APPENDIX B-1. RESIDENTIAL MEASURE DESCRIPTIONS

Residential measures can be categorized as retrofit or equipment measures.

Residential Retrofit Measure Descriptions

Heating and Cooling

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

Construction—SIP. Structural insulated panels (SIPs) use continuous foam insulation throughout the panel, providing excellent energy efficiency and low air infiltration levels. The baseline is standard wood framing.

Cool Roofs. ENERGY STAR®-qualified cool roofs, with reflective coatings, can lower roof surface temperatures by up to 100ºF, thereby decreasing amounts of heat transferred into a building. Cool roofs can help reduce amounts of air conditioning needed in buildings, and can reduce peak cooling demand by 10% to 15%.[1]

Doors. Composite or steel doors with a foam core increase overall insulation, slowing heat loss. This measure includes adding a thermal door with resistance values listed in Table B-1.1.

Table B-1.1. Door R-Value Comparison

Measure Insulation	Baseline Insulation
R-10 (Above CA Code)	R-2.6 (CA Code)
R-5 (Above CA Code)	R-2.6 (CA Code)
R-10 (Above ID, WY, & UT Code)	R-2.9 (ID, WY, & UT Code)
R-5 (Above ID, WY, & UT Code)	R-2.9 (ID, WY, & UT Code)
R-10 (Above WA Code - Multi Family Homes Only)	R-2.5 (WA Code - Multi Family Homes Only)
R-5 (Above WA Code - Multi Family Homes Only)	R-2.5 (WA Code - Multi Family Homes Only)
R-10 (Above WA Code - Single Family and Manufactured Homes Only)	R-5 (WA Code - Single Family and Manufactured Homes Only)
R-5 (WA Code - Single Family and Manufactured Homes Only)	R-2.5 (Below WA Code - Single Family and Manufactured Homes Only)

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.

[1] http://www.aceee.org/consumer/cooling

Duct System Efficiency Upgrade—Ducts Inside. In many homes, ducts run through unconditioned areas, such as attics, garages, crawlspaces, and basements, for convenience and practical reasons. Ducts in unconditioned areas lose energy because of large temperature differences between conditioned air in the ducts and the surrounding space. Locating ducts in conditioned spaces helps to reduce wasted heat loss.[2]

Electronically Commutated Motor (ECM)—Air Conditioner/Electric/Gas Furnace ECM Fan and Air Source Heat Pump. ECMs are smaller, variable-speed motors that operate from a single-phase power source, which consumes less power than standard motors in ventilation and circulation systems. The baseline measure is a standard-efficiency motor.

Green Roof. The added mass and thermal resistance of green roofs reduce building heating and cooling loads. These systems reduce ambient temperatures around a roof, decreasing a building's urban heat island effect, reducing the ambient temperature of the roof's surface, and slowing the transfer of heat into the building, thus lowering cooling costs. They also provide added insulation to the roof structure, reducing heating requirements in winter.[3]

Heat Exchangers Air-to-Air. An air-to-air heat exchanger mechanically ventilates homes in colder climates. During winter, it transfers heat from air exhausted to fresh, outside air entering the home. Fifty percent to 80% of the heat normally lost in exhausted air returns 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 an area.[4]

Infiltration Control. Sealing air leaks in windows, doors, roof, crawlspaces, and outside walls decreases overall heating and cooling losses. Filling gaps in windows with synthetic filler prevents drafts and heating/cooling loss. This measure represents a reduction in air exchanges per hour (ACH) of 0.1 ACH.

Insulation—Attic/Ceiling. This measure represents an increase in R-value. Adding insulation in existing buildings increases thermal performance, and brings the resistance value up to and past code, depending on vintage.

Table B-1.2 summarizes different resistance values compared in the measure.

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

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

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

Table B-1.2. Ceiling R-Value Comparison

Measure Insulation	Baseline Insulation
R-60 (Above CA, ID, & WY Code)	R-49 (CA, ID, & WY Code)
R-49 (CA & WY Code)	R-14 (Existing Insulation)
R-49 (ID Code)	R-15 (Existing Insulation)
R-49 (Above UT Code)	R-38 (UT Code)
R-38 (UT Code)	R-15 (Existing Insulation)
R-60 (Above WA Code—Single-Family and Manufactured Homes Only)	R-49 (WA Code—Single-Family and Manufactured Homes Only)
R-49 (WA Code—Single-Family and Manufactured Homes Only)	R-11 (Existing Insulation)
R-49 (Above WA Code—Multifamily Homes Only)	R-38 (WA Code—Multifamily Homes Only)
R-38 (WA Code—Multifamily Homes Only)	R-11 (Existing Insulation)

Insulation—Floor. Adding insulation to the floor increases the overall resistance value, slowing heat transfer from basements and crawl spaces to upper levels. Table B-1.3 summarizes different resistance values compared in the measure.

Table B-1.3. Floor R-Value Comparison

Measure Insulation	Baseline Insulation
R-38 (Above CA, ID, UT, & WA Code)	R-30 (CA, ID, UT, & WA Code)
R-30 (CA, ID, & UT Code)	R-1 (Existing Insulation)
R-30 (WA Code)	R-0 (Existing Insulation)
R-38 (Above WY Code)	R-21 (WY Code)
R-21 (WY Code)	R-0 (Existing Insulation)

Insulation—Slab (New Construction). 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.

Insulation—Wall. Wall insulation slows the transfer of heat, and reduces heating and cooling loads in houses. Table B-1.4 compares different insulation levels.

Table B-1.4. Wall Insulation Measures

Measure Insulation	Baseline Insulation
R-13 (CA Code - Maximum Insulation Feasible)	R-1 (Existing Insulation)
R-13 (Below UT & WY Code - Maximum Insulation Feasible)	R-1 (Existing Insulation)
R-13 (Below ID Code - Maximum Insulation Feasible)	R-2 (Existing Insulation)
R-13 (Below WA Code - Maximum Insulation Feasible)	R-0 (Existing Insulation)
R-21 (Above CA Code- New Construction)	R-13 (CA Code)
R-13 (CA Code)	R-1 (Existing Insulation)
R-21 + R-5 Sheathing (Above ID Code- New Construction)	R-20 (ID Code)
R-20 (ID Code)	R-2 (Existing Insulation)
R-21 + R-5 Sheathing (Above UT Code)	R-19 (UT Code)
R-19 (UT Code)	R-1 (Existing Insulation)

Measure Insulation	Baseline Insulation
R-21 + R-5 Sheathing (Above WA Code – New Construction Single Family and Manufactured Homes Only)	R-21 (WA Code - Single Family and Manufactured Homes Only)
R-21 + R-6 Sheathing (Above WA Code – New Construction Multi Family Homes Only)	R-13 + R-6 Sheathing (WA Code - Multi Family Homes Only)
R-21 (WA Code - Single Family and Manufactured Homes Only)	R-0 (Existing Insulation)
R-13 + R-6 Sheathing (WA Code - Multi Family Homes Only)	R-0 (Existing Insulation)
R-21 + R-5 Sheathing (Above WY Code – New Construction)	R-19 (WY Code)
R-19 (WY Code)	R-1 (Existing Insulation)

Quality Installation—Heat Pump. Quality installation of a heat pump includes: proper sizing of equipment; and correct refrigerant charge and airflow. By properly sizing HVAC equipment rather than using "rules of thumb," a system load tool, such as Air Conditioning Contractors of America (ACCA) guidelines for sizing HVAC equipment (ACCA Manual J Residential Load Calculation), results in optimum equipment operating efficiency and better control.[5]

Radiant Barrier (Ceiling). Radiant barriers generally consist of a thin piece of aluminum installed in buildings to help reduce solar heat gain during summer, and to help trap heat during winter. These work by reducing heat transfers between air spaces of the roof deck and the attic floor.

