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Appendix B.2: Measure Descriptions

This section contains a brief description of each measure used in the energy-efficiency potential.

Residential Electric Retrofit Measure Descriptions

Heating and Cooling

Air-to-Air Heat Exchanger. This measure mechanically ventilates homes in cold climates. During the winter, it transfers heat from the air being exhausted to outside air entering the home. Between 50 and 80 percent of the heat normally lost in exhausted air is returned to the house. Air-to-air heat exchangers can be installed as part of a central heating and cooling system or in walls or windows. Wall- and window-mounted units resemble air conditioners and ventilate one room or area.

Ceiling Fan. ENERGY STAR®-qualified ceiling fans have improved motor and blade designs that allow the user to increase the thermostat set point by a few degrees, which decreases the AC cooling runtime yet still feels at least 5° cooler. The fans do not create cooler temperatures. This measure does not include light fixtures; all savings are associated with installing an ENERGY STAR® ceiling fan where no prior fan was present.

Ceiling Insulation. This measure represents an increase in R-value. Added ceiling insulation increases the building's thermal performance and brings the resistance value up to and past code, depending on the building vintage. Table B-2.1 summarizes the different resistance values compared in the measure.

Table B-2.1 Ceiling Insulation Efficiency Comparison

Measure Efficiency	Baseline Efficiency
R-49	R-0, R-8.0, R-11.9, R-38
R-38	R-0, R-9.6
R-60	R-49

Check Me! O&M Tune-up. Performing a system tune-up and regular maintenance ensures that the refrigerant charge and airflow through the evaporator coil (two factors that affect system efficiency) are properly tested and correctly adjusted. Maintenance includes changing filters and cleaning the coils to maintain the overall performance and efficiency of the unit.

Combined Duct Sealing and Insulation. Duct sealing and insulation save energy, improve air and thermal distribution (comfort and ventilation), and reduce cross contamination between different zones in buildings (i.e., smoking vs. non-smoking, bio-aerosols, localized indoor air pollutants). This measure assumes a baseline of existing duct conditions sealed and insulated to R-8 and R-11.

Construction, ICF. Building a concrete home with insulating concrete forms (ICFs) saves energy. Greater insulation, tighter construction, and the temperature-moderating mass of the walls conserve heating and cooling energy much better than conventional wood-frame walls.

Construction, SIP. A structural insulated panel (SIP) uses continuous foam insulation throughout the panel, which provides excellent energy efficiency and low levels of air infiltration. The baseline is standard wood framing.

Conversion Baseboard Heating to Ductless Heat Pump (DHP). DHPs move heat to or from the air to cool and heat a home without the need for costly ductwork. This method of heating has a HSPF value of 7.7, consuming less energy than baseboard heating that has a HSPF value of 1.

Conversion Electric Furnace to Air Source Heat Pump (ASHP). ASHPs move heat to or from the air to cool and heat a home. This method of heating has a HSPF value of 7.7, consuming less energy than an electric furnace that has a HSPF value of 1.

Conversion Room AC to Ductless Heat Pump (DHP). DHPs use less energy than room AC while also producing less noise and requiring no costly ductwork. DHPs have an efficiency of 13 SEER, replacing a room AC unit with an efficiency rating of 9.8 EER.

Doors. Composite or steel doors with a foam core increase overall insulation, slowing heat loss. This measure includes adding a thermal door with a resistance value of R-5 or R-11 to houses without a thermal or storm door (R-2.5).

Doors, Weatherization. Mounting weather stripping to the bottom of an exterior door minimizes infiltration door sweep. This type of weatherization consists of an extruded aluminum strip holding a flexible vinyl strip that blocks the air space between the door frame and the door. The baseline for this measure is no weather stripping.

Duct Fittings, Leak-Proof. The majority of duct leakage in residential HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time.

Duct Location. Locating ducts in conditioned spaces reduces wasted heat loss. Many homes have ducts that run through unconditioned areas (such as attics, garages, crawlspaces, and basements) for convenience and practical reasons. Ducts in unconditioned areas lose energy because of the temperature difference between conditioned air in the ducts and the surrounding space.

Fan, Whole House. A whole house fan is a simple and inexpensive method of cooling a house when outdoor temperatures are lower than indoor temperatures. The fan draws cool outdoor air inside the home through open windows and exhausts hot indoor air through the attic to the outside.

Floor Insulation. The addition of floor insulation increases the overall resistance value of a home and slows heat transfer from the basement to the upper levels. Table B-2.2 summarizes the different resistance values compared in the measure.

Table B-2.2 Floor Insulation Efficiency Comparison

Measure Efficiency	Baseline Efficiency
R-30	R-0, R-5.2, R-6.7, R-8.5
R-38	R-30

Green Roof. The added mass and thermal resistance of green roofs reduces the heating and cooling loads of the building. These roofs reduce the ambient temperature of the roof surface and slow the transfer of heat into the building, which reduces cooling costs. They also add insulation to the roof structure, reducing heating requirements in the winter. Additionally, they reduce the ambient temperature around the roof, which decreases the building's urban heat island effect.

HVAC Unit, Central AC and Heat Pump Commissioning, Controls & Sizing. Correctly-sized HVAC systems operate for longer periods of time (instead of cycling on and off frequently), which results in optimum equipment operating efficiency and better control.

Infiltration Control (Caulk, Weather Strip, etc.) Blower Door Test. Sealing air leaks in windows, doors, the roof, crawlspaces, and outside walls prevents drafts and reduces overall heating and cooling losses.

Programmable Thermostat. This measure controls set point temperature automatically, ensuring the HVAC system is not running during low-occupancy hours.

Radiant Barrier, Ceiling. A radiant barrier generally consists of a thin piece of aluminum installed in a ceiling that reduces the solar heat gain from the sun during the summer and traps heat in during the winter. These barriers reduce heat transfer between the air space of the roof deck and the attic floor.

Smart Siting. This measure, which applies only to new construction, entails optimizing the building orientation to minimize the heating and cooling load on the HVAC system.

Slab Insulation. Substantial heat can be lost through an uninsulated slab, resulting in cold, uncomfortable floors. Even if foundation walls have been insulated vertically under the slab, significant heat escapes from the slab edge closest to the cold outside air. This measure compares a slab insulated with R-15 insulation to a slab insulated to code R-10. Applicable to new construction only.

Solar Attic Fan. This measure provides forced attic fan ventilation, which reduces residential heat gains from the ceiling. Because this fan is solar-powered, it runs conveniently when the sun is shining. The baseline uses passive ventilation without a fan.

Thermal Shell, Infiltration at 0.2 ACH w/ HRV. Heat recovery ventilation (HRV) provides fresh air and improved climate control, while also saving energy by reducing the heating (or cooling) requirements of a building. Combining this feature with better infiltration control (0.2 air changes per hour) minimizes the energy needed to maintain a healthy level of fresh air and reduces heat loss due to air leakage.

Thermostat, Multi-Zone. A multi-zone programmable thermostat automatically controls the set point temperatures for multiple areas (rooms or zones), ensuring the HVAC system is not running during low-occupancy hours. The baseline for this measure is a programmable thermostat with central control only.

Wall Insulation, 2x4 and 2x6. The presence of wall insulation slows the transfer of heat and reduces the heating and cooling loads in a house. Table B-2.3 compares the different insulation levels for 2x4 and 2x6 framing.

Table B-2.3 Wall Insulation Efficiency Comparison

Measure Name	Measure Efficiency	Baseline Efficiency
Wall Insulation 2x4	R-13 (Below WA Code - Maximum Insulation Feasible)	R-0 (Zero Insulation)
Wall Insulation 2x6	R-21 + R-5 sheathing (Above WA Code - Single Family and Manufactured Homes Only)	R-21 (WA Code - Single Family and Manufactured Homes Only)
Wall Insulation 2x6	R-21 (Above WA Code - Multi Family Only)	R-13 + R-6 sheathing (WA Code - Multi Family Only)

Wi-Fi Thermostat. Thermostats connected to the internet can be controlled from any location with an internet connection and follow occupant schedules for heating and cooling, decreasing run time for heating and cooling.

Windows. This measure provides increased building performance by reducing the U-value in existing and new construction windows, as shown in Table B-2.4.

Table B-2.4 Window Efficiency Comparison

Measure Efficiency	Baseline Efficiency
U-value = 0.22	U-value = 0.30 (WA Code)
U-value = 0.25	U-value = 0.30 (WA Code)
U-value = 0.30 (WA Code)	Double Pane (Existing Window)
U-value = 0.30 (WA Code)	Single Pane (Existing Window)

Window Overhang. A window overhang shades windows, which reduces solar heat gains and decreases the overall cooling load on the home.

Lighting

Daylighting Controls (Photocell), Outdoor. Photocells adjust lighting levels according to the level of daylight the room is receiving. The baseline is no daylighting controls.

Occupancy Sensor. An occupancy sensor turns off the lights after a space is unoccupied for a designated amount of time. The lights turn on again when the sensor detects a person in the space.

Time Clock, Exterior Lighting. This technology allows users to program times for lights outside the residence to be turned on and off automatically. Programmed exterior lighting saves energy by ensuring that lights are not left on during the daytime.

Water Heat

Clothes Washer. This clothes washer uses less energy and water than regular washers. We compared three levels of efficiency—in units of the corresponding Modified Energy Factor (MEF) —for this

measure, as shown in Table B-2.5. The baseline MEF represents the average MEF of non-ENERGY STAR®-qualified models.

Table B-2.5 Clothes Washer Efficiency Comparison

Measure Efficiency	Baseline Efficiency
CEE Tier 2 (MEF 2.2 - 2.39) - Electric DHW & Dryer	RTF Market Standard 2016 Clothes Washer - MEF 2.64 and WF 3.9 (Electric DHW & Dryer)
RTF Market Standard 2018 Clothes Washer - MEF 2.68 and WF 3.7 (Electric DHW & Dryer)	RTF Market Standard 2016 Clothes Washer - MEF 2.64 and WF 3.9 (Electric DHW & Dryer)
CEE Tier 3 (MEF 2.4 or higher) - Electric DHW & Dryer	RTF Market Standard 2016 Clothes Washer - MEF 2.64 and WF 3.9 (Electric DHW & Dryer)
ENERGY STAR - Most Efficient (3.2 MEF or higher) - Electric DHW & Dryer	RTF Market Standard 2016 Clothes Washer - MEF 2.64 and WF 3.9 (Electric DHW & Dryer)
CEE Tier 3 (MEF 2.4 or higher) - Electric DHW & Dryer	RTF Market Standard 2018 Clothes Washer - MEF 2.68 and WF 3.7 (Electric DHW & Dryer)
ENERGY STAR - Most Efficient (3.2 MEF or higher) - Electric DHW & Dryer	RTF Market Standard 2018 Clothes Washer - MEF 2.68 and WF 3.7 (Electric DHW & Dryer)

Dishwasher. This dishwasher uses advanced technology to clean dishes with less water and energy. The efficient model uses less than 307 kWh/year (including standby consumption) and less than 5 gallons of water per cycle. The baseline model consumes 340 kWh/year.

Drain Water Heat Recovery. Also called gravity film heat exchanges, this device recovers heat energy from domestic drain water, which is then used to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating set point and the temperature of the water entering the system.

Faucet Aerators, Bathroom and Kitchen. Faucet aerators, by mixing water and air, reduce amounts of water flowing through faucets. The faucet aerator creates a fine water spray, using a screen inserted in the faucet head.

Table B-2.6 displays the measure and baseline efficiencies.

Table B-2.6 Aerator Efficiency Comparison

Measure Efficiency	Baseline Efficiency
0.5 GPM - Bathroom	2.2 GPM - Bathroom
1.0 GPM - Bathroom	2.2 GPM - Bathroom
1.5 GPM - Bathroom	2.2 GPM - Bathroom
2.2 GPM - Bathroom	Existing Faucet Aerator (3.0 GPM)
1.5 GPM - Kitchen	2.2 GPM - Kitchen
2.2 GPM - Kitchen	Existing Faucet Aerator (3.0 GPM)

Hot Water Pipe Insulation. The addition of R-4 insulation around pipes decreases heat loss. The baseline is a hot water pipe without insulation.

