

Sizing Electric Water Heating Swaps

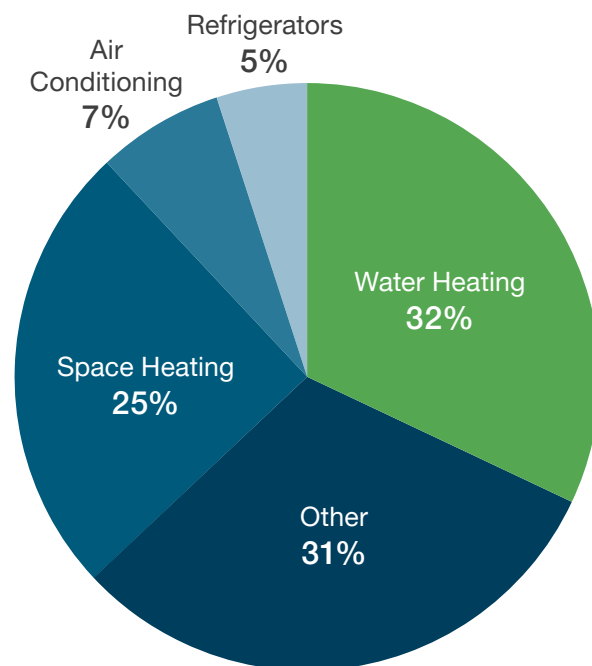
Introduction

This fact sheet is intended to assist those looking to make the transition to all-electric water heating systems from systems that rely on fossil fuel combustion. Electrifying building water heating systems allows building owners to futureproof and decarbonize their property while improving indoor air quality and streamlining utility bills.

Domestic hot water (DHW) represents, on average, almost 20% of the site energy use for multifamily buildings.

Multifamily buildings generally provide DHW to occupants in one of two ways; via a centralized boiler with recirculation or unitized (individual hot water heaters in dwelling units). This guide focuses on replacements for buildings with centralized systems.

Average Site Energy End Use for Multifamily (5+ units) Buildings





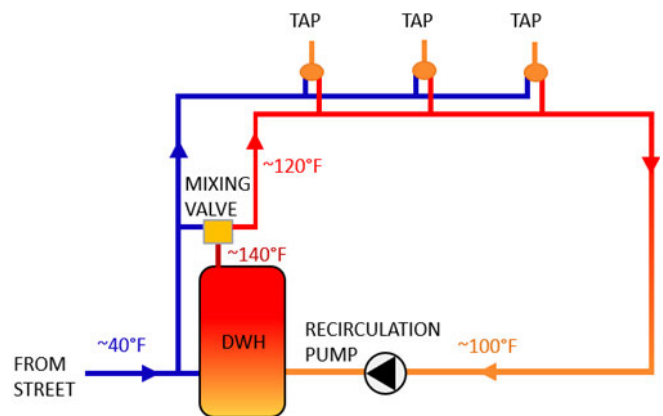
Multifamily Centralized Systems

Generally, centralized DHW systems operate by piping water from the municipal water system into a building and heating it to at least 140°F to prevent Legionella and other water-borne diseases. That water is then mixed with cold water to bring the temperature to around 120°F, where it circulates throughout the building and is delivered to taps in dwelling units.

In order to allow for hot water on demand, most buildings will implement recirculation loops that keep water constantly flowing and mixing with new water brought in from the street.

This system has the advantage of providing centralized DHW quickly to dwelling units but the disadvantage of being very energy intensive and reliant on combustion of fossil fuels to heat the water in the boiler system.

Fortunately, technologies are emerging to allow buildings to electrify DHW, including Heat Pump Water Heaters (HPWH). HPWH use electricity and refrigerant to take heat from the ambient air and transfer it to water via a heat exchanger. This water can then be circulated and delivered to units via the same piping already utilized by your central system.



Central plant with DHW reheat loop. Source: Steven Winter Associates

Appropriate Steps to Take When Planning Your Heating Swap

1

Understand Your True Demand

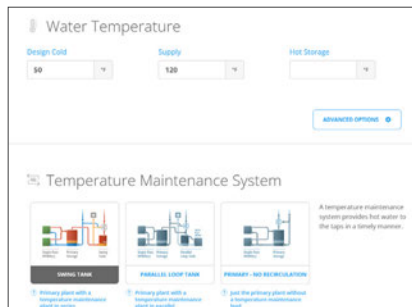
Prior to selecting and installing a HPWH as a replacement for a standard boiler system, you should first evaluate the actual demand for DWH in your building. Oftentimes central DWH systems are oversized to ensure hot water is available at each unit almost instantly. This generally isn't an issue for gas boilers because they are capable of modulating output via smart controls and take up a relatively small footprint.¹

HPWH have larger footprints, require right sizing of loads, and shouldn't cycle more than 6x/ hour if they are to maintain efficiency. Ideally, the heat pump is running regularly to heat water most efficiently. This means that excess storage capacity is more important with HPWH systems than excess heating capacity. Therefore, it's important to understand the true demand for your building. If your DWH system is submetered and you can calculate the average and peak demand for your system, start there. If not, investigate your true demand by auditing unit fixture capacities.

2

Calculate Loads Accurately

It is imperative that you not size a HPWH system using a boiler sizing methodology. As mentioned above, boilers can be oversized without dramatically impacting the performance (and cost) of supplying DWH. To properly size your system, utilize the **Ecotope Ecosizer** tool to better understand your loads and potential system size. Using the Ecotope Ecosizer tool allows you to vary inputs to better understand the HPWH size and storage capacities required for your space.



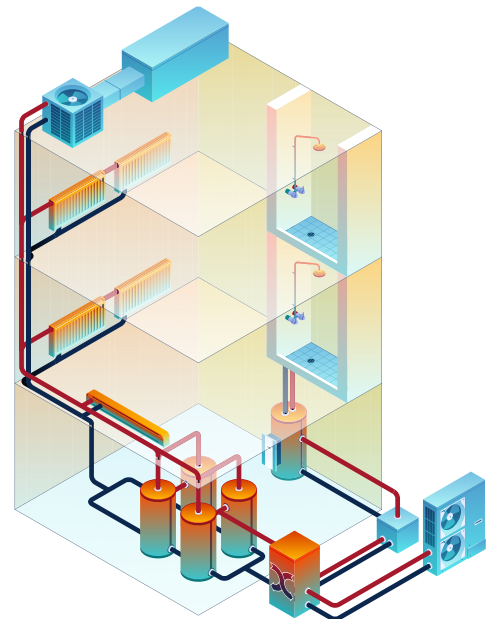
Screenshot of Ecosizer tool.

3

Properly Install

Heat pumps are more efficient at generating heat than burning fossil fuels but require space to operate. This is because they extract heat from ambient air using the refrigeration cycle and then reject cooler air into their surroundings.

Some spaces may not be suitable for HPWH due to the amount of space available vs the amount of space HPWH take up. Some systems will require multiple heat pumps to meet capacity and may require indoor and outdoor units to properly exchange heat. If a system is installed improperly or isn't provided the amount of space required to operate, it will lose efficiency quickly and operational costs will quickly escalate.



¹ <https://www.aceee.org/sites/default/files/pdf/conferences/hwf/2018/1c-oram.pdf>

This factsheet was developed in collaboration between New Buildings Institute and Steven Winter Associates.



Disclosure: This material is based upon work supported by the Department of Energy and Office of Energy Efficiency and Renewable Energy (EERE), under the Building Technology Office (BTO) Award Number EE0009747. The report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Sizing Electric Water Heating Swaps is made available under a Creative Commons Attribution 4.0.