capacity certified for the facility after the expansion or modification is less than 10 kW, the facility can clip operation at the capacity certified for the existing facility when the control operation is performed.(For details on clip operation, please refer to the explanation below.)

(3) When the capacity of the facility after the expansion or modification is 10 kW or more

※ This pattern is a representative example of a basic expansion/change target. Patterns with different configurations need to be checked in light of the system.



※The number of kW in parentheses ( ) is an example.

		Output Control
④Expansion of modules only	Existing	Not subject ⇒ Subject
	Expansion	Subject
⑤PCS change (output increase)		Not subject ⇒ Subject
⑥PCS change (no output change)		Not subject ⇒ **Not subject**

4. Additional specifications: Upper limit clip operation (1/3)

(1) Concept of upper limit clip operation target

It is conceivable that PCS replacement may occur due to reasons such as failure or deterioration. At this time, if a change in the installed capacity occurs, it is subject to output control under the current system. As a remedy in such a case, a clip operation function will be available only when the certified capacity is less than 10 kW, which enables output regardless of the power command up to the certified capacity before the replacement.

	Output Control (Subject/not subject)
(A) Module replacement in case of module failure *Increased capacity due to increased conversion efficiency	**Subject**
(B) Replacing the power conditioner when it breaks down *Increasing capacity by increasing output	**Subject** ※1

For the time being, output control is not implemented for facilities under 10 kW (as of January 2024), but the requirements are listed because output control devices may be required in the future.

See page 14 for capacity examples.

※1. (i) When control operation is used, output is not controlled up to the capacity approved for the existing facility (3.4kW), and clipping operation is possible at the existing capacity.
(ii) Without internet communication → Clip operation is possible up to the capacity approved for the existing facilities (3.4kW).
(iii) Narrowly defined PCS can always operate clipping at existing capacity (3.4kW) (without output control unit)

■Supplemental Explanation

*(A) When repairing and replacing an old PV system, if a module of the same capacity cannot be secured, it must be replaced with a new product (with increased capacity due to increased efficiency). In such a case, the system is subject to output control.

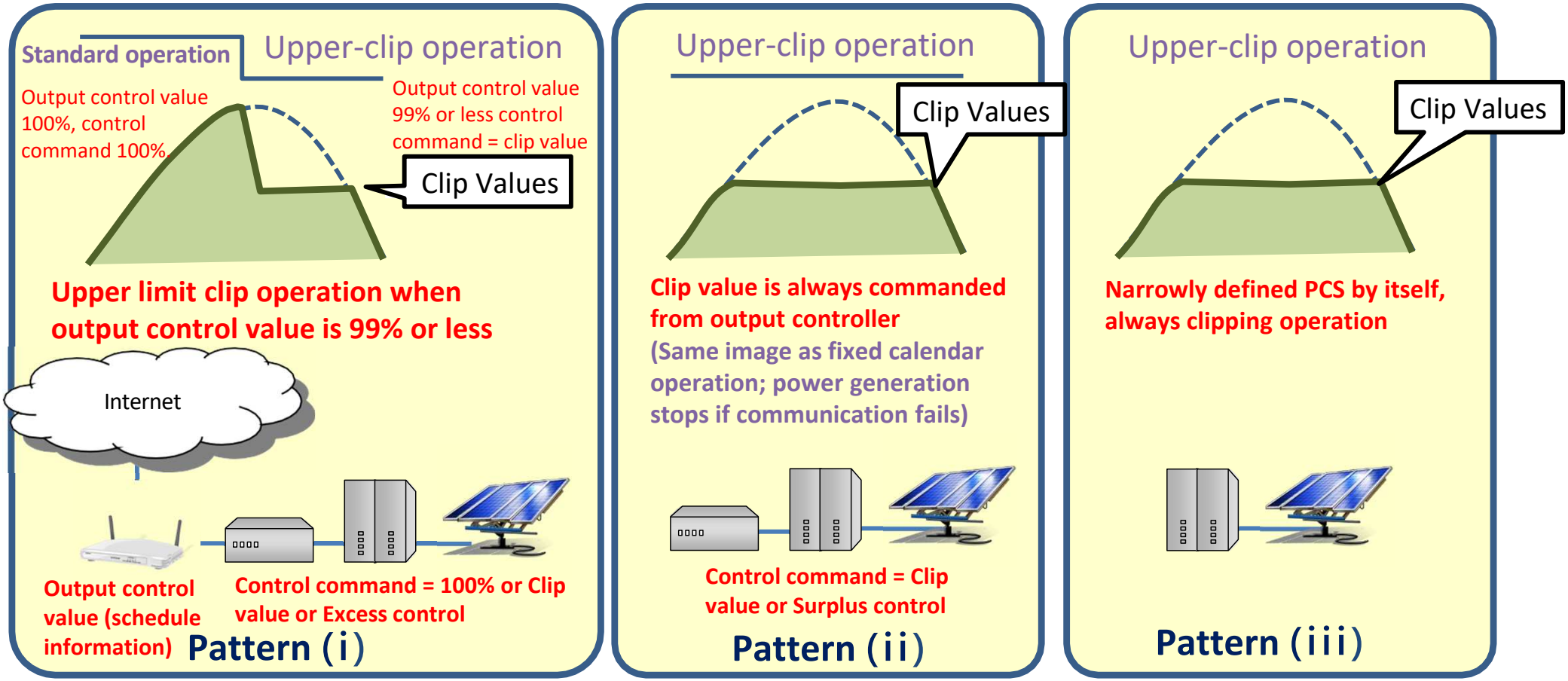
(B) When repairing and replacing a power conditioner, there are cases where the communication environment cannot be newly prepared. In addition, the behavior in case of upper-level communication disruption in a system that performs clipping operation is clarified in *1 (i).Since an Internet connection contract is required to repair an old PCS, it is clarified in *1(ii) that the operation situation in the event of communication interruption is considered the same as 0% suppression, and the specification is to be a constant clip operation. In this case, in order to avoid additional purchase of an output control unit, we specified *1(iii) for the clipping operation in narrowly defined PCS.

(2) Explanation of control operation

Pattern (i): The output controller is connected to the Internet. When the output control value (schedule information) is 100%, PCS is unconstrained (normal operation)When the output control value (schedule information) is 99% or less, the PCS can generate power up to the upper clip value or the amount of self-consumption.

