USING REAL-TIME ENERGY MANAGEMENT (RTEM) TO OPTIMIZE RUNTIME AND CAPACITY

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Reducing Energy Costs by Optimizing Start-Up and Capacity Control

The runtime hours of heating, cooling and ventilation equipment equates directly to energy consumption and utility expenditures. Adjusting the capacity of a building's central plant to compensate for weather conditions and occupancy can also lead to energy and cost savings. Real Time Energy Management (RTEM) offers property owners and operators the right combination of operational techniques and practices to take advantage of these opportunities to reduce energy consumption and utility costs.

A multi-year NYSERDA-led M&V analysis of eight **Rudin Management Company, Inc.** commercial buildings in NYC, equipped with **Nantum by RTEM vendor Prescriptive Data**, finds that buildings are able to **reduce daily electricity consumption** through **Real Time Energy Management (RTEM). By leveraging RTEM, buildings can optimize start-up and capacity control strategies** to reduce loads during periods of lower than normal occupancy.

The Status Quo – Manual and Fixed Scheduling

Many buildings rely on fixed schedules programmed into building automation systems (BAS) to operate the building's heating, cooling and ventilation systems. Unfortunately, the start-up, and capacity adjustment of the plant equipment, which contribute to a significant portion of the building's energy expenses, are rarely optimized once comfort settings are satisfied. Figure 1 is an example of a fixed building start-up and serves as the baseline HVAC plant consumption profile.

BAS too often only monitor proxy conditions of the space environment. For example, measurements of supply and return air temperatures in air-handling units or chilled water leaving/returning temperatures in a chilled water loop are used as substitutes for measuring the actual temperatures and air quality of a space. Consequently, the start-up and capacity control of heating, cooling and ventilation plant equipment are conservatively determined and are often left unchanged for years. Adjustments for excessively hot or cold weather conditions are left to the experience and judgment of building staff, who often have very little historical data trends to assist in determining optimal start-up and active management of building systems for disparate weather conditions.

Using RTEM to Optimize Runtime and Capacity

Building maintenance staff can readily lower heating, ventilation, and cooling-related energy consumption without sacrificing comfort by using RTEM to optimize capacity and runtime during:

- **Start-Up:** Start up building mechanical system at the beginning of the day
- **Occupancy-Based Control:** Reduce building mechanical system capacity during periods of lower than normal occupancy, such as during lunch hours and ramp-down.

At a glance, the potential energy reduction from delaying start-up and reducing capacity throughout the day may seem small compared to the effort expended. Skeptical building owners and operators may surmise that concerns over the risk of failing comfort settings obligated in tenant leases are not justified; however, the results of this study show that **buildings can save 31% by deploying these measures through real time energy management**. This document provides an illustrative example of the potential savings dervied from optimizing start-up and capacity control.

The uncertainty is mostly derived from the lack of insight into the physical properties of a building in obtaining a desired thermal state and the time it takes to deviate from the achieved state when the energy introduced by mechanical conditioning is removed or reduced. Reducing capacity in anticipation of a load shift (ie. active occupancy tracking and temperature monitoring) assists in the control and management of load in real-time. **RTEM data provides this insight.**

Savings from Optimizing Start-Up

The simplified profile in Figure 1 is used as a baseline to calculate relative savings as the start-up time is delayed.

The total electric energy measured in kWh is equal to the area contained within the kW profile over the operating hours. Using Figure 1 as the baseline, delaying the start-up time by one hour from 3 a.m. to 4 a.m. would reduce kWh consumption by 6.48%; all other factors would remain unchanged (according to Figure 1). Delaying the start-up time by another hour to 5 a.m. would increase savings to almost 13% compared to the baseline.

If the start-up is eventually delayed to 6 a.m., as shown in Figure 2, **savings in electricity jump to 19.4%**.

