



Introduction of Non-Firm Type Connection to Expand Introduction of Renewable Energy

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Introduction

- Due to the rapid increase in renewable energy connected to transmission lines, we faced two problems; 1) too much transmission construction cost burden for generation owner, and 2) too large scale of transmission construction.
- This poster introduces a Non-Firm type connection currently being studied, discussed, and introduced in Japan.

About the power flow record in Japan

- The power flow in the grid fluctuates. There are occasional times when it flows close to the operational capacity limit, while most of the time the flow is much lower, which is also shown by the power flow curation curve.

Power equipment policy in Japan before the introduction of non-farm type connection

- Prior to the introduction of Non-Firm type connection, as shown in Figure 1 calculation of the available capacity was essentially conducted based on power flow peak season and congestion was not expected to occur. If applications for grid interconnection exceeded the capacity limit, large-scale system reinforcement work was generally requested.

Advantages of introducing non-farm type connection

- In contrast, as shown in Figure 2, Non-Firm type connection enables the connection of new power sources to the grid with no available capacity by controlling the power generation output during grid congestion, and does not require large-scale system reinforcement work.

Target systems and target power sources

— Target systems

- Bulk lines with no available capacity (some local lines are also being tested in the same manner).

— Target power sources

- Power sources under bulk transmission with Non-Firm connections whose rated capacity is 10kW and more are the target for controlling power generation output (hereinafter, Non-Firm generations).

Power generation output control

- Usually, the power generation output control amount (MW) required to be free from congestion every 30 minutes is distributed to all connected Non-Firm generations regardless of the type of power source, from thermal power to renewable energy. Specifically, as shown in Figure 3, the power generation output control amount is uniformly distributed to each Non-Firm generation on a pro rata basis.
- As shown in Figure 4, when the grid facility is suspended due to planned outage work (including outage work after a contingency), power generation output control is ordered to Non-Firm power sources first, followed by Firm power sources if additional curtailment is necessary.

Devices and systems required for power generation output control

- As shown in Figure 5, the power source owners are required to prepare an output control unit that interlocks with the output control instructions and an output control-compatible power conditioning subsystem (PCS), etc., prior to the start of grid interconnection on the assumption that output control without financial compensation is to be performed during times of grid congestion.



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Notifications for power generation output control

- As shown in Figure 5, There are three times when a transmission operator gives notice of power generation output control under the assumption of system congestion: (1) at 12 o'clock the day before, (2) 1 + α hours before actual demand supply, and (3) 1 hour before actual demand supply. The timing of (3) is the final output control value.