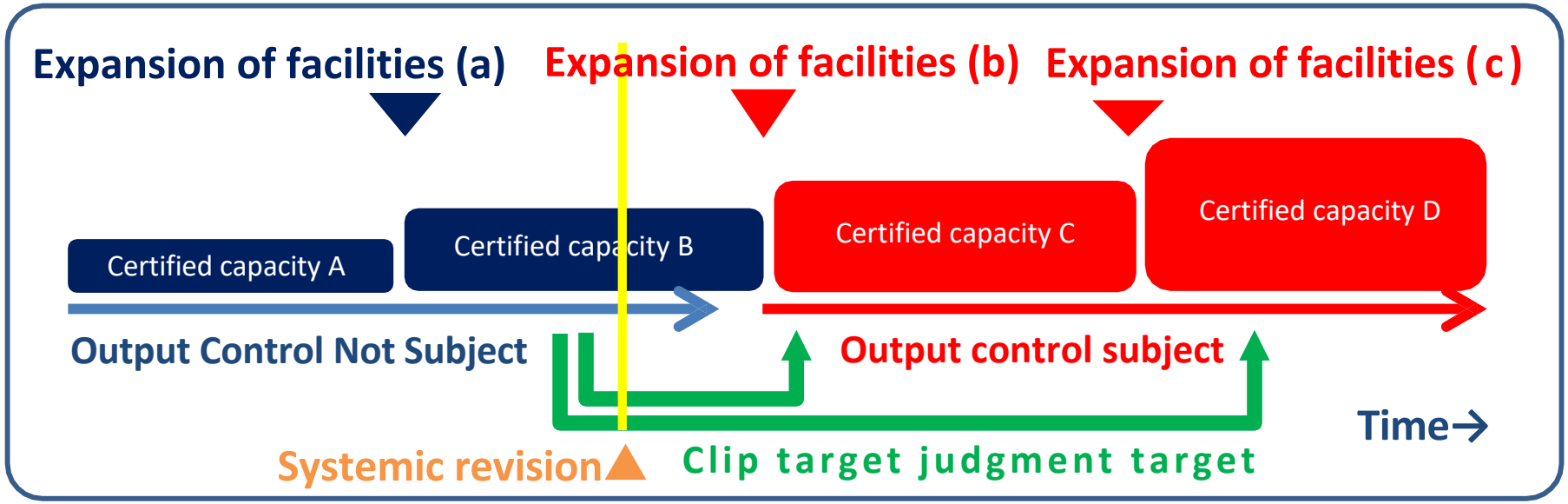
Pattern (ii): Below the constantly clipped value, the output controller can generate power up to the upper clipped value or the amount of self-consumption.

Pattern (iii): Always clipped value or less, upper limit clipping operation by narrowly-defined PCS



4. Additional specifications: Upper limit clip operation (3/3)

(3) Clip value determination method for upper limit clip operation



■How to judge whether to clip or not

- Replacement of equipment (a): PCS replacement before the revision of the system is not subject to output control.
- Replacement of equipment (b/c): Upper limit clipped by the value of the approved capacity B

*Note that the upper limit is not clipped by the certified capacity C.

■Explanation of setting method

- Pattern(i) : Setting and display of PCS rating and PV module capacity in the last and latest status before the system revision.
- Pattern (ii): Setting and display of the upper limit clip value (certified capacity in the final state before the system revision).
- Pattern (iii): Last status before the system revision, setting and display of the latest certified capacity and the target of expansion (power conditioner or PV).

5 Additional specifications: Upper limit clip operation

(Reference) Display method of the system that performs upper limit clip control when the installed capacity increases due to the replacement of PCS (1)

Display means (example)	Image
1-1) Full graphic LCD display	Highly flexible display method (e.g., monitor equipment)
1-2) Line display	Display character type (numeric, alphabetic, kana, etc.) with limitation of number of characters on screen
1-3) LED	Character type (numeric, alphabetic, etc.) with limitation on number of characters on screen
2-1) External connection (PC or other dedicated communication software)	Display method with high degree of freedom
2-2) External display terminal (e.g., web display such as smartphone)	Display method with high degree of freedom

5 Additional specifications: Upper limit clip operation

(Reference) Display method of the system that performs upper limit clip control when the installed capacity increases due to the replacement of PCS (1)

Considering the means of display, the contents of the display should be one of the following 1), 2), or 3).

Display Contents	Remarks
1) Before and after the expansion (1) PCS rating (2) PV module capacity before and after expansion	It is confirmed in the certification test of broadly defined PCS that the upper limit clip operation is performed only when the upper limit clip is applied. Settings should be made in a mode where settings are not rewritten by general user operations, such as the constant value setting mode.
2） Direct setting and display of upper limit clip operation (〇〇kW, etc.) *1	Same as above
3) Setting and display of the capacity certified before and after the expansion, and whether the power conditioner or the PV module is expanded.	Same as above

※1 Note that scaling by facility certified capacity and PCS rated value is originally required.

Although there are a variety of possible settings and display contents, the broadly defined PCS certification test shall be used to confirm that the device operates according to the specifications.

5 Additional specifications: Upper limit clip operation

(Reference) Example of display on monitor screen of PCS with upper limit clip control (1)

Output control setting	Upper limit clip control setting and display (example)			
With output control, less than 10 kW of additional capacity	Power conditioner capacity previous/new	Module Capacity Previous / Current	Previous Output Control Subject	This time output Control Subject
Power conditioner 1	3.0kW/4.0kW	5000W/5000W	Not Subject	Subject
Power conditioner 2	--. -kW/--. -kW/--.	--. -kW/--. -kW/--.		
Power conditioner 3	--. -kW/--. -kW --.	--. -kW/--. -kW --.		

Clip control when the previous output control was "not subject" and the current output control is "subject" and there is no increase in module capacity, but the capacity of the facility has increased due to an increase in the capacity of the power conditioner. In the above example, if the output control schedule is 99% or less, the upper output limit of power converter 1 is suppressed to 3 kW.

Output control setting	Settings and indications that do not result in upper limit clip control (Example 1)			
With output control, less than 10 kW of additional capacity	Power conditioner capacity previous/new	Module Capacity Previous / Current	Previous Output Control Subject	This time output Control Subject
Power conditioner 1	3.0kW/4.0kW	5000W/5000W	Subject	Subject
Power conditioner 2	--. -kW/--. -kW/--.	--. -kW/--. -kW/--.		
Power conditioner 3	--. -kW/--. -kW --.	--. -kW/--. -kW --.		

If the previous output control is "subject to", the upper limit clip control is not applied. Normal output control.

5 Additional specifications: Upper limit clip operation

(Reference) Example of display on monitor screen of PCS with upper limit clip control (2)

Output control setting	Settings and indications that do not result in upper limit clip control (Example 2)			
With output control, less than 10 kW of additional capacity	Power conditioner capacity previous/new	Module capacity previous / new	Previous Output Control Subject	Output control subject this time
Power conditioner 1	3.0kW/4.0kW	3000W/4000W	Not Subject	Subject
Power conditioner 2	--. -kW/--. -kW/--.	-----W/-----W		
Power conditioner 3	--. -kW/--. -kW --.	-----W/-----W		

If the capacity of the facility has increased due to an increase in module capacity, even if the previous output control was "not applicable", the upper limit clip control is not applied, but the normal output control is applied.

