Part-Load Efficiency

What is Part-Load Efficiency?

Part-load efficiency refers to the ability of a system to handle part-load energy use and it should be taken into consideration when specifying an HVAC system. Systems generally operate at their peak efficiency when they are working at their maximum capacity and most systems are sized to meet heating and cooling conditions that occur only 1% to 2.5% of the time. Because of this, systems are often oversized, rarely operate at full load, and thus do not operate efficiently.[1]

Figure 1 – Multiple Boilers
(Source: Rutgers University)

How to Implement Part-Load Efficiency

Proper sizing of an HVAC system can maximize part-load efficiency. Selecting the appropriately sized system requires an understanding of the peak heating load and the system's load profile.[2] Determine how often the HVAC system will be running under part-load conditions. If that will be a frequent occurrence, look for a system that will be efficient for those part-load conditions.[3] Beyond right-sizing equipment, there are system components and modular components that can be selected to improve efficiency. A few examples of these components that can operate efficiently at part-load include variable volume fan systems and variable speed drive controls for fan motors; variable capacity boiler plants, cooling plants, cooling towers, and pump systems; and temperature reset controls for hot water, chilled water, and supply air.[4]

In buildings with highly variable loads, which is common in commercial buildings, multiple, modular boilers are an option. Modular systems are more efficient as they permit each boiler to operate around maximum rated load most of the time and reduce

---

[1] Whole Building Design Guide. High-Performance HVAC. http://www.wbdg.org/resources/hvac.php (accessed June 9, 2010).
[2] United States Department of Energy Office of Energy Efficiency and Renewable Energy. How to Buy an Energy-Efficient Commercial Boiler. http://www1.eere.energy.gov/femp/technologies/eep_boilers.html (accessed June 11, 2010).
[3] Facilities.net. http://www.facilitiesnet.com/energyefficiency/tip/When-Selecting-HVAC-Products-Look-at-Part-Load-Performance--609 (accessed January 9, 2011).
[4] Whole Building Design Guide. High-Performance HVAC. http://www.wbdg.org/resources/hvac.php (accessed June 9, 2010).

standby losses. Other options include condensing boilers, and modulating boilers that can run at partial capacity rather than cycling on and off.[5]

Some engineers design systems with multiple boilers and chillers – one can be sized for 75% to 80% of the design load, while another is sized for the part load (30% to 40% of the full load). Operators can then select a unit based on the energy efficiency performance and the heating and cooling needs.[6]

The United States Department of Energy administers a directory of HVAC software tools to select appropriate HVAC systems:
http://apps1.eere.energy.gov/buildings/tools_directory/subjects.cfm/pagename=subjects/pagename_menu=materials_components/pagename_submenu=hvac_systems

Note: At the beginning of 2010 a new metric for measuring part-load cooling efficiency, the Integrated Energy Efficiency Ratio (IEER), replaced the Integrated Partial Load Value (IPLV) for unitary HVAC equipment greater than or equal to 65,000 Btu/h in the ASHRAE standard 90.1-2007.[7] More information is available at the Consortium for Energy Efficiency's website at: http://www.cee1.org/com/hecac/hecac-main.php3.

Example

The Meadows at Oldwick Assisted Living Facility – Oldwick, NJ

The development team for the Meadows at Oldwick decided on incorporating an efficient heat pump system into the design for a number of reasons, including its lower operating costs, especially under partial load conditions, its quiet operation, and its ability to deliver adequate heat in the cold Northeastern winter.[8]

http://www.daikinac.com/commercial/productsCases7.asp?sec=products&page=12

[5] United States Department of Energy Office of Energy Efficiency and Renewable Energy. How to Buy an Energy-Efficient Commercial Boiler. http://www1.eere.energy.gov/femp/technologies/eep_boilers.html (accessed June 11, 2010).
[6] Flex Your Power. HVAC System. http://www.fypower.org/com/tools/products_results.html?id=100124 (accessed June 9, 2010).
[7] Consortium for Energy Efficiency. Commercial HVAC. http://www.cee1.org/com/hecac/hecac-main.php3 (accessed June 11, 2010).
[8] Daikinac.com http://www.daikinac.com/commercial/productsCases7.asp?sec=products&page=12 (accessed January 10, 2011)

Benefits

- Optimizes energy efficiency
- Reduces on capital, installation and energy costs

Costs

The cost of implementing part load efficiency will vary depending on the equipment and system selected. Considering part load performance when designing and installing a system will save in first costs as well as operating costs.[9]

Resources

The Consortium for Energy Efficiency - directory of energy-efficient small commercial HVAC equipment
www.ceedirectory.org

US DOE | EERE - guide on how to select energy efficient commercial boilers
http://www1.eere.energy.gov/femp/technologies/eep_boilers.html

HVAC Design and Analysis Tools
http://www.trane.com/COMMERCIAL/DesignAnalysis/Default.aspx?i=898

Air cooled chillers
http://www1.eere.energy.gov/femp/technologies/eep_ac_chillers.html

Water cooled chillers
http://www1.eere.energy.gov/femp/technologies/eep_wc_chillers.html

Florida Solar Energy Center
http://www.fsec.ucf.edu

[9] Whole Building Design Guide. http://www.wbdg.org/resources/hvac.php (accessed March 20, 2011).