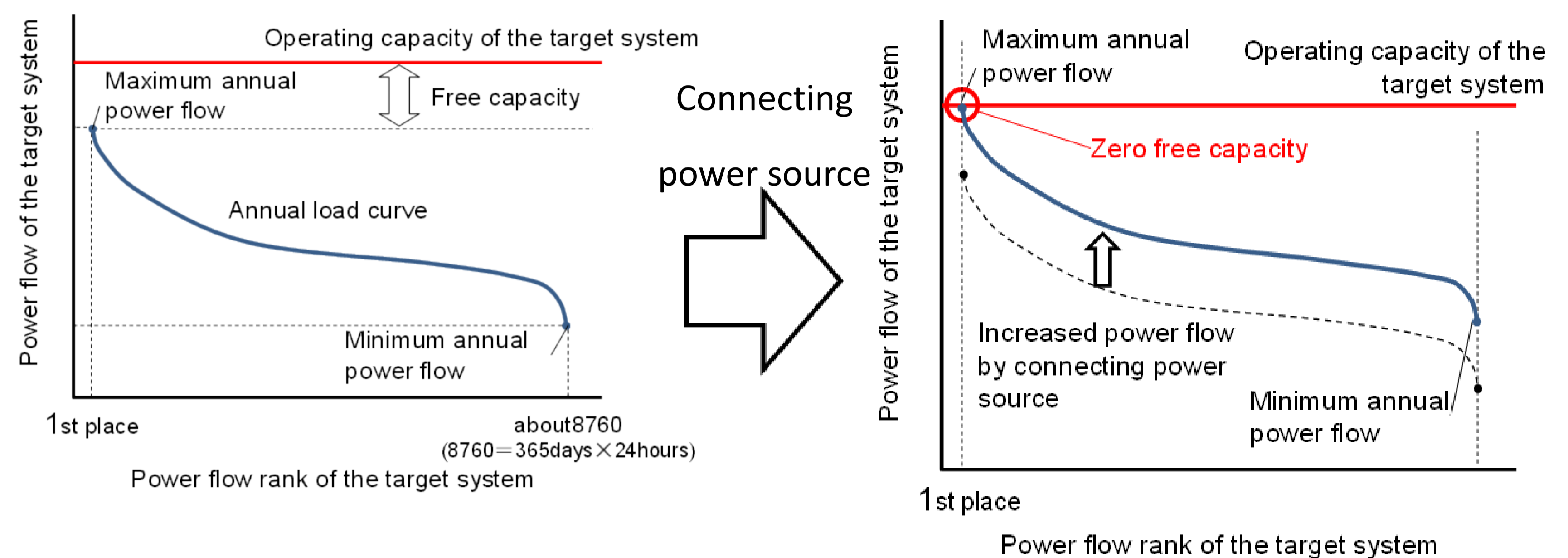


Figure 1: Assumed zero free capacity

The relationship between supply-demand control and grid congestion control

- If control due to grid congestion and control due to supply-demand balancing are required at the same time, power generation output control based on grid congestion is performed first, and then supply-demand control follows after this, as shown in Figure 6.

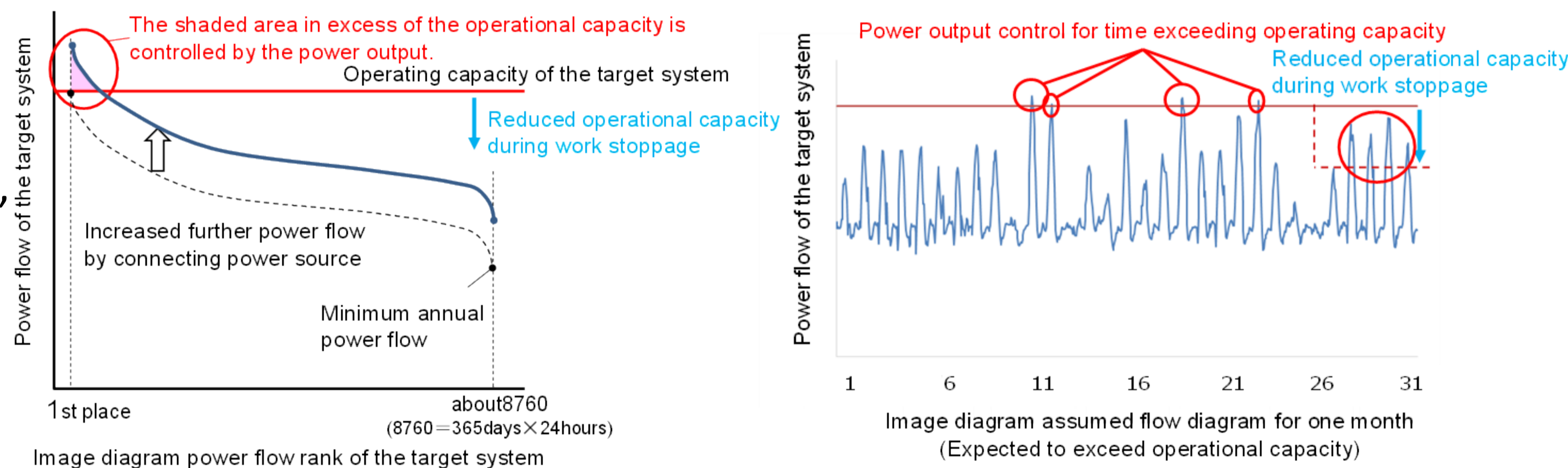


Figure 2: Estimated flow after Non-Firm type connection

Discussions about Non-Firm connections

- We have decided that all generator should be treated as Non-Firm connected generator from April 2022.
- Furthermore, the concept of a priority order for generators under control will be streamlined in the near future. We are currently studying the application of economic merit-order control, instead of the conventional first-come, first-served approach, seeking a further reduction of social costs.

Conclusion

- With the emergence of an ambitious national policy of replacing conventional generators with renewable energy sources as the main power source in Japan, the nationwide deployment of Non-Firm type connections - not only at the bulk level but also to local systems - with new congestion management techniques (at present, still first-come, first-served basis) is being discussed, along with current developments to shift to market-oriented economic merit-order control.
- Non-Firm type connection is a dependable solution to help facilitate the smooth introduction of renewable energy sources through fast and flexible interconnections without major T&D upgrades.

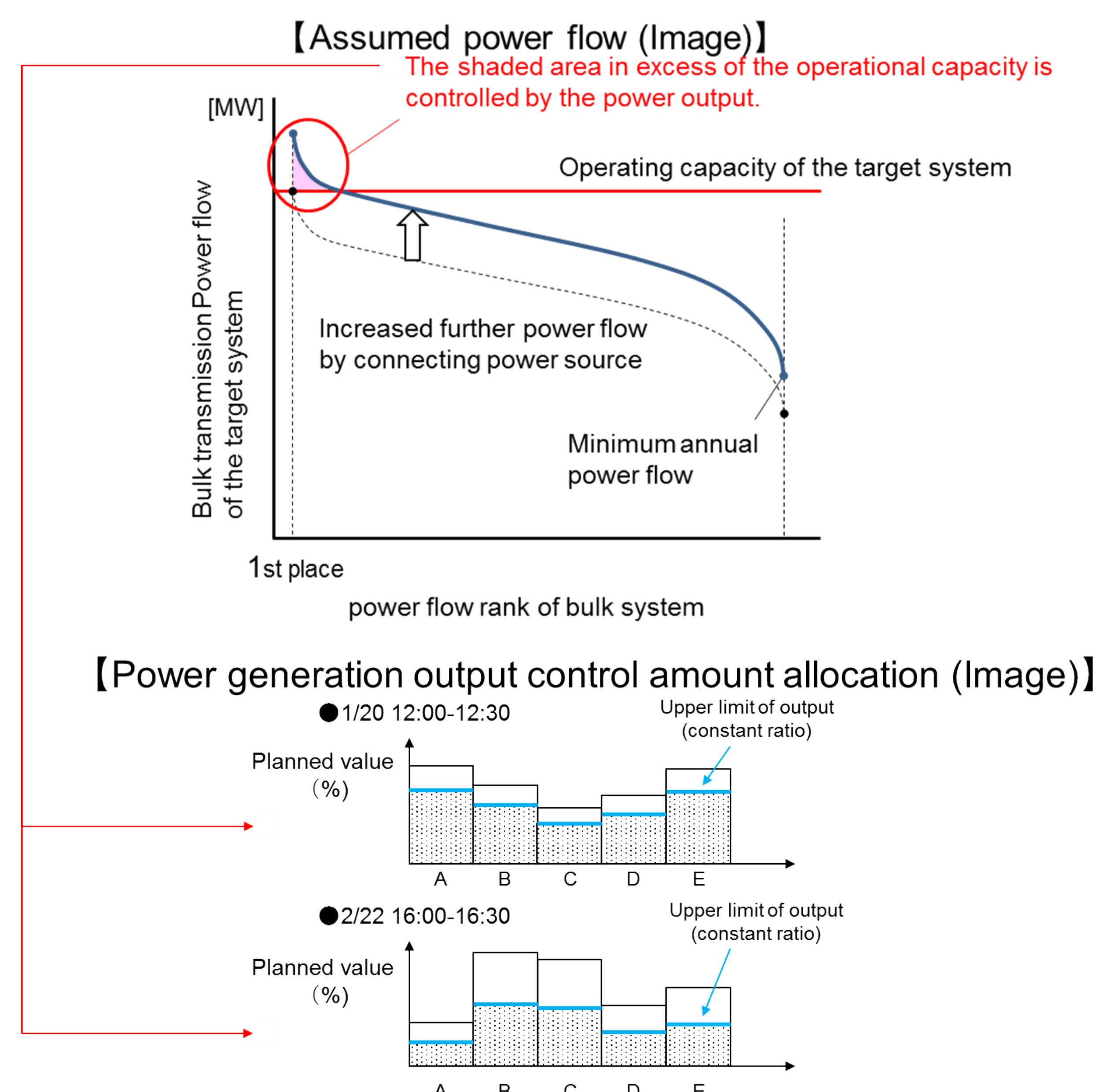


Figure 3: Estimated power flow and distribution of power generation output control (illustration)