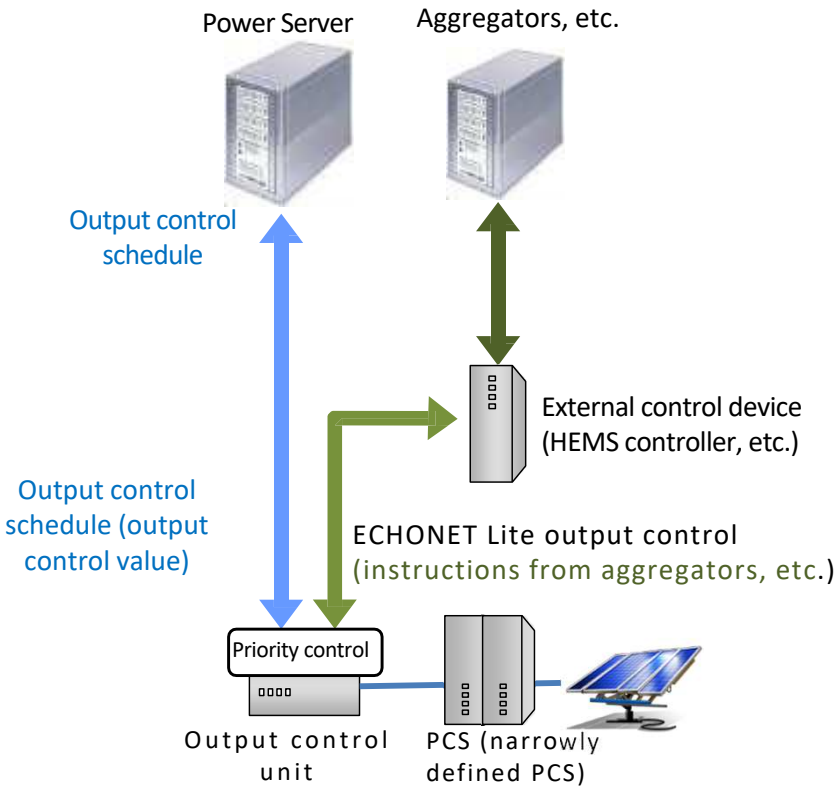
Output control setting	Settings and indications that do not result in upper limit clip control (Example 3)			
With output control, less than 10 kW of additional capacity	Power conditioner capacity previous/new	Module capacity previous / new	Previous Output Control Subject	Output control subject this time
Power conditioner 1	--. -kW/4.0kW	-----W/5500W		Subject
Power conditioner 2	--. -kW/--. -kW/--.	-----W/-----W		
Power conditioner 3	--. -kW/--. -kW --.	-----W/-----W		

In case of new installation, there is no upper limit clip control.(In the case of new installation, there is no input of previous power supply capacity, previous module capacity, previous output control, etc.)

6 Additional specifications: ECHONET Lite-compliant PCS with output control function (1/6)

(1) Definition of PCS with output control function compatible with ECHONET Lite

A PCS with an output control function that has an output control function* using ECHONET Lite in addition to the output control schedule (output control values).



Security must be ensured against external access

(1) Alteration of the output control schedule is prevented by communications from sources other than the power server.

(2) The priority of power commands and instructions from aggregators, etc. shall be controlled by determining the priority within the PCS (broadly defined PCS).

(3) Unauthorized access to external control devices such as aggregators shall be prevented in communication with the aggregator's server.

※ Output control function

Function to control PCS output according to the "ECHONET Device Object Detailed Requirements, Residential Photovoltaic Generation Class Requirements".

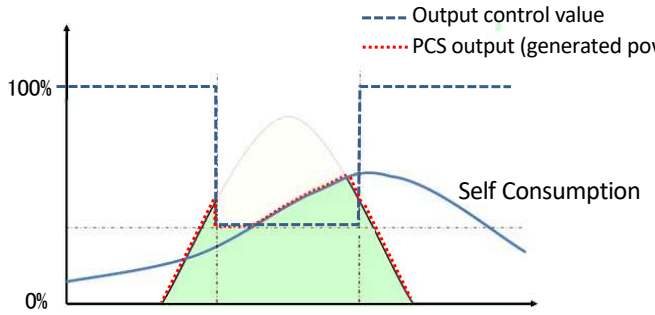
The properties related to PCS output control are shown on the next page.

(2) Properties related to PCS output control

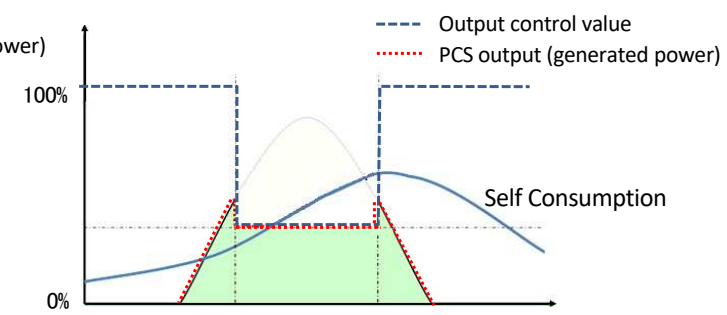
Property Name	EPC	Description
Output power control setting 1	0xA0	Sets the output control setpoint (upper limit of power generation) in % of the facility's certified capacity and obtains the setting status.
Output power control setting 2	0xA1	Set the output control setpoint (upper limit of power generation) in W and acquire the setting status.
Function to control purchase of excess electricity setting*.	0xA2	When controlling output with output control settings 1 and 2, set whether or not the function to control reverse power flow = 0 at the point of interconnection is used, and acquire the setting status.
Power generation output limit setting 1	0xE5	Set the power generation power limit in % of the rated power generation value (catalyst value) and acquire the setting status.
Power generation output limit setting 2	0xE6	Sets the power generation power limit in watts and obtains the setting status.
Limit setting for the amount of electricity sold	0xE7	Sets the power sold in W and gets the setting status.

Surplus purchase control function setting

Surplus purchase control function is enabled.



Surplus purchase control function is disabled.



The above properties are current as of the ECHONET Device Objects Detailed Requirements Release K and may be added in the future.

6 Additional specifications: ECHONET Lite-compliant PCS with output control function (3/6)

(3) Operation of PCS with output control function compatible with ECHONET Lite control.

The operation shall compare the output control schedule (output control values) from the power server with the instructions of the aggregator, etc., and perform the operations shown in the table below.

Output control value	Instructions for aggregators, etc.	Operation of PCS with ECHONET Lite-compatible output control function
Output control value=100	No output control instructions	No restrictions
Output control value<100	No output control instructions	Operates by power command
Output control value=100	With output control instructions	Operated by the indicated value of an aggregator, etc.
Output control value <100	With output control instructions	Output control value ≥ instruction value of aggregator, etc. →Operate by the indicated value of an aggregator, etc. Output control value < indication value of aggregator etc. →Operate by the output control value

※ Compare the latest output control schedule information with the instructions of aggregators, etc.

※ When comparing output control values with the instructions of aggregators, etc., the upper limit of power generation shall be determined by considering the upper limit clip value.

※ In the event of a communication failure after receiving an output control instruction from an external control device via ECHONET Lite, the output control state will continue unnecessarily until the failure is recovered and a new aggregator or other instruction is received. To prevent this, a function shall be provided to reset the value of the property indicated by the aggregator, etc. to no output control instruction.