Thermal Shell—Infiltration @ 0.2 ACH w/HRV (New Construction). Heat recovery ventilation (HRV) provides fresh air and improved climate control, while saving energy by reducing heating (or cooling) requirements. 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—Programmable. A programmable thermostat controls set point temperatures automatically, ensuring HVAC systems do not run during low-occupancy hours.

Tune-up—Air Conditioner and Air Source Heat Pump. Proper system tune-up/maintenance ensures refrigerant charges and airflows through evaporator coils are properly tested and correctly adjusted—two factors affecting system efficiency. Maintenance includes changing filters and cleaning coils to maintain the overall performance and efficiency of units.

Whole-House Fan. Draws cool outdoor air inside through open windows, and exhausts hot indoor air through the attic to the outside. A whole house fan provides a simple and inexpensive method of cooling a house when outdoor temperatures fall below indoor temperatures.

Window—Upgrade. This measure increases building performance by reducing U-values in existing and new construction windows, as shown in Table B-1.5**Error! Reference source not found.**.

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5 http://www.toolbase.org/Technology-Inventory/HVAC/hvac-sizing-practice

Table B-1.5. High-Efficiency Window Measures

Measure Insulation	Baseline Insulation
0.38 (CA Code)	Existing - Single Pane
0.30 (Above CA Code)	0.38 (CA Code)
0.25 (Above CA Code)	0.38 (CA Code)
0.22 (Above CA Code)	0.38 (CA Code)
0.35 (ID, UT, WY Code)	Existing - Single Pane
0.30 (Above ID, UT, WY Code)	0.35 (ID, UT, WY Code)
0.25 (Above ID, UT, WY Code)	0.35 (ID, UT, WY Code)
0.22 (Above ID, UT, WY Code)	0.35 (ID, UT, WY Code)
0.32 (WA Code)	Existing - Single Pane
0.30 (Above WA Code)	0.32 (WA Code)
0.25 (Above WA Code)	0.32 (WA Code)
0.22 (Above WA Code)	0.32 (WA Code)

Lighting

Photocell Daylighting Control—Interior/Exterior Lighting. Photocells adjust lighting levels according to daylight levels rooms receive. The baseline is no daylighting controls.

Occupancy Sensors. In a space unoccupied for a designated amount of time, occupancy sensors turn off the lights, turning them on again once the sensor detects a person has entered the space.

Time Clocks (Exterior Lighting). Allows the user to program times to automatically turn lights on and off outside the residence. Programmed exterior lighting saves energy by ensuring lights are not accidentally left on during the daytime.

Water Heat

Clothes Washer. ENERGY STAR and CEE-qualified clothes washers use less energy and water than regular washers.[6] Table B-1.6 lists baseline and measure modified energy factor (MEF) and water factor (WF) levels considered. Note: each measure has multiple baselines, which change over time due to changes in the federal standard.

Table B-1.6. Clothes Washer Modified Energy and Water Factor Comparisons

State	Measure Level	Efficiency (MEF & WF)
CA, ID, UT, and WY	Federal Standard 2011 [Baseline]	MEF 1.48 and WF 9.5
CA, ID, UT, and WY	Federal Standard 2016 [Baseline]	MEF 1.72 and WF 8.0
CA, ID, UT, and WY	Federal Standard 2018 [Baseline]	MEF 2.0 and WF 6.0
CA, ID, UT, and WY	ENERGY STAR	MEF 2.0 and WF 6.0
CA, ID, UT, and WY	CEE Tier 2	MEF 2.2 and WF 4.5
CA, ID, UT, and WY	CEE Tier 3	MEF 2.4 and WF 4.0
WA	RTF Market Standard 2011 [Baseline]	MEF 1.94 and WF 7.0
WA	RTF Market Standard 2016 [Baseline]	MEF 2.29 and WF 4.5
WA	RTF Market Standard 2018 [Baseline]	MEF 2.36 and WF 4.1

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

State	Measure Level	Efficiency (MEF & WF)
WA	RTF Tier 1	MEF 2.05 and WF 4.97
WA	RTF Tier 2	MEF 2.28 and WF 4.14
WA	RTF Tier 3	MEF 2.66 and WF 3.52

Dishwasher. ENERGY STAR-qualified dishwashers use advanced technology to clean dishes, using less water and energy. As shown in Table B-1.7**Error! Reference source not found.**, two efficiency levels were compared for this measure.

Table B-1.7. Dishwasher Efficiency Levels

State	Measure Level	Measure kWh/yr & Gal/Cycle	Baseline kWh/yr & Gal/Cycle
CA, ID, UT, and WY	ENERGY STAR	295 kWh/yr 4.25 Gal/Cycle	307 kWh/yr 5 Gal/Cycle
CA, ID, UT, and WY	Enhanced Efficiency	250 kWh/yr 4.25 gal/cycle	307 kWh/yr 5 Gal/Cycle
WA	RTF ENERGY STAR	277 kWh/yr 4.25 Gal/Cycle	289 kWh/yr 5 Gal/Cycle
WA	RTF Enhanced Efficiency	250 kWh/yr 4.25 gal/cycle	289 kWh/yr 5 Gal/Cycle

Drain Water Heat Recovery. Also called gravity film heat exchanges, these devices, which recover heat energy from domestic drain water, are used to pre-heat cold water entering hot water tanks. This minimizes temperature differences between heating set points and entering water temperatures.

Faucet Aerators. 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-1.8 presents flow rate requirements for this measure.

Table B-1.8. Faucet Aerator Flow Rates

Measure Flow Rate (GPM*)	Baseline Flow Rate (GPM)
2.2 GPM	3.0 GPM (Existing)
1.5 GPM	2.2 GPM
0.5 GPM	2.2 GPM

* Gallons per minute.

