CEE Commercial Water Heating Initiative Description

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- Rheem Water Heating: Chuck Rohde, Wholesale Market Manager and Rick Miller, Retail Market Manager
- Rinnai Tankless Water Heaters: Brian Rountree, Project Engineer and Business Development Manager for Commercial Accounts and Nina Knight, Marketing Communications Coordinator

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1 Overview

1.1 Initiative Purpose

There is currently potential for highly efficient commercial water heaters to gain traction in the marketplace. While the market for commercial water heaters is in most instances smaller than residential water heater market, there is still significant savings potential to be realized. This Initiative seeks to identify those actions which, if voluntarily adopted by energy efficiency programs, will make installation of high efficiency water heaters in commercial establishments common throughout the US and Canada.

The momentum built from the 2009 ENERGY STAR® label for residential water heaters is likely to encourage the supply chain to be more proactive about offering high efficiency to small commercial in addition to residential customers. The *CEE℠ Residential Gas Fired High Efficiency Water Heating Initiative* (referred to as the "CEE Residential Initiative" throughout this document), launched in January of 2008, may also provide momentum for a high efficiency commercial water heating effort because many of the same key industry representatives promote commercial water heating in addition to residential water heating. Awareness and interest in high efficiency may be further raised among business owners as the importance of capitalizing on lower energy use becomes more important to their overall profitability. In addition, conversations with industry suggest that manufacturers and distributors are becoming increasingly motivated to encourage the market diffusion of high efficiency commercial water heaters.

These factors, among others, have encouraged CEE to explore the area of commercial water heating for initiative development. The purpose of this initiative description will be to provide guidance for CEE members seeking to run or currently running natural gas efficiency programs for both commercial storage and tankless water heaters. The purpose of the initiative as a whole will be to increase the market share and availability of high efficiency natural gas commercial water heaters as defined by the Energy Policy Act of 2005 for use in commercial buildings in both the US and Canada.

The Initiative provides a common Initiative Approach including a definition of high efficiency equipment for both storage and tankless water heaters. Using this common Approach, energy efficiency programs can promote the adoption of high efficiency technologies and bolster their individual programs' effectiveness.

1.2 Initiative Goal and Objectives

The long-term goal of the Initiative is to increase the market penetration of high efficiency commercial water heaters and to develop specifications that achieve savings and are cost-effectiveness for our members. This goal will be achieved when:

- Building owners, building managers, energy managers, or property managers request high efficiency equipment

- High efficiency equipment is included in new construction building design plans by builders, design engineers, architects, or developers
- High efficiency equipment is promoted, sold, and installed in commercial buildings by installers
- High efficiency equipment is available from manufacturers, wholesalers and distributors and promoted to installers and key commercial building decision makers.

The Initiative's primary objectives in pursuit of the long-term goals are to:

- Increase the number of high efficiency models available
- Increase the percentage of sales of high efficiency equipment
- Build a market of sufficient size to help achieve the scale of production that allows manufacturers to offer high efficiency equipment at an attractive price to commercial building customers
- Increase the number of manufacturers, wholesalers, and installers who promote high efficiency equipment to their respective customer bases

1.3 Definition of Commercial Water Heaters

Commercial storage gas fired water heaters are, for the purposes of this Initiative, defined as those gas storage water heaters with capacities greater than 75,000 Btu/h and a minimum thermal efficiency (Et) of 80 percent or greater. This is consistent with the definition for commercial water heaters found within the US Energy Policy Act of 2005.[1] Commercial tankless water heaters also fall under the Energy Policy Act of 2005, but have a burner capacity that is equal to or greater than 200,000 Btu/h and a rated storage volume of less than 2 gallons. The Canadian Standards Association (CSA) and American National Standards Institute (ANSI) Accredited Standards Committee Z21/83 has developed a safety and testing standard that covers those units that have burners with capacities above 75,000 Btu/h for commercial gas storage and tankless water heater types (ANSI 2004). This ANSI standard is designated by the Energy Policy Act of 2005 to describe the test method for rating the efficiency of these technologies. Please note that there are currently no Canadian federal standards for commercial storage or commercial tankless water heaters, but Natural Resources Canada is working to address this through revising and expanding the scope of their current residential water heater regulations (NRCan 2010). In Canada, the definition of residential tankless water heaters has been extended to cover appliances up to 250,000 Btu/h. For more details about the federal regulations and test procedures as they relate to both

[1] Those units that are in compliance with the Energy Policy Act of 2005 and US Code Title 10, Chapter II, Part 431: Energy Efficiency Program for Certain Commercial and Industrial Equipment, Subpart G: Commercial Water Heaters, Hot Water Supply Boilers and Unfired Hot Water Storage Tanks.

commercial and residential water heating, please see 0: Water Heater Regulations, Test Methods, and Rulemakings.

1.4 Initiative Scope

The scope of this initiative includes natural gas as a fuel source and commercial storage and tankless units as technology options. High efficiency units are considered to be any natural gas storage or tankless water heater with an Et of 90 percent or greater. The majority of this guidance is applicable to both the new construction and retrofit markets, although some differences will be noted.

Those seeking to use residentially sized storage and tankless water heaters in commercial applications are encouraged to refer to the CEE Residential Initiative for guidance related to CEE efficiency specification tiers for these technologies and the related initiative approach. Some guidance is provided within this commercial water heating initiative regarding when it may be applicable to include residential units into commercial programs. This guidance is deemed appropriate because residential storage and tankless water heaters are commonly used in commercial applications, and a number of CEE members provide incentives for these technologies in their commercial programs. Further supplementary guidance may be developed to address considerations of particular applications for residential technologies used in commercial applications.

CEE will explore the inclusion of advanced and highly efficient water heating technologies and other fuel sources as they grow in interest to efficiency programs and commercial end users. At this time, the Initiative will not address boilers used to heat water in commercial applications, solar water heater systems, booster heaters, or electric water heating technologies. Efficiency programs are interested in understanding the efficiency gains and losses of both water heaters and system design. These areas will be further explored by CEE after the Initiative is established. This approach will create an opportunity to put a stake in the ground with a specification and will allow more time to explore both these areas as more data and case studies become available, and as CEE member interest grows.

1.5 Research Methodology

Wherever possible, publicly available data and published reports have been cited throughout this document. In other instances, where there were no published reports or data available, CEE conducted interviews with industry experts. These interviews have been cited throughout this document and have been made anonymous in order to protect the privacy of manufacturers in a competitive environment. These industry experts were sought out for their technical and engineering credentials as well as their ability to provide useful insights into the market for high efficiency water heating technologies. Because of the nature of these one-on-one interviews, independent verification of this information is not possible. In addition to the published literature and industry interviews, information shared by industry experts during the 2010 CEE

Industry Partners Meeting has been cited within this document where appropriate. Finally, CEE members with technical or marketing expertise who have contributed to this document have been cited as appropriate as well.

2 Market Overview

Storage water heaters are the most common type of water heater manufactured in the US, but tankless water heaters are beginning to see an increased market presence. Both storage and tankless units with higher efficiencies are produced and sold by all of the major manufacturers, but in smaller quantities than the models meeting the US federal minimum standard (AHRI 2011a).