【Property to be reset】：Output control setting 1, Output control setting 2, Generated power limit setting 1, Generated power limit setting 2, Sold power limit setting

【Example of trigger for resetting】：Date changes, equipment reboots, user operation to reset, etc.

(4) Control specifications based on the instructions of aggregators, etc.

The output control value is specified as a percentage of the certified capacity, the instructions of aggregators, etc. may be given in % of the certified capacity (output control setting 1), % of the rated power generation value (catalog value) (power generation power limit setting 1), or W (output control setting 2 or power generation power limit setting 2), and regardless of which format the instructions are given, (2) priority control shall be possible.
The resolution of the indication value of the aggregator, etc. shall be in 1% units when % is specified and in 1W units when W is specified, and the output change time and control accuracy shall comply with the "Technical Specifications for PCS with Output Control Function".
*There are products that support only % indication, products that support only W indication, and products that support both.

(5) Requirements for ensuring security

Fixed schedules and update schedules obtained from electric power companies shall not be rewritten by the indicated values of aggregators, etc.

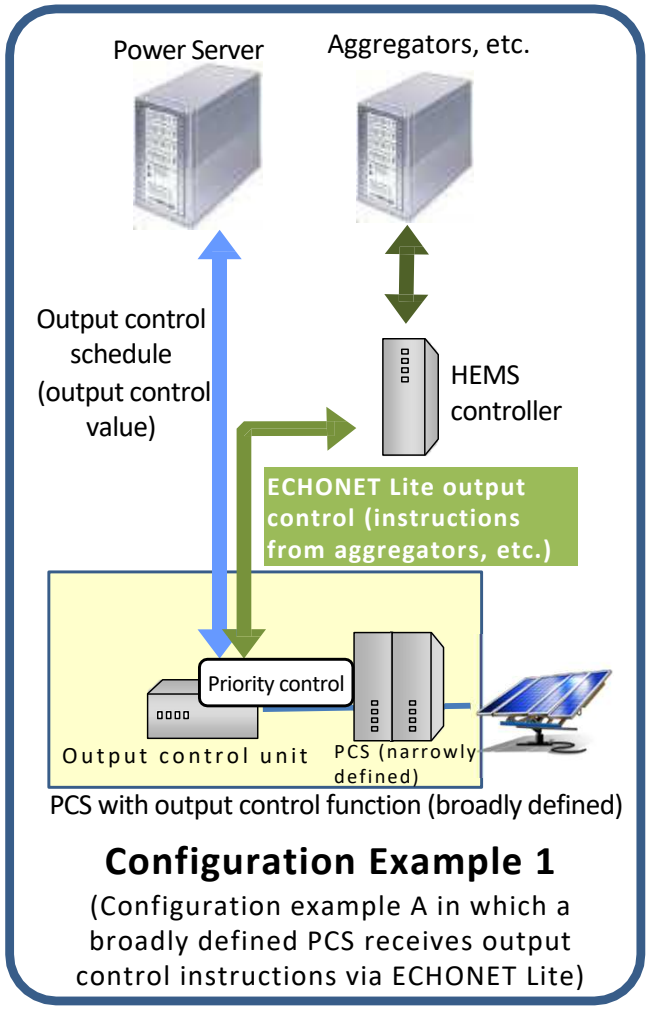
(6) Interoperability between external control equipment and ECHONET Lite-ready PCS with output control function

It is recommended that products that receive output control instructions from aggregators, etc. via ECHONET Lite obtain certification specified by the ECHONET Consortium.

6 Additional specifications: ECHONET Lite-compliant PCS with output control function (5/6)

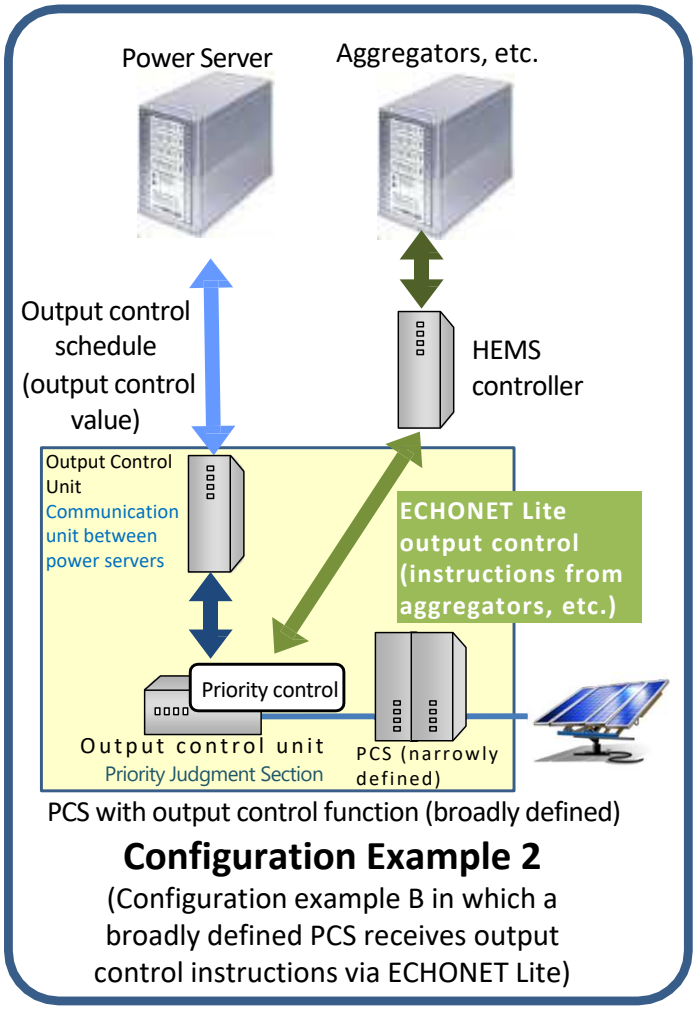
(Reference 1) Example of equipment configuration

An example configuration of a PCS with an ECHONET Lite control-compatible output control function is shown below.