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce amounts of water flowing through the showerhead, which creates a fine water spray through an inserted screen. This measure represents the various showerhead flow rate reduction levels shown in Table B-1.9**Error! Reference source not found.**.

Table B-1.9. Low-Flow Showerhead Water Flow Levels

Measure Flow Rate (GPM*)	Baseline Flow Rate (GPM)
2.5 GPM	3.0 GPM (Existing)
2.0 GPM	2.5 GPM
1.75 GPM	2.5 GPM
1.5 GPM	2.5 GPM

* Gallons per minute

Water Heater—Pipe Insulation. Insulation around pipes decreases heat loss. The baseline is a hot water pipe without insulation or with code insulation, as seen in Table B-1.10**Error! Reference source not found.**.

Table B-1.10. Pipe Insulation Levels

Measure Insulation	Baseline Insulation
R-3.6 (WA/CA Code)	No Pipe Insulation
R-5.6 (ID/UT/WY Code)	No Pipe Insulation
R-8 (Above WA/CA Code)	R-3.6 (WA/CA Code)
R-8 (Above ID/UT/WY Code)	R-5.6 (ID/UT/WY Code)

Appliances

***Freezer—Removal of Standalone* .** This refers to environmentally friendly disposal of unneeded and/or inefficient standalone freezers. Removal of standalone freezers eliminates the freezer's consumption. Proper disposal is required, as they use hazardous materials such as Freon and CFCs.

Refrigerator—Removal of Secondary. This refers to environmentally friendly disposal of unneeded and/or inefficient secondary refrigerators. The removal eliminates the refrigerator's consumption. Proper disposal is required, as they use hazardous materials such as Freon and CFCs.

Consumer Electronics Battery Chargers—ENERGY STAR. Battery charging systems recharge a wide variety of cordless products, including power tools, small household appliances, and personal care products, such as electric shavers. Conventional battery chargers—even when not actively charging a product—draw as much as five to 20 times more energy than that actually stored in the battery. ENERGY STAR battery chargers, on average, use 35% less energy. The baseline is a standard battery charger.[7]

Smart Strip. Energy-saving products, such as power strips with an occupancy sensor, are found in workstations where power strips are commonly used. Based on occupancy within the work area, the sensor turns on and off power to all devices, such as computers, desk lights, and audio equipment plugged into the power strip.

[7] http://www.energystar.gov/index.cfm?c=battery_chargers.pr_battery_chargers

Residential Equipment Measure Descriptions

Heating and Cooling

Central Air Conditioners. This measure consists of several different air conditioner technology/efficiency levels, as summarized in Table B-1.11**Error! Reference source not found.**. The baseline size is the same as the measure size.

Table B-1.11. Central AC Efficiency Comparison

<table>
<tr><th>State</th><th>Measure SEER/EER</th><th>Baseline SEER/EER</th></tr>
<tr><td>CA</td><td>Federal Standard 2015—SEER/EER 14/12.2*</td><td rowspan="6">Federal Standard 2006 SEER/EER 13/11</td></tr>
<tr><td>All (except CA)</td><td>ENERGY STAR—SEER/EER 14.5/12</td></tr>
<tr><td>All</td><td>CEE Tier 3—SEER/EER 16/13</td></tr>
<tr><td>All</td><td>Enhanced—SEER/EER 18/14</td></tr>
<tr><td>All</td><td>Standard Evaporative Cooler</td></tr>
<tr><td>All</td><td>Premium Evaporative Cooler</td></tr>
</table>

* Becomes baseline after 2015.

Heat Pump—Air or Ground Source (ASHP or GSHP). Electric heat pumps move heat to or from the air or ground to cool and heat homes. Table B-1.12**Error! Reference source not found.** shows different efficiency levels compared in this measure. The baseline size is the same as the measure size.

Table B-1.12. Heat Pump SEER/HSPF Comparisons

<table>
<tr><th>State</th><th>Measure</th><th>Cooling SEER/EER</th><th>Heating HSPF</th><th>Baseline</th><th>Cooling SEER/EER</th><th>Heating HSPF</th></tr>
<tr><td>WA</td><td>RTF Tier 1</td><td>13/11</td><td>8.2</td><td rowspan="7">Federal Standard 2006</td><td rowspan="7">13/11</td><td rowspan="7">7.7</td></tr>
<tr><td>WA</td><td>RTF Tier 2</td><td>14/12</td><td>8.5</td></tr>
<tr><td>CA</td><td>Federal Standard 2015*</td><td>14/12</td><td>8.2</td></tr>
<tr><td>ALL</td><td>ENERGY STAR</td><td>14.5/12</td><td>8.2</td></tr>
<tr><td>ALL</td><td>CEE Tier 2</td><td>15/12.5</td><td>8.5</td></tr>
<tr><td>ALL</td><td>Enhanced</td><td>16/13</td><td>9.0</td></tr>
<tr><td>ALL</td><td>ENERGY STAR Ground Source Heat Pump</td><td>NA/17.1</td><td>3.6 COP</td></tr>
<tr><td>ALL</td><td>CEE Tier 2</td><td>15/12.5</td><td>8.5</td><td>Standard Electric Furnace</td><td>NA</td><td>1.0</td></tr>
</table>

* Becomes the baseline after 2015.

Heat Pump—Ductless Mini-Split. Ductless heat pumps move heat to or from the air, cooling and heating homes without the need for costly ductwork. This measure provides savings when compared to baseboard heating or room air conditioners. Baseline and measure efficiencies are listed in Table B-1.13.

Table B-1.13. Ductless Mini-Split Comparisons

<table>
<tr><th>Measure SEER/EER & HSPF</th><th>Baseline CEER/EER & HSPF</th></tr>
<tr><td rowspan="2">Ductless Heat Pump - SEER/EER 18/12.5, HSPF 10.0</td><td>Baseboard Heating HSPF 1</td></tr>
<tr><td>Federal Standard 2001 Room AC CEER/EER 9.7/9.8</td></tr>
</table>

Room Air Conditioner (Room AC)—(8,000-13,999 BTU/HR). ENERGY STAR-qualified room air conditioners use less energy than conventional models, through improved energy performance as well as timers for better temperature control. Table B- 1.14 shows different efficiency tiers considered in this measure.

Table B- 1.14. Room AC CEER/EER Comparisons

Measure CEER/EER	Baseline CEER/EER
Federal Standard 2015 - CEER/EER 10.9/11*	Federal Standard 2001 CEER/EER 9.7/9.8
ENERGY STAR - CEER/EER 10.7/10.8	Federal Standard 2001 CEER/EER 9.7/9.8

* Becomes the baseline after 2015.

Lighting

GENERAL SERVICE LAMP

Compact Fluorescent Light Bulbs (CFLs). Standard CFLs use less energy than the maximum mandated by the Energy Independence and Security Act of 2007 (EISA). This measure considers exterior and interior standard screw base lighting, and measure and baseline consumption is a weighted average of bulb wattages used in each condition. The baseline for this measure reflects changes over 2012–2014 to accommodate EISA.