Figure 1: Fixed Schedule Baseline HVAC Plant Consumption Profile

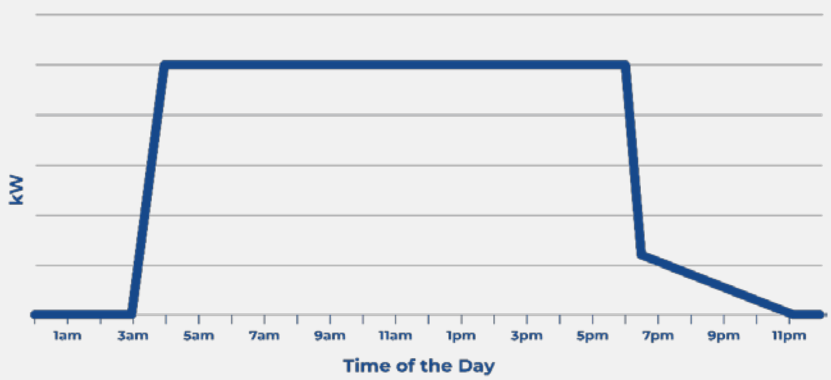


Figure 2: Delay in HVAC Plant Start-Up Time

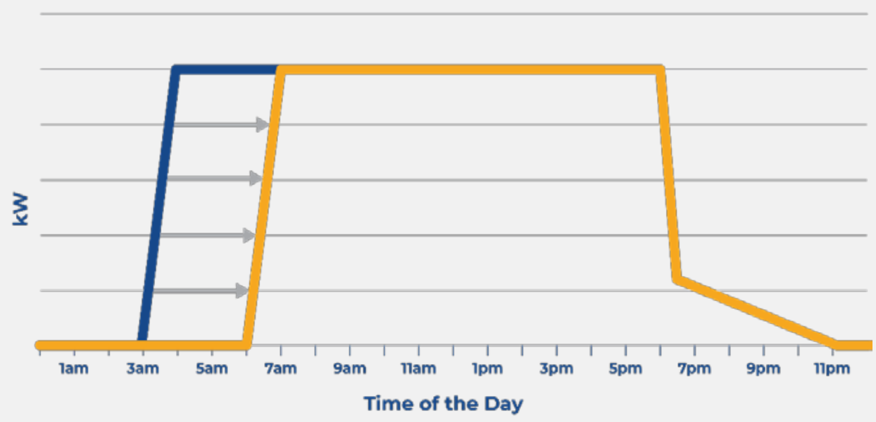


Table 1 summarizes the savings for delaying start-up from 3 a.m. to 4 a.m., 5 a.m. and 6 a.m., respectively. The savings are reported in percentages compared to the consumption of the baseline profile.

Table 1: Energy Savings Compared to Figure 1 Baseline

	Savings	Run Hours
3 a.m. Start-Up	Baseline	15
4 a.m. Start-Up	6.48%	14
5 a.m. Start-Up	12.96%	13
6 a.m. Start-Up	**19.43%**	**12**

Knowledge of the rate at which the building's various interior environments respond to mechanical cooling or heating is necessary to confidently optimize start-up, and **having an RTEM system installed in a building is critical to support data-driven decision making.** By integrating additional temperature sensors in representative spaces within the building, the RTEM system supplements readings provided by the BAS. The real-time monitoring of the actual space environment enables building maintenance staff to optimize operating hours, with each hour of reduction providing corresponding savings.

The benefits of this strategy are readily available in commercial buildings where the building plant is not operating 24x7. Operators and consultants can quickly evaluate the level of savings possible for any building by analyzing existing data and historical records. It may require a straightforward retrofitting of sensors and fine-tuning of the existing BAS to implement this strategy.

Savings from Automatic Capacity Control Modulation

Occupancy information such as the data collected by a building's security turnstile system is very useful for estimating the number of building occupants for the purpose of HVAC control. Also, using this data, the relationship between the temperatures in various spaces and occupant levels can be understood.

Once this relationship is understood, the building operator can confidently scale back the building plants and save energy as building occupancy decreases. A building plant with variable-frequency drives provides the adjustment mechanism to scale the mechanical conditioning capacity.

Figure 3 shows the baseline and two scenarios in which the building plant is ramped down 10% and 20%, respectively, for 90 minutes during an occupancy shift, such as during the lunch hour period.

