Smarter Small Buildings Campaign

# Product Selection Guidance for Small Building Control

The guidance presented in the table below can be used by building owners and operators to help define the HVAC roof-top unit (RTU) control solution features required to meet the needs of their building or building portfolio. The guidance is organized in a tabular format and includes the following sections[1]: Networked Thermostatic Control, Advanced RTU Control, Optimized RTU Control, Trending & Analytics, Accessibility & IT Requirements, Scalability & Compatibility, and Delivery Model & Ongoing Services. Each section includes relevant capabilities along with guidance that describes the capability, benefits, and considerations.

The product capabilities listed in the table may not be exhaustive; they are intended to support dialog between different stakeholders within an organization to determine their requirements. Following the table of capabilities, a discussion of cost implications is presented. The owner can use the capabilities and list of cost implications in discussions with vendors to help determine if a solution meets the needs of the building(s) and stakeholders.

**How to Use This Guidance**

- For each capability, it is recommended to identify relevant stakeholders (e.g. IT, maintenance, energy management, sustainability, finance, management, etc.) and work with them to determine if the capability is required, nice to have, or not necessary for operation. This designation will help you when you work with vendors to determine the technical specification and cost of the proposed controls solution.
- Share your list of requirements with potential vendors to determine if they meet your defined criteria and ask for a proposed cost. Also see the section at the end of this document titled, “Cost Implications” to get a high level understanding of capabilities and requirements that may impact the cost of your solution.
- Once you’ve selected a few ‘top candidates’, request a live demonstration of the product’s interface for your key stakeholders that will be using the control solution. This will allow you to ask additional detailed questions about the functionality, installation, O&M, and determine if the interface of the controls solution will meet your needs.

[1] The first three sections of the table, “Networked Thermostatic Control”, “Advanced RTU Control”, and “Optimized RTU Control” align with the “Stairway to Better Buildings”, which reflects differing levels of control and their benefits.

| Product Capabilities | Guidance |
|---|---|
| **Networked Thermostatic Control** | |
| Centralized **monitoring** of zone temperatures, setpoints, schedules, equipment status, and critical alarms, for multiple RTUs and buildings | The capability to remotely monitor building conditions and equipment status can help facilitate remote troubleshooting. The capability to make remote adjustments can potentially alleviate the need for a site visit and reduce equipment downtime. Data monitoring points and historical data storage can vary between vendors (as noted in the Trending & Analytics section). |
| Centralized **adjustment** of control parameters such as setpoints and schedules for multiple RTUs and buildings | |
| **Advanced RTU Control** | |
| Variable speed or multi speed supply fan control | If the existing RTU is a constant volume unit (i.e., constant speed fan), there are a number of solutions that can add this control capability. It can be converted to variable speed or multi speed through the addition of a variable speed drive, a variable speed motor and controller, or a multi speed motor and controller. Note that variable speed fan control is becoming more common in newer RTUs and your RTU may already be a variable speed unit. |
| Economizer controls, Fault detection & diagnostics (FDD) | For RTUs that do not have an economizer, you may consider retrofitting the RTU with hardware and control to allow for economizing. An economizer adjusts the position of the RTU dampers to utilize outdoor air for cooling when the conditions are favorable to do so. Adding an economizer to an existing RTU saves energy.<br><br>Economizer FDD messages include economizer not operating when it should be operating, economizer operating when it should not be operating, stuck damper, or sensor fault (e.g., sensor out of range, sensor value not changing, etc.). Economizer FDD is required by ASHRAE 90.1 and some state-level building codes (e.g. California Title 24) for newly installed RTUs with air economizers and cooling capacity over 4.5 tons. New RTUs likely have this embedded in the unit controller, and some control products also offer the required capabilities. |
| Occupancy-based control for heating/cooling, lighting, ventilation, etc. | Occupancy-based control is beneficial for zones such as conference rooms that may be unoccupied for significant periods of the day, or in offices where hybrid schedules lead to zones being unoccupied for an entire day. If the zone served by an RTU includes multiple spaces, each space should have its own occupancy sensor. |
| Demand-controlled ventilation (DCV) | DVC is a specific form of occupancy-based control. Implementing a DCV strategy will likely require the installation of a $CO_2$ sensor in the zone served by an RTU or return air ductwork.<br><br>DCV strategies reduce ventilation rates when $CO_2$ readings indicate zone occupancy is less than design. Reducing ventilation will generally reduce the energy required to condition air being distributed to the building. |