Light Emitting Diodes (LEDs). LEDs are solid-state devices, converting electricity to light using very high efficiency, requiring significantly less energy, and providing long life. This measure considers exterior and interior standard screw base lighting, and measure and baseline consumption is a weighted average of bulb wattages used in each condition. The baseline for this measure reflects changes over 2012–2014 to accommodate EISA.

SPECIALTY LAMP

Compact Fluorescent Light Bulbs. Specialty CFLs use less energy than an incandescent light bulb. This measure considers interior specialty lighting, including the bulb types listed below, and measure and baseline consumption is a weighted average of bulbs used in each condition. The baseline for this measure is an incandescent light bulb.

Light Emitting Diodes. LEDs are solid-state devices, converting electricity to light using very high efficiency, requiring significantly less energy, and providing long life. This measure considers interior specialty lighting including the bulb types listed below, and measure and baseline consumption is a weighted average of bulbs used in each condition. The baseline for this measure is an incandescent light bulb.

Specialty lamps include:

- 3-Way
- Dimmable
- CC Candelabra—decorative
- CC Candelabra—primary
- Torpedo
- Reflector
- Globe
- A-Lamp
- Daylight
- High Wattage
- T2 Twist

Water Heat

Water Heater—Heat Pump. The heat pump moves heat from a warm reservoir (such as air), transferring this heat into hot water systems.[8] Baseline and measure efficiencies are listed in Table B-1.15.

Table B-1.15. Heat Pump Water Heater Comparisons

State	Measure Efficiency	Baseline Efficiency
ALL	Federal Standard 2015 > 55 GAL - EF 1.97*	Federal Standard 2004 Storage Water Heater > 55 GAL - EF 0.87
CA, ID, UT, and WY	ENERGY STAR > 55 GAL - EF 2.0	
WA	RTF Market Standard > 55 GAL - EF 1.99	
WA	RTF Tier 1 > 55 GAL - EF 2.05	
WA	RTF Tier 2 > 55 GAL - EF 2.08	
WA	RTF Tier 1 ≤ 55 GAL - EF 1.43	Federal Standard 2004 Storage Water Heater ≤ 55 GAL - EF 0.92
CA, ID, UT, and WY	ENERGY STAR ≤ 55 GAL - EF 2.0	
WA	RTF Tier 2 ≤ 55 GAL - EF 2.08	

* Becomes baseline after 2015.

Water Heater—Storage. High-efficiency water heaters operate more efficiently than standard electric water heaters due to reduced standby losses. This measure assumes an energy factor (EF) for high-efficiency water heaters less than or equal to 55 gallons of 0.93 and 0.95 (Federal Standard, April 2015), an increase from a standard EF of 0.92 (Federal Standard, 2004).

Appliances

Cooking Oven. 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.

Clothes Dryer. High-efficiency dryer features, such as moisture sensors, minimize energy usage while retaining performance. Steam clothes dryers can also save additional energy by efficiently eliminating wrinkles, requiring less dryer reruns to refresh wrinkled clothing.

Dehumidifier—ENERGY STAR. ENERGY STAR-qualified models have more efficient refrigeration coils, compressors, and fans than conventional models, meaning they use less energy to remove moisture. These qualified models remove the same amount of moisture as a similarly-sized standard unit, but use 10% to 20% less energy. The baseline for this measure is a 2013 federal standard dehumidifier.[9]

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 and three RTF tiers, ranging from 10% to 35% more efficient than the 2001 federal standard shown in Table B-1.16.

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

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

Table B-1.16. Freezer Measure Levels

State	Measure Level	Baseline Level
CA, ID, UT, and WY	Federal Standard 2015*	Federal Standard 2001
CA, ID, UT, and WY	ENERGY STAR	
WA	RTF Tier 1 (ENERGY STAR 10% to 20% More Efficient)	RTF Market Standard
WA	RTF Tier 2 (ENERGY STAR 20% to 30% More Efficient)	
WA	RTF Tier 3 (ENERGY STAR 30% to 35% More Efficient)	

* Becomes baseline after 2015.

Microwave—High-Efficiency. High-efficiency microwaves, with more efficient power supplies, fans, magnetron, and reflective surfaces, provide energy savings in comparison with conventional microwaves.

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, shown in Table B-1.17.

Table B-1.17. Refrigerator Measure Levels

State	Measure Level	Baseline Level
CA, ID, UT, and WY	Federal Standard 2015*	Federal Standard 2001
CA, ID, UT, and WY	ENERGY STAR	
CA, ID, UT, and WY	CEE Tier 2	
CA, ID, UT, and WY	CEE Tier 3	
WA	RTF Tier 1 (ENERGY STAR)	RTF Market Standard
WA	RTF Tier 2	
WA	RTF Tier 3	

* Becomes baseline after 2015.

Consumer Electronics

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” modes, resulting in 30% to 65% energy savings.

DVD Player—ENERGY STAR. ENERGY STAR-qualified DVD products meeting the new requirements use up to 60% less energy than standard models.[10] ENERGY STAR DVD players use only 1 watt, as little as one-fourth the energy used by standard models, in “off” or “sleep” modes. The baseline for this measure is a standard DVD player.

Home Audio System—ENERGY STAR. According to ENERGY STAR specifications, qualified audio systems must have: default power down timing; 1 watt sleep/off mode consumption; and 55% efficiency for amplifiers greater than 20 watts input power.[11]

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

11 http://www.energystar.gov/index.cfm?c=audio_dvd.pr_crit_audio_dvd

Monitors—ENERGY STAR. ENERGY STAR monitors feature: (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.[12]

Office Multifunction Device—ENERGY STAR. 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. 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.[13]

Office Printers—ENERGY STAR fax machines enter sleep mode after inactivity. This reduces their total power consumption by 50%.[14]

Set Top Box—ENERGY STAR. Set-top boxes earning ENERGY STAR prove at least 40% more efficient than conventional models.[15] The baseline measure is a standard receiver.

TV—ENERGY STAR. ENERGY STAR-qualified TVs use about 40% less energy than standard units.[16] ENERGY STAR models must consume no more than 1 watt while in Sleep Mode. The baseline is a standard television, generally consuming more than 3 watts when off.

Other

Pool Pumps—Two-Speed Motor. This enables pool pump motors to run at high and low speeds, rather than constantly running at full power. The baseline for this measure is a standard, one-speed motor.

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

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

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

14 http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf

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

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

APPENDIX B-2. COMMERCIAL MEASURE DESCRIPTIONS

Commercial Retrofit Measure Descriptions

Heating and Cooling

Automated Exhaust 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 VFD Control (Occupancy/CO2 sensors). This measure is also known as Demand Control Ventilation (DCV), where the ventilation system automatically adjusts air flow when CO2 levels rise above a specified level. When using CO2 control, a minimum ventilation rate is maintained at all times to control non-occupant contaminants, such as off-gassing from furniture, equipment, and building components. Without this, as a baseline, the ventilation system would run constantly.