2.1 Market Structure

Interviews with manufacturers and discussions with CEE members have helped to provide a strong sense of the overall market size for commercial water heating and are reflected in the subsections below. Manufacturers of commercial technologies typically sell solely to distributors or wholesalers, unlike the residential market where approximately half of the units are sold to retailers and the other half to wholesalers and distributors. It is very rare for commercially sized water heaters to be sold through big box retailers or local retailers.

2.1.1 Manufacturers

As noted in Section 2.2, the three major manufacturers of residential storage water heaters, A.O Smith, Bradford White, and Rheem, also produce the vast majority of commercial storage water heaters. However, there are a number of smaller manufacturers that produce commercial units as well.

Tankless water heater manufacturers such as Bosch, Navien, Nortiz, Paloma, Rinnai, and Takagi are beginning to build up a larger customer base in both the US and Canada. There are fewer commercial tankless water heaters on the market than commercial storage, but the use of tankless in commercial applications is becoming increasingly popular. Table 2 in Section 2.2 depicts the number and type of commercial tankless products, both condensing and non-condensing, currently being offered by tankless manufacturers. See 0: Manufacturers of Storage and Tankless Water Heaters for a current list of natural gas storage and tankless water heater manufacturers and their related brand names.

2.1.2 Distributors and Wholesalers

Distributors and wholesalers of both commercial and residential water heaters generally sell their product directly to installers rather than to the end user. They work directly with most manufacturers of commercial water heaters to buy their product, and often have relationships with a single manufacturer. For instance, Bradford White works with their own network of distributors and wholesalers for both their commercial and residential products. Distributors and wholesalers are often in the

position to be the communication link between the manufacturer and installer because they have the capacity to describe which products installers are looking for to their manufacturing contacts.

2.1.3 Installers

Installers most often acquire commercial water heaters through wholesalers or distributors. There are a multitude of installer types with various levels of experience. For example, some installers of commercial equipment who also work with other commercial HVAC equipment, such as furnaces and boilers, may be more familiar with the installation differences associated with higher efficiency water heaters. These differences can include system design upgrades, condensing drainage needs, and differences in venting requirements.

2.1.4 Building Owners, Building Managers, Property Mangers, and Design Engineers

In retrofit situations when the water heater needs to be immediately replaced, building owners, building managers, or property managers may work directly through an installer for selection and installation. In some cases, it is common business practice for property managers to handle the replacement without contacting the building owner. In new construction it is often the case that a design engineer is instrumental in selecting the type of water heater to be used. Design engineers often work from product lists to make selections on water heaters, and then works through an installer for installation. In order for higher efficiency units to be installed in new construction applications, it may be important for these models to be listed on a design engineer's product list.

2.2 Availability

The vast majority of available commercial storage water heater models have efficiencies of 80 percent Et. The major efficiency breakpoints are concentrated at that 80 percent Et level with about 380 models, with a jump of model availability occurring between 94 to 96 percent Et about 70 models between the three efficiency levels (AHRI 2011a).

The majority of all of these models are between 75,000 Btu/h and 500,000 Btu/h, with most between 100,000 to 200,000 Btu/h (AHRI 2011a). While this is not necessarily indicative of the installed base, industry experts suggests that it could be inferred since manufacturers are offering these models in significant quantities. Table 1 below highlights these efficiency breakpoints in more detail.

Table 1. **High Efficiency Commercial Storage Availability**[2]

Thermal Efficiency	Number of Available Models
90%	12
91–93%	9
94%	4
95%	32
96%	35

The availability of commercial tankless water heaters is less clear. Table 2 depicts the current availability of commercial tankless water heaters based on a review of manufacturer web sites and feedback from manufacturers. Again, these data points only account for commercial tankless model availability and not necessarily actual market share. There are currently very few commercial tankless units listed in the Air-Conditioning, Heating, and Refrigeration Institute Directory of Certified Product Performance (AHRI Directory), and yearly AHRI shipment data does not currently distinguish between residential and commercial shipments or manufacturers. Tankless manufacturers have indicated there is still quite low market penetration of these units in general, but there is a growing interest.

Table 2. **Commercial Tankless Water Heater Availability**[3]

Manufacturer	Efficiency	Available Models	Type of Models
Bosch	N/A	N/A	No commercial models listed
Navien	98% Et	2	Condensing only
Nortiz	80-84% Et	2	Non-condensing only
Paloma	84% Et	1 series	Non-condensing only; able to meet various input capacities for indoor, outdoor, and direct vent
Rinnai	84% Et	1 series	Non-condensing only; able to meet various input capacities for indoor and outdoor use
Takagi	80-84% Et	2	Non-condensing only

Residential tankless units are often used in commercial applications and can be staged together to provide the necessary capacity to meet a commercial building's demand. Because of this, they are also often included as part of efficiency program's commercial rebate offerings (CEE 2010). These units have seen significant market uptake over the

[2] Ibid. [AHRI], 2011. *Directory of Certified Product Performance*. AHRI Publishing. Web. 1 Apr. 2011. <www.ahridirectory.org>.

[3] Information provided by tankless manufacturers and gathered from tankless water heater manufacturer websites. Please note that models highlighted only represent capacities of 200,000 Btu/h and above. There are a number of residential tankless water heaters on the market designed to condense that are often used in commercial applications. For more information on this please refer to Section 3.2.

last few years, with many more residential tankless being offered by manufacturers in comparison to commercial tankless. Currently there are about 175 residential tankless models listed in the AHRI Directory, and of that number about 20 are condensing tankless with an energy factor (EF) of 0.90 or greater (AHRI 2011b). Please refer to Section 3 for more information about the differences between residential and commercial tankless water heaters. The CEE Residential Initiative also offers further details about residential tankless water heaters.

2.3 Market Size

In the US in 2010, shipments of commercial electric and gas storage water heaters totaled approximately 136,963 (AHRI 2011b). Of that, gas water heaters (both natural gas and propane) saw a somewhat higher percentage of shipments than electric resistance storage water heater shipments (78,614 units and 58,349 units, respectively). Table 3 is based on AHRI industry shipment data and compares 2009 and 2010 sales of commercial gas and electric storage water heating technologies.

Table 3. **Table 3: 2010 Year End Total Commercial Water Heater Shipments**[4]

Type	2010 Totals	2009 Total	% Change Market Share
Commercial Gas	78,614	75,487	+4
Commercial Electric	58,349	55,625	+5

In Canada, storage water heaters account for 90 percent of the market (NRCan 2010). Only about 21,000 storage units are shipped in Canada per year with estimates of about 13,000 gas storage and 7,000 electric storage. There is a split of about 20 percent for new installation and 80 percent for replacement in Canada.

There is currently very little publicly available data related to the sales volume market penetration for commercial tankless water heaters; however, conversations with tankless manufacturers suggest that a significant part of their sales are in the residential market. For instance, one tankless manufacturer estimates that about 10 percent of its sales are to commercial applications. If this were true across all other tankless manufacturers, then about 40,000 units per year would be sold to the commercial market—although not enough data is available from other manufacturers to verify that this is the case. This same manufacturer suggests that about 315,751 gas tankless units from both AHRI members and non members were shipped to the residential and commercial markets as a whole in 2010. This illustrates a marked increase over the 2006 market for tankless, which was reported to be 254,600 units.