Figure 3: Lunchtime Occupancy Adjustment

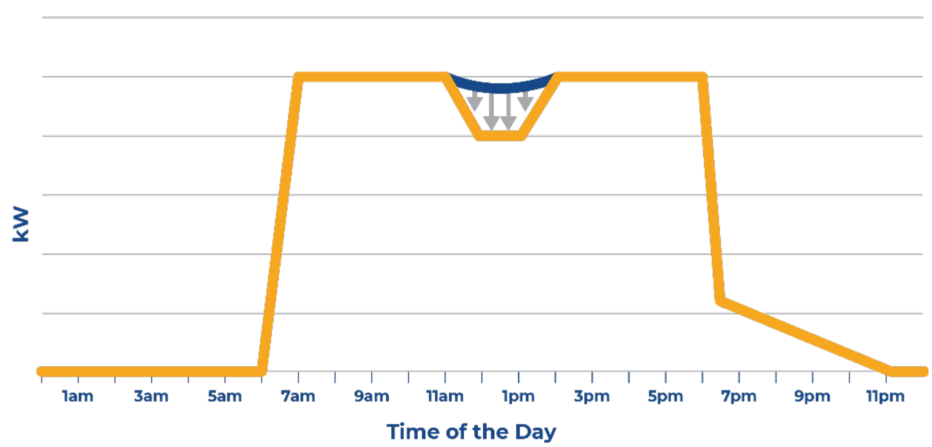


Table 2 summarizes the savings for the two lunch period ramp-down scenarios. A reduction of 10% during the lunch period provided a daily energy savings of 1.6%, compared to the baseline case without lunchtime control. **A reduction of 20% provides daily energy savings of 3.2% compared to the baseline.** In these scenarios, the baseline is shown in Figure 3, where the plant was started up at 6 a.m.

Table 2: Energy Savings Based on 1.5 Hours of Lunchtime Control

Lunchtime Control	Savings
No Adjustment	Baseline
10% Adjustment	1.61%
20% Adjustment	**3.22%**

Additional Savings from Automatic Capacity Control Modulation

As a thermal storage medium, a building does not lose conditioned thermal energy quickly. There is an opportunity for energy savings by using a building's actual occupancy level to determine when the building plant should ramp down while maintaining comfort levels.

Figure 4 compared ramp-down at 6 p.m. with two scenarios of early occupancy-based automatic capacity control startegies: one at 5 p.m. and the other at 4 p.m. In both scenarios, the ramp-down times were based on occupants' leaving the building, which decreases the building load. The earlier ramp-down would avoid the wasting of energy in zones that are no longer occupied by leveraging & optimizing the thermal inertia of the building.

Figure 4: Occupancy-Based Capacity Control

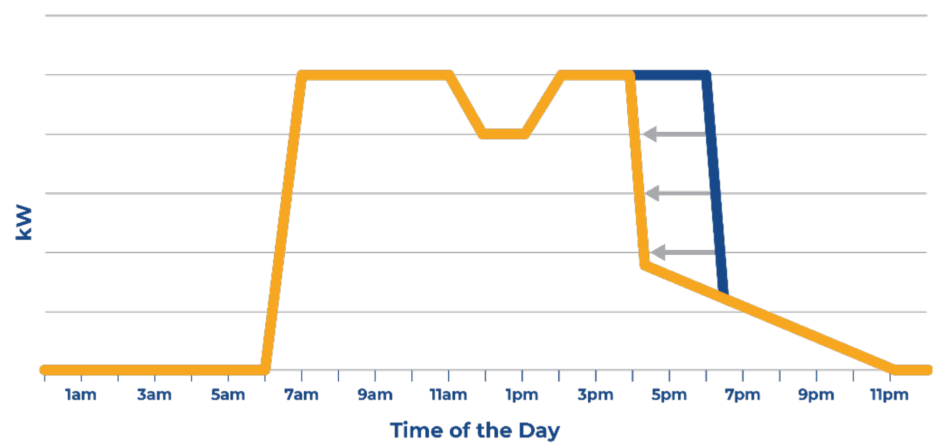


Table 3 summarizes the energy savings of the early ramp-down. Ramping down earlier by one hour can save energy by almost 6%. **Ramping down earlier by two hours provides savings of 11.4%**.