Chilled Water/Condenser Water Settings-Optimization. Adjustments made to chilled and condenser water system settings better match building loads and reduce unnecessary use of 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, varying pump speeds and chilled water flows to match varying cooling loads, thus reducing pumping energy requirements. The baseline is a constant speed pump with three-way valves.

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

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

Cool Roof. ENERGY STAR®-qualified cool roofs can lower roof surface temperatures up to 100ºF, thereby decreasing amounts of heat transferred into a building. Cool roofs can help reduce amounts of air conditioning needed in buildings, and can reduce peak cooling demand by 10%–15%. This measure could be considered a passive measure.

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 tower water leaving and the wet-bulb temperature. This measure assumes a 6-degree delta, compared to the baseline of a 10-degree temperature delta.

Cooling Tower—Two-Speed Fan Motor. A two-speed fan cycles between off, low, and high speeds to maintain the tower set point. The low-speed setting option uses less energy than a single, high-speed fan. The baseline measure is a single-speed fan motor.

Cooling Tower—VSD Fan Control. One step more sophisticated than a two-speed fan motor is the variable speed drive (VSD). A VSD drive modulates the air flow, so heat rejection exactly matches the load at the desired set point. The baseline measure is a two-speed fan motor.

Direct/Indirect Evaporative Cooling, Pre-Cooling. A direct evaporative cooler is a low-energy system that evaporates water into the air stream, thus reducing the air temperature, but increases the humidity. An indirect evaporative cooler uses a secondary air stream, cooled by water, and going through a heat exchanger with the primary air stream, cooling the air but not affecting the humidity. A direct/indirect system cools the air stream, first through an indirect cooler, and then cools it further through a direct cooler. Including an evaporative cooler before the Direct Expansion (DX) system will reduce the overall cooling load.

Direct Digital Control System—Optimization. Direct digital control (DDC), also known as an energy management system (EMS), allows digital monitoring and control of HVAC and lighting systems. Optimization of the control system upgrades a high-efficiency EMS to a premium efficiency system.

Duct Repair and Sealing. The repair and sealing of leaky ducts creates significant energy savings by ensuring conditioned air goes only to occupied spaces, thereby reducing excessive runtimes/loads on HVAC systems.

DX Package Air-Side Economizer. An air-side economizer uses already cooled air (return air), mixed with a proportion of outside air to cool indoor spaces. Using the return air results in energy savings, as less air must be cooled.

DX Tune-Up/Diagnostics. Regular maintenance of DX air-conditioning systems includes activities such as: checking controls, replacing filters, cleaning coils and blowers, and checking refrigerant levels.

Exhaust Air to Ventilation Air Heat Recovery. Captures air exhausted out of a building during the heating season, which would be warmer than the air outside. Transferring this heat to incoming air lowers overall heating loads.

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

Green Roof. A green roof is a living roof, supporting soil and plant growth. A series of carefully engineered layers, applied to the roof deck, are watertight, lightweight, and long lasting. Green roofs can be incorporated into new buildings as long as load requirements can be met. They are suited for roofs with slopes ranging up to 20°, and are most successful when sufficient attention has been paid to selecting plants that thrive in the local climate and conditions. One of the most significant advantages green roofs offer is they can last up to three times longer than a standard roof. A green roof can also buffer temperature extremes, improving a building's energy performance by dropping the temperatures on the roof.

Hotel Key Card Energy Control System. This a key card system controls room HVAC and lighting during non-occupied periods. Occupancy is determined by 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 a guest returns and inserts the key card, they can fully control of the room systems.

Infiltration Reduction (Caulking, Weather Stripping, etc.). Sealing air leaks in windows, doors, roof, crawlspaces, and outside walls decreases overall heating and cooling losses. The baseline measure is 1.00 Air Changes per Hour (ACH), while the measure value is 0.65 ACH.

Insulation—Ceiling. These measures represent an increase in R-value from existing building conditions to current state code, and current state code to better than code R-value improvements. Table B-2.1 presents baseline and measure values.

Table B-2.1. Ceiling Insulation Measures

Measure	Baseline
R-20ci (ID, UT, & WY State Code)	Average Existing Conditions
R-25ci (CA State Code)	Average Existing Conditions
R-30	R-20ci (ID, UT, & WY State Code)
R-30	R-25ci (CA State Code)
R-30ci (WA State Code)	Average Existing Conditions
R-38	R-30ci (WA State Code)

Insulation—Duct. Packaged DX and heat-pump equipment generally are coupled with a ducting system inside a building. Insulating ducts reduces energy loss in unoccupied plenum space. Table B-2.2**Error! Reference source not found.** presents baseline and measure values.

Table B-2.2. Duct Insulation Measures

Measure	Baseline
R-5 (ID, UT, & WY State Code)	No Insulation
R-7 (WA State Code)	No Insulation
R-8 (CA State Code)	No Insulation
R-8	R-5 (ID, UT, & WY State Code)

Insulation—Floor (Non-Slab). These measures represent an R-value increase from existing building conditions to current state code, and from current state code to better than code R-value improvements for the floor space (non-slab). Table B-2.3 presents baseline and measure values.

Table B-2.3. Floor Insulation Measures

Measure	Baseline
R-25 (CA State Code)	Average Existing Conditions
R-30 (ID, UT, WA & WY State Code)	Average Existing Conditions
R-30	R-25 (CA State Code)
R-38	R-30 (ID, UT, WA & WY State Code)

Insulation—Wall. These measures represent an increase in the R-value to current state code values or better. Table B-2.4 presents baseline and measure values.

Table B-2.4. Wall Insulation Measures

Measure	Baseline
R-13 + 3ci (WY State Code)	Average Existing Conditions
R-13 + 7.5ci (ID, UT, & WA State Code)	Average Existing Conditions
R-16 (CA State Code)	Average Existing Conditions
R-13 + 10ci	R-13 + 3ci (WY State Code)
R-13 + 10ci	R-13 + 7.5ci (ID, UT, & WA State Code)
R-21	R-16 (CA State Code)

Natural Ventilation. Natural ventilation systems rely on pressure differences to move fresh air through buildings. Unlike fan-forced ventilation, natural ventilation uses the natural forces of wind and buoyancy to deliver fresh air into buildings. The specific approach and design of natural ventilation systems varies, based on building types and local climates. However, the amount of ventilation depends on careful design of internal spaces, and the size and placement of openings in the building. Natural ventilation offsets energy required to run forced air ventilation systems.[17]

New Construction Integrated Building Design. Leadership in Energy and Environmental Design (LEED) has developed guidelines to build energy-efficient buildings, using high-performance integrated building design. Tier I integrated buildings are up to 30% more energy efficient than standard code, according to ASHRAE/IESNA Standard 90.1-1999. Tier II buildings are up to 50% more efficient than standard building codes. The baseline measure is built to ASHRAE/IESNA Standard 90.1-1999.