| Product Capabilities | Guidance |
|---|---|
| **Advanced RTU Control Continued** | |
| Optimal start/stop | Optimal start algorithms avoid starting HVAC equipment earlier than necessary, thus saving energy. They do this by automatically determining the latest time equipment can start and still reach the occupied temperature setpoint on time.<br><br>Optimal stop algorithms automatically determine when equipment heating and cooling can be turned off near the end of the day, allowing the building temperature to drift for the remainder of scheduled occupancy. The supply fan continues to run to provide ventilation air during the optimal stop period. |
| **Optimized RTU Control** | |
| Vapor Compression Cycle Fault Detection & Diagnostics (FDD) | FDD tools for vapor compression cycles enable the detection and possibly the diagnosis of faults such as refrigerant undercharge or overcharge, condenser fouling, liquid line restrictions, etc.<br><br>This capability will likely require additional sensors and analytic software beyond what is standard in an RTU. |
| Coordination of units to limit peak demand at startup | In this strategy, RTU operation is coordinated during the morning start-up period. This strategy minimizes the consumption spike that can occur if all RTUs in a building start simultaneously, with the potential to reduce monthly electricity demand charges on the utility bill. |
| Dynamic multi-unit coordination | Dynamic multi-unit coordination is a more sophisticated strategy when compared to “coordination of units to limit peak demand at startup”. It can be executed via a number of strategies that perform continuous coordinated control of multiple RTUs to achieve one or more objectives. Most commonly, these strategies aim to reduce total electrical demand while maintaining comfort.<br><br>One strategy limits the maximum number of stages of cooling that are used across all your RTUs at any given time and rotates which RTUs are allowed to operate (or are allowed to operate with more than one stage of cooling) based on zone demand. There are also more sophisticated algorithms that use model-predictive control to continuously adjust zone setpoints in order to limit demand and maintain comfort. |

| Product Capabilities | Guidance |
|---|---|
| **Optimized RTU Control Continued** | |
| Facilitation of automated grid-responsive strategies | Examples of automated grid-responsive strategies include temporary zone setpoint adjustments in response to a signal from the utility using openADR or IEEE 2030.5.<br><br>More utilities are offering incentives to temporarily reduce building loads during peak demand periods, for example through demand response (DR) programs. Even if you are not ready to implement DR immediately, this may be a future feature that you consider if your utility offers or might offer a DR program. |
| **Trending & Analytics** | |
| Enhanced monitoring through feedback on equipment status and operating parameters | Monitoring and feedback of equipment status and operating parameters may help with troubleshooting issues. Determine which conditions are required for your O&M team and which are nice to have, and then ensure the control system can support the needed sensor inputs and control outputs (e.g. fan status, status of heating/cooling stages, CO2 level, outside air temperature, supply air temperature, economizer damper position and fan speed). |
| Historical data on equipment status and operating parameters goes back a minimum of [X days/months/years] and is accessible through the user interface | Historical data can be useful for numerous reasons, including as a benchmark of past performance against which current performance can be measured. Historical data can also be very useful for maintenance technicians as a diagnostic tool. Generally, having at least a year of historical data is beneficial, but offerings from vendors vary and may require additional cost. In addition, you may request that data collected shall be made freely available to the operator if you were to end your software subscription. |
| Notifications/alerts/alarms via email or text for [x,y,z] | Notifications can be helpful to alert your maintenance team about issues prior to occupant complaints. Vendors may have different notification types and sensitivities, so you can define your preferences. Vendors may have pre-defined alarms, while other alarms you require may be considered custom. For example, notifications can be sent for economizer and vapor compression cycle FDD. |
| Additional trending and analytics features | There may be additional trending and analytics features your team needs that are not listed in this table. For example, graphical representations of equipment, import of custom floor plans. |