2010 estimates from Canada suggest that tankless water heaters account for approximately 10 percent of the commercial water heating market, but this data also does not differentiate between commercial and residential tankless or fuel type (NRCan 2010).

[4] AHRI, 1 Jan. 2011."Statistics for the Month of December 2010." AHRI Publishing.

Tankless manufacturers have suggested that while storage water heaters continue to dominate the market, tankless water heaters have been seeing an increase in market share in both the US and Canada over the last number of years. According to feedback from both storage and tankless manufacturers, condensing commercial storage and tankless water heaters have seen an increase in sales volume market share as they become more widely available and interest in high efficiency grows. For example, in Canada, condensing sales account for 18 percent of shipments, with 4 percent of that total consisting of condensing tankless (Ibid).

There is limited data related to market share by manufacturer for the various commercial water heater types. The three largest residential storage water heater manufacturers, A.O. Smith, Bradford White, and Rheem, are also likely to see the greatest sales of commercial water heaters based on current availability listed in the AHRI Directory. Table 4 below depicts percent market share for commercial gas fired water heaters by manufacturer and is based on 2008 data from a 2009 Appliance Magazine's 32d Annual Portrait of the U.S. Appliance Industry. From this data, it is inferred that A.O. Smith is likely the current industry leader in sales, with Rheem, Bradford White, then Lochinvar following (Appliance Magazine 2009). Refer to 0: Manufacturers of Storage and Tankless Water Heaters for a listing of all current commercial water heater manufacturers and their related brands.

Table 4. **2008 Commercial Gas Water Heater Estimated Manufacturer Market Share**

Manufacturer	Percent Market Share
A.O. Smith	56%
Rheem	25%
Bradford White	14%
Lochinvar	4%
Others	1%

3 Technology Overview

High efficiency commercial storage and tankless water heaters are designed somewhat differently than standard efficiency units. These differences can include different venting technologies, advanced or multiple heat exchangers, or condensing design components. There may also be different installation, operation, and functionality considerations to be aware of, such as the need to install condensate drains. More details regarding design, operation, and functionality are described below.

3.1 Natural Gas Storage Water Heaters

The following technical design features and considerations have been sourced from conversations with manufacturers of both storage and tankless water heaters, product literature, and feedback from technical experts from within the CEE membership.

3.1.1 Design Features

Storage water heaters are also commonly referred to as tank type water heaters. They often have a glass lined steel tank, foam insulation, a heat exchanger coil or flue running through the center of the tank, and a gas burner at the bottom of the tank. The water heater is activated when a gas burner is ignited. Combustion takes place in the burner when incoming air mixes with gas. The hot gases from the combustion process ascend through the flue or heat exchanger coil and transfer heat to the surrounding water in the tank. The heated water rises to the top of the tank and is then transferred through a hot water outlet to the tap. Storage units are designed to maintain water stored in the tank at a constant temperature, and heat is lost through the tank when hot water is not being demanded. This heat loss is also called standby loss.

Commercial storage water heaters with higher levels of efficiency often have increased insulation and often employ power venting and power direct venting technologies. These venting technologies control drafts, exhaust flue gases, and minimize airflow through the use of a draft inducer fan. It is important to note that power venting does not necessarily suggest that a technology is high efficiency—these venting options can be used with standard efficiency equipment as well. Technical staff from Natural Resources Canada and the PG&E Food Service Technology Center suggests that anti-convection valves, flue baffling, heat traps, or sealed combustion designs are other technology improvements that are often used with high efficiency equipment and can increase the efficiency of the water heater by improving combustion efficiency or limiting standby heat losses.

Condensing storage water heaters use the same general design concept as the non-condensing units; however, some key differences have been incorporated into the design, allowing condensing units to reach higher efficiency levels. Condensing units typically have a burner that is within a vertical flue near the middle or top of the tank. The gases travel through one or two heat exchanger coils which more effectively transfer heat to the surrounding water. As the gases reach the end of the heat exchanger coil, they begin to condense into a somewhat acidic solution and must then be drained away from the unit. Because these units more effectively make use of the heat from combustion, the exhaust air exiting the unit is typically cooler, and will thus need the assistance of a fan and power venting or power direct venting technologies to more quickly move the cooler, slower moving air away from the system and out of the building. The major efficiency advantage of these units is the ability to use the heat of condensation of the combustion gases.

Condensing storage units typically have efficiencies that range between 90 to 98 percent Et (AHRI 2011a). Commercial storage units are the only storage water heaters that are currently designed to condense, and thus reach higher levels of efficiency. Programs that incorporate residential storage water heaters into their commercial rebate offerings should be aware that manufacturers are not yet producing residential condensing storage units (Ibid).

3.2 Natural Gas Tankless Water Heaters

3.2.1 Design Features

Natural gas tankless units are also commonly referred to as instantaneous or on-demand water heaters. As with storage water heaters, a tankless water heater has a burner and a heat exchanger, but it does not store water in a tank. The burner in a tankless water heater is activated when a minimum water draw occurs. Once a hot water tap is turned on and a flow sensor is triggered, the burner begins to heat a heat exchanger. Cold water enters the unit and ascends through the heat exchanger where heat is transferred to the water. Once the water reaches its set point temperature, it exits the unit ready for consumption (Davis Energy Group 2007).

Both residential and commercial tankless units have similar design principles, but commercial units come equipped with larger burner capacities in order to meet larger commercial building demand, and sometimes have slightly different heat exchangers. A few residential and commercial condensing tankless models are currently available. See Table 2 in Section 2.2 for a listing of current commercial tankless water heaters (both condensing and non-condensing).

Because residential tankless water heaters make up the bulk of the tankless market, many commercial buildings make use of residential tankless units to meet their hot water demands. Industry experts suggests this is typically done through staging, otherwise known as manifolding, cascading, or ganging, the units together into a single system. Staging is often done in larger commercial buildings in order to meet high hot water demands and can be an advantage for the system designer, the installer, and the end user in applications where modularity and built-in redundancy are important. Newer tankless units often have advanced controls that allow these systems to be more easily staged together.

According to tankless manufacturers and based on information gathered for the 2010 CEE Commercial Water Heating Program Summary, condensing tankless are just beginning to gain market traction and are beginning to be manufactured, sold, installed, and offered by efficiency programs with greater frequency. Condensing tankless water heaters work in a similar fashion as condensing storage water heaters by utilizing the heat of condensation of the combustion gases. They often have secondary heat exchangers that help to capture this excess heat, which would otherwise be lost in standard efficiency tankless units. When the exhaust gas is cooled, water vapor in the combustion products condense to liquid and must be drained away from the unit. It is important that installers are well trained in installing the condensate drainage. Please refer to Section 3.3 for more details regarding condensate drainage installation practices.

The efficiency improvements of tankless units occur in part because there is very little heat loss to the surrounding environment when the unit is in standby mode, unlike storage water heaters which constantly heat water within a tank to a specified

temperature. Tankless water heaters only heat water as it is needed, avoiding most standby losses and improving efficiency in some instances. In commercial applications where there may be continuous long draws of hot water, standby loss may become less relevant; however, this is highly dependent upon the specific application and the related hot water draw patterns. For instance, CEE members suggest that in some applications during evening hours when the storage unit is not in operation, standby losses will still occur.