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen in the showerhead.

Table B-2.7 displays the measure and baseline efficiencies.

Table B-2.7 Showerhead Efficiency Comparison

Measure Efficiency	Baseline Efficiency
2.0 GPM	2.24 GPM (RBSA Baseline: Manufactured)
2.0 GPM	2.14 GPM (RBSA Baseline: Multifamily)
2.0 GPM	2.14 GPM (RBSA Baseline: Single Family)
1.5 GPM	2.24 GPM (RBSA Baseline: Manufactured)
1.5 GPM	2.14 GPM (RBSA Baseline: Multifamily)
1.5 GPM	2.14 GPM (RBSA Baseline: Single Family)
1.75 GPM	2.24 GPM (RBSA Baseline: Manufactured)
1.75 GPM	2.14 GPM (RBSA Baseline: Multifamily)
1.75 GPM	2.14 GPM (RBSA Baseline: Single Family)

Water Heater Tank Blanket. The installation of R-5 insulation on older models of water heaters helps reduce standby losses.

Water Heater Thermostat Setback. This measure generates savings by reducing the thermostat set point temperature from 135° to 120°F. The set point temperature on hot water systems is often set higher than necessary.

Appliances

Refrigerator/Freezer, Removal of Secondary. This refers to environmentally friendly disposal of unneeded or inefficient appliances such as secondary refrigerators or stand-alone freezers.

Stand-Alone Freezer, Removal. The removal of stand-alone freezers is beneficial because of the inefficient use of energy by these appliances. Proper disposal is required due to their use of hazardous materials such as Freon and CFCs.

Plug Load

1-Watt Standby Power. Standby power is the electricity used by small electrical equipment or appliances when they are switched off or are not performing their main function. Minimizing this loss to one watt or less can reduce this standby energy consumption by more than 50 percent.

Battery Charger, ENERGY STAR®. On average, these battery chargers use 35 percent less energy than conventional battery chargers, which draw as much as five to 20 times more energy than is actually stored in the battery (even when not actively charging a product). Battery charging systems recharge a variety of cordless products, including power tools, small household appliances, and electric shavers. The baseline is a standard battery charger.

Advanced Power Strip. Power strips with an occupancy sensor will turn power to all devices plugged into the strip on and off, such as computers, desk lights, and audio equipment, based on occupancy within the work area.

Other (Pool)

Pool Pump Timers. A pool pump with a timer set to run during off-peak times (starting after 8:00 p.m. and cycling off before 10:00 a.m.) reduces energy costs. Cycling the pumps will further reduce monthly costs. The baseline is a continuously running pump.

Residential Electric Equipment Measure Descriptions

Heating and Cooling

Air or Ground Source Heat Pump (ASHP or GSHP). Electric heat pumps move heat to or from the air or the ground to cool and heat a home. The current RTF single family and manufactured home market baseline is less than the new 2015 federal standard. Therefore, for single manufactured homes the federal baseline is assumed. Table B-2.8 displays the different efficiency levels we compared for this measure. The baseline size is the same as the measure size.

Table B-2.8 Air or Ground Source Heat Pump (ASHP or GSHP) Efficiencies

Measure Name	Measure Efficiency	Baseline Efficiency
Heat Pump - ENERGY STAR	ENERGY STAR Heat Pump - SEER/EER 14.5/12 and HSPF 8.2 (Split System)	Federal Standard 2015 Heat Pump - SEER/EER 14/12 and HSPF 8.2 (Split System)
Heat Pump - CEE Tier 2	CEE Tier 2 Heat Pump - SEER/EER 15/12.5 and HSPF 8.5 (Split System)	Federal Standard 2015 Heat Pump - SEER/EER 14/12 and HSPF 8.2 (Split System)
Heat Pump - Enhanced	Enhanced Heat Pump - SEER/EER 14/12 and HSPF 9.0 (Split System)	Federal Standard 2015 Heat Pump - SEER/EER 14/12 and HSPF 8.2 (Split System)
Heat Pump - Advanced	Advanced Heat Pump - SEER/EER 16/12.5 and HSPF 10 (Split System)	Federal Standard 2015 Heat Pump - SEER/EER 14/12 and HSPF 8.2 (Split System)
Heat Pump - ENERGY STAR Most Efficient	ENERGY STAR Most Efficient Heat Pump - SEER/EER 18/12.5 and HSPF 9.6 (Split System)	Federal Standard 2015 Heat Pump - SEER/EER 14/12 and HSPF 8.2 (Split System)
Heat Pump - Ground Source	ENERGY STAR Ground Source Heat Pump - EER 17.1 and 3.6 COP (Split System)	Federal Standard 2015 Heat Pump - SEER/EER 14/12 and HSPF 8.2 (Split System)

Central Air Conditioner. This measure consists of several different air conditioner technology/efficiency levels, as summarized in Table B-2.9. The baseline size is the same as the measure size.

Table B-2.9 Central Air Conditioner Efficiencies

Measure Name	Measure Efficiency	Baseline Efficiency
Central Air Conditioner - ENERGY STAR	ENERGY STAR Central Air Conditioner SEER/EER 14.5/12 (Split System)	Federal Standard 2015 Central Air Conditioner SEER/EER 13/11.2 (Split System)
Central Air Conditioner - CEE Tier 3	CEE Tier 3 Central Air Conditioner SEER/EER 16/13 (Split System)	Federal Standard 2015 Central Air Conditioner SEER/EER 13/11.2 (Split System)
Central Air Conditioner - ENERGY STAR Most Efficient	ENERGY STAR Most Efficient Central Air Conditioner	Federal Standard 2015 Central Air Conditioner SEER/EER

Measure Name	Measure Efficiency	Baseline Efficiency
	SEER/EER 18/13 (Split System)	13/11.2 (Split System)

Motor, ECM and ECM-VFD. Electronically commutated motors (ECMs) and ECMs with variable frequency drives (VFD) consume less power than the standard motor used in ventilation and circulation systems.

Room Air Conditioner (Room AC). 10,000 BTU/HR. ENERGY STAR®-qualified room ACs use less energy than conventional models through improved energy performance and timers, which allow for better temperature control. ENERGY STAR®-qualified room air conditioners have an efficiency rating of 10.8 EER, compared to standard models, which have an efficiency rating of 9.8 EER.

Lighting

Compact Fluorescent Lights (CFL) - Specialty. Specialty (or EISA exempt) bulbs include 3-way, candelabra, some globes, and some reflectors. CFLs use up to 77 percent less energy and have a longer life than incandescent specialty light bulb.

Compact Fluorescent Lights (CFL) - Standard. Standard CFLs use 67 percent less energy than the Energy Independence and Security Act (EISA) incandescent bulbs.

Light emitting diodes (LEDs) - Specialty. Specialty LEDs are solid-state devices that convert electricity to light, use 89 percent less energy, and have a long life.

Light emitting diodes (LEDs) - Standard. Standard LEDs use 72 percent less energy than the Energy Independence and Security Act (EISA) incandescent bulbs.

Incandescent – 2020 EISA Backstop Provisions. EISA contains a backstop provision that requires have a minimum efficacy of 45 lumens per watt lighting technologies, beginning in 2020.

Water Heat

Water Heater, Storage, Heat Pump,* CO2 Heat Pump *and Solar. A high-efficiency storage water heater reduces standby loss and is more efficient than a standard electric water heater Heat pump water heater measure moves heat from a warm reservoir (such as air) into the hot water system. CO2 heat pump water heaters use carbon dioxide as a refrigerant, emitting less carbon and decreasing fuel costs compared to a standard heat pump water heater. Solar Water Heaters use thermal energy to heat water without the use of electricity, gas, or heating oil.

Table B-2.10 displays the measure and baseline efficiencies.

Table B-2.10 Electric Water Efficiency Comparison

End Use	Measure Efficiency	Baseline Efficiency
Water Heat GT 55 Gal	RTF Market Standard Heat Pump Water Heater - EF 1.99	RTF Market Standard Heat Pump Water Heater - EF 1.99
Water Heat GT 55 Gal	RTF Tier 1 Heat Pump Water Heater - EF 2.05	RTF Market Standard Heat Pump Water Heater - EF 1.99
Water Heat GT 55 Gal	RTF Tier 2 Heat Pump Water Heater - EF 2.08	RTF Market Standard Heat Pump Water Heater - EF 1.99
Water Heat GT 55 Gal	CO2 Heat Pump Water Heater	RTF Market Standard Heat Pump Water Heater - EF 1.99
Water Heat GT 55 Gal	Solar Hot Water (SHW)	RTF Market Standard Heat Pump Water Heater - EF 1.99
Water Heat LE 55 Gal	RTF Tier 1 Heat Pump Water Heater - EF 1.43	Federal Standard 2015 Storage Water Heater - EF 0.948
Water Heat LE 55 Gal	RTF Tier 2 Heat Pump Water Heater - EF 2.08	Federal Standard 2015 Storage Water Heater - EF 0.948
Water Heat LE 55 Gal	RTF Tier 2 Heat Pump Water Heater - EF 2.08	Federal Standard 2015 Storage Water Heater - EF 0.948
Water Heat LE 55 Gal	CO2 Heat Pump Water Heater	Federal Standard 2015 Storage Water Heater - EF 0.948
Water Heat LE 55 Gal	Solar Hot Water (SHW)	Federal Standard 2015 Storage Water Heater - EF 0.948
Water Heat LE 55 Gal	Solar Hot Water (SHW)	Federal Standard 2015 Storage Water Heater - EF 0.948

Water Heat LE 55 Gal

Appliances

Cooking Oven, High Efficiency. A high-efficiency cooking oven uses fans to circulate heat evenly throughout the oven (convection heat), operating at lower temperatures and achieving cook times quicker than a standard oven. The baseline is a standard oven.

Dryer, High Efficiency. A high-efficiency dryer has features (such as moisture sensors) that minimize energy usage while retaining performance. The efficiency levels for this measure are shown in Table B-2.11.

Table B-2.11 High Efficiency Dryer Comparison

Measure Name	Measure Efficiency	Baseline Efficiency
Dryer - Below Standard	Below Standard Dryer - EF 2.95	Below Standard Dryer - EF 2.95
Dryer - Federal Standard 2015	Federal Standard 2015 Dryer - CEF 3.73	Federal Standard 2015 Dryer - CEF 3.73
Dryer - Advanced Efficiency	Advanced - Efficiency Dryer - EF 4.10	Federal Standard 2015 Dryer - CEF 3.73
Dryer - Heat Pump Dryer	Premium Efficiency - Heat Pump Dryer (0.23 kWh/kg Clothing)	Federal Standard 2015 Dryer - CEF 3.73

Freezer, ENERGY STAR. ENERGY STAR® -qualified freezers use 10 percent less energy than standard models due to improvements in insulation and compressors.

Microwave, High Efficiency. High-efficiency microwaves use more efficient power supplies, fans, magnetron, and reflective surfaces that provide energy savings compared to conventional microwaves.

Refrigerator, ***ENERGY STAR.*** ENERGY STAR®-qualified refrigerators use 20 percent less energy than standard models, due to improvements in insulation and compressors.

Plug Load

Air Purifier, Energy Star. ENERGY STAR certified room air purifiers are 40% more energy-efficient than standard models[1].

Computer, ENERGY STAR. ENERGY STAR® computers consume less than 2 watts in sleep and off modes, and are more efficient than conventional units in idle mode, resulting in 30 percent to 65 percent energy savings.

DVD, ENERGY STAR. ENERGY STAR®-qualified DVD products meeting the new requirements use up to 60 percent less energy than standard models.[2] ENERGY STAR® DVD players use as little as one-fourth of the energy of standard models in the off mode. The baseline for this measure is a standard DVD player.

Home Audio System, ENERGY STAR. According to ENERGY STAR® products, a 6 percent energy savings can be achieved over standard home audio systems.[3]

Monitor, ENERGY STAR. ENERGY STAR® monitors feature: (1) on mode, where the maximum allowed power varies based on the computer monitor's resolution; (2) sleep mode, where computer monitors must consume 2 watts or less; and, (3) off mode, where computer monitors must consume 1 watt or less. The baseline equipment does not include these features.[4]

Multifunction Device (All-in-One). ENERGY STAR models meeting the most recent ENERGY STAR requirements are 40% more energy efficient, and feature efficient designs helping the equipment run cooler and last longer.

Office Copier, ENERGY STAR®. These copy machines are 40 percent more efficient than standard office copy machines.

Office Printer, ENERGY STAR®. These printers are 40 percent more efficient than standard printers.

1 https://www.energystar.gov/products/certified-products/detail/air-purifiers-cleaners
2 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DP
3 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=HA
4 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.ShowProductGroup&pgw_code=MO

Set Top Box, ENERGY STAR. Set top boxes that have earned the ENERGY STAR® rating are at least 30 percent more efficient than conventional models.[5] The baseline measure is a standard receiver.

TV, ENERGY STAR. ENERGY STAR®-qualified TVs use roughly 40 percent less energy than standard units.[6] ENERGY STAR® models are required to consume no more than 1 watt while in sleep mode. The baseline is a standard television, which generally consumes more than 3 watts when turned off.

Other (Pool)

Pool Pumps, VSD. This measure enables a pool pump motor to operate at variable speeds as opposed to constantly running at full power. The baseline for this measure is a standard one speed motor.

5 http://www.energystar.gov/index.cfm?c=settop_boxes.settop_boxes

6 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=TV

Residential Gas Retrofit Measure Descriptions

Heating

Air-to-Air Heat Exchanger. An air-to-air heat exchanger mechanically ventilates homes in cold climates. During the winter, it transfers heat from the air being exhausted to the fresh, outside air entering the home. Between 50 and 80 percent of the heat normally lost in exhausted air is returned to the house. Air-to-air heat exchangers can be installed as part of a central heating and cooling system or in walls or windows. Wall- and window-mounted units resemble air conditioners and will ventilate one room or area.[7]

Ceiling Insulation. This measure represents an increase in R-value. Added ceiling insulation increases the building's thermal performance and brings the resistance value up to and past code, depending on the building vintage. Table B-2.12 summarizes the different resistance values compared in the measure.

Table B-2.12 Ceiling Insulation Comparison

Measure Efficiency	Baseline Efficiency
R-49 (WA Code - Single Family and Manufactured Homes Only)	R-0 (Zero Insulation - Single Family and Manufactured Homes Only)
R-49 (WA Code - Single Family and Manufactured Homes Only)	R-8.0 (Existing Insulation - Manufactured Homes Only)
R-49 (WA Code - Single Family and Manufactured Homes Only)	R-11.9 (Existing Insulation - Single Family Only)
R-60 (Above WA Code - Single Family and Manufactured Homes Only)	R-49 (WA Code - Single Family and Manufactured Homes Only)
R-38 (WA Code - Multi Family Only)	R-0 (Zero Insulation - Multi Family Only)
R-38 (WA Code - Multi Family Only)	R-9.6 (Existing Insulation - Multi Family Only)
R-49 (Above WA Code - Multi Family Only)	R-38 (WA Code - Multi Family Only)

Combined Duct Sealing and Insulation. Duct sealing and insulation cost-effectively save energy, improve air and thermal distribution (comfort and ventilation), and reduce cross contamination between different zones in buildings (i.e., smoking vs. non-smoking, bio-aerosols, localized indoor air pollutants). This measure assumes a baseline of existing duct conditions sealed and insulated to R-8 and R-11.

Construction, ICF. Building a concrete home with insulating concrete forms (ICFs) saves energy. Greater insulation, tighter construction, and the temperature-moderating mass of the walls conserve heating and cooling energy much better than conventional wood-frame walls.

Construction, SIP. A structural insulated panel (SIP) uses continuous foam insulation throughout the panel, which provides excellent energy efficiency and low levels of air infiltration. The baseline is standard wood framing.

[7] http://cipco.apogee.net/res/reevhex.asp

Doors. Composite or steel doors with a foam core increase overall insulation, slowing heat loss. This measure includes adding a thermal door with a resistance value of R-5 or R-11 to houses without a thermal or storm door (R-2.5).

Doors, Weatherization. Mounting weather stripping to the bottom of an exterior door minimizes infiltration door sweep. This type of weatherization consists of an extruded aluminum strip holding a flexible vinyl strip that blocks the air space between the door frame and the door. The baseline for this measure is no weather stripping.

Duct Fittings, Leak-Proof. The majority of duct leakage in residential HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time.

Duct Location. Locating ducts in conditioned spaces reduces wasted heat loss.[8] Many homes have ducts that run through unconditioned areas (such as attics, garages, crawlspaces, and basements) for convenience and practical reasons. Ducts in unconditioned areas lose energy because of the temperature difference between conditioned air in the ducts and the surrounding space.

Floor Insulation. The addition of floor insulation increases the overall resistance value of a home and slows heat transfer from the basement to the upper levels. Table B-2.13 summarizes the different resistance values compared in the measure.

Table B-2.13 Floor Insulation Comparison

Measure Efficiency	Baseline Efficiency
R-30 (WA Code)	R-0 (Zero Insulation)
R-30 (WA Code)	R-6.7 (Existing Insulation: Manufactured Homes)
R-30 (WA Code)	R-5.2 (Existing Insulation: Multifamily)
R-30 (WA Code)	R-8.5 (Existing Insulation: Single Family)
R-38 (Above WA Code)	R-30 (WA Code)

Infiltration Control (Caulk, Weather Strip, etc.) ***Blower Door Test.*** Sealing air leaks in windows, doors, the roof, crawlspaces, and outside walls prevents drafts and reduces overall heating and cooling losses.

Integrated Space and Water Heating. These systems provide space conditioning and hot water heating in one appliance/energy source. Domestic hot water is heated directly and space is heated by a hot water heat exchanger coil piped to the forced air heating system. This combination space/water heating system provides high efficiency heating for the cost of one high efficiency appliance.

Programmable Thermostat. This measure controls set point temperature automatically, ensuring the HVAC system is not running during low-occupancy hours.

[8] http://www.toolbase.org/pdf/techinv/ductsinconditionedspace_techspec.pdf

Radiant Barrier, Ceiling. A radiant barrier generally consists of a thin piece of aluminum installed in a ceiling that reduces the solar heat gain from the sun during the summer and traps heat in during the winter. These barriers reduce heat transfer between the air space of the roof deck and the attic floor.

Slab Insulation. Substantial heat can be lost through an uninsulated slab, resulting in cold, uncomfortable floors. Even if foundation walls have been insulated vertically under the slab, significant heat escapes from the slab edge closest to the cold outside air. This measure compares a slab insulated with R-15 insulation to a slab insulated to code R-10. Applicable to new construction only.

Smart Siting. This measure, which applies only to new construction, entails optimizing the building orientation to minimize the heating and cooling load on the HVAC system.

Thermal Shell, Infiltration at 0.2 ACH w/ HRV. Heat recovery ventilation (HRV) provides fresh air and improved climate control, while also saving energy by reducing the heating (or cooling) requirements of a building. Combining this feature with better infiltration control (0.2 air changes per hour) minimizes the energy needed to maintain a healthy level of fresh air and reduces heat loss due to air leakage.

Thermostat, Multi-Zone. A multi-zone programmable thermostat automatically controls the set point temperatures for multiple areas (rooms or zones), ensuring the HVAC system is not running during low-occupancy hours. The baseline for this measure is a programmable thermostat with central control only.

Wall Insulation, 2x4 and 2x6. The presence of wall insulation slows the transfer of heat and reduces the heating and cooling loads in a house. Table B-2.14 compares the different insulation levels for 2x4 and 2x6 framing.

Table B-2.14 Wall Insulation R-Value Comparison

Measure Name	Measure Insulation	Baseline Insulation
Wall Insulation 2x4	R-13 (Below WA Code - Maximum Insulation Feasible)	R-0 (Zero Insulation)
Wall Insulation 2x6	R-21 + R-5 sheathing (Above WA Code - Single Family and Manufactured Homes Only)	R-21 (WA Code - Single Family and Manufactured Homes Only)
Wall Insulation 2x6	R-21 (Above WA Code - Multi Family Only)	R-13 + R-6 sheathing (WA Code - Multi Family Only)

Wi-Fi Thermostat. Thermostats connected to the internet can be controlled from any location with an internet connection and follow occupant schedules for heating and cooling, decreasing run time for heating and cooling.

Windows. This measure provides increased building performance by reducing the U-value in existing and new construction windows, as shown in Table B-2.15.

Table B-2.15 Window U-Value Comparison

Measure U-value	Baseline U-value
U-value = 0.22 (Above WA Code)	U-value = 0.30 (WA Code)
U-value = 0.25 (Above WA Code)	U-value = 0.30 (WA Code)
U-value = 0.30 (WA Code)	Double Pane (Existing Window)
U-value = 0.30 (WA Code)	Single Pane (Existing Window)

Water Heat

Clothes Washer, ENERGY STAR®. This clothes washer uses less energy and water than regular washers.[9] Three levels of efficiency—in units of the corresponding Modified Energy Factor (MEF) —are shown in **Error! Reference source not found.**. The baseline MEF represents the average MEF of non-ENERGY STAR®-qualified models.

Dishwasher, ENERGY STAR®. This dishwasher uses advanced technology to clean dishes with less water and energy. The efficient model uses less than 307 kWh/year (including standby consumption) and less than 5 gallons of water per cycle. The baseline model consumes 340 kWh/year.

Drain Water Heat Recovery. Also called gravity film heat exchanges, this device recovers heat energy from domestic drain water, which is then used to pre-heat cold water entering the hot water tank. This minimizes the temperature difference between the heating set point and the temperature of the water entering the system.

Faucet Aerators, Bathroom and Kitchen. This measure mixes water and air, reducing the amount of water that flows through the faucet. It creates a fine water spray through an inserted screen in the faucet head.

Table B-2.16 displays the measure and baseline efficiencies.

Table B-2.16 Aerator Efficiency Comparison

Measure Efficiency	Baseline Efficiency
0.5 GPM - Bathroom	2.2 GPM - Bathroom
1.0 GPM - Bathroom	2.2 GPM - Bathroom
1.5 GPM - Bathroom	2.2 GPM - Bathroom
2.2 GPM - Bathroom	Existing Faucet Aerator (3.0 GPM)
1.5 GPM - Kitchen	2.2 GPM - Kitchen
2.2 GPM - Kitchen	Existing Faucet Aerator (3.0 GPM)

[9] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW

Hot Water Pipe Insulation. The addition of R-4 insulation around pipes decreases heat loss. The baseline is a hot water pipe without insulation.

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen in the showerhead.

Table B-2.17 displays the measure and baseline efficiencies.

Table B-2.17 Showerhead Efficiency Comparison

Measure Efficiency	Baseline Efficiency
2.0 GPM	2.24 GPM (RBSA Baseline: Manufactured)
2.0 GPM	2.14 GPM (RBSA Baseline: Multifamily)
2.0 GPM	2.14 GPM (RBSA Baseline: Single Family)
1.5 GPM	2.24 GPM (RBSA Baseline: Manufactured)
1.5 GPM	2.14 GPM (RBSA Baseline: Multifamily)
1.5 GPM	2.14 GPM (RBSA Baseline: Single Family)
1.75 GPM	2.24 GPM (RBSA Baseline: Manufactured)
1.75 GPM	2.14 GPM (RBSA Baseline: Multifamily)
1.75 GPM	2.14 GPM (RBSA Baseline: Single Family)

Water Heater Tank Blanket. The installation of R-5 insulation on older models of water heaters helps reduce standby losses.

Water Heater Thermostat Setback. This measure generates savings by reducing the thermostat set point temperature from 135° to 120°F. The set point temperature on hot water systems is often set higher than necessary.

Residential Gas Equipment Measure Descriptions

Heating

Gas Boiler. Boilers are classified as condensing or non-condensing. Condensing boilers condense the flue gas and water vapor, extracting useful heat and improving the boiler efficiency. This measure compares several boilers with different thermal efficiencies and is applicable to both new and existing construction. The overall efficiency of the boiler is defined as the gross energy output divided by the energy input, and is affected by combustion efficiency, standby losses, cycling losses, and heat transfer. Table B-2.18 displays the measure and baseline thermal efficiencies.

Table B-2.18 Gas Boiler Efficiency Comparison

Measure Name	Measure Efficiency	Baseline Efficiency
Boiler - Below Standard	Below Standard Boiler - 78% AFUE	Below Standard Boiler - 78% AFUE
Boiler - Federal Standard 2012	Federal Standard 2012 Boiler - 82% AFUE	Federal Standard 2012 Boiler - 82% AFUE
Boiler - High Efficiency	High Efficiency Boiler - 90% AFUE	Federal Standard 2012 Boiler - 82% AFUE
Boiler - ENERGY STAR Most Efficient	ENERGY STAR Most Efficient Boiler - 95% AFUE	Federal Standard 2012 Boiler - 82% AFUE
Boiler - Advanced Efficiency	Advanced Efficiency Boiler - 98% AFUE	Federal Standard 2012 Boiler - 82% AFUE

Gas Furnace. Improvements in furnace technology, such as new ignition and heat exchange design, have led to increased furnace efficiency. The AFUE levels considered in this measure are shown in Table B-2.19.

Table B-2.19 Gas Furnace Efficiency Comparison

Measure Name	Measure Efficiency	Baseline Efficiency
Furnace - Below Standard	Below Standard Furnace - 76% AFUE	Below Standard Furnace - 76% AFUE
Furnace - Federal Standard 2007	Federal Standard 2007 Furnace - 78% AFUE	Federal Standard 2007 Furnace - 78% AFUE
Furnace - High Efficiency	High Efficiency Furnace - 90% AFUE	Federal Standard 2007 Furnace - 78% AFUE
Furnace - Advanced Efficiency	Advanced Efficiency Furnace - 95% AFUE	Federal Standard 2007 Furnace - 78% AFUE
Furnace - ENERGY STAR Most Efficient	ENERGY STAR Most Efficient Furnace - 97% AFUE	Federal Standard 2007 Furnace - 78% AFUE

Water Heat

Water Heater, Storage, Tankless, and Solar. A high-efficiency storage water heater reduces standby loss and is more efficient than a standard electric water heater. Tankless water heaters provides hot water at

a preset temperature as needed without storage, thereby reducing or eliminating standby losses. Solar Water Heaters use thermal energy to heat water without the use of electricity, gas, or heating oil.

Table B-2.20 displays the measure and baseline efficiencies.

Table B-2.20 Natural Gas Water Heater Efficiency Comparison

End Use	Measure Efficiency	Baseline Efficiency
Water Heat GT 55 Gal	Condensing Water Heater - EF 0.85	Federal Standard 2015 Condensing Water Heater - EF 0.743
Water Heat GT 55 Gal	Solar Water Heater	Federal Standard 2015 Condensing Water Heater - EF 0.743
Water Heat LE 55 Gal	ENERGY STAR Storage Water Heater - EF 0.67	Federal Standard 2015 Storage Water Heater - EF 0.615
Water Heat LE 55 Gal	ENERGY STAR Tankless Water Heater - EF 0.82	Federal Standard 2015 Storage Water Heater - EF 0.615
Water Heat LE 55 Gal	Condensing Water Heater - EF 0.90	Federal Standard 2015 Storage Water Heater - EF 0.615
Water Heat LE 55 Gal	Solar Water Heater	Federal Standard 2015 Storage Water Heater - EF 0.615

Appliances

High Efficiency Dryer. High efficiency dryers have features, such as moisture sensors, that minimize energy usage while retaining performance. Baseline is the Federal Standard 2015 Dryer with an EF of 3.30, compared to 3.36.

Other

Cooking Oven, High Efficiency. High-efficiency convection ovens operate at lower temperatures and achieve quicker cook times than standard ovens, due to fans circulating heat evenly throughout the oven. The baseline is a 2012 federal standard oven.

Energy Efficient Pool Heater. Gas pool heaters use natural gas or propane. The water circulated by the pump passes through a filter and then travels to the heater. Gas burns in the heater combustion chamber, generating heat that warms the water returning to the pool. This measure assumes an efficiency level of 88 percent, compared to a standard 83 percent efficient pool heater.

Commercial Electric Retrofit Measure Descriptions

HVAC (and Envelope)

Automated Exhaust Variable Frequency Drive (VFD) Control, Parking Garage CO Sensor. This measure allows the ventilation system to run only when CO levels rise above a specified level. The ventilation system would run constantly without this measure.

Automated Ventilation Variable Frequency Drive (VFD) Control, Occupancy/CO_2 sensors. This measure is also known as demand-control ventilation (DCV), where the ventilation system automatically adjusts air flow when CO_2 is above a specified level. CO_2 controls maintain a minimum ventilation rate at all times to control non-occupant contaminants, such as off-gassing from furniture, equipment, and building components. The baseline of this measure is a ventilation system that runs constantly.

Chilled Water/Condenser Water Settings, Optimization. Making adjustments to the chilled and condenser water system settings to better match the building load will reduce unnecessary use of the compressor and pumps.

Chilled Water Piping Loop with Variable Speed Drive (VSD) Control. A VSD controller, with two-way valves at the cooling coils, controls the chilled water pump speed to vary based on the cooling load, thus reducing pumping energy requirements. The baseline is a constant speed pump with three-way valves.

Chiller Water-Side Economizer. This measure consists of a heat exchanger attached to a condenser water piping loop that operates when outdoor conditions can produce colder condenser water than the mixed air temperature. A water side economizer is used when an outdoor-air economizer is not practical. The baseline measure is no economizer.

Convert Constant Volume Air System to Variable Air Volume (VAV). This measure allows the airflow volume of a HVAC system to vary the heating or cooling load rather than over-conditioning and short-cycling. The baseline is a constant volume system.

Cooling Tower, Decrease Approach Temperature. An oversized cooling tower allows a reduced approach temperature, which saves energy. The approach temperature is the difference between the water leaving the tower and the wet-bulb temperature. This measure assumes a 6 degree delta compared to the baseline of a 10 degree delta.

Cooling Tower, Variable Speed Drive (VSD) Fan Control. VSDs modulate the air flow so that heat rejection exactly matches load at the desired set point, which saves energy. The baseline measure is a two-speed fan motor.

Direct Digital Control (DDC) System, Installation. DDC systems allow for both HVAC and lighting to be controlled and monitored. For lighting, the DDC system allows for direct control of lights from a remote location. Entire HVAC systems, including pumps, motors, fans, and set points, can be digitally programmed for tighter control of the system.

Direct Digital Control (DDS) System, Wireless Performance Monitoring. This second-generation building automation systems allows for wireless optimization and operation of building systems (such as HVAC)
Direct Expansion (DX) Package Air-Side Economizer. An air-side economizer mixes return air with outside air to cool indoor spaces, which saves energy as less air needs to be cooled.

Direct Expansion (DX) Tune-Up/Diagnostics. Regular maintenance of DX air-conditioning systems includes checking controls, replacing filters, cleaning coils and blowers, and checking refrigerant levels.

Direct/Indirect Evaporative Cooling, Pre-Cooling. Direct evaporative coolers are low-energy systems that evaporate water into the air stream, thus reducing air temperature and increasing humidity. Indirect evaporative coolers use a secondary air stream that is cooled by water and travels through a heat exchanger with the primary air stream, cooling the air but not affecting the humidity. Direct/indirect systems cool the air stream via the indirect cooler, then cool it further through the direct cooler. Including an evaporative cooler before the DX system reduces the overall cooling load.

Duct Fittings, Leak-Proof. The majority of duct leakage in residential HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time.

Duct Repair and Sealing. This maintenance creates significant energy savings by ensuring conditioned air only goes to occupied spaces, thereby reducing an excessive runtime/load on the HVAC system.

Exhaust Air to Ventilation Air Heat Recovery. This measure captures heated air exhausted out of a building and transfers it to the incoming air, decreasing the overall heating load.

Exhaust Hood Makeup Air. This measure provides exhaust air at the hood instead of allowing the hood to exhaust conditioned air in the room. The baseline measure is for conditioned air to be expelled through exhaust hoods.

Green Roof. The added mass and thermal resistance of green roofs reduces the heating and cooling loads of the building. These roofs reduce the ambient temperature of the roof surface and slow the transfer of heat into the building, which reduces cooling costs. They also add insulation to the roof structure, reducing heating requirements in the winter.[10] Additionally, they reduce the ambient temperature around the roof, which decreases the building's urban heat island effect.

Hotel Key Occupancy Control System. This measure controls room HVAC and lighting during non-occupied periods. Occupancy is determined by the presence of a key card and/or additional sensors. The central system sets heating and cooling to a minimum and turns off lighting when the key card is removed. Once the key card is inserted, the hotel guest has full control of the room systems.

[10] http://www.toolbase.org/Technology-Inventory/Roofs/green-roofs

Infiltration Reduction (Caulking, Weather Stripping, etc.). Sealing air leaks in windows, doors, the roof, crawlspaces, and outside walls decreases overall heating and cooling losses.

Insulation, Ceiling. These measures represent an increase in R-value from existing building conditions to current state code or from current state code to better than code. Baseline and measure values are presented in Table B-2.21.

Table B-2.21 Ceiling Insulation Efficiency Comparison

Measure Efficiency	Baseline Efficiency
R-38 c.i.	R-30 c.i. (WA State Code)
R-49 c.i.	R-38 c.i.
R-30 c.i. (WA State Code)	Average Existing Conditions
R-38 c.i.	R-30 c.i. (WA State Code)
R-49 c.i.	R-38 c.i.
R-30 c.i. (WA State Code)	Average Existing Conditions

Insulation, Duct. Packaged direct expansion and heat-pump equipment are generally coupled with a ducting system inside the building. Insulating these ducts reduces energy loss to the unconditioned plenum space. This measure assumes that R-7 insulation is installed where no insulation previously existed.

Insulation, Floor (Non-Slab). These measures represent an increase in R-value from existing building conditions to current state code or from current state code to better than code. The baseline and measure R-values are presented in Table B-2.22.

Table B-2.22 Floor (Non-Slab) Insulation Efficiency Comparison

Measure Efficiency	Baseline Efficiency
R-30 (WA State Code)	Average Existing Conditions
R-38	R-30 (WA State Code)
R-30 (WA State Code)	Average Existing Conditions
R-38	R-30 (WA State Code)

Insulation, Wall. These measures represent an increase in R-value from existing building conditions to the current state code value of R-13 + 7.5. The baseline value of R-3 represents the average existing insulation level.

Natural Ventilation System. This measure relies on pressure differences to move fresh air through buildings. Natural ventilation, unlike fan-forced ventilation, uses the natural forces of wind and buoyancy to deliver fresh air into buildings. The specific approach and design varies by building type and local climate. The amount of ventilation depends on internal space design and the size and placement of

openings in the building. Natural ventilation offsets the energy required to run forced air ventilation systems. [11]

Pipe Insulation. Adding 1.5-inches of insulation to water pipes yields an approximate R-value of R-6, which decreases temperature losses, thereby reducing demand on chilled water systems.

Programmable Thermostat, Web Enabled. This measure controls set point temperature automatically, ensuring the HVAC system is not running during low-occupancy hours.

Retro-Commissioning. Commissioning ensures that energy-using systems are operating in an optimal fashion in order to maximize energy efficiency. This commissioning process can be applied to existing buildings to restore them to optimal performance. Retro-commissioning is a systematic, documented process that identifies low-cost operational and maintenance improvements in existing buildings and brings them up to the design intentions.[12,13] The baseline measure is no commissioning.

Sensible Heat Recovery Devices. This measure preconditions incoming air by transferring energy between the exhaust air stream and the supply air stream. This raises the temperature of incoming air during the winter and decreases it in the summer. Energy savings results from the reduced need for mechanical heating or cooling.

Total Heat Recovery Devices. This measure, also called enthalpy recovery, transfers sensible and latent heat. Latent heat, which is released or absorbed due to a phase change (such as the condensation of water vapor), significantly raises the outdoor air humidity in the winter and reduces it in the summer.[14]

Water Source Heat Pump > 135 kBTU/hr. This measure results in fuel savings up to 11 percent compared to standard water source heat pumps >135 kBTU/kr.