Table 3: Energy Savings of Early Shut-Down Using the Building's Actual Occupancy Level

	Savings	Hours
6 p.m. Shut-Down	Baseline	12
5 p.m. Shut-Down	5.92%	11
4 p.m. Shut-Down	**11.42%**	**10**

Aggregated Energy Savings Opportunity

By aggregating all three use cases (optimizing start-up, ramping down during periods of lower occupancy, and ramping down the building plant early), **buildings can save nearly 31% compared to baseline fixed schedule daily electricity consumption**, as summarized in Table 4.

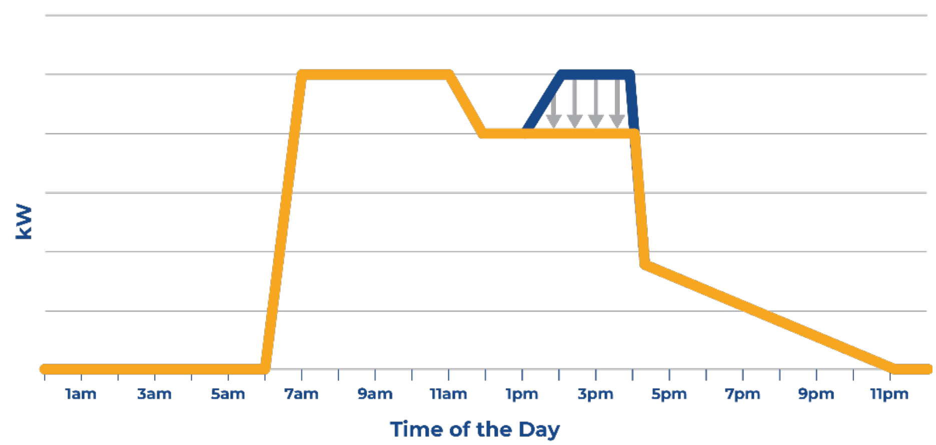
Table 4: Energy Savings Comparing Figure 1 to Figure 4

	Savings
Fixed Schedule Baseline HVAC Plant Consumption (Figure 1)	Baseline
Occupancy-Based Early Shut-Down (Figure 4)	**30.93%**

Additional Opportunities for Energy Savings

There are additional novel opportunities where creative building operators can exploit the strategies described in the three uses cases. Figure 5 shows a savings strategy that is available when occupancy levels depart from normal patterns, such as Fridays during the summer and just before major holidays.

Figure 5: Friday Consumption Profile



On days such as Fridays, building occupancy levels never returned to the morning peak after the lunch-hour lull. The same profile also occurs just before major holidays.

The occupancy-based ramp-down strategy would automatically detect the reduction in building occupancy and scale back the mechanical plant capacity. Figure 5 shows significant savings are available with the building operating at 80% capacity for the afternoon period.

How do I deploy RTEM services like real-time optimal capacity control?

NYSERDA Real Time Energy Management Program

The New York State Energy Research and Development Authority (NYSERDA) supports the deployment of RTEM services such as optimal capacity control through its Real Time Energy Management program (RTEM). Through this program, NYSERDA provides a 30% cost share for all project costs associated with cloud-based energy management systems and related on-going services for up to five years. RTEM provides up to $300,000 per eligible site[1] for installation, hardware, software, analytics, training, and more.

All you have to do is work with a NYSERDA-qualified RTEM vendor. NYSERDA has more than 50 qualified and vetted RTEM vendors to choose from for these projects, including several with no upfront cost subscription payment models. Many of the RTEM vendors provide real-time optimal capacity control.

We want to support your project

The NYSERDA team is eager to work with you and will happily provide additional information and guidance to answer any questions you may have about real time energy management Contact NYSERDA at RTEM@nyserda.ny.gov to speak with a RTEM technology expert or visit us at nyserda.ny.gov/rtem.

[1] Participants must be New York State electricity distribution customers of a participating utility company that pays into the System Benefits Charge (SBC). These utilities include Central Hudson Gas & Electric Corporation, Consolidated Edison, New York State Electric & Gas Corporation, National Grid, Orange and Rockland Utilities, Inc., and Rochester Gas and Electric Corporation.