3.2.2 Tankless Considerations

Despite the technical potential for increased efficiency attributed to tankless water heaters, manufacturers and CEE members suggest that there are additional considerations to ensure tankless water heaters are installed in applications where their efficiency potential will be realized.

Delay at the Tap: Many tankless units (but not all) have a minimum water flow requirement of 0.4 to 0.8 gallons per minute to activate the burner with 0.5 as the industry standard.[5] In low hot water volume commercial applications where hand washing is one of the most prevalent draws, an insufficient amount of water could be drawn from the tap to activate the burner. One manufacturer suggests that it may take an extra 5 to 15 seconds in addition to the normal delay time to meet the desired water temperature as a result of time required to fire the cold burner. CEE members suggest that this means that either there may be no hot water for the desired use or that the tap is kept on longer to reach the desired temperature. However, tankless manufacturers suggest that in many larger commercial applications, hot water recirculation loops will be able to overcome this challenge and supply hot water at the tap very quickly.

Maintenance Considerations: In some instances, tankless units will require more regular maintenance than storage units. CEE members and manufacturers suggest this is especially true in high volume commercial applications where filter cleaning can be a monthly need depending on flow rates and water quality. Many commercial customers may not be used to performing regular maintenance on their water heaters to avoid restricted flow due to scale build up in hard water areas. Owners of tankless water heaters should be made aware of these maintenance requirements to avoid service outages and decreased performance.

Lower Incoming Water Temperature: CEE members suggest that tankless units are also impacted to a greater extent by lower incoming water temperatures than storage units. In many colder climates tankless water heaters used in commercial applications will need to be sized for the lowest inlet water temperature expected throughout the year. It is important to properly size these units to be able to compensate for this issue. Proper sizing may mean that additional units or units with larger input capacities need to be

[5] Gallon per minute data based on a review of 2011 product literature and feedback from tankless manufacturers.

installed. In some instances, this may lead to increased initial cost and system complexity.

Efficiency Degradation Over Time: Industry interviews and discussions with CEE members suggest that another consideration with commercial tankless is the concern over efficiency degradation over time. Tankless units in commercial applications use high firing rates in relatively small water passages. This efficiency degradation also holds true for most storage water heaters, but has the potential to effect tankless more because of scale buildup over the lifetime of the particular tankless design.

Parts and Service Networks: CEE members and manufacturer feedback suggests that the infrastructure of commercial tankless parts and service networks is immature when compared to commercial storage units. This can result in difficulties finding replacement parts in the field and lack of locally trained commercial tankless service technicians.

Increased Hot Water Use: In some applications, end users may be inclined to use more hot water with tankless water heaters because one of the major selling features is the promise of an endless supply of hot water. CEE members and manufacturers suggest this can occur because there is no storage tank to re-heat and because the burner can heat the water almost instantaneously and for a long period of time. Increased hot water use may lead to lower than expected energy and monetary savings. This is less of a concern in many commercial applications, with the exception of some smaller commercial applications, because, unlike in homes, businesses may use hot water more consciously to fulfill specific activities related to the business in question.

Proper Sizing: In many larger applications with high hot water demand, CEE members point out that more tankless units may be needed to deliver the same output that fewer storage waters could provide. In other words, multiple tankless units may be needed to cover the peak demand period that fewer storage water heaters could accommodate because the physical size of the tankless heat exchanger tubing limits the throughput. Whereas the tankless water heater is limited in the maximum delivered volume in a short period of time, it can sustain this flow over long periods. A storage tank is not as challenged by short term maximum flow rates because the hot water saved within the tank can quickly be withdrawn. It is, however, limited by the volume of the tank because it will no longer be able to meet the same hot water demands once the tank is depleted.

To address some of these issues, installer education and training programs are strongly encouraged since it is critical to understand the benefits and costs of installing these water heaters. This may help to avoid diminished level of service and unintended increases in gas and water consumption. These and other considerations will be addressed further in Section 6.

3.3 Other Storage and Tankless Installation Considerations

There are a number of other considerations to take into account that relate to efficiency when installing either storage or tankless units. A number of these considerations are highlighted below; in addition to these, efficiency programs should require installation by a licensed contractor in compliance with local codes, federal regulations and codes such as the National Fuel Gas Code, and manufacturer instructions for both storage and tankless water heaters.

Commercial vs. Residential: The efficiency differences between residential and commercial units are important considerations to take into account when a program or installer is deciding on what to install in a given application. Condensing technologies are on a whole more efficient than non-condensing technologies and their installation is strongly encouraged where appropriate. All condensing storage water heaters are currently commercially rated but condensing tankless water heaters can be both residentially and commercially rated.

Staff from the PG&E Food Service Technology Center have noted that depending on the geographic region, some installers may be less familiar or well versed in how to install either condensing storage or tankless technologies. For instance, installers in colder climates with more heating degree days are often more familiar with installing other condensing technologies, such as furnaces or boilers and may thus be more willing or capable of installing condensing water heating technologies. In regions within fewer heating degree days, installer education and training programs are strongly encouraged to emphasize proper installation of condensing storage and tankless units.

Usage Profiles and System Design: A building's daily hot water usage profile is another key consideration for selecting a water heater (Fisher-Nickel 2010). It should also be noted that even if the water heater is highly efficient, installation in a system that has a hot water recirculation loop that is poorly designed or insulated will result in significant energy losses, resulting in lower efficiency overall. Further efficiency program guidance on usage profiles and efficient system design considerations will be considered as a next step of the initiative development process. A well designed system is better able to track load demands and modulate to meet the hot water draw requirement of the system.

Other Heat Loss Considerations: A number of considerations related to heat loss are worth taking note when considering high efficiency installations. The importance of these considerations have been shared with CEE from technical staff at Natural Resources Canada as well as the PG&E Food Service Technology Center.

In lower efficiency non-condensing commercial water heaters, flue dampers are often used in an attempt to reduce heat losses through the central flue during standby periods. One study has noted that in practice these devices can become stuck and may consequently be removed or disabled, although it should be noted that not all units are required to have a flue damper and that without a much larger site survey study it is

difficult to estimate the extent of the problem. Additionally, some lower efficiency non-power venting products may require a draft-diverter in the vent to prevent downdrafts from significantly affecting the combustion. While it is not considered in the efficiency calculation for the water heater, the draft-diverter is a significant source of heat loss. Also, in non-condensing power-vented water heaters, the vent dilution air levels can be very high to facilitate the use of lower-cost plastic venting which is also a significant source of heat loss from the building that is not accounted for in the thermal efficiency metric.

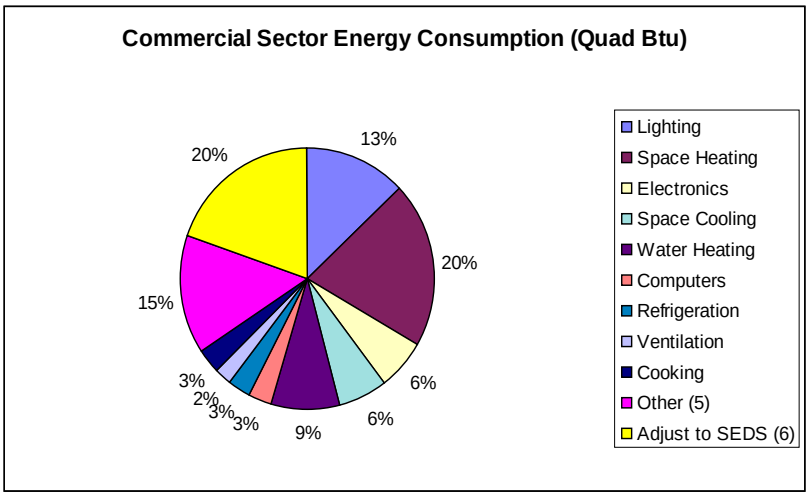
AHRI currently provides data on the standby heat loss of commercial storage water heaters (AHRI 2011a). The thermal efficiency metric does not take into account these standby heat losses so it may not represent in field energy consumption. Efficiency programs are encouraged to consider these heat loss issues when working with commercial customers. CEE will continue to monitor these issues and may consider developing specifications that take into account standby heat loss in the future.

4 Energy Use, Emissions, and Savings Potential

4.1 Energy Consumption

Commercial water heating represents a major source of energy use in the US and Canada accounting for approximately 7 to 12 percent of the total energy load in average commercial buildings, equally approximately 1.2 Quads (one Quad is equivalent to 100 quadrillion British Thermal Units) of commercial energy use (US DOE 2007). As depicted in the chart below, in the US, commercial water heating as a whole (including natural gas, electric, and petroleum sources) accounts for about 8.8 percent of energy used in comparison to other end uses (EIA 2006). This makes it one of the largest commercial end uses behind lighting (26 percent), space heating (14 percent) and space cooling (13 percent) (US DOE 2007). Of that amount, natural gas water heating accounts for 0.54 Quads per year (5.4 billion therms), or 3.2 percent of total consumption. In Canada, commercial water heating is estimated to be the second largest commercial energy end use behind space heating (NRCan 2010).

Figure 1. **Commercial Sector Energy Consumption**[6]



As noted in Section 3.1, the majority of the commercial market is made up of standard efficiency units (generally about 80 percent Et). One of these units may consume about 220 therms per year.[7] In comparison, an individual high efficiency condensing unit at 90 percent Et may consume about 195 therms per year.[8] Note that these energy use data points are just estimates and that the true energy usage and efficiency of a commercial water heater is not just dependent on the Et rating, but, as manufacturers and CEE members point out, also depends on other factors such as how well the overall hot water system within the building is designed, how often maintenance is performed on the units, the quality of particular water heater used, and how suitable the water heater is for the particular application it has been installed in (Fisher-Nickel 2010).

4.2 Commercial Water Heating Emissions

In addition to energy use, all water heaters emit greenhouse gases as a byproduct. For example, on average, natural gas commercial water heating accounts for 28.6 million metric tons (MMT) of carbon dioxide (CO_2) emissions per year (EIA 2006). Commercial water heating as a whole, including natural gas, electric and petroleum sources, accounts for 5.5 percent of total commercial sector CO_2 emissions (US EPA 2008).

Alongside carbon dioxide and water vapor, the combustion process also releases nitrogen oxides (NO_x), carbon monoxide, and other particulates into the air. NO_x consists of two forms of nitrogen oxides—nitric oxide (NO) and nitrogen dioxide (NO_2)—that are generated by gas water heaters and are together referred to as total

[6] Energy Information Administration (EIA), 2006. *2003 Commercial Building Energy Consumption Survey (CBECS): Preliminary end-use consumption estimates.* Web. <www.eia.doe.gov/emeu/cbecs/enduse_consumption/intro.html>.

[7] These estimates were based on a CEE analysis that takes into account thermal efficiency and yearly energy usage estimates, and the test procedure within ANSI Z21.10.3-2004/CSA 4.3-2004.

[8] Ibid.

oxides of nitrogen or NO_x. The US EPA requires states and cities to adopt and implement measures to reduce greenhouse gases and solid particulate matters in the air, such as NO_x. Currently, only the California South Coast Air Quality Management District (SCAQMD), the Bay Area Air Quality Management District (BAAQMD), and a few other districts regulate NOx emissions for commercial water heaters; however, this may become a trend across other regions in the future. The SCAQMD NO_x regulations as related to water heaters that meet the scope of this initiative are outlined in Table 5.

Table 5. **SCAQMD NO_x Emissions Regulations for Water Heaters**[9]

Capacity (Btu/h input)	NO_x Limit (ng/j)[10]	Date
< 400,000[11]	14 ng/j	Jan 1, 2012
> 400,000 and ≤ 2 million	14 ng/j	Jan 1, 2010

These regulations apply to water heaters intended for commercial use only, including existing units. Other regions are adopting similar regulations, a trend that is expected to continue across other regions. This may create situations of forced replacement, which in turn creates implications for efficiency programs. It also creates the need for rapid product innovation by manufacturers, which can in some instances lead to increased upfront cost or lower availability.

4.3 Savings Potential

At the individual commercial building level, high efficiency water heaters typically generate about 10 to 20 percent in savings over a building owner's previous water heater, although manufacturers and CEE members note that this estimate can vary widely as efficiencies are highly application dependent. This of course depends on a number of factors, such as the efficiency of both water heaters and the particular application and use pattern of the individual commercial building (Fisher-Nickel 2010). On a per unit basis, high efficiency 90 percent Et commercial gas water heaters have the potential to yield yearly energy savings of about 25 therms in comparison to minimum efficiency 80 percent Et storage water heaters.[12]

While understanding the installed base (total number of units currently installed in commercial buildings) for commercial water heaters would be a useful metric to help identify the associated savings potential, there is limited data available. This is likely

[9] South Coast Air Quality Management District, 2006. *Rules and Regulations: Regulation XI: Source Specific Standard; Rule 1146.2: Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters.* Adopted January 9, 1988. Last Amended May 5, 2006.

[10] Ng/j, or nanograms of NOx per joule of heat output.

[11] Excluding units federally designated and intended for use in residential applications.

[12] These estimates were based off of CEE analysis that takes into account thermal efficiency of baseline and high efficiency units, per unit yearly energy usage and savings estimates, and the test procedure within ANSI Z21.10.3-2004/CSA 4.3-2004.

due to the many variations in commercial building types, from small commercial buildings where it is unclear if a residential or commercial unit is being used, to large commercial buildings where multiple commercial water heaters may be staged together (EIA 2006). Because of the difficulty in estimating the installed base, the following estimates are based on yearly shipment data from AHRI for commercial water heaters.

As noted in Section 2.2, total shipments for commercial gas (both natural and propane) and electric storage water heaters in the US in 2009 were 131,112, and total shipments for commercial storage water heaters in Canada average about 21,000 units per year. If 50 percent of yearly total shipments for gas and electric storage water heaters in both the US and Canada combined were converted to 90 percent Et units, it would save 14,733,420 therms.[13] This is an equivalent to saving 8,286,513 gallons of gasoline, or taking 14,085 passenger cars off the road (US EPA 2008). Similarly, if 100 percent of yearly shipments were converted to 90 percent Et units, about 29.4 million therms per year would be saved, which would be an equivalent to saving about 16.6 million gallons of gasoline, or taking 28,171 passenger cars off the road (Ibid).