| Product Capabilities | Guidance |
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| **Accessibility & IT Requirements** | |
| Remotely access devices through a web-based platform from a desktop | A web-based platform can be accessed from a desktop to perform management functions “at scale”: central management of schedules, setpoints, thermostat configuration, alert management, etc. |
| Remotely access devices through a mobile interface/app | A mobile interface can allow technicians to easily see equipment status and adjust thermostat settings while in the field. |
| IT Requirements (see this example of IT requirements from UC Davis) | Consult with your IT team to determine IT configuration and cybersecurity requirements. IT may have separate software requirements in addition to network standards. For example, IT may require devices to be on a dedicated network, either through a secondary wired network or VLAN. |
| Additional accessibility requirements | Examples of additional requirements include: ability to assign building operators remote access to individual thermostat controls, ability to assign permission levels to different user types, or the ability to allow occupants to make temporary setpoint adjustments at the local thermostats that will reset after a predetermined period of time. |
| **Scalability & Compatibility** | |
| Compliance with local energy codes (e.g. California Title 24, Part 6) | Many state and local jurisdictions have adopted energy codes with requirements pertaining to demand-controlled ventilation, economizer control, FDD, and other energy-saving strategies. |
| Compatible with the different types of HVAC systems in the building | For example, ensure the product works with more complex HVAC equipment and systems such as dual fuel Heat Pumps, multiple-zone HVAC systems, or RTUs with VAV distribution systems. |
| Capability to host [X] number of buildings/RTUs through the central interface | Ensure the product’s interface will be able to support the total number of HVAC units/buildings that could eventually be connected to the networked control system. |
| Capability to integrate with and monitor other energy end uses and provide on/off control of [lighting, pumps, fans, and other equipment] | Update this to clarify other end uses you plan to or may want to integrate in the future. |
| Device accessibility through open protocol [Note if there is a specific communication protocol you require. e.g. Modbus or BACnet] | Thermostats from different manufacturers can likely be integrated into a single platform if they support the same open communication protocol. |
| Data accessible through web API | Describe if there is any data you would like to access from your controls solution and pull in to a central location (e.g. historical temperature and operating parameters) or if you’d like to interface with other applications such as a Computerized Maintenance Management System (CMMS). |

| Product Capabilities | Guidance |
|---|---|
| **Scalability & Compatibility Continued** | |
| Compatibility with other products (such as hardware from other vendors) | Some vendors may offer a solution that deploys a software overlay to implement physical control strategies. Vendors providing software solutions may utilize their own hardware or hardware from other vendors to implement the physical control changes (e.g., setpoint changes) dictated by their control strategies. These vendors sometimes provide a list of approved thermostats or other control devices/hardware to which they have successfully integrated their software. |
| **Delivery Model & Ongoing Services** | |
| Who sells and installs the control solution? | Often the control solutions are available either direct from the manufacturer or through their channel partners or network of authorized distributors. Manufacturer websites typically have a “Contact Us” or “Find a Distributor” link to help get you started.<br><br>Local contractors commonly purchase control products from distributors and perform the installation and servicing. Ask if a contractor’s technicians have experience installing the product being considered. |
| Describe the managed services offering such as remote monitoring and periodic performance reporting | Additional services may be cost effective for organizations that do not have staff to monitor their control system to troubleshoot problems or implement findings. |
| Is there local staff available to service the product and troubleshoot issues? If not, how do you provide support? | Some vendors may not have local staff to troubleshoot issues and may only have a Technical Support Line. If that's the case, ensure the vendor provides adequate documentation and training that is updated regularly. This will be especially important if you plan to have existing staff install and maintain the system and will not rely on vendor staff. |
| Briefly describe the software and firmware updating process. How often (frequency) are updates provided, what does the user have to do, and is there a cost?<br><br>What is the average lead time on replacement parts? | These questions will help you begin to plan for operating and maintaining the system. |

## Cost Implications

The cost of the control solution and ongoing services will depend on what is required to meet your defined specifications. There are a range of cost models on the market, so the list of questions below can be sent to vendors to help estimate the cost of the solution based on your required vs. nice to have capabilities.

### List of Questions to Ask in Relation to Product Costs

- Does your product fall under utility rebates in my jurisdiction?
- What is the itemized cost of the hardware required to meet my specification (e.g. sensors, thermostats, etc.)?
- What is the ongoing (annual) base cost for the software? Is it based on # of thermostats, # of gateways, # of buildings, sq. footage, etc.?
- What is the cost of software subscriptions that provide enhancements to the base offering?
- Do you need to license this system? If so, what is the cost?
- Is there a cost for additional users?
- Is there an additional cost to use the mobile app?
- What is the warranty on this system?
- What is the cost of data storage? What is included in your base offering and what do you charge for additional storage?
- Is there a cost to facilitate communication of receiving grid signals for demand response?
- If the control solution uses a wireless connection to a gateway, how many gateways will I need to purchase?
    - What is the maximum range between the gateway and the thermostat?
    - How many thermostats/RTUs can be connected to a single gateway?
- Do you offer local labor for installation? If so, what is the cost breakdown?

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