Window Film. Solar control window films applied to existing windows reduces peak demand during hot months and conserves air conditioning energy. The use of these films also reduces exposure to ultraviolet radiation and glare.[15]

Windows, High Efficiency. This measure increases building performance by reducing the U-value, as shown in Table B-2.23.

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11 National Renewable Energy Laboratory; http://www.nrel.gov/docs/fy03osti/33698.pdf

12 http://www.green.ca.gov/CommissioningGuidelines/default.htm

13 http://cbs.lbl.gov/BPA/cct.html

14 http://www.mcquay.com/mcquaybiz/marketing_tools/mt_corporate/EngNews/0701.pdf

15 http://www.iwfa.com/iwfa/Consumer_Info/windowfilmbenefits.html

Table B-2.23 High Efficiency Window Efficiency Comparison

Measure Efficiency	Baseline Efficiency
U-0.32	U-0.40 (WA State Code)
U-0.40 (WA State Code)	Average Existing Conditions

Lighting

Bi-Level Control, Stairwell Lighting. This measure allows an occupancy sensor to reduce the light load in an unoccupied stairwell by 50 percent for a set amount of time. The baseline is continuous operation at full power.

Cold Cathode Lighting. This measure is a tubular light or bulb that passes an electrical current through a gas or vapor, much like neon lighting. A cold cathode light is up to five times brighter than neon, and has one of the longest lives of any lighting fixture at roughly 50,000 hours.[16] Cold cathode lighting uses 5 watts compared to 30 watts for an incandescent bulb.

Covered Parking Lighting. This measure reducing the energy use of covered parking garages by replacing inefficient metal halide lamps with LED and replacing high pressure sodium lamps with LED low bay lighting.

Daylighting Controls, Outdoors (Photocell). Exterior photocells adjust lighting levels according to sunlight levels reaching desired set points. This measure achieves savings over time-clock or manual controls through changes in seasonal and site conditions by improving night time durations.

Dimming, Continuous: Fluorescent Fixtures. A continuous dimming switch allows light level brightness to vary from 0 percent to 100 percent, increasing electricity savings. The baseline measure is fluorescent fixtures operating at full power.

Dimming, Stepped: Fluorescent Fixtures. This measure allows the user to vary the light level by a number of specified tiers to adjust for the amount of outside daylight. The baseline measure is fluorescent fixtures operating at full power.

Display Case Motion Sensors. Motion sensors decrease usage by shutting off power to light sources when the device is not in use. The baseline are display cases with no motion sensors.

Exit Sign, Light Emitting Diodes (LED). LED exit signs use only 2 watts of power and last over 50,000 hours, compared to CFL exit signs that use 9 watts of power and have a shorter life.

Exit Sign, Photoluminescent or Tritium. This measure uses no energy and provides lighting suitable for exit signage.

[16] Conjecture Corporation of wisegeek.com; http://www.wisegeek.com/what-is-a-cold-cathode-light.htm

Exterior Building Lighting, Package. This measure decreases lighting power density by 30 percent. The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot.

Light Emitting Diodes (LED) Refrigeration Case Lights. These highly efficient bulbs create 55 percent energy savings over standard 60 watt fluorescent refrigeration case light.

Occupancy Sensor Control. This measure turns off lights after a space is unoccupied for a designated amount of time. The lights turn on again when the sensor detects a person in the space. Occupancy measures can control single or multiple lighting zones. The controlled lighting wattage varies depending on application. The baseline assumes no lighting controls.

Solid State Light Emitting Diode (LED), White Lighting. LEDs are solid-state devices that convert electricity to light, with very high efficiency and long life. Recently, lighting manufacturers have indirectly produced 'cool' white LED lighting using ultraviolet LEDs to excite phosphors that emit a white-appearing light. This measure applies to exterior lighting for landscape, merchandise, signage, and structures. The baseline for this measure is 50 watts, 10 hrs/day, 365 days/yr.

Surface Parking Lighting. Replacing inefficient metal halide lamps that consume between 100-150 watts with LED lighting that consumes 60-111 watts reduces the energy use of surface parking lots. LED lights also last longer than metal halide lamps, reducing the labor of replace lamps.

Time Clock. This technology allows users to program lights and other loads to be turned on and off automatically in response to a time schedule, an occupancy sensor, or a building automation system.

Water Heat

Clothes Washer, Ozonating. This measure disinfects water with ozone-enriched air, which suppresses subsequent biological activity and controls biological growth within the appliance, thus reducing the need for hot water. The baseline measure is a standard commercial clothes washer.[17]

Clothes Washer Commercial, ENERGY STAR®. This measure has more capacity than conventional top-load models with an agitator. Some front-loaders can wash over 20 pounds of laundry at once, compared to 10–15 pounds for a standard top-loader.[18]

Demand-Controlled Circulating Systems. This measure circulates hot water only when required. The baseline measure is a continuously circulating hot water system, resulting in energy loss through pipes.

Dishwasher, Residential ENERGY STAR®. Residential sized ENERGY STAR® dishwashers are often appropriate for smaller commercial buildings, and are 10 percent more efficient than the federal minimum standard used as the baseline.[19]

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17 http://www.patentstorm.us/patents/6607672-description.html

18 http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers_comm

Dishwasher, Commercial: High Temperature ENERGY STAR®. This measure has a minimal idle rate, consumes a minimal amount of water per rack of loaded dishes, and is on average 25 percent more efficient than standard high temp commercial dishwashers.[20]

Dishwasher, Commercial: Low Temperature ENERGY STAR®. This measure uses chemicals combined with low temperatures to save energy compared to standard high temperature commercial dishwashers.

Drain Water Heat Recovery, Water Heater. This measure recovers heat energy from drain water and uses it to heat water entering the hot water tank, minimizing the temperature rise required to achieve the water heater set point.[21]

Hot Water (SHW) Pipe Insulation. One inch of extra insulation on hot water pipes yields an approximate R-value of R-4, decreasing temperature losses. This measure is only applicable for existing construction. The baseline measure is no insulation.

Low-Flow Faucet Aerators. This measure mixes water and air, reducing the amount of water that flows through the faucet. It creates a fine water spray through an inserted screen in the faucet head. Flow rate requirements for this measure are presented in Table B-2.24.

Table B-2.24 Low-Flow Faucet Aerators Efficiency Comparison

Measure Efficiency	Baseline Efficiency
1.5 GPM	2.2 GPM (Federal Code)
2.2 GPM (Federal Code)	3.0 GPM
1.0 GPM	2.2 GPM (Federal Code)
0.5 GPM	2.2 GPM (Federal Code)

Low-Flow Pre-Rinse Spray Valves. This measure mixes water and air, reducing the amount of water that flows through the spray head. The head creates a fine water spray through an inserted screen, achieving a flow reduction from 1.6 GPM (federal standard) to 0.6 GPM.

Low-Flow Showerheads. This measure mixes water and air, reducing the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen. Flow rate requirements for this measure are presented in Table B-2.25.

19 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DW
20 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COH
21 www.toolbase.org/Techinventory/TechDetails.aspx?ContentDetailID=858&BucketID=6&CategoryID=9

Table B-2.25 Low-Flow Showerhead Efficiency Comparison

Measure Efficiency	Baseline Efficiency
2.0 GPM	2.5 GPM (Federal Code)
2.5 GPM (Federal Code)	3.0 GPM
1.75 GPM	2.5 GPM (Federal Code)
1.5 GPM	2.5 GPM (Federal Code)

Ultrasonic Faucet Control. Ultrasonic sensors automatically turn faucet water on and off when motion is detected at the sink. This eliminates water running continuously while the sink is in use.

Water Cooled Refrigeration with Heat Recovery. Heat recovery gathers and uses thermal energy for the water heater that would normally be rejected to the ambient environment.

Refrigeration

Add Doors to Refrigerated Open Display Cases. Doors on refrigerated cases create a barrier between the conditioned space and the non-conditioned space, decreasing energy use necessary to maintain temperature. The baseline are standard refrigerated open display cases.

Anti-Sweat (Humidistat) Controls. This measure enables the user to turn refrigeration display case anti-sweat heaters off when ambient relative humidity is low enough that sweating will not occur. Without controls, heaters generally run continuously.

Case Electronically Commutated Motor (ECM). A case fan is one component of a refrigeration system. ECMs are smaller variable speed motors that operate from a single-phase power source with an electronic controller in or on the motor. The baseline measure is a standard efficiency motor.

Case Replacement, Low and Medium Temperatures. Efficient refrigerated display cases achieve higher performance efficiency and reduce overall energy consumption by incorporating high performance evaporative fans, such as ECMs, energy-efficient double-pane glass doors, anti-sweat controls, high efficiency lighting and ballast, such as T8 or LED lamps, and improved insulation.

Commercial Refrigerator, Semivertical and Vertical No Doors Medium Temp. High efficiency semivertical and vertical refrigeration open cases (medium temperature) compared to standard equipment.

Compressor VSD Retrofit. This measure modulates motor speed in response to load changes. When low-load conditions exist, current to the compressor motor is decreased, slowing the compressor motor. Baseline is a constant-speed compressor.

Demand Control Defrost, Hot Gas. Evaporator frost reduces coil capacity by acting as a layer of insulation and reducing the airflow between fins. With hot gas defrost, refrigerant vapor from the

compressor discharge or the high pressure receiver is used to warm the evaporator coil and melt the frost.[22]

Evaporative Condenser, High Efficiency. This water cooled measure can cycle a refrigerator with less energy than a standard air-cooled system.

Evaporator Fan Controller. This measure adds controls to evaporator fans that reduces fan speed by decreasing applied voltage. The base case is an evaporator fan with no controller.

Floating Condenser Head Pressure Controls. This measure adds controls to float head pressure temperature down during periods of low load. The base case is a standard multiplex system with a fixed condensing set point.

Glass Door, ENERGY STAR® Refrigerators/Freezers. Low-E, double-pane thermal glass doors reduce cooling loses in refrigerated reach-in cases.

High Efficiency Compressors. A component of refrigeration systems, this measure operates up to 15 percent more efficiently than standard-efficiency compressors.

Night Covers for Display Cases. This measure eliminates wasted refrigeration cooling by insulating display cases. In addition, it reduces the heating load of buildings by allowing less refrigerated air to escape and need reheated.

Refrigeration Commissioning or Re-Commissioning. Commissioning ensures that refrigeration systems are operating in an optimal fashion in order to maximize energy efficiency. Retro-commissioning checks previously commissioned equipment to ensure that it is continuing to run efficiently. The baseline measure is no commissioning.[23]

Solid-Door Refrigerators/Freezers, ENERGY STAR®. This measure is designed with high efficiency components such as an ECM evaporator, condenser fan motors, hot gas anti-sweat heaters, or high-efficiency compressors, saving energy compared to standard models.[24]

Standalone to Multiplex Compressor. This measure consists of multiple compressors drawing from a common suction header, serving any number of refrigerated display fixtures. The suction group is controlled to satisfy the lowest temperature required by any of the attached display fixtures, and therefore the fixtures served by a given suction group usually have similar temperature requirements. Baseline is a single dedicated compressor system for each refrigeration load.[25, 26]

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[22] Parker Refrigeration Specialists; http://www.parker.com/literature/Refrigerating%20Specialties%20Division/90-11a.pdf

[23] http://cbs.lbl.gov/BPA/cct.html

[24] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CRF

[25] http://www.energysmartgrocer.org/pdfs/PGE/BridgeEquipment%20SpecificationTandCs.pdf

Strip Curtains on Walk-In Refrigerators. This measure reduces the infiltration of warm air into the refrigerated space by improving the barrier between the refrigerated and the ambient air.

Walk-In Electronically Commutated Motor (ECM). A walk-in fan is one component of refrigeration systems. ECMs typically have small horse power motors (less than 1 HP) that are factory programmed to run at certain speeds. ECMs operate from a single-phase power source with an electronic controller in or on the motor. The baseline measure is a standard efficiency motor.[27]

Variable Refrigerant Flow System. This energy efficient heating and cooling system using inverter driven compressor technology without ducting. Baseline technology is assumed to be a typical VAV rooftop HVAC system.

VFD Rooftop Unit Supply Fan (Grocery Only). This measure is installed on rooftop unit supply fans, serving grocery store sales floors. Units must have fixed ventilation damper and shut-off damper controls allowed, and must have continuous fan operation during occupied periods. Units with fans in "auto" mode do not qualify. A CO2 control is required to provide increased ventilation during times of high occupancy (maintain 1,150 ppm CO2 concentration).[28]

Visi Cooler. A Visi Cooler is a self-contained vertical storage cooler, with a glass door to visibly display retail products. Such coolers typically are found in grocery and restaurant businesses. Energy-efficient Visi Coolers include: high-efficiency cooling units; self-closing doors; and energy-efficient lighting.

Other

Battery Charger, ENERGY STAR®. On average, these battery chargers use 35 percent less energy than conventional battery chargers, which draw as much as five to 20 times more energy than is actually stored in the battery (even when not actively charging a product). Battery charging systems recharge a variety of cordless products, including power tools, small household appliances, and electric shavers. The baseline is a standard battery charger.[29]

Combination Oven. This measure uses both dry heat and steam, which are injected into the oven when the food being cooked needs it. High efficiency combination ovens with 60 percent efficiency use roughly half the energy of standard combination ovens.[30]

Cooking Hood Controls. Utilizing sensors and two-speed or variable speed fans, hood controls reduce exhaust (and makeup) airflow when appliances are not at capacity (or have been turned off). The baseline for this measure is no hood controls.

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26 http://www.bizlink.com/HPAC_articles/March2007/306.pdf

27 http://www.fishnick.com/publications/appliancereports/refrigeration/GE_ECM_revised.pdf

28 http://www.nwcouncil.org/energy/rtf/measures/Com/GroceryHVACvfd_v1_1.xlsm

29 http://www.energystar.gov/index.cfm?c=battery_chargers.pr_battery_chargers

30 http://www.energystar.gov/ia/partners/publications/pubdocs/restaurants_guide.pdf

Deep Fat Fryer, Consortium for Energy Efficiency (CEE). Commercial, 15 inch CEE rated electric fryers have a heavy load cooking efficiency of 80 percent or better, and use less than 1,000 watts when idle.[31] The baseline is standard electric deep fat fryer.

Griddle, ENERGY STAR®. This measure is approximately 10 percent more efficient than standard models, and must have a minimum cooking efficiency of 38 percent. They must use less than 0.026 therm/hour/ft^2 when idle. The baseline measure is a standard grill at 32 percent efficiency.[32]

High Efficiency Convection Oven, ENERGY STAR®. This measure must meet the specification requirements of 70 percent cooking energy efficiency and an idle energy rate of 1.6 kW. Standard electric convection ovens have a 65 percent cooking energy efficiency and an idle energy rate of 2 kW.[33]

High Efficiency Ice Maker. This measure uses high efficiency compressors, fan motors, and thicker insulation to achieve 15 percent more efficiency than the baseline measure, which is a conventional automatic commercial ice maker.[34]

Hot Food Holding Cabinet, ENERGY STAR®. This measure uses a maximum of 40 watts/cubic foot. The baseline measure is a conventional holding cabinet.[35]

Low Pressure Air Distribution Complex HVAC. This under-floor measure introduces air into occupancy zones at relatively low velocities. The decrease in pressure differentials and, therefore in air velocity, results in lower energy consumption by the air handlers. The baseline for this measure is a variable air volume or constant volume HVAC system.

Motor, Consortium for Energy Efficiency (CEE) Premium-Efficiency Plus. These motors (also known as "super" or "enhanced") are more efficient than standard NEMA premium efficiency motors.[36] This measure specifically relates to HVAC motors ranging from 1 HP to 200 HP.

Motor, Pump and Fan System: Variable Speed Control. This measure allows pump and fan motors to operate at a lower speed while still maintaining set points during partial load conditions. This reduces energy consumption as motor operation can vary with load rather than frequently cycling on and off at constant speed.

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31 http://www.energystar.gov/index.cfm?c=fryers.pr_fryers

32 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

33 http://www.energystar.gov/index.cfm?c=ovens.pr_comm_ovens

34 Consortium for Energy Efficiency (CEE); http://www.cee1.org/com/com-kit/com-kit-equip.php3

35 http://www.energystar.gov/index.cfm?c=hfhc.pr_hfhc

36 CEE motor nominal efficiencies are higher than the NEMA federal minimum efficiency levels that became effective in December 2010. On December 19, 2010, the 2007 Energy Independence and Security Act updated the minimum efficiency standards for motors, and the previous NEMA premium efficiency specifications became the federal standard.

Motor: Variable Air Volume (VAV) Box High Efficiency Electronically Commutated Motor (ECM). High efficiency fan-powered boxes prevent hot and cold spots by maintaining room air circulation while modulating supply-air temperature to match load. This measure applies to a motor efficiency upgrade. An ECM powers the fan in each VAV box. An ECM is a brushless DC motor with electronically built-in speed and torque controls, which allows the motor speed to adjust for optimal airflow. The baseline assumes a standard VAV with induction motors including silicon controlled rectifier speed control.[37]

Network PC Power Management. This software tool intelligently manages computer powers remotely and automatically across a network overnight, on weekends, and when not in use. This significantly lowers energy consumption without impacting user productivity, desktop maintenance, or upgrades. Workstations operating on a local area network or a wide area network can implement PC power-management policies across a network to maximize energy savings.

Optimized Variable Volume Lab Hood Design. This measure allows volumetric flow rate to vary, which causes a constant speed through the duct regardless of sash opening. The baseline measure is a constant volume lab hood.

Power Supply Transformer/Converter. This measure applies to the 80 PLUS performance specification requirements for power in computers and servers. 80 PLUS specifies 80 percent or greater efficiency at 20 percent, 50 percent, and 100 percent of rated load with a true power factor of 0.9 or greater.[38] The baseline assumes an 85 percent efficient power supply (>51 watts).

RE – Deciduous Trees, Thermal Wall, Windows Overhang. Shade trees, thermal walls, and overhangs passively decrease cooling loads.

Residential Refrigerator/Freezer Recycling. This refers to the environmentally-friendly disposal of unneeded appliances such as secondary refrigerators or stand-alone freezers.

Scanner, ENERGY STAR®. This measure enters a low power sleep mode after inactivity.[39]

Server Virtualization. This measure replaces multiple under-utilized servers with one server. Many data center servers operate at 10 percent capacity or less, allowing their functions to be consolidated onto one virtual server that operates in the range of 85 percent capacity. This measure applies to the plug load end use, although it has a savings effect on the cooling load by reducing power and, therefore, the heat generated by equipment.

Advanced Power Strip. Power strips with an occupancy sensor will turn power to all devices plugged into the strip on and off, such as computers, desk lights, and audio equipment, based on occupancy within the work area.

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37 LEED-qualified Justice Center, reported by DCJ.com and the Minnesota Power Incentive Program.

38 www.80PLUS.org

39 http://www.energystar.gov.au/products/scanners.html

Steam Cooker, ENERGY STAR®. This measure has a cooking efficiency of 50 percent, with idle energy rates that vary depending upon pan size.[40] The baseline efficiency is a standard commercial steam cooker with 35 percent efficiency.

Vending Miser. This measure senses occupancy and cycles the vending machine cooling off when no occupancy is detected.

Water Cooler, ENERGY STAR®. This measure provides only cold water and consumes less than 0.16 kWh per day. A unit providing hot and cold water consumes less than 1.20 kWh per day. ENERGY STAR®-qualified water coolers consume 45 percent less energy than standard models.[41]

40 http://www.energystar.gov/index.cfm?c=steamcookers.pr_steamcookers

41 http://www.energystar.gov/index.cfm?c=water_coolers.pr_water_coolers

Commercial Electric Equipment Measure Descriptions

HVAC

Air or Ground Source Heat Pump (ASHP or GSHP). Electric heat pumps move heat to or from the air or the ground to cool and heat a home. Table B-2.26 displays the different efficiency levels we compared for this measure. The baseline size is the same as the measure size.

Table B-2.26 ASHP or GSHP Efficiency Comparison

Measure Name	Measure Efficiency	Baseline Efficiency
Air Source Heat Pump 65 to 135 kBTU/hr - Below Standard	Below Standard Air Source Heat Pump 65 to 135 kBTU/hr - 9.5 EER, 3.0 COP	Below Standard Air Source Heat Pump 65 to 135 kBTU/hr - 9.5 EER, 3.0 COP
Air Source Heat Pump 65 to 135 kBTU/hr - Federal Standard 2010	Federal Standard 2010 Air Source Heat Pump 65 to 135 kBTU/hr - 11.0 EER, 3.3 COP	Federal Standard 2010 Air Source Heat Pump 65 to 135 kBTU/hr - 11.0 EER, 3.3 COP
Air Source Heat Pump 65 to 135 kBTU/hr - High Efficiency	High Efficiency Air Source Heat Pump 65 to 135 kBTU/hr - 11.5 EER, 3.4 COP	Federal Standard 2010 Air Source Heat Pump 65 to 135 kBTU/hr - 11.0 EER, 3.3 COP
Air Source Heat Pump 65 to 135 kBTU/hr - Premium Efficiency	Premium Efficiency Air Source Heat Pump 65 to 135 kBTU/hr - 12.0 EER, 3.8 COP	Federal Standard 2010 Air Source Heat Pump 65 to 135 kBTU/hr - 11.0 EER, 3.3 COP
Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - Advanced Efficiency	Advanced Efficiency Ground Source Heat Pump Replacing Air Source Heat Pump 65 to 135 kBTU/hr - 16.2 EER 4.0 COP	Federal Standard 2010 Air Source Heat Pump 65 to 135 kBTU/hr - 11.0 EER, 3.3 COP

Direct Expansion (DX) Package. DX systems transfer heat with a refrigerant piping circuit, compressor, and refrigerant coils. All components are in a single package typically installed on the building roof. Commercial-sized units are normally rated by their Energy Efficient Ratio (EER). Table B-2.27 displays the different models compared in this measure.

Table B-2.27 Direct Expansion Efficiency Comparison

Measure Efficiency	Baseline Efficiency
Below Standard DX Package 65 to 135 kBTU/hr - 9.5 EER	Below Standard DX Package 65 to 135 kBTU/hr - 9.5 EER
Federal Standard 2010 DX Package 65 to 135 kBTU/hr - 11.2 EER	Federal Standard 2010 DX Package 65 to 135 kBTU/hr - 11.2 EER
High Efficiency DX Package 65 to 135 kBTU/hr - 11.5 EER	Federal Standard 2010 DX Package 65 to 135 kBTU/hr - 11.2 EER
Premium Efficiency DX Package 65 to 135 kBTU/hr - 12 EER	Federal Standard 2010 DX Package 65 to 135 kBTU/hr - 11.2 EER

Screw Chiller. Screw compressors are positive displacement devices. The refrigerant chamber actively compresses to a smaller volume by the twisting motion of two interlocking, rotating screws. Refrigerant trapped in the space between the two rotating screws is compressed as it travels from the inlet to the outlet of the compressor. A slide valve adjusts the compression effect by varying the amount of compression that occurs before the refrigerant is discharged. Screw chillers are generally used for small- to medium-sized buildings.

Water Heating

Water Heater, Heat Pump. This measure moves heat from a warm reservoir (such as air) into the hot water system.[42] Baseline and efficient measure EF values are given in Table B-2.28.

Table B-2.28 Heat Pump Water Heater Efficiency Comparison

Measure Efficiency	Baseline Efficiency
Advanced Efficiency Heat Pump Water Heater - EF 2.04	RTF Market Standard Storage Water Heater - EF 0.93
Advanced Efficiency Heat Pump Water Heater - EF 2.04	Federal Standard 2015 Storage Water Heater - EF 0.948

Water Heater, Solar. Solar Water Heaters use thermal energy to heat water without the use of electricity, gas, or heating oil.

Lighting

Lighting Interior, Screw Based. This measure upgrades screw-based lighting fixtures to a more efficient lighting technology. A lumen equivalence is used to avoid changing the lighting level by varying the number of fixtures during the upgrade process. If the lumen equivalence happens to be within 10% of the baseline lumens, however, the number of fixtures remains constant. This measure only applies to existing construction.

Lighting Interior Fluorescent. This measure upgrades fluorescent lighting fixtures to a more efficient lighting technology. A lumen equivalence is used to avoid changing the lighting level by varying the number of fixtures during the upgrade process. If the lumen equivalence happens to be within 10% of the baseline lumens, however, the number of fixtures remains constant. This measure only applies to existing construction. Table B-2.29 displays the different models compared in this measure.

Table B-2.29 Fluorescent Lighting Comparison

Measure	Baseline

[42] Description source: U.S. Department of Energy; http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=12840

Reduced Wattage T8	T8
High Performance T8	T8
T5	T8
LED Tube	T8

Lighting Interior High Intensity Discharge (HID) and High Bay. This measure represents upgrading HID and high-bay lighting fixtures to more efficient lighting technologies. A lumen equivalence is used to avoid changing the lighting level by varying the number of fixtures during the upgrade process. If the lumen equivalence happens to be within 10% of the baseline lumens, however, the number of fixtures remains constant. This measure only applies to existing construction. Table B-2.30 displays the different models compared in this measure.

Table B-2.30 HID and High Bay Lighting Comparison

Measure	Baseline
Efficient Metal Halide	Weighted Average of Mercury Vapor, High Pressure Sodium, and Metal Halide
LED	Weighted Average of Mercury Vapor, High Pressure Sodium, and Metal Halide
T5 High Output	Weighted Average of Mercury Vapor, High Pressure Sodium, and Metal Halide

Lighting Reduction Package, Advanced Efficiency. This measure results in a 15 percent decrease in lighting power density (W/sqft). The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot. Installation of the lighting reduction package reduces lighting power density with higher efficiency technologies, such as high performance T8 or T5 tubes, high-efficiency ballasts, reflective lighting fixtures, etc.

Lighting Reduction Package, High Efficiency. This measure results in a 20 percent decrease in lighting power density (W/sqft). The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot. Installation of the lighting reduction package reduces lighting power density with higher efficiency technologies, such as high performance T8 or T5 tubes, high-efficiency ballasts, reflective lighting fixtures, etc.

Lighting Reduction Package, Premium Efficiency. This measure results in a 25 percent decrease in lighting power density (W/sqft). The baseline lighting technology includes all available technologies in a building that make up the total watts per square foot. Installation of the lighting reduction package reduces lighting power density (W/sqft) with higher efficiency technologies, such as high performance T8 or T5 tubes, high-efficiency ballasts, reflective lighting fixtures, etc.

Other

Computer, ENERGY STAR. This measure consumes less than 2 watts in sleep and off modes, and is more efficient than conventional units in idle mode, resulting in 30 to 65 percent energy savings.

Copiers, ENERGY STAR. ENERGY STAR copiers deliver the same performance as conventional equipment, and are, on average, 27% more efficient, and power down when not in use. The baseline measure is a non-ENERGY STAR copier.[43]

Fax, ENERGY STAR. ENERGY STAR fax machines enter sleep mode after inactivity, reducing their total power consumption by 50%.[44]

Freezer. ENERGY STAR-qualified freezers use at least 10% less energy than standard models due to improvements in insulation and compressors. This measure considers the change in 2015 federal standard efficiency levels and three RTF tiers, ranging from 10% to 35% more efficient than the 2001 federal standard.

Monitor, Energy Star. ENERGY STAR monitors feature the following: (1) an "on" mode, where the maximum allowed power varies, based on the computer monitor's resolution; (2) a "sleep" mode, where computer monitor models must consume 2 watts or less; and (3) an "off" mode, where computer monitor models must consume 1 watt or less. The baseline equipment does not include these features.[45]

Printer, Energy Star. ENERGY STAR printers deploy a maximum time delay to sleep, depending upon the equipment's size. This reduces power consumption during inactive periods, resulting in 37% energy savings.[46]

Refrigerator. ENERGY STAR and CEE-qualified refrigerators use at least 20% less energy than standard models, due to improvements in insulation and compressors. This measure considers the change in 2015 federal standard efficiency, and two RTF and two CEE tiers above ENERGY STAR. Table B-2.31 shows baseline and efficient measures.

Table B-2.31 Refrigerator Efficiency Comparison

Measure Efficiency	Baseline Efficiency
RTF Tier 1 (ENERGY STAR) Refrigerator	RTF Market Standard Refrigerator
RTF Tier 2 Refrigerator	RTF Market Standard Refrigerator
RTF Tier 3 Refrigerator	RTF Market Standard Refrigerator
ENERGY STAR Most Efficient Refrigerator	RTF Market Standard Refrigerator

Server, High Efficiency. ENERGY STAR High Efficiency servers use 23 percent less energy than standard servers due to more efficient power suppliers, better voltage regulators, advanced professors, and more efficient fans.[47]

[43] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CP

[44] http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf

[45] http://www.energystar.gov/index.cfm?fuseaction=find_a_product.ShowProductGroup&pgw_code=MO

[46] http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf

Vending Machines, High Efficiency. ENERGY STAR High Efficiency Vending Machines use more efficient compressors, fan motors, and lighting systems than standard vending machines, and also come equipped with low power modes.[48]

[47] https://www.energystar.gov/index.cfm?c=power_mgt.datacenter_efficiency_purchasing

[48] http://www.energystar.gov/products/certified-products/detail/vending-machines

Commercial Gas Retrofit Measure Descriptions

HVAC (and Envelope)

Automated Ventilation Variable Frequency Drive (VFD) Control, Occupancy/CO_2 sensors. This measure is also known as demand-control ventilation (DCV), where the ventilation system automatically adjusts air flow when CO_2 is above a specified level. CO_2 controls maintain a minimum ventilation rate at all times to control non-occupant contaminants, such as off-gassing from furniture, equipment, and building components. The baseline of this measure is a ventilation system that runs constantly.

Boiler Economizer. This measure recovers heat energy that would otherwise be lost out the boiler stack by using a heat exchanger located on the stack to preheat boiler feed water.

Convert Constant Volume Air System to Variable Air Volume (VAV). This measure allows the airflow volume of a HVAC system to vary the heating or cooling load rather than over-conditioning and short-cycling. The baseline is a constant volume system.

Direct Digital Control (DDC) System, Installation. DDC systems allow for both HVAC and lighting to be controlled and monitored. For lighting, the DDC system allows for direct control of lights from a remote location. Entire HVAC systems, including pumps, motors, fans, and set points, can be digitally programmed for tighter control of the system.

Direct Digital Control (DDS) System, Wireless Performance Monitoring. This second-generation building automation systems allows for wireless optimization and operation of building systems (such as HVAC) through computerized monitoring and control software and interfaces.

Duct Fittings, Leak-Proof. The majority of duct leakage in residential HVAC systems is due to improperly sealed connections between ductwork and fittings. Even when duct connections are initially well-sealed, leakage may increase over time.

Duct Repair and Sealing. This maintenance creates significant energy savings by ensuring conditioned air only goes to occupied spaces, thereby reducing an excessive runtime/load on the HVAC system.

Exhaust Air to Ventilation Air Heat Recovery. This measure captures heated air exhausted out of a building and transfers it to the incoming air, decreasing the overall heating load.

Exhaust Hood Makeup Air. This measure provides exhaust air at the hood instead of allowing the hood to exhaust conditioned air in the room. The baseline measure is for conditioned air to be expelled through exhaust hoods.

Infiltration Reduction (Caulking, Weather Stripping, etc.). Sealing air leaks in windows, doors, the roof, crawlspaces, and outside walls decreases overall heating and cooling losses. This measure reduces the number of air changes per hour from 1.00 to 0.65.

Insulation, Ceiling. These measures represent an increase in R-value from existing building conditions to current state code or from current state code to better than code. Baseline and measure values are presented in Table B-2.32.

Table B-2.32 Ceiling Insulation Efficiency Comparison

Measure Efficiency	Baseline Efficiency
R-38 c.i.	R-30 c.i. (WA State Code)
R-49 c.i.	R-38 c.i.
R-30 c.i. (WA State Code)	Average Existing Conditions

Insulation, Duct. Packaged direct expansion and heat-pump equipment are generally coupled with a ducting system inside the building. Insulating these ducts reduces energy loss to the unconditioned plenum space. This measure assumes that R-7 insulation is installed where no insulation previously existed.

Insulation, Floor (Non-Slab). These measures represent an increase in R-value from existing building conditions to current state code or from current state code to better than code. Baseline and measure values are presented in Table B-2.33.

Table B-2.33 Floor (Non-Slab) Efficiency Comparison

Measure Efficiency	Baseline Efficiency
R-30 (WA State Code)	Average Existing Conditions
R-38	R-30 (WA State Code)

Insulation, Wall. These measures represent an increase in R-value from existing building conditions to the current state code value of R-13 + 7.5. The baseline value of R-3 represents the average existing insulation level.

Programmable Thermostat, Web Enabled. This measure controls set point temperature automatically, ensuring the HVAC system is not running during low-occupancy hours.

RE Thermal Wall. Thermal walls use passive shading to decrease cooling needs, saving at least 2 percent of energy per building. The baseline efficiency is conventional wall construction.

Retro-Commissioning. Commissioning ensures that energy-using systems are operating in an optimal fashion in order to maximize energy efficiency. This commissioning process can be applied to existing buildings to restore them to optimal performance. Retro-commissioning is a systematic, documented

process that identifies low-cost operational and maintenance improvements in existing buildings and brings them up to the design intentions.[49,50] The baseline measure is no commissioning.

Sensible Heat Recovery Devices. This measure preconditions incoming air by transferring energy between the exhaust air stream and the supply air stream. This raises the temperature of incoming air during the winter and decreases it in the summer. Energy savings results from the reduced need for mechanical heating or cooling.

Total Heat Recovery Devices. This measure, also called enthalpy recovery, transfers sensible and latent heat. Latent heat, which is released or absorbed due to a phase change (such as the condensation of water vapor), significantly raises the outdoor air humidity in the winter and reduces it in the summer.[51]

Steam Pipe Insulation. R-4 insulation reduces heat loss from a steam pipe. The loss size depends on the pipe diameter and steam temperature.

Windows, High Efficiency. This measure increases building performance by reducing the U-value, as shown in Table B-2.34.

Table B-2.34 Windows Efficiency Comparison

Measure Efficiency	Baseline Efficiency
U-0.32	U-0.40 (WA State Code)
U-0.40 (WA State Code)	Average Existing Conditions

Water Heat

Clothes Washer, Ozonating. This measure disinfects water with ozone-enriched air, which suppresses subsequent biological activity and controls biological growth within the appliance, thus reducing the need for hot water. The baseline measure is a standard commercial clothes washer.[52]

Clothes Washer, Commercial. ENERGY STAR qualified commercial washers have a greater capacity than conventional top-load models with an agitator. Some front-loaders can wash over 20 pounds of laundry at once, compared to 10–15 pounds for a standard top-loader. This means residents can do fewer loads. and avoid having to bring big, bulky items to the Laundromat.[53] This measure replaces a clothes washer, having a Modified Energy Factor (MEF) of 1.60, with an ENERGY STAR model assigned a MEF value of 2.43.

49 http://www.green.ca.gov/CommissioningGuidelines/default.htm
50 http://cbs.lbl.gov/BPA/cct.html
51 http://www.mcquay.com/mcquaybiz/marketing_tools/mt_corporate/EngNews/0701.pdf
52 http://www.patentstorm.us/patents/6607672-description.html
53 http://www.energystar.gov/index.cfm?c=clotheswash.pr_clothes_washers_comm

Demand-Controlled Circulating Systems. This measure circulates hot water only when required. The baseline measure is a continuously circulating hot water system, resulting in energy loss through pipes.

Dishwasher, Commercial: High Temperature ENERGY STAR®. This measure has a minimal idle rate, consumes a minimal amount of water per rack of loaded dishes, and is on average 25 percent more efficient than standard high temp commercial dishwashers.[54]

Dishwasher, Commercial: Low Temperature ENERGY STAR®. This measure uses chemicals combined with low temperatures to save energy compared to standard high temperature commercial dishwashers.

Dishwasher, Residential ENERGY STAR®. Residential sized ENERGY STAR® dishwashers are often appropriate for smaller commercial buildings, and are 10 percent more efficient than the federal minimum standard used as the baseline.[55]

Drain Water Heat Recovery, Water Heater. This measure recovers heat energy from drain water and uses it to heat water entering the hot water tank, minimizing the temperature rise required to achieve the water heater set point.[56]

Hot Water (SHW) Pipe Insulation. One inch of extra insulation on hot water pipes yields an approximate R-value of R-4, decreasing temperature losses. This measure is only applicable for existing construction. The baseline measure is no insulation.

Integrated Space Heating/Water Heating. These systems provide space conditioning and hot water heating in one appliance/energy source. Domestic hot water is heated directly and space is heated by a hot water heat exchanger coil piped to the forced air heating system. This combination space/water heating system provides high efficiency heating for the cost of one high efficiency appliance.

Low-Flow Faucet Aerators. This measure mixes water and air, reducing the amount of water that flows through the faucet. It creates a fine water spray through an inserted screen in the faucet head. Flow rate requirements for this measure are presented in in Table B-2.35.

Table B-2.35 Low Flow Faucet Aerators Efficiency Comparison

Measure Efficiency	Baseline Efficiency
1.5 GPM	2.2 GPM (Federal Code)
2.2 GPM (Federal Code)	3.0 GPM
1.0 GPM	2.2 GPM (Federal Code)
0.5 GPM	2.2 GPM (Federal Code)

54 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COH

55 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DW

56 www.toolbase.org/Techinventory/TechDetails.aspx?ContentDetailID=858&BucketID=6&CategoryID=9

Low-Flow Pre-Rinse Spray Valves. This measure mixes water and air, reducing the amount of water that flows through the spray head. The head creates a fine water spray through an inserted screen, achieving a flow reduction from 1.6 GPM (federal standard) to 0.6 GPM.

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce the amount of water that flows through the showerhead. The showerhead creates a fine water spray through an inserted screen in the showerhead. Flow rate requirements for this measure are presented in in Table B-2.36.

Table B-2.36 Low-Flow Showerhead Efficiency Comparison

Measure Efficiency	Baseline Efficiency
2.0 GPM	2.5 GPM (Federal Code)
2.5 GPM (Federal Code)	3.0 GPM
1.75 GPM	2.5 GPM (Federal Code)
1.5 GPM	2.5 GPM (Federal Code)

Ultrasonic Faucet Control. Ultrasonic sensors automatically turn faucet water on and off when motion is detected at the sink. This eliminates water running continuously while the sink is in use.

Water Cooled Refrigeration with Heat Recovery. Heat recovery gathers and uses thermal energy for the water heater that would normally be rejected to the ambient environment.

Other

Broiler. High efficiency broiler ovens have rigorous start-up, shut down, and turn down schedules for additional energy savings over standard units. Improved efficiency broilers have an efficiency of 34 percent, compared to baseline models at 15 percent.

Convection Oven, High Efficiency ENERGY STAR®. This measure must meet the specification requirements of 70 percent cooking energy efficiency and an idle energy rate of 18,000 Btu/h. Standard electric convection ovens have a 65 percent cooking energy efficiency and an idle energy rate of 13,000 Btu/h.[57]

Fryers, Commercial Gas Cooking ENERGY STAR®. These measures are 50 percent efficient, and when idle use less than 9,000 Btu/hr.[58] The baseline efficiency is 35 percent for a non-ENERGY STAR® commercial fryer.

Griddle, ENERGY STAR®. This measure is approximately 10 percent more efficient than standard models, and must have a minimum cooking efficiency of 38 percent. They must use less than 0.026 therm/hour/ft^2 when idle. The baseline measure is a standard grill at 32 percent efficiency.[59]

57 http://www.energystar.gov/index.cfm?c=ovens.pr_comm_ovens

58 http://www.energystar.gov/index.cfm?c=fryers.pr_fryers

Oven, Conveyor. A high efficiency conveyor oven is 23 percent efficient, compared to a standard conveyor oven with 15 percent efficiency.

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Steam Cooker, ENERGY STAR®. This measure has a cooking efficiency of 50 percent, with idle energy rates that vary depending upon pan size.[60] The baseline efficiency is a standard commercial steam cooker with 35 percent efficiency.

Swimming Pool/Spa Covers. This measure reduces evaporation, which is the largest source of pool/spa energy loss. It takes one British thermal unit (Btu) to raise one pound of water by one degree. Each pound of 80º F water that evaporates takes 1,048 Btus of heat out of the pool.[61] The baseline measure is an uncovered pool or spa.

59 http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COG

60 http://www.energystar.gov/index.cfm?c=steamcookers.pr_steamcookers

61 http://www.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=13140

Commercial Gas Equipment Measure Descriptions

HVAC

Gas Boiler. Boilers are classified as condensing or non-condensing. Condensing boilers condense the flue gas and water vapor, extracting useful heat and improving the boiler efficiency. This measure compares several boilers with different thermal efficiencies and is applicable to both new and existing construction. The overall efficiency of the boiler is defined as the gross energy output divided by the energy input, and is affected by combustion efficiency, standby losses, cycling losses, and heat transfer. Table B-2.37 displays the measure and baseline thermal efficiencies.

Table B-2.37 Gas Boiler Efficiency Comparison

Measure Efficiency	Baseline Efficiency
Boiler 85% Thermal Efficiency	Federal Standard 2012 Boiler - 80% Thermal Efficiency
Boiler 90% Thermal Efficiency	Federal Standard 2012 Boiler - 80% Thermal Efficiency

Gas Furnace. Improvements in furnace technology, such as new ignition and heat exchange design, have led to increased furnace efficiency. The AFUE levels considered in this measure are shown in Table B-2.38.

Table B-2.38 Gas Furnace Efficiency Comparison

Measure Efficiency	Baseline Efficiency
High Efficiency Furnace - 90% AFUE	Federal Standard 2003 Furnace - 80% AFUE
High Efficiency Furnace - 94% AFUE	Federal Standard 2003 Furnace - 80% AFUE
ENERGY STAR Most Efficient Furnace - 97% AFUE	Federal Standard 2003 Furnace - 80% AFUE

Water Heat

Water Heater. This measure has a range of thermal efficiencies as shown in Table B-2.39. High efficiency models have better insulation, which reduces standby losses.

Table B-2.39 Water Heater Efficiency Comparison

Measure Efficiency	Baseline Efficiency
Federal Standard 2015 Storage Water Heater - EF 0.615	Federal Standard 2015 Storage Water Heater - EF 0.615
ENERGY STAR Storage Water Heater - EF 0.67	Federal Standard 2015 Storage Water Heater - EF 0.615
ENERGY STAR Tankless Water	Federal Standard 2015 Storage

Measure Efficiency	Baseline Efficiency
Heater - EF 0.82	Water Heater - EF 0.615
Condensing Water Heater - EF 0.90	Federal Standard 2015 Storage Water Heater - EF 0.615

Other

RE - Installation of Solar Pool/Spa Heating Systems. Solar pool and spa heating systems use thermal energy instead of gas to regulate pool and spa temperatures, eliminating the need for gas heating in the spa system. The baseline comparison is standard pool heat equipment.

Industrial Electric Measure Descriptions

Air Compressor Improvements (Demand Reduction, Optimization, Equipment). These measures improve the overall compressed air system by improved system design, leak repair, usage practices, more efficient dryer and storage systems, and compressor upgrades.

Clean Room Improvements (Change Filter Strategy, Chiller Optimize, HVAC). These measures aim to save energy through improved clean room equipment and practices. Savings are attributable to optimization of chiller operating parameters, upgrading to more efficient equipment, and improving filter replacement strategies.

Efficiency Centrifugal Fan. This measure achieves energy savings through improved fan design.

Fan System Optimization. This measure involves the overall optimization of the fan system with improved system design, enhanced flow design, better maintenance practices, and adjustments to system parameters.

Food Manufacturing (Cooling and Storage, Refrigerator Storage Tune-up). These measures maintain and enhance the cooling equipment for each facility type. Tune-ups may include refrigerant charge, equipment cleaning, general maintenance, and improved practices.

General Process Improvements (Paper: Premium Fan, Paper: Large Material Handling, Paper: Material Handling, Paper: Premium Control Large Material, Efficient Pulp Screen, Wood: Replace Pneumatic Conveyor, Metal: New Arc Furnace). These measures include upgrading equipment, replacing hydraulic/pneumatic equipment with electrical equipment, and using optimum size and capacity equipment.

High Efficiency Fans (Fan Equipment Upgrade). This measure involves upgrading motors to higher efficiency. Since NEMA Premium motors are becoming the baseline code requirement in 2010, this measure is based off of super premium motors with efficiency levels at least one efficiency band above NEMA premium.

Light Emitting Diode (LED) Street Light Conversions. LED street lights can replace standard high-pressure sodium (HPS) street lights, with similar lumens achieved with less wattage.

Lighting Improvements (Efficient Lighting 1, 2, and 3 Shift; HighBay Lighting 1, 2, and 3 Shift; Lighting Controls). Changes to overall illumination levels, use of natural lighting, or technology improvements to more efficient bulbs or ballasts will decrease the overall lighting energy consumption. These measures include upgrades from T12 to T8 systems, T8 to high-performance T8 systems, HID to fluorescent conversions, standard HID to high-efficiency HID systems, and occupancy and day lighting controls.

Material Handling (Material Handling Variable Speed Drive (VFD) 1 and 2, Material Handling 1 and 2). This measure includes equipment upgrades (such as to VSDs) and enhanced system design or practices.

Motor Rewind. This measure follows the Green Motors Practices Group™ recommendations of best practices to maintain original efficiency, commonly called a Green Rewind.[62, 63] A failed motor can be rewound to a lower efficiency, rewound to maintain the original efficiency, or replaced.

Pump Equipment Upgrade. This measure achieves energy savings through improved pump design and sizing.

Pump Improvements (Pump Energy Management, Pump System Optimization). This measure involves optimizing the overall pump system with improved system design, enhanced flow design, better maintenance practices, and adjustments to system parameters.

Synchronous Belts. This measure contains mating, corresponding grooves in the drive sprocket, preventing slip and thus reducing energy losses.

Transformers (New & Retrofit). Energy efficient transformers provide improved power quality while minimizing losses.

Whole Plant Improvements (Fan Energy Management, Plant Energy Management, Integrated Plant Energy Management, Energy Project Management). These measures include synergistic savings of plant-wide energy management and improvements across multiple systems such as compressed air, pumping, and fan systems.

62 http://www.bpa.gov/energy/n/industrial/Green_motors/

63 http://www.greenmotors.org/downloads/RTFSubmittalMay_08%20_2_.pdf

Industrial Gas Measure Descriptions

Boiler Improvements. A boiler generally creates steam or hot water for process or non-process applications. Savings are generated by installation of a waste heat boiler to provide direct power or use of flue gas heat to preheat boiler feed water.

Boiler Operation and Maintenance. This measure includes analyzing flue gas for proper air/fuel ration, establishing maintenance schedules, or reducing excessive boiler blow down.

HVAC Improvements. Many measures can reduce a plants' HVAC energy consumption, such as conditioning only space in use, installing timers and/or thermostats, lowering ceilings to reduce conditioned space, and installing or upgrading insulation on distribution systems.

HVAC Operation and Maintenance. These measures include sizing air handling grills/ducts/coils to minimize air resistance, adjusting vents to minimize energy use, and maintaining air filters by cleaning or replacing.

Other Process Improvements/Operation and Maintenance. These measures include upgrading obsolete equipment, reducing fluid flow rates, and using optimum size and capacity equipment.

Process Heating Improvements. These measures decrease the energy required for process-related heating. Examples include optimizing the drying oven schedule, reducing the temperature of process equipment when on standby, and modifying equipment to improve the drying process.

Process Heating Operation and Maintenance. These measures improve overall energy efficiency. Examples include repairing faulty insulation, adjusting burners for efficient operation, and eliminating leaks in combustible gas lines.

Steam Distribution Systems. These measures include leak elimination and improved duct insulation to reduce distribution system loss.