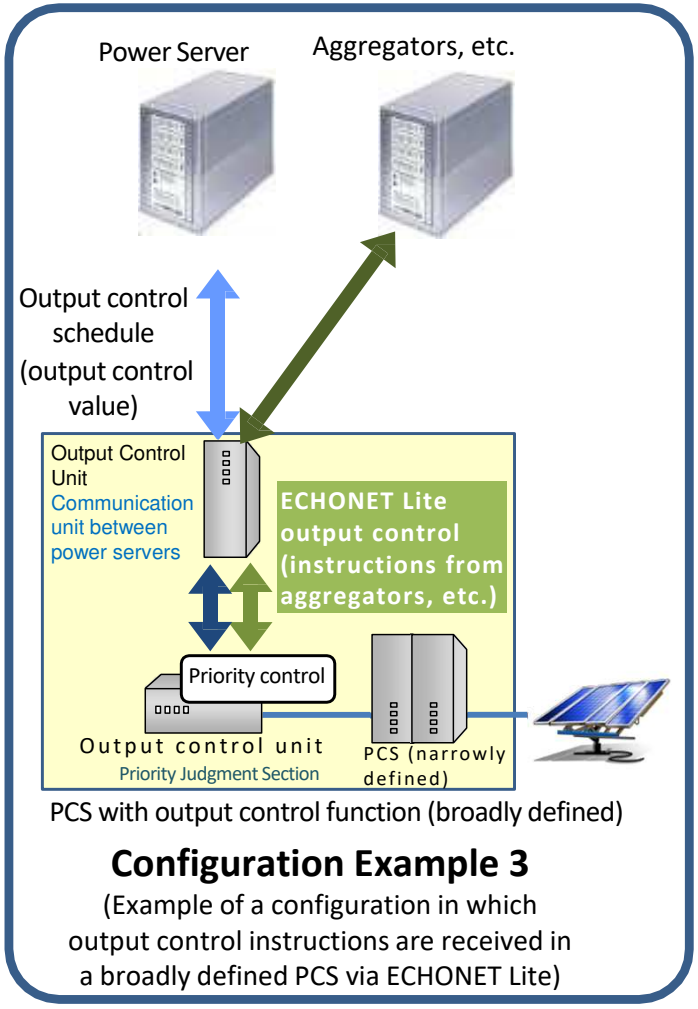
Configuration Example 1

(Configuration example A in which a broadly defined PCS receives output control instructions via ECHONET Lite)



Configuration Example 2

(Configuration example B in which a broadly defined PCS receives output control instructions via ECHONET Lite)



Configuration Example 3

(Example of a configuration in which output control instructions are received in a broadly defined PCS via ECHONET Lite)

The functional part to obtain the output control schedule shall have the same security as the configuration on P.22, regardless of which of the above configuration examples is used.(preventing output control schedule tampering, maintaining priority control, and preventing unauthorized access from outside)

6 Additional specifications: ECHONET Lite-compliant PCS with output control function (6/6)

(Reference 2) Example of Judgment Considering Upper Limit Clip Value

An example of judging the upper limit of power generation in consideration of the upper limit clip value is shown below.

No	Upper limit value selection condition	Selection Results
Condition 1	Output control value is other than 100% (=Upper clip value valid) and (Upper clip value ≦ Aggregator instruction)	Upper clip value (highest priority)
Condition 2	Output control value is other than 100% (=Upper clip value is valid) and (Upper clip value > Aggregator instruction, etc.)	Instructions from Aggregators, etc.
Condition 3	When the output control value is 100% (= no limit by the output control side)	

Example 1 (Condition 1)

PV module capacity 4.0kW, power conditioner capacity 4.0kW, upper limit clip value 3.0kW, power consumption 1.0kW, power command 90%, aggregator's instruction 80%,The upper limit of power generation by the power command is 3.6 kW, but due to the upper limit clip function, 3.0 kW is the upper limit of power generation, and the power generation indication value by the aggregator's instruction is 3.2 kW, and the power command (upper limit clip value) is adopted.

Example 2 (Condition 2)

PV module capacity 4.0kW, power conditioner capacity 4.0kW, upper limit clip value 3.0kW, power consumption 1.0kW, power command 0%, aggregator instructions 50%,The upper limit of power generation by the power command is 0 kW, but the upper limit clip function sets the upper limit of power generation at 3.0 kW, and the power generation indication value by the aggregator's instruction is 2.0 kW, so the aggregator's instruction is adopted.

※ Details of the upper limit clip are described in "4. Additional Specifications: Upper Limit Clip Operation".

7. Examples of verification/improvement implemented during development/operation (1/6)

(1) Prevention of excessive power server access

1) Obtaining an update schedule each time by restarting the system at the time of regular reset

Example of a problem: A product that resets the output controller at a fixed time every day, and there was a case in which the update schedule was obtained from the power server every time immediately after the reset.
Problem: For the power server, unauthorized access from multiple locations can be misidentified as unauthorized access, preventing stable operation.
Example of countermeasure: Retain the update schedule and use the stored update schedule after a reset to prevent unscheduled access to the power server.

2) Fixed schedules are retrieved daily

Example of the problem: Fixed schedules were being retrieved daily despite no change in the update flag.
Problem: Unnecessary large volume of accesses from each power plant occurred, resulting in server load.
Example of countermeasure: Fixed schedules should be acquired when there is a change in the update flag. The acquired fixed schedule and the update flag should be stored, so that the fixed schedule does not need to be read from the server every time after a power failure or reset.
(As of 2020, the schedule will be updated once a year.)

3) Inappropriate access regarding registration confirmation of power plant IDs

Example of problem:1) There was an output controller that performed registration confirmation of power plant IDs every day.2) Due to an input error in the power station ID, registration confirmation to the server was retried endlessly.
Problem: Unnecessary large volume of accesses from each power plant occurred, resulting in server load.
Example of Countermeasure: Do not routinely confirm that power plant IDs have been registered, e.g., only when setting up the system. When a power plant ID is entered, first check whether the input value is a normal thumb value, and if the power plant ID is a normal value, confirm the registration of the power plant ID with the power server. If an unregistered response is received, do not retry, inform the settler of the unregistration, confirm the input error of the power station ID, and consult with the power transmission and distribution provider.

7. Examples of verification/improvement implemented during development/operation (2/6)

(2) Points to be noted in the technical specifications

1) Retry specifications for failure in acquiring update schedule

Example of problem: There was a product that generated many retries within 30 minutes, such as when acquiring an update schedule.
Problem: Due to issues on the communication path or server side, if retries are concentrated from many output control devices at the same time or if the retry interval to the server is short, cases of mistaken recognition as a cyber attack will occur.
Countermeasure example: Communication errors include communication errors, response errors, and application errors, and only response errors are defined in the transmission specifications in terms of the number of retries and retry intervals. It is desirable to apply retry timing, number of times, and retry timing to communication errors and application errors as well. However, it is desirable that the number of retries for the update schedule should not require a limit on the number of retries when communication errors are taken into consideration.

2) Misinterpretation of 13-month basis for fixed schedule (annual)

Example of Problem: An output controller was trying to obtain data for 13 months from the current month for the fixed schedule (annual) every month.
Problem : Both Fixed Schedule (Annual) and Fixed Schedule (Monthly) are prepared with the same annual plan. When reading 13 months ahead from the middle of the fiscal year, data for the period not prepared is accessed and an error occurs.
Example of countermeasure: When the update flag is updated for the fixed schedule (annual), or when the schedule is downloaded for the first time, the fixed schedule (monthly) reads data for the following month (If you want to read ahead, do not read data for the period beyond 13 months from the time when the update flag changes).

3) Power generation continues when the system is restarted the next day due to a communication wiring breakdown.

Example of Problem: Some products continued to generate power when the DC power supply was restarted the next day when the communication line between the narrowly defined PCS and the output controller was disconnected.
Problem: When the communication line is disconnected or the output controller malfunctions, the PCS continues to generate power.
Example of countermeasure: Set or memorize the fact that output control is set in the narrowly defined PCS, and set the specification that the narrowly defined PCS stops within 5 minutes even if the control power of the narrowly defined PCS is turned on and normal communication from the output control device does not come.

4) Power servers and NTP servers

Example of problem: An NTP server that is publicly available on the Internet, such as Japan Standard Time, is used as the NTP server.
Problem: As of December 2023, if there is an NTP server designated by a general transmission and distribution company, the NTP server to synchronize the time must be the designated server.
Example of Countermeasure: Connect to the NTP server designated by the general transmission and distribution companies.

5) Time synchronization method

Example of problem: The time synchronization of Linux is only performed at startup, which may cause time synchronization to be out of sync.
Problem: When there is no communication, the clock accuracy is less than 1 minute/month due to the crystal oscillator (quartz) connected to the real-time clock (RTC).On the other hand, during normal output control, output control is performed using the time function of Linux, etc. According to the standard specification of Linux, the timing to synchronize with the RTC is at OS startup, and if the OS is not restarted periodically, the deviation from the RTC may be large.
Example of countermeasure: If the clock accuracy is defined by a crystal oscillator connected to the RTC, synchronize the Linux time to the RTC time on a regular basis. When clock accuracy is specified by the crystal oscillator that determines the Linux time, periodically synchronize the RTC time with the Linux time.

6) Description of MAC address randomization

Example of Problem: Randomization of MAC addresses. (Randomization of MAC addresses, a technique used in cell phones and other devices, is used to prevent leakage of location information by tracking MAC addresses, etc.)
Problem: MAC address information is included in the message determined by the transmission specifications, and if this information is changed frequently, the connection may be misidentified as a connection from multiple locations using the same power plant ID.
Example of countermeasure: Do not randomize MAC addresses for output control equipment.

7. Examples of verification/improvement implemented during development/operation (4/6)

7) Counting up the fixed schedule update flag

Example of problem: There was a case in which the next count-up was not handled as 0 when the fixed schedule update flag was 9.

Problem: The Fixed Schedule Update Flag in 3.4.3 Update Schedule of the Transmission Specification states "A flag that counts up when a fixed schedule is updated to notify that a new fixed schedule is available for acquisition." and considering only the meaning of the word "count up", the next of '9' may not be accepted. In this case, the problem will only be discovered after several years.

Example of countermeasure: The value counted up after 9 in the update flag of the fixed schedule should be 0.

8) Update flag on the first read of a fixed schedule

Example of problem: There was a case in which the value of the update flag was fixed at 0 on the first readout of a fixed schedule.

Problem: When a fixed schedule is read, if the update flag is not set, a calendar different from the corresponding year to be read is read.

Example of countermeasure: Before reading out the fixed schedule for the first time,1) Read the updated schedule and once read the update flag of the fixed schedule.2) Using the readout update flag, specify the necessary fixed schedule and read it out.

The order in which the necessary fixed schedules are specified and read out should be "1) read out the update schedule, and then once read out the update flag of the fixed schedule.

7. Examples of verification/improvement implemented during development/operation (5/6)

(3) Prevention of operational errors

1) Inadequate response to abnormal sum value calculation in power plant ID input

Example of problem: Power plant IDs have a checksum portion. Some output controllers were able to access the power server with an incorrect power plant ID because the check of the checksum value was not performed.

Problem: The power plant IDs are incorrectly identified as the power server when they are accessed.

Example of countermeasure: Check the checksum when entering the power plant ID, and warn the configurator of the input error. If the thumb value of the power plant ID is incorrect, the power server is not accessed.

2) Without PCS connection, the setup is completed

Example of the problem: There was a power plant where the output controller was set up, but the narrowly defined PCS was not.

Problem: The narrowly defined PCS does not stop generating power, and the communication between the output controller and the power server is normal, so the operation appears normal from the server side.

Example of countermeasure: If the communication between the PCS and the output controller is not completed, the setting of the output controller is not completed. It is desirable to use a sequence in which the output controller confirms that communication with the narrowly defined PCS side is established before the setting of the output controller is completed, so as to prevent omissions in the procedure.

7. Examples of verification/improvement implemented during development/operation (6/6)

(4) Support for Non-firm type connection

1) Support for update schedule size and overwrite operation

In January 2021, the nationwide deployment of non-firm type connections was announced.
In this context, PCS used in high-voltage and low-voltage interconnection is a method that uses the mechanism of remote output control equipment, and since the specifications are upward compatible, it is desirable that products shipped in the future be compatible with non-firm connections.
The following major enhancements have been made. For details, check the transmission specifications provided by the power transmission and distribution companies.

- Overwrite updating of the update schedule is possible.
  - Before change: Update schedule data is available until 30 minutes following the next access date and time
  - After change: No limit (i.e., data that can overlap schedules is expanded)

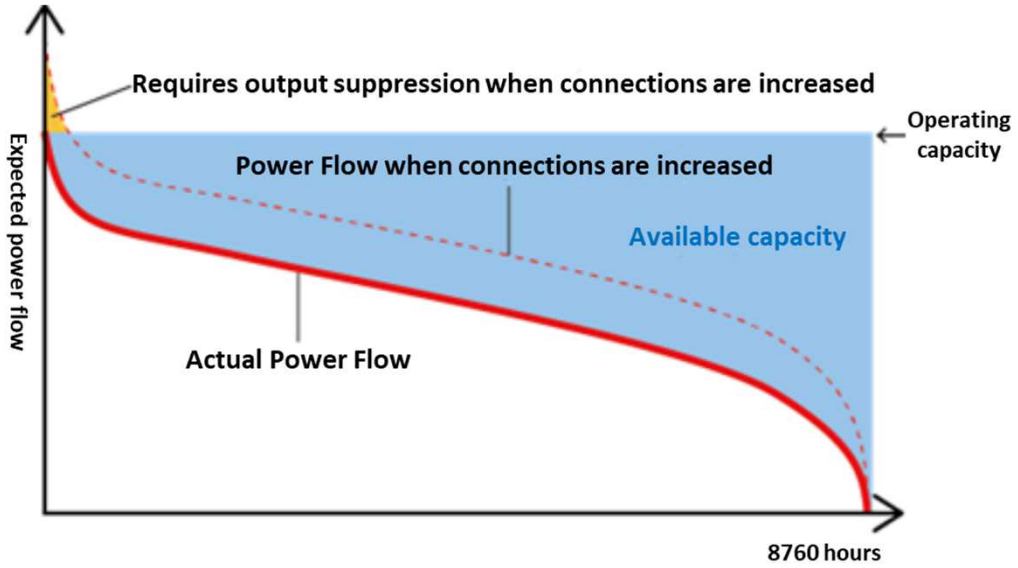
(5) Other points to note

1) Access at a time that is far off from the next access date and time

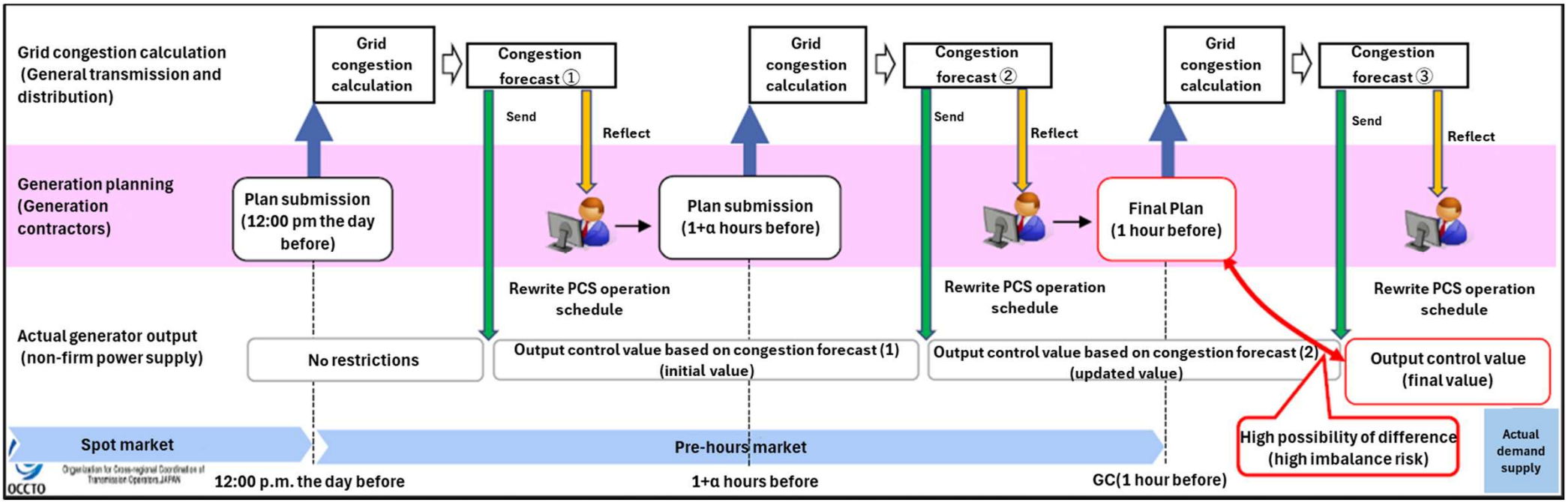
Example of problem: In a communication to the power server, access is occurring at a time that is significantly off the next update date and time for acquiring the update schedule.
Problem: The unauthorized access to the power server is misidentified as unauthorized access, and the operation of unauthorized access detection is hindered.
Example of countermeasure: Do not acquire schedules from the power server while synchronization with NTP has not been completed.
Before releasing the product, it should be sufficiently confirmed that out-of-specification access is not performed.

What is non-firm connection?

A connection method in which connection to the grid is permitted when there is available transmission capacity in the grid, and connection is restricted (output control) when there is no available capacity. The grid will stop interconnection when there is no more transmission capacity available. This is called "non- firm" because interconnection is not always allowed. The aim is to increase the amount of renewable energy connected to the grid by utilizing the transmission capacity that is normally available. The plan for output control is required to be announced at 12:00 pm the day before.



＜Output control for non-firm power supplies＞



Source: 42nd Regional System Development Committee Document 1

The technical specifications for output control issued by general transmission and distribution companies have been revised (in the second half of FY2020) for the introduction of non-firm type connections.

7.3 Data structure of the update schedule

After the revision

The data structure of the update schedule shall be the control value (output%) data of up to 7 days × 48 points (336 points) specifying an arbitrary date and time and the number of rewrite data, and shall be distributed together with the "fixed schedule update flag" for notifying that the fixed schedule has been updated and the "next access date and time" which is the access specification date and time from the client to the server.

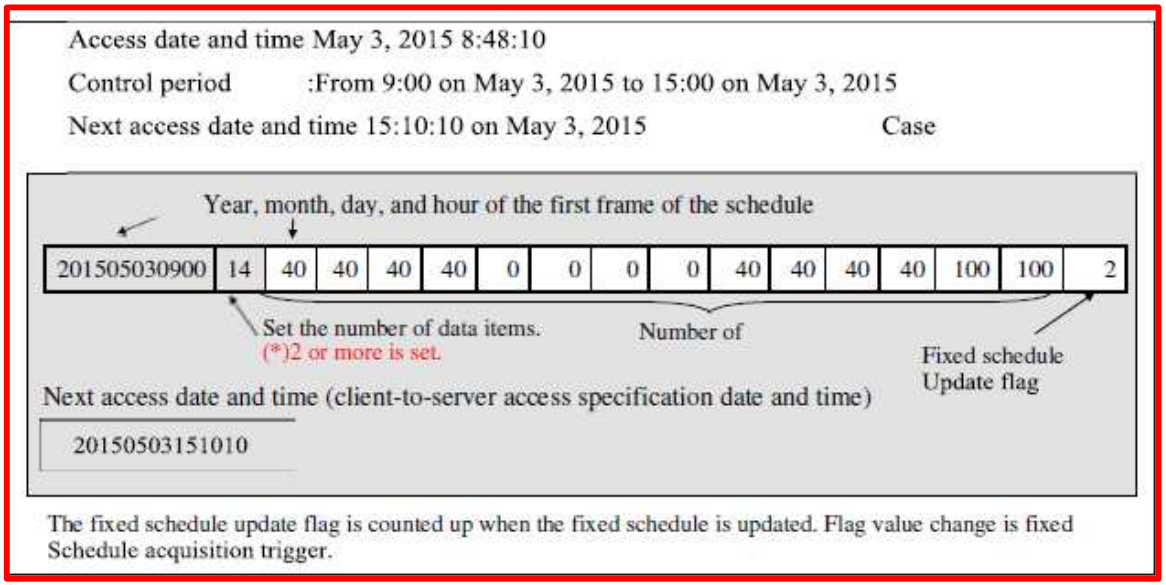
<Data Structure of Update Schedule>

Update schedule

Time period following access date/time - arbitrary time period (*)

(Provided up to 30 minutes ahead, considering retries in case of access errors)

(The output control schedule is specified in units of 30 minutes per hour and rated output control value is specified in units of 1%).



Before the revision

7.3 Data structure of the update schedule

The data structure of the update schedule shall be the control value (output%) data of up to 7 days × 48 points (336 points) specifying an arbitrary date and time and the number of rewrite data, and shall be distributed together with the "fixed schedule update flag" for notifying that the fixed schedule has been updated and the "next access date and time" which is the access specification date and time from the client to the server.

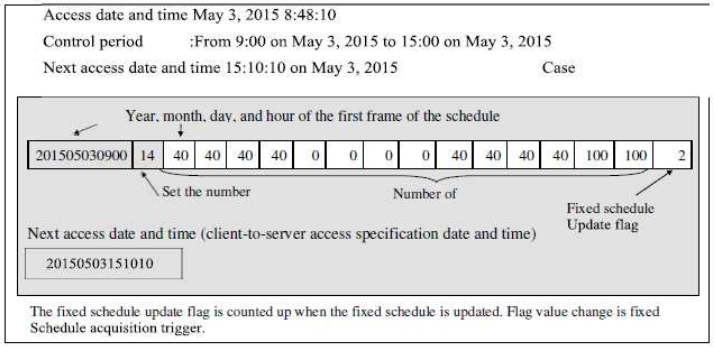
<Data Structure of Update Schedule>

Update schedule

30-minute value from the next hour of the access date and time to the next 30-minute window of the next access time

(Provided up to 30 minutes ahead, considering retries in case of access errors)

(The output control schedule is specified in units of 30 minutes per hour and rated output control value is specified in units of 1%).



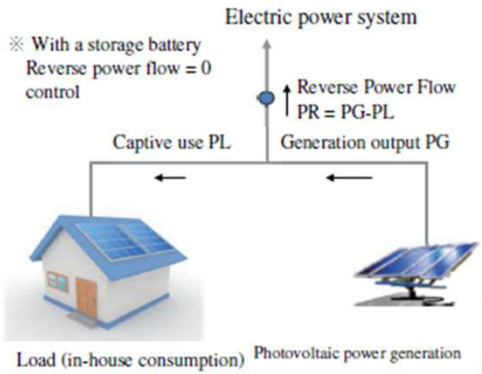
Delete all items related to the next 30 minute window following the next access date and time.

The revised point of this time is to change the example to "distribute the schedule after the next access date and time".

(Reference 2) Example of reverse power flow up to the output control value in surplus purchase control

The technical specifications for output control issued by general transmission and distribution utilities have been revised (June 2023), allowing for reverse power flow up to the output control value without, in principle, controlling the portion for self-consumption in the case of surplus power purchase.

<Surplus purchase control>
(example of solar power generation)

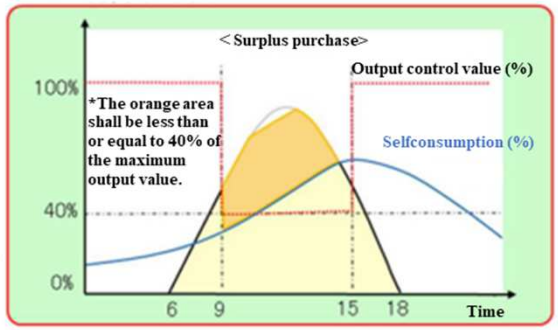


※ Control details of reverse power flow = 0 control

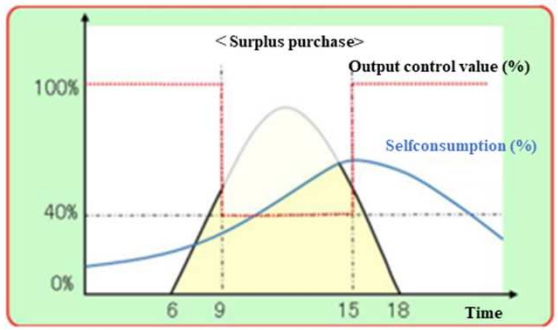
- *PR > 0: Ouput decrease control up to the ouput upper limit*
- *PR ≦ 0: Ouput increase control until PR =0 converges*

<Surplus purchase> Either of the following control methods (a) or (b) may be used

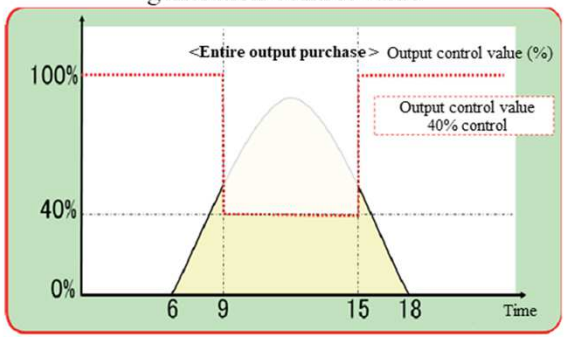
(a) Example of controlling reverse power flow below the output control value (output limit)



(b) Example of reverse power flow = 0 control*.

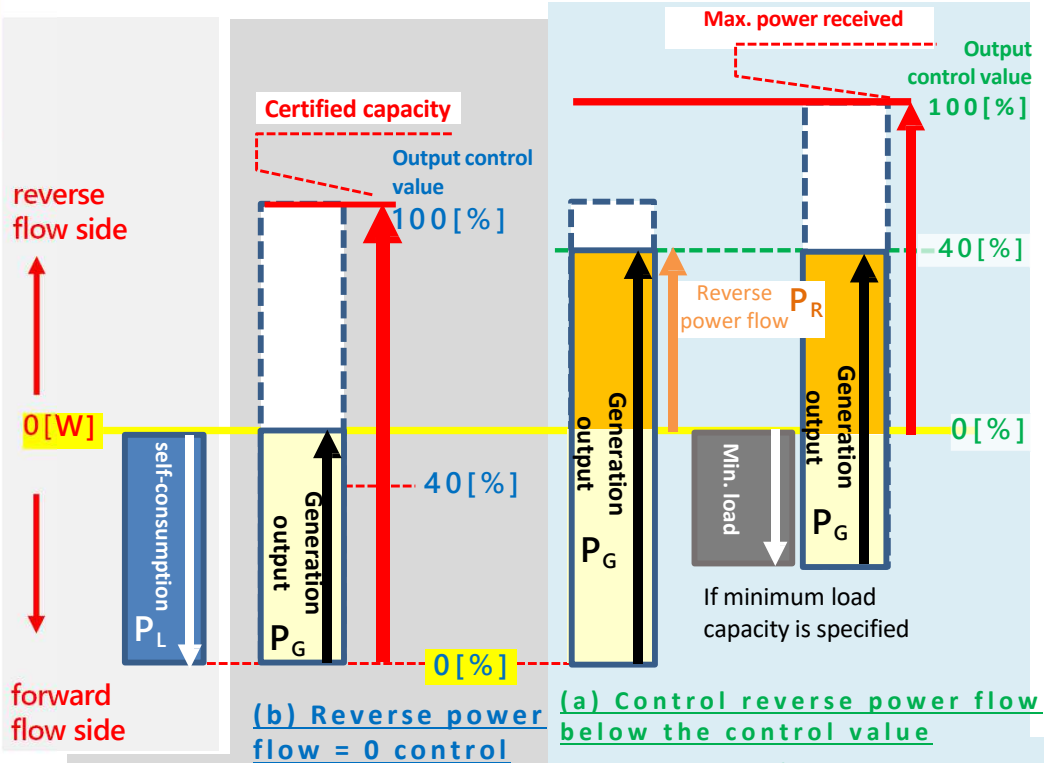


<Full purchase> Example of controlling 40% of generation control value



(b) Reverse power flow = 0 control is an operation encompassed in (a), meaning that the product can be interconnected even if it corresponds to the number of non-firm frames before the revision (older products that do not support reverse power flow control).

The portion of the operation description added in the June 2023 revision of the technical specifications.



(b) Reverse power flow = 0 control

Control the generation output PG below the output control command value or set the reverse power flow PR = 0.

Output control value 100% means that the power generation output PG is the same as the capacity approved for the facility.

(a) Control reverse power flow below the control value

The reverse power flow PR is controlled below the output control command value.

Output control value 100% means that the reverse power flow PR is equal to the maximum power received.