Pipe Insulation. Adding 1.5 inches of R-6 insulation around chilled water pipes minimizes increases in temperature, thereby reducing demand on chiller systems.

Re-Commissioning. Commissioning ensures installed energy-using systems operate in an optimal fashion to maximize energy efficiency. The commissioning process can be applied to existing buildings to restore them to optimal performance. Retrocommissioning is a systematic, documented process, identifying low-cost operational and maintenance improvements in existing

[17] Description source: National Renewable Energy Laboratory

buildings, bringing the buildings up to the design intentions of its current operation.[18,19] The baseline measure is no commissioning.

Window Film. Solar control window films, applied to existing windows, reduce peak demand during hot months, and conserve energy when air conditioning might be required. In addition to energy management benefits, use of these films reduces exposure to ultraviolet radiation and glare.[20]

Windows—High-Efficiency. This measure represents an increase in building performance by reducing the U-value in existing construction and new construction windows, as shown in Table B-2.5**Error! Reference source not found.**.

Table B-2.5. High-Efficiency Window Measures

Measure U-Value	Baseline U-Value
0.50 (WY State Code)	Average Existing Condition
0.47 (CA State Code)	Average Existing Condition
0.40 (WA State Code)	Average Existing Condition
0.35 (ID & UT State Code)	Average Existing Condition
0.32	0.35 (ID & UT State Code)
0.32	0.40 (WA State Code)
0.32	0.47 (CA State Code)
0.32	0.50 (WY State Code)

Lighting

Bi-level Control, Stairwell Lighting. An occupancy sensor reduces light loads by 50% when stairwells are unoccupied for a set amount of time. The baseline is continuous operation at full power.

Controlled Atmosphere—Fruit Storage—High Bay Lighting Upgrade Package. Lighting reduction high bay packages include upgrading to high efficiency fixtures, such as T5 high output, to reduce the overall lighting load.

Controlled Atmosphere—Fruit Storage—Lighting Controls. Lighting reduction control packages include lighting controls, such as time clocks and occupancy sensors, to reduce overall lighting loads.

Covered Parking Lighting. Replacing inefficient metal halide lamps with LEDs and high-pressure sodium lamps with LED Low Bay lighting, reduces energy use of covered parking garages.

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

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

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

Daylighting Controls, Outdoors (Photocell). Exterior lighting controls via photocell turn on and off exterior light fixtures when sunlight levels reach desired set points. The measure achieves savings over time-clock or manual controls through changes in seasonal and site conditions by improving nighttime durations.

Dimming-Continuous, Fluorescent Fixtures. A dimming switch allows light levels to vary from 0%–100% brightness. A continuously dimming switch permits variations throughout the range, increasing electricity savings. The baseline measure is operating fluorescent fixtures at full power.

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

Exit Sign—LED. LED exit signs use only 6 watts of power, and last over 50,000 hours, while CFL exit signs use 26 watts of power and have a shorter life.

Exit Sign—Photoluminescent or Tritium. Photoluminescent or tritium signs use little to no energy (a maximum of 2 watts), while providing bright lighting suitable for exit signage. This measure's low-energy consumption can provide savings, compared to the 6 watts consumed by LED signs.

Exterior Building Lighting—Package. Exterior lighting package results in a 30% decrease in lighting power density. The baseline lighting technology is representative of all available technologies making up total watts per square foot.

Display Case LEDs. LEDs are highly efficient bulbs that can be used for refrigeration case lights, resulting in energy savings over a standard fluorescent case light. This measure applies specifically to closed cases.

Display Case LEDs (Open Cases). LEDs can be used for refrigeration case lights, resulting in energy savings over a standard fluorescent case light. This measure applies specifically to open cases.

Occupancy Sensor Control. These units turns off lighting in areas where activity is not detected. Occupancy measures can control single or multiple lighting zones. Controlled lighting wattage varies, depending on applications. The baseline assumes no lighting controls.

Solid State LED White Lighting. LEDs are solid-state devices that convert electricity to light, with very high efficiency and long life. Recently, lighting manufacturers have been able to produce "cool" white LED lighting indirectly, using ultraviolet LEDs to excite phosphors emitting a white-appearing light. This measure applies to exterior lighting, and includes landscape, merchandise, signage, and structure lighting.

Surface Parking Lighting. By replacing inefficient metal halide lamps with LED lighting, the energy use of surface parking lots can be reduced.

Time Clock. The units include an integrated time-clock, which automatically switches lighting and other loads on and off on a time schedule, or in response to an occupancy sensor or building automation system.

Refrigeration

Anti-Sweat (Humidistat) Controls. Enables the user to turn refrigeration display case anti-sweat heaters off when ambient relative humidity reaches levels low enough to prevent sweating. Without the control, the heaters generally run continuously.

Controlled Atmosphere—Fruit Storage—Controlled Atmosphere Retrofit—CO2 Scrub. A carbon dioxide scrubber absorbs CO2, and are used in controlled atmosphere (CA) storage to maintain a specified CO2 level.

Controlled Atmosphere—Fruit Storage—Controlled Atmosphere Retrofit—Membrane. Membrane technology units feature a quality-air, pre-treatment filtration system. Fruit storage depends on a very controlled environment, which slows the ripening process until a product is ready to be removed from the controlled atmosphere storage room. This makes the membrane generator an extremely low-cost and reliable source for infusing nitrogen into the rooms.

Controlled Atmosphere—Fruit Storage—Fruit Storage Refrigeration Retrofit. This measure for CA storage is designed as a combined package of other refrigeration measures. The system upgrade includes: a premium-efficiency EMS system; a VSD compressor; a VSD condenser; a VSD evaporator fan; and floating condenser head pressure controls.

Controlled Atmosphere—Fruit Storage—Fruit Storage Refrigeration Tune-up. Refrigeration tune-ups include procedures such as: checking set points; keeping supply and return air grilles clean; checking and adjusting settings of thermostatic expansion valves (TXV); adjusting head pressure controls; and reviewing suction pressure set points. Tune-ups of refrigeration systems in controlled atmosphere storages extends their lifetimes, and increases the system's overall energy efficiency.

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

Case Replacement Low and Med Temp. 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 ballasts such as T8 or LED lamps; and improved insulation. Replacing inefficient display cases with more efficient display cases reduces energy consumption.

Commercial Refrigerator—Semi-Vertical and Vertical—No Doors—Med Temp. This measure represents an efficient open (no doors), refrigerated, medium temperature case, including a high-efficiency cooling unit and an optimum design to minimize energy consumption. The baseline assumes a standard efficiency unit.

Compressor VSD Retrofit. Modulates motor speeds in response to changes in load. When low-load conditions exist, the current to the compressor motor decreases, slowing the compressor motor. The baseline is a constant-speed compressor.

Demand Control Defrost—Hot Gas. When frost collects on the evaporator, it reduces coil capacity by acting as a layer of insulation, reducing airflow between the fins. In hot gas defrost, refrigerant vapor from the compressor discharge or the high-pressure receiver warms the evaporator coil, melting frost collected there.[21]

Display Case Motion Sensors. Savings result from a direct reduction in lighting runtimes, and a reduced cooling load from addition of display case motion sensors.[22]

Floating Condenser Head Pressure Controls. This measure adds controls to float head pressures down to lower temperatures 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.

Night Covers for Display Cases. Night covers help eliminate wasted refrigeration cooling by insulating display cases. In addition, they reduce heating loads of buildings through less escaped refrigerated air needing to be reheated.

Refrigeration Commissioning or Recommissioning. Commissioning ensures refrigeration systems installed operate in an optimal fashion to maximize energy efficiency. Retrocommissioning checks previously commissioned equipment to ensure it continues to run efficiently. The baseline measure is no commissioning.[23]

Solid Door ENERGY STAR Refrigerators/Freezers. ENERGY STAR-labeled, commercial, solid-door refrigerators and freezers are designed with high-efficiency components, such as: ECM evaporators and condenser fan motors; hot gas, anti-sweat heaters; or high-efficiency compressors. Compared to standard models, ENERGY STAR-labeled, commercial, solid-door refrigerators and freezers save energy.[24]

Standalone to Multiplex Compressors. A multiplex-compressor system consists of multiple compressors, drawing from a common suction header, serving any number of refrigerated display fixtures. The suction group is controlled to satisfy lowest temperatures required by any of the attached display fixtures; consequently, the fixtures served by a given suction group usually have similar temperature requirements (low- versus medium-temperature groups). The baseline is a single, dedicated compressor system for each refrigeration load.

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[21] Parker Refrigeration Specialists.

[22] http://www.nwcouncil.org/energy/rtf/measures/com/ComGroceryDisplayCaseLEDs_v2_1.xlsm

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

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

Strip Curtains for Walk-Ins. Strip curtains on walk-in refrigerators reduce infiltration of warm air into refrigerated spaces by improving barriers between cold spaces and ambient air.

Walk-In ECM. The walk-in fan is a refrigeration system components. ECMs are smaller, variable-speed motors operating from a single-phase power source, with an electronic controller mounted in or on the motor. The baseline measure is a standard efficiency motor.

Walk-in Evaporator Fan ECM Controllers. This measure represents adding a controller to walk-in cooler and freezer evaporator fan motors. The evaporator fan motor type is an ECM. The controller cycles motors between high and low speeds (2-speed) or on/off, when there is no call for cooling.[25]

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.

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).[26]

Water Heating

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.[27] 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.

Clothes Washer Residential. ENERGY STAR-qualified clothes washers use less energy and water than regular washers.[28] Measure iterations are shown below in Table B-2.6.

Table B-2.6. Residential Clothes Washer MEFs

State	Measure MEF	Baseline MEF
CA, ID, UT, and WY	ENERGY STAR - MEF 2.0	Standard Clothes Washer - MEF 1.48
CA, ID, UT, and WY	CEE Tier 2 - MEF 2.2	Standard Clothes Washer - MEF 1.48
CA, ID, UT, and WY	CEE Tier 3 - MEF 2.4	Standard Clothes Washer - MEF 1.48
CA, ID, UT, and WY	ENERGY STAR - MEF 2.0	Federal Standard 2016 - MEF 1.72
CA, ID, UT, and WY	CEE Tier 2 - MEF 2.2	Federal Standard 2016 - MEF 1.72

25 http://www.nwcouncil.org/energy/rtf/measures/com/GroceryEvapFanControllerECMWalkIn_v1.xls

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

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

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

State	Measure MEF	Baseline MEF
CA, ID, UT, and WY	CEE Tier 3 - MEF 2.4	Federal Standard 2016 - MEF 1.72
CA, ID, UT, and WY	CEE Tier 2 - MEF 2.2	Federal Standard 2018 - MEF 2.0
CA, ID, UT, and WY	CEE Tier 3 - MEF 2.4	Federal Standard 2018 - MEF 2.0
WA	RTF Tier 1 - MEF 2.05	RTF Market Standard 2011 - MEF 1.94
WA	RTF Tier 2 - MEF 2.28	RTF Market Standard 2011 - MEF 1.94
WA	RTF Tier 3 - MEF 2.66	RTF Market Standard 2011 - MEF 1.94
WA	RTF Tier 3 - MEF 2.66	RTF Market Standard 2016 - MEF 2.29
WA	RTF Tier 3 - MEF 2.66	RTF Market Standard 2018 - MEF 2.36

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

Dishwasher Residential. Residential-sized ENERGY STAR dishwashing systems often are more appropriate for smaller commercial buildings. Measure iterations are shown in Table B-2.7.

Table B-2.7. Residential Dishwasher Maximum Consumptions (kWh/yr)

State	Measure	Baseline
CA, ID, UT, and WY	ENERGY STAR - 295 kWh/yr	Federal Standard 2010 - 355 kWh/yr
CA, ID, UT, and WY	Enhanced Efficiency - 250 kWh/yr	Federal Standard 2010 - 355 kWh/yr
CA, ID, UT, and WY	ENERGY STAR - 295 kWh/yr	Federal Standard 2014 - 307 kWh/yr
CA, ID, UT, and WY	Enhanced Efficiency - 250 kWh/yr	Federal Standard 2014 - 307 kWh/yr
WA	RTF ENERGY STAR - 277 kWh/yr	RTF Market Standard 2010 - 313 kWh/yr
WA	RTF Enhanced Efficiency - 250 kWh/yr	RTF Market Standard 2010 - 313 kWh/yr
WA	RTF ENERGY STAR - 277 kWh/yr	RTF Market Standard 2014 - 289 kWh/yr
WA	RTF Enhanced Efficiency - 250 kWh/yr	RTF Market Standard 2014 - 289 kWh/yr

Dishwashing—Commercial—High Temp. ENERGY STAR high-temperature commercial dishwashers have a minimal idle rate as well as a minimal amount of water consumption per rack of loaded dishes, depending on size, and are more efficient than standard high-temperature commercial dishwashers.[29]

Dishwashing—Commercial—Low Temp. ENERGY STAR low-temperature commercial dishwashers use chemicals, combined with low temperatures, to save energy when compared to standard, high-temperature commercial dishwashers.

Drainwater Heat Recovery Water Heater. Drain water heat recovery devices recover heat energy from drain water, and use that heat to preheat cold water entering the hot water tank, minimizing the temperature rise required to achieve the set point on the water heater.[30]

29 ENERGY STAR; http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COH

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

Hot Water Storage Hot Water (SHW) Pipe Insulation. One inch of R-4 insulation, added around hot water pipes, decreases heat loss. This measure only applies for existing construction and SWH. The baseline measure is no insulation.

Low-Flow Faucet Aerators. Faucet aerators, mixing water and air, reduce amounts of water flowing through the faucet, creating a fine water spray through an inserted screen in the faucet head. This measure has flow-rate requirements of 1.5 GPM, compared to a baseline of 2.2 GPM.

Low-Flow Pre-Rinse Spray Valves. Low-flow spray valves mix water and air to reduce amounts of water flowing through the spray head, which creates a fine water spray through an inserted screen in the spray head. This achieves a flow reduction of over 50%, from a flow rate of 1.6 GPM (code) to 0.6 GPM.

Low-Flow Showerheads. Low-flow showerheads mix water and air to reduce amounts of water flowing through the showerhead. The showerhead creates a fine water spray using an inserted screen in the showerhead. Table B-2.8 shows flow-rate requirements for this measure.

Table B-2.8. Low-Flow Showerhead Flow Rates

Measure Flow Rate (GPM)	Baseline Flow Rate (GPM)
2.5	3.0
1.75 (WA State Code)	3.0
1.5	2.5
1.5	1.75 (WA State Code)

Ultrasonic Faucet Control. Ultrasonic sensors automatically turn faucet water on and off when motion is detected at the sink, eliminating water running continuously while washing hands.

Water-Cooled Refrigeration with Heat Recovery. Heat recovery gathers and uses thermal energy that normally would be rejected from the system to the ambient environment; in this case, rejected heat is utilized by the water heater.

Other

Combination Oven. Commercial combination ovens use dry heat and steam, injected into the oven when the food being cooked needs it. High-efficiency combination ovens with 60% efficiency use about one-half as much energy as standard combination ovens.[31]

Convection Oven—High Efficiency. Commercial ENERGY STAR electric convection ovens must meet specification requirements of 74% cooking energy-efficiency, and an idle energy rate of 1.3 kW, whereas standard electric convection ovens have a 67% cooking energy efficiency, and an idle energy rate of 1.5 kW.

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

31 http://www.energystar.gov/ia/partners/publications/pubdocs/restaurant%20guide%20508%20-%20Dec%202009.pdf

ENERGY STAR—Battery Charging System. Battery charging systems recharge a wide variety of cordless products, including power tools and small appliances. An ENERGY STAR charging system uses 35% less energy than a baseline, non-ENERGY STAR battery charger. [32]

ENERGY STAR—Scanners. ENERGY STAR-enabled scanners enter a low power "sleep" mode after inactivity.[33]

ENERGY STAR—Water Cooler. ENERGY STAR coolers, providing only cold water, consume 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% less energy than standard models.[34]

Fryers—New CEE Efficient Electric Deep Fat Fryers. Commercial, 15-inch wide, CEE-rated electric fryers have a heavy-load cooking efficiency of 80% or better, and, when idle, use less than 1,000 watts.[35] The baseline is a standard, electric deep fat fryer.

Griddle. Electric ENERGY STAR griddles operate at least 70% more efficiently. The baseline measure is a standard grill at 32% efficiency.[36]

Hot Food Holding Cabinet. ENERGY STAR hot food-holding cabinets use a maximum of 40 watts/cubic foot, less than the baseline measure, a conventional holding cabinet.[37]

Ice Maker. High-efficiency commercial ice makers use high -efficiency compressors and fan motors, thicker insulation, and other measures to achieve 10% more efficiency than the baseline measure—a conventional automatic commercial ice maker.

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

Motor—CEE Premium-Efficiency Plus. CEE premium-efficiency motors are more efficient than standard NEMA efficiency motors.[38] This measure specifically relates to HVAC motors, ranging from 1 HP to 200 HP, depending on the building size.

Motor Rewind. When a motor fails, the user or owner faces three choices: rewind to a lower efficiency; rewind and maintain the original efficiency; or replacement with a new motor. Motor

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

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

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

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

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

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

38 CEE (Consortium for Energy Efficiency) motor nominal efficiencies are higher than the NEMA federal minimum efficiency levels that became effective in December 2010.

rewind follows the Green Motors Practices Group recommendations of best practices to maintain its original efficiency, commonly called a Green Rewind.[39, 40]

Motor—Pump and Fan System—Variable Speed Control. Variable speed controls allow pump and fan motors to operate at lower speeds while still maintaining set points during partial load conditions. Energy reduces when motor operation varies with load rather runs at a constant speed.

Motor—VAV Box High Efficiency (ECM). High-efficiency, fan-powered boxes prevent hot and cold spots by maintaining room air circulation, while modulating supply-air temperatures to match loads. This measure applies to motor efficiency as an upgrade. An ECM powers the fan in each VAV box. An ECM is a brushless DC motor, with all of its speed and torque controls built in electronically, allowing the motor to adjust its speed to ensure optimal airflow at all times. The baseline assumes a standard VAV with induction motors, including silicon controlled rectifier (SCR) speed controls.[41]

Network PC Power Management. This software tool intelligently power manages computers across a network remotely and automatically overnight, on weekends and when not in use. This significantly lowers energy consumption without impacting user productivity. Workstations operating on a local area network (LAN) or a wide area network (WAN) can implement PC power-management policies across a LAN or WAN to maximize energy savings by placing machines into lower power states, without interfering with end-user productivity, desktop maintenance, or upgrades.

Optimized Variable Volume Lab Hood Design. Allows the volumetric flow rate to vary, which causes a constant speed through the duct, regardless of sash opening. For buildings such as universities, schools, and hospitals using lab hoods, savings can be obtained by utilizing a variable, rather than constant, volume lab hood. The baseline measure is a constant volume lab hood.

Power Supply Transformer/Converter. Applies to 80 PLUS performance specification requirements for power supplies in computers and servers. 80 PLUS specifies 80% or greater efficiency at 20%, 50%, and 100% of rated loads, with a true power factor of 0.9 or greater.[42]

Residential Freezer Recycling. This refers to environmentally friendly disposal of unneeded appliances, specifically standalone freezers.

Residential Refrigerator/Freezer Recycling. This refers to environmentally friendly disposal of unneeded appliances, specifically refrigerators.

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[39] http://www.bpa.gov/energy/n/industrial/Green_motors/

[40] http://www.greenmotors.org/downloads/RTFSubmittalMay_08%20_2_.pdf

[41] LEED qualified Justice Center reported by DCJ.com and Minnesota Power Incentive Program

[42] www.80PLUS.org

Server Virtualization. Virtualