Renewable Energy Control Model for Water Distribution Main Telemeters

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INTRODUCTION

A water distribution main telemeter is a remote device that automatically collects water flow, pressure, and other data. There are telemeters currently installed in 313 locations in Tokyo. These telemeters play a necessary role in proper water supply operation.

Tokyo Waterworks maintains operation of water distribution main telemeters for 72 hours or longer after power failure in case of emergencies, focusing on providing a better backup (UPS) power system to prevent data loss in power outages.

This project on the power system that incorporates three power sources – solar panels (renewable energy), stored batteries, and power supplied by power companies – entered verification testing. One backup system was installed at a water distribution mains telemeter in eastern Tokyo area in March 2016 to collect data for one year beginning in April 2016.

This paper describes the following two points, regarding the results of verification testing on power system operation:

(1) Backup power (UPS) function that activates power supply during power outages

(2) Environmental load reduction through precise usage control of the power supplied by power companies

In this article, "water distribution mains" are defined as distribution pipes, distributing water from water supply stations to supplied areas, that are installed under the public streets and similar in Tokyo and have a diameter of 400 mm or larger with no faucet directly connected to them.

Figure 1: Telemeter board exterior

Methods

1. Overview of three power source systems

- The three power sources consist of …
  Power generated through solar panels, power in storage batteries, and power supplied by power companies
- Their usage is determined based on the priority order assigned for the three power sources.
- Their priority order is as follows:
  With the aim to satisfy both power backup (UPS) and lower environmental load simultaneously, we have set priority as:
  First, power generated by solar panels first
  Second, power by storage battery
  Third, power from the power company

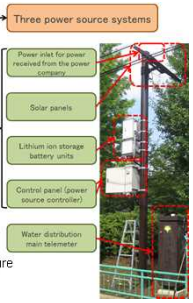


Figure 2: Installed equipment

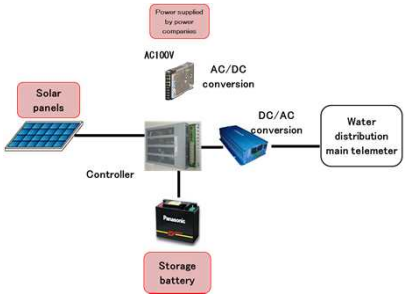


Figure 3: Chart of the three-power source system configuration

2. Usage examples for the three power sources

- These three power source systems are installed on the pole closest to a water distribution main telemeter (Figure 2).
- A control panel (Figure 3) regulates the power source switcher.
- During daytime in good weather, the solar panels generate power to supply the telemeter and store surplus in storage battery units (top-left of Figure 4).
- At night, the storage battery with sufficient remaining charge supplies the stored power to the telemeter (bottom-left of Figure 4).
- As the storage battery charge gets low, power supplied by the power company is used, providing power to the load and charge to the storage battery (top-right and bottom-right of Figure 4).

3. Evaluation methods

- This verification test collected data, including the amount of power generated by solar panels and the remaining charge in the storage battery units, for a period of one year. The data we compiled were evaluated based on the following:

(1) Backup power (UPS) in power outages

- Testing of backup power in a power outage was conducted in the control circuit under a combination of two conditions: no power supply from a solar panel or only storage battery at the time of power failure or nighttime.
- Under these conditions, power to the water distribution main telemeter was maintained for 72 hours to verify the power depletion trend needed for backup in the storage battery charge.

(2) Environmental load reduction

- In pursuit of lower environmental load, we have changed to a control method that prioritizes the power from solar panels and storage battery units and reduces usage of power supplied by power companies as much as possible.

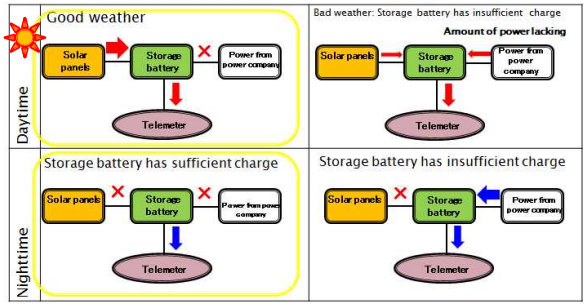


Figure 4: Usage examples for the three power sources

- In line with our goal to use as much solar-generated power as possible, we confirmed the difference in usage rates of power from power companies at our initial settings with those after the change.

RESULTS

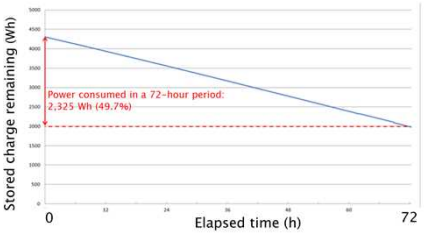
1. Backup power (UPS) in a power outage

- The storage battery used was a lithium ion storage battery with a 4,700 Wh rated capacity.
- Water distribution main telemeter load was 25W, with a power consumption of 2,325 Wh (49.7%) over the period of 72 hours (Figure 5).
- As the storage battery is designed to stop providing power when the remaining charge drops to 3%, it has been determined that 49.7 + 3=52.7 ≒ 53% (2,491 Wh) is the minimum required to ensure a 72-hour backup power supply when only a storage battery is used.

2. Environmental load reduction

- Backup power (UPS) functionality for power outages was achieved at 53% remaining stored charge.
- Thus, for the operational range of the other 47% (= 100% - 53 %) of stored battery charge, default settings were changed to prioritize solar power (Figure 6).
- Comparison of measurements

This adjustment improved the usage rate of power supplied by power companies by approximately 45 points (approx. 58%, measured in November for a month period → approx. 13 %, measured in February for a month period), compared with the initial settings for storage battery charge (Table 1).



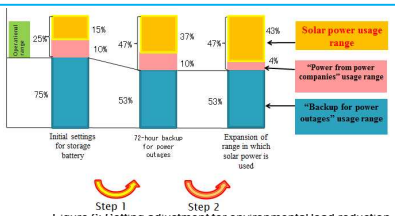


Figure 6: Setting adjustment for environmental load reduction

Table 1: Change in actual load management measurements

	Nov. 11 to Dec. 2	Dec. 3 to Feb. 8	Feb. 9 to Mar. 25
Commercial power usage (kWh)	11.05	16.91	5.04
Commercial power usage rate (%)	57.78	29.67	12.67

Step 1
Approx. 28-point improvement
Step 2
Approx. 16-point improvement

CONCLUSIONS

- With regard to the backup power (UPS) function, we have verified its effectiveness and that the percentage of storage battery charge balance required to maintain power supply to a water distribution main telemeter over a period of 72 hours is 53%.
- Furthermore, we were able to lower the environmental load within the 47% storage battery operable range. This was done through configuration changes to prioritize use of power generated by solar panels and reducing power from the power companies.
- We confirmed the effectiveness of this control model as a power control method that can serve as both a power backup (UPS) during power outages and also reduce environmental load.
- We hope that these advances will contribute to the further implementation of UPS systems at water supply facilities and the use of renewable energy sources.