These are very rough estimates which are intended to create a general portrait of the existing savings potential. These estimates assume that the efficiency of the most commonly shipped unit averages about 80 percent Et and that those annual shipment numbers hold steady. Additionally, they assume a 100 gallon storage tank (but in reality tank size will vary widely). Other differences such as daily hot water draw, system design configuration, and standby loss all have significant impacts on the overall efficiency and savings potential of the water heater. Contact CEE with questions regarding how this analysis was performed.

For those efficiency program administrators that address residentially sized units in commercial applications, it is also challenging to estimate the potential savings of moving to high efficiency because there is relatively little data related to their installed base. In the residential market, high efficiency (0.62 EF) residential storage water heater may save between 7 and 14 percent in energy used per year in comparison to minimum efficiency (0.58 EF) units.[14] If half of the total residential storage water heaters sold per year were raised from minimum to high efficiency, approximately 35 million therms could be saved. If just 5 percent of the storage water heaters sold per year were converted to 0.67 EF storage water heaters, almost 8 million therms could be saved. More information is needed about the number residential units installed in commercial applications to understand how these savings translate for commercial programs.

[13] Ibid.

[14] This savings information is based off the DOE test procedure measuring energy consumption per year. The standard equation is (41,045 Btu/EF x 365)/100,000

5 Barriers to and Opportunities for Increased Market Uptake

The key barriers and to opportunities for increasing market penetration of efficient, natural gas storage and tankless water heaters are listed below.

5.1 Emergency Replacement is Common

According to installers, manufacturers, and CEE member feedback, emergency replacements are a common occurrence in commercial water heater applications and make up the bulk of installations. Emergency replacement may be slightly less prominent in the commercial market than in the residential market because of the increased attentiveness of building owners and building managers to the functionality and age of the technologies within their buildings. They may also be more likely to think through implications of the cost of replacement in advance to ensure their business runs smoothly, especially if it is heavily hot water dependent. Emergency replacements still do occur with frequency, however. The immediacy of the installation often does not allow for the time needed for installers to order high efficiency units if they don't have them in stock. It also gives the key decision maker at the facility less time to weigh their options as to whether to include a standard efficiency or higher efficiency unit.

5.2 Installation Challenges

Incorporating high efficiency technologies into already complex systems can pose design challenges for installers. Conversations with CEE members and manufacturers suggest that installers may be unfamiliar with the particular installation needs of high efficiency water heaters since they do not make up a significant portion of the installed base. One specific consideration is condensate drainage required for condensing storage and tankless units. High efficiency units may need electricity, and if there are no outlets nearby, an installer works with an electrician to make this upgrade. Many high efficiency units also have different venting requirements than traditional units (refer to Section 3 for more information regarding these installation challenges). This may pose a challenge to installers replacing a water heater in an existing building, as that building may not have a built in venting option that is appropriate for the higher efficiency unit. This also allows for less time for the end user to budget for the cost of a high efficiency unit.

5.3 Potential for Higher First Cost

Based on conversations with manufacturers, installers, and CEE members, high efficiency units can be more expensive to purchase, and potentially to install than minimum efficiency water heaters. These higher upfront and installation costs can be significant barriers to the market acceptance of these technologies. According to conversations with manufacturers, the addition of such features as increased insulation

or advanced heat exchangers can add significant cost to the unit itself. Installation costs can be increased because of different venting requirements and condensate drainage installations. Commercial buildings have higher use profiles, however, which can make the initial investment in high efficiency technologies seem more feasible. These units have the potential to drive down life cycle costs quickly and allow the owner to recoup their initial costs at a faster rate. If high efficiency water heaters were to establish a stronger market presence with more units manufactured and sold per year, economies of scale may produce cost savings and lead to further sales through more competitive offerings.

5.4 Key Decision Makers Unaware of High Efficiency Benefits

Manufacturers and CEE members suggest that key decision makers at the commercial building level can include building owners, building managers, property management companies, and design engineers. These groups may not have the tools they need to make informed decisions on equipment installations. Building owners and building managers may rely on their property management companies, energy managers, or installers as experts to guide them through an equipment replacement. They may lean upon their installers, builders, architects, or design engineers to make that decision, as these groups often have a list of which technologies and models they recommend using.

Repeated conversations with manufacturers and CEE members suggest that water heating is a low involvement product area in which the end user does not often take time to research different options or learn how efficiency can lower overall cost. More high efficiency water heaters might be installed if the distribution chain were better able to inform key decision makers at the building level of the option of installing energy efficient models. In new construction applications, if builders and design engineers were to be educated or incentivized to discuss high efficiency with building owners, it might be possible to increase the number of new installations. In retrofit applications, installers have the opportunity to guide the building decision makers to choose the most appropriate water heater for their given installation.

5.5 Key Decision Makers Unaware of Daily Hot Water Demand

Manufacturers and CEE members have noted that even in the more sophisticated commercial buildings such as hotels or restaurants, the key decision makers regarding equipment installation are often unaware of their building's daily hot water requirements. One manufacturer also suggested that in other commercial buildings, water heaters may be oversized to meet health codes. Because of issues such as these, many commercial buildings may not have water heaters appropriate to their given applications resulting in inefficiencies and extra cost. Usage information can be acquired through monitoring the building daily hot water draws or more generally through using industry guidelines for the specific applications. The data can be used to highlight particular use characteristics of a building, and can help building owners or managers match the most applicable and energy efficient technology to their hot water needs (Fisher-Nickel 2010). If installers were to encourage building owners and other

key decision makers at the building level to monitor their hot water use profile, appropriately sized water heaters may be more likely to be installed to best meet the needs of particular applications.

5.6 Market Players May Not Have the Appropriate Marketing Tools or Are Not Incentivized To Promote High Efficiency

Conversations with manufacturers as well as attendants at the 2010 GasNetworks Annual Conference have highlighted the fact that the water heating equipment sales industry is strongly driven by lowest-bid quotes. Manufacturers and distributors suggest that high efficiency commercial units are not stocked as regularly by wholesalers and distributors, or installed as frequently as average efficiency units. These groups have an opportunity to sell high efficiency equipment (which can be a higher value and profit opportunity) by educating commercial customers about the life cycle benefits of that investment. These key players can lack the training and tools to effectively educate and promote the benefits of high efficiency equipment. Incorporating the concept of selling efficiency into manufacturer or efficiency program training sessions and outreach activities are effective ways to influence the supply channel. Incentivizing these decision makers to promote and stock high efficiency, whether in new construction or retrofit applications, is another way to influence promotion and sales.

5.7 Split Incentives—Builder, Design Engineer, and Property Owner versus Building Tenant

Based on a number of conversations with CEE members, it is suggested that those responsible for suggesting or installing the water heating system in a commercial building often choose water heating equipment on a low first cost basis. They do so to reduce the overall price of the equipment installation and to increase profit margins. In rental properties, tenants are responsible for paying the energy bills, and they might prefer that a high efficiency unit be installed to potentially achieve lower monthly energy bills. In a new construction scenario, builders and design engineers are not incentivized to offer high efficiency products because they're typically more concerned with driving down the upfront cost for the building owner. In replacement scenarios, property owners or managers do not receive the resulting benefits of installing high efficiency equipment through lower energy bills. If builders or property owners could be incentivized to offer higher efficiency models, perhaps through rebates, it could improve the likelihood of installations of high efficiency water heaters.

5.8 Lack of Reliable and Objective Sources of Information Regarding Appropriate Water Heating Options and Savings Potential

It can be difficult to determine what water heater model is the right choice for a given application. Manufacturers and CEE members suggest that field testing or lab testing to understand the true efficiency, reliability or cost-effectiveness of storage and tankless water heaters, as well as the overall system efficiency, could help to better compare technologies based on performance and savings potential of specific commercial building applications.

6 Initiative Approach

This initiative seeks to encourage the purchase of energy efficient commercial water heaters. It consists of two major components designed to achieve the savings and overcome key market barriers through the use of efficiency specifications and awareness building activities. Common technical specifications help to provide consistency around specific efficiency levels and signal the market that efficiency programs are willing to support advanced technologies. The second major aspect, awareness building, consists of developing and offering trainings, educational collateral and messaging for key decision makers within the supply channel including installers, builders and developers, building owners and managers, design engineers, wholesalers, and other related groups. Reaching out to these key decision makers helps to build awareness about the importance and effectiveness of high efficiency.

6.1 Efficiency Specifications

This section provides efficiency specifications for programs to address commercial water heating efficiency. CEE developed a two tier approach to define high efficiency for both storage and tankless water heaters as highlighted in Table 6. Widespread promotion of a common performance specification provides a consistent definition of high efficiency to all market players. CEE specification tiers seek to identify meaningful levels of savings for the commercial building sector; in this case it is water heaters that achieve condensing levels of efficiency. A key consideration related to these specifications is that the market for condensing tankless water heaters is still in the early stages of development, but product is becoming increasingly available and customer interest is growing. While this Initiative is sensitive to the effect that limited availability may have on efficiency programs, it recommends condensing tankless products as a way to further spur interest in and product development for these important technologies.

These specifications apply only to water heaters that have been approved for commercial use and have been installed by licensed contractors in compliance with manufacturer instructions, and meet all applicable local and Federal codes and standards.

Table 6. **Efficiency Specifications for Commercial Storage and Tankless Water Heating**

Tier	Efficiency
Tier 1	90-93% Et
Tier 2	94%+ Et

To create greater consistency in defining a low emissions water heater, CEE has developed the optional specification for low NO_x emissions, detailed in Table 7. Efficiency programs are not required to include this optional NO_x specification in order to be considered CEE Initiative Participants. The voluntary requirements below are based on SCAQMD requirements.

Table 7. **Optional NO_x Emissions Specifications for Commercial Water Heating**

Capacity (Btu/h input)	NOx Limit (ng/j)[15]
< 400,000[16]	14 ng/j
> 400,000 and ≤ 2 million	14 ng/j

6.2 Awareness Building Activities

In order to help transform the market toward higher efficiency commercial water heaters, efficiency programs should consider adding outreach components that target key decision makers within the supply channel. In the commercial water heating market, those key decision makers include manufacturers, wholesalers, builders and developers, installers, and building owners, building managers, and design engineers. Outreach efforts by efficiency programs to these target audiences heighten their awareness of the efficiency program industry's dedication to high efficiency technologies and the related rebate and incentive offerings. For example, sponsoring marketing and technical training sessions helps ensure that installers are well-versed in how to upsell efficiency to their customer base and are well-trained in how to install high efficiency units.

6.2.1 Manufacturer Outreach

Manufacturers know their products best and often have sophisticated marketing approaches to encourage investment in their high efficiency products at a national level. It may be useful for efficiency programs and manufacturers to communicate in order to support the market for high efficiency within the efficiency program's service territory. This helps ensure that manufacturers are aware of efficiency program rebates and incentives, and may provide opportunities to sponsor joint installer trainings or co-brand on marketing efforts related to high efficiency products. In addition, if manufacturers are aware of efficiency program rebate and incentive programs, they

[15] Ng/j, or nanograms of NOx per joule of heat output.

[16] Excluding units federally designated and intended for use in residential applications.

may be likely to inform others in the supply channel that they have relationships with, such as distributors, wholesalers, and installers, about efficiency program opportunities on the regional level.

6.2.2 Distributor and Wholesaler Outreach

As discussed in Section 2.1.2, wholesalers and distributors often have exclusive relationships with individual manufacturers of commercial water heating products. Because of this, wholesalers and distributors may be informed of efficiency program incentives and rebates through their manufacturing contacts. Efficiency programs should, however, be proactive about reaching out to distributors and wholesalers within their service territories to ensure they know about efficiency program rebates and incentives and to encourage them to stock qualifying models. If a wholesaler or distributor does not have high efficiency products in stock when installers ask for them, the end user is likely to take the available model and the opportunity to capture more efficiency is lost. Wholesalers and distributors also have direct relationships with installers, making them valuable partners when it comes to educating installers about highly efficient commercial water heaters. Efficiency programs are strongly encouraged to find opportunities to build relationships with wholesalers to promote energy efficiency.

6.2.3 Installer Training and Education

As highlighted in Sections 2.1.3 and 5, installers play a crucial role in building a market for high efficiency commercial water heaters. When emergency replacements occur, installers have an opportunity to encourage the replacement of the failed unit with a high efficiency unit. Decisions about what water heater to include in new construction situations can be more challenging for installers to have an influence on because the design engineers or the builders themselves may take on the role of specifying which water heating technology to include.

Regardless, efficiency programs are encouraged to actively create opportunities to reach out to installers within their service territory to communicate about the benefits of high efficiency and applicable rebates and incentives. One way in which to work with installers is to coordinate or sponsor training sessions to ensure installers know how to address the various installation challenges associated with some high efficiency equipment. Providing technical training to installers can amplify the impact of efficiency program outreach efforts, help installers assist their customers in making more efficient decisions, and help them make a higher value sale. Another option is to develop educational pieces that provide marketing advice to help installers feel confident in their ability to upsell high efficiency products to their customer base.

6.2.4 Building Owner, Building Manager, Energy Manager, Property Management, or Design Engineer Outreach

In commercial buildings, there are a number of different players that may be responsible for making decisions about the technologies to install or upgrade.

Depending on the building, these decisions may fall to building owners, building managers, energy managers or design engineers. These players may not choose the most efficient water heaters because of high first costs, lack of awareness of the benefits of high efficiency or lack of knowledge about rebates and incentives in their service territories. They are also often unaware of their building daily hot water draw, making it challenging to calculate the return on investment of a more efficient water heater.

Efficiency programs are strongly encouraged to begin developing relationships with these players within their own service territories. Education may help these players to look past the higher upfront cost of high efficiency, understand the value of the lower life cycle cost of such units, and feel more confident about asking their installers for these higher efficiency options. This in turn will help to transform the market for high efficiency commercial water heaters.

7 Initiative Participation

As with all CEE initiatives, participation in the High Efficiency Natural Gas Commercial Water Heating Initiative by efficiency programs is voluntary. Initiative participation requirements focus efficiency program efforts on those aspects which, if undertaken by all, are most likely to have an impact on the markets for high efficiency equipment. For the purposes of this initiative, high efficiency commercial water heaters have been defined as those that achieve condensing levels of efficiency. The following Initiative Participation Requirements help achieve that goal:

1. Incorporate the CEE efficiency specifications for water heaters in an incentive program for at least one of the specification tiers outlined in Section 6.1 for one or both storage or tankless water heaters; and
2. Undertake at least one of the Outreach Activities to the supply channel described in Section 6.2.

The two tiered efficiency specification allows efficiency program administrators to tailor their rebate and incentive programs to support the most cost effective and widely available condensing options within their service territories. Tier 1 allows programs that do not have many condensing products in their market or have strict cost-benefit analysis requirements to provide rebate offerings for products at the 90 percent Et level. Tier 2 allows those programs that have higher savings targets or in which 90 percent Et water heaters are already widely available to provide rebate offerings that achieve higher levels of savings at the 94 percent Et level. As noted in Section 6.1, Commercial tankless water heaters at both the Tier 1 and Tier 2 levels have limited market availability at this time, although interest from building owners and installers is growing rapidly and a number of efficiency programs are beginning to offer rebates for these technologies. Both of these tiers support the purpose and goals of this Initiative. The outreach activities may help to build the market share and acceptance of high efficiency commercial water heating technologies, especially when it comes to enabling

installers to understand the unique installation requirements of condensing water heaters.

Efficiency programs who choose to become Initiative Participants are encouraged to think through which specifications and outreach activities will best meet the needs of their programs and customer base. Knowing the most common market sectors in a given service territory and being aware of what technologies are commonly available are key considerations.

8 CEE Role in Initiative Promotion

CEE will support this initiative in a number of ways:

- CEE will encourage members to adopt the Initiative and will publish annual program summaries that track initiative participation. These program summaries will then be publicized to industry stakeholders.
- CEE will support member outreach efforts (see Section 6.2) by sharing effective promotion approaches the conditions that enabled that success. For example, information will be shared regarding which approaches to installer training and education have been effective in raising the level of installer confidence and skill when promoting and installing high efficiency. CEE will monitor members outreach activities during Gas Committee conference calls, through CEE in-person meetings, and through annual Program Summaries.
- CEE will manage a Qualified Products List for member use that will be updated on a quarterly basis. Qualifying product lists are intended to more readily identify the products that meet CEE efficiency specification tiers. Some efficiency programs link to these lists on their web sites to provide their customers with the most recent listing of efficient products and to show their regulators that they are providing rebates for equipment with third party certified performance. To qualify for the CEE product lists, models must meet the efficiency specification tiers developed by CEE. Initially, the data for these lists will be sourced from the Air-conditioning, Heating, and Refrigeration Institute (AHRI). CEE may consider other sources of third party certified product data if available and able to meet efficiency program needs.
- CEE will provide a forum where efficiency programs and industry stakeholders can exchange information and that will promote the adoption of high efficiency commercial water heaters. Dialog between programs and industry stakeholders can be achieved through individual conference calls, an extranet called the “CEE Forum,” or potentially, in person at CEE' Annual Industry Partners Meetings, though commercial water heating may not be on the agenda every year.

Appendix A: Acronyms

Acronym	Full Text
AHRI	Air-Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
ANSI	American National Standards Institute
Btu	British Thermal Units
CBECS	Commercial Buildings Energy Consumption Survey
CEE	Consortium for Energy Efficiency
DOE	United States Department of Energy
EF	Energy Factor
EPA	Environmental Protection Agency
EPCA	Energy Policy and Conservation Act
FEMP	Federal Energy Management Program
H	hour
NOx	Nitrogen oxides
Quad	One Quad is equivalent to 100 quadrillion British Thermal Units
SCAQMD	South Coast Air Quality Management District
Et	Thermal Efficiency

Appendix B: Water Heater Regulations, Test Methods, and Rulemakings

Energy Policy Act of 2005 (EPACT)

EPACT classifies units with burner capacities greater than 75,000 Btu/h for *storage* and equal to or greater than 200,000 Btu/h for *tankless* as "commercial". The related rulemaking, Title 10, Code of Federal Regulations, Chapter II, Part 431, Subpart G, requires that these storage and tankless units be rated with an efficiency metric called thermal efficiency (Et). EPACT storage and tankless water heaters are currently being considered under the commercial water heater initiative and are not included in the CEE Residential Water Heating Initiative.

The CSA Accredited Standards Committee Z21/83 safety and testing standard ANSI/CSA Z21.10.3/CSA 4.3 covers those units that have burner capacities greater than 75,000 Btu/h for both storage and tankless water heaters and does not require the inclusion of FVIR technology.

National Appliance Energy Conservation Act (NAECA)

The National Appliance Energy Conservation Act (NAECA) classifies *storage* water heaters as units with burner capacities equal to or less than 75,000 Btu/h and *tankless* water heaters with burner capacities between 50,000 and 200,000 Btu/h. Under this federal regulation, these units are classified as "residential". The related rulemaking, Title 10, Code of Federal Regulations, Chapter 11, Part 430, Subpart B, Appendix E, requires these storage and tankless technologies be measured with an efficiency metric called the Energy Factor (EF). NAECA units are covered under the CEE Residential Water Heating Initiative.

NAECA *storage* water heaters must adhere to ANSI/CSA Z21.10.1/CSA 4.1 safety and testing standard which covers those units that have burner capacities less than or equal to 75,000 Btu/h. This standard requires the inclusion of Flammable Vapor Ignition Resistance (FVIR) technology, a consumer safety mechanism. These units are not included under the Specifications within the CEE Commercial Water Heating Initiative, but members who do make use of these technologies within their commercial programs are encouraged to look to the CEE High Efficiency Natural Gas Residential Water Heating Initiative for guidance regarding specification and program approaches.

NAECA *tankless* water heaters comply with the safety and testing standards ANSI Z21.10.3/CSA 4.3 rather than ANSI Z21.10.1/CSA 4.1. These units do not have FVIR requirements. Please note that not all ANSI Z21.10.3/CSA 4.3 *tankless* units are included in the CEE High Efficiency Natural Gas Residential Water Heating Initiative —only tankless units with burner capacities up to 200,000 Btu/h are included. Tankless units with capacities equal to or above 200,000 Btu/h are covered by the Energy Policy Act (EPACT) and are included in the scope of the CEE High Efficiency Natural Gas Commercial Water Heating Initiative.

Appendix C: Manufacturers of Storage and Tankless Water Heaters[17]

Commercial Water Heater Manufacturers	Storage	Tankless	Brands
A.O. Smith Water Products	X	X	A.O. Smith, American, Apollo, GSW, Kenmore, Maytag, Reliance, State
Bock	X		
Bosch		X	
Bradford White	X	X	Bradford White, Laars
Garrison	X		
Giant	X		
Hamilton Engineering	X		
Lochinvar	X		
National Combustion Co.	X		
Navien		X	
Noritz		X	
Paloma		X	
Reco Industries	X		
Rheem			Rheem, Ruud, Richmond
Rinnai		X	
Takagi		X	

[17] It should be noted that some of the storage manufacturers buy their tankless units from the tankless manufacturers.

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