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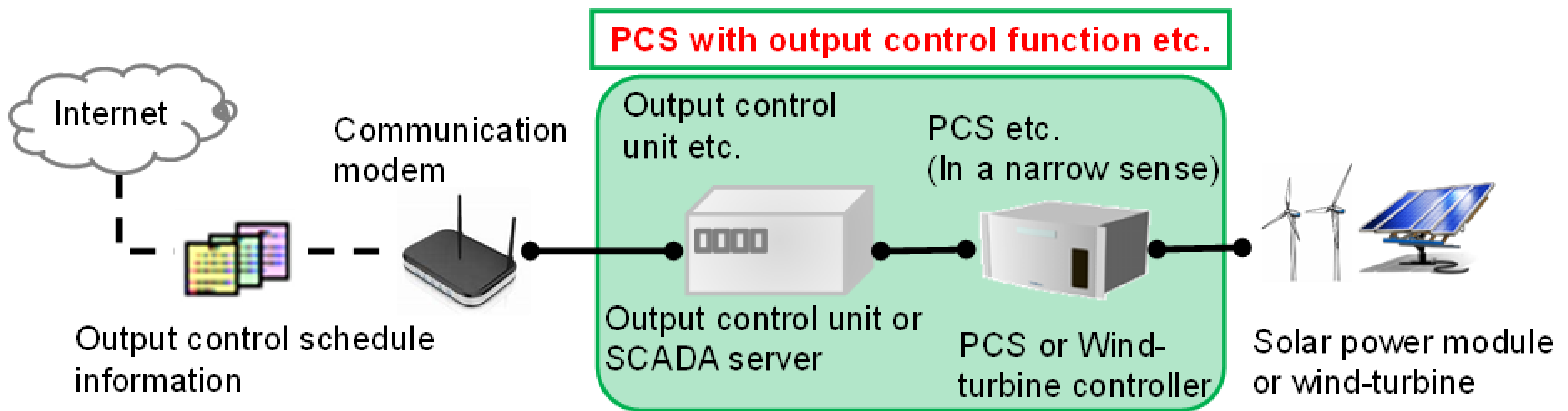


Figure 4: Apparatus for power generation output control

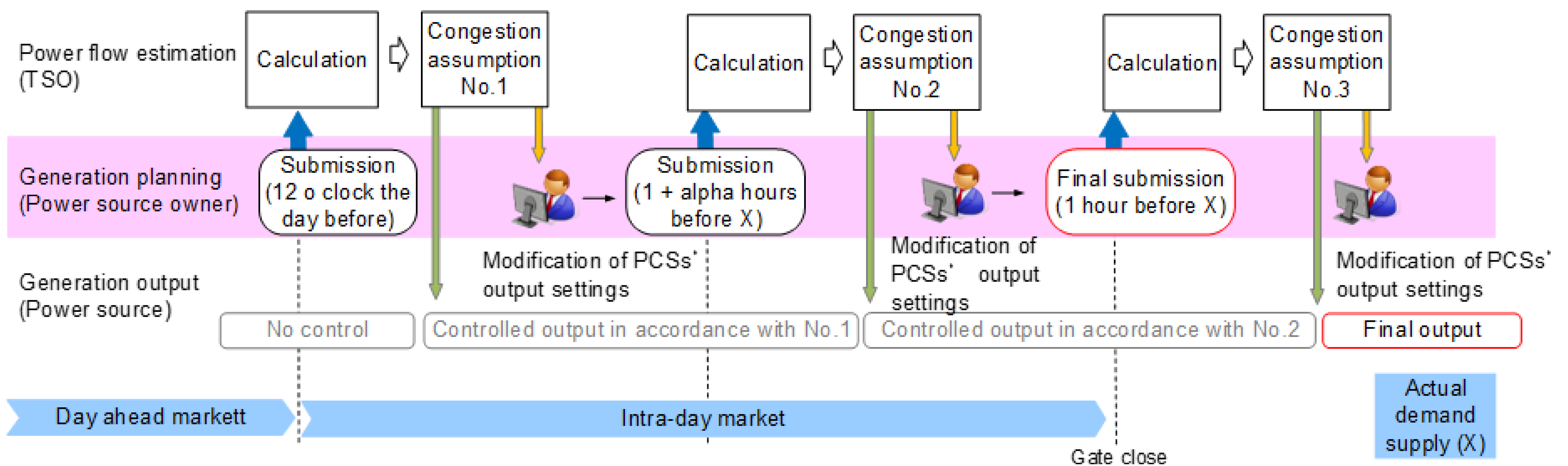


Figure 5: Notification for power generation output control

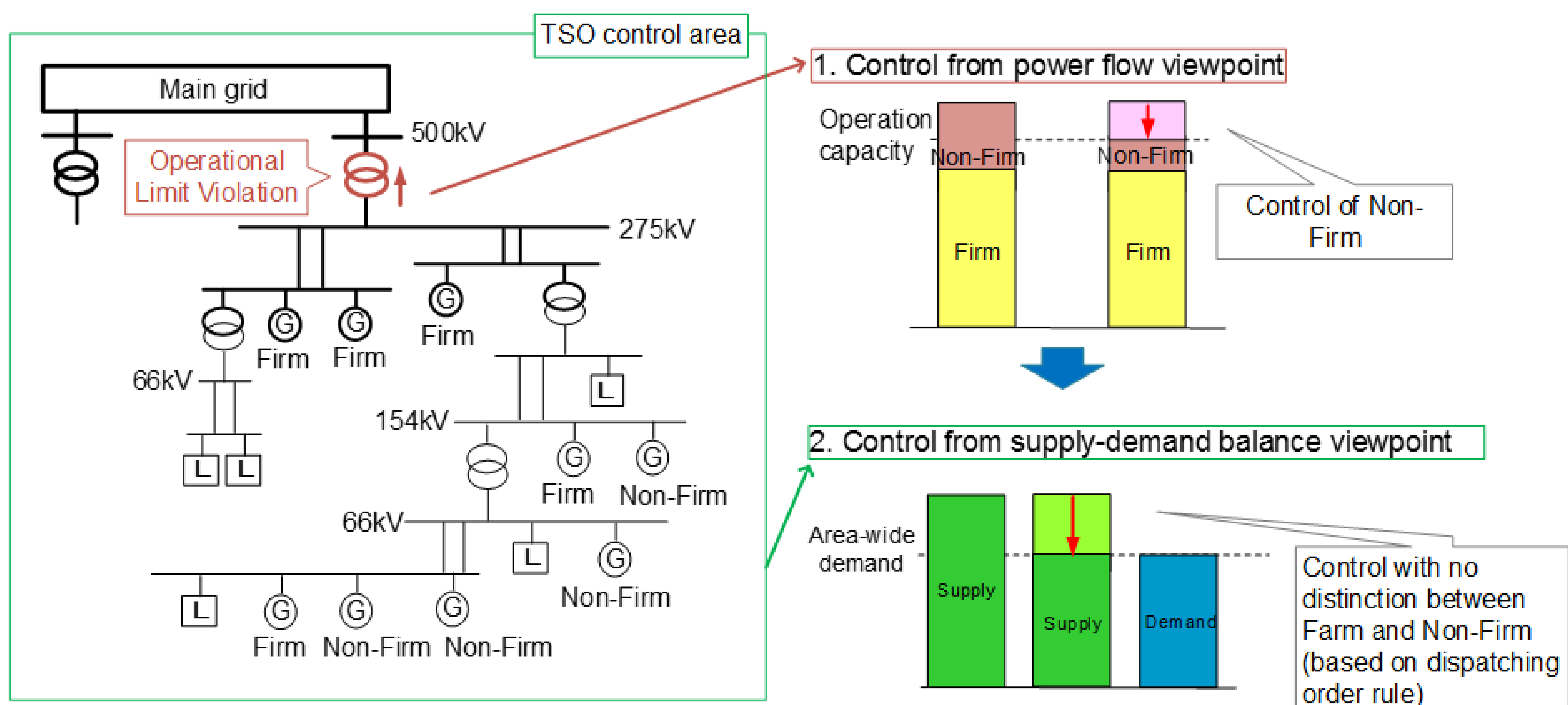


Figure 6: Relationship between supply and demand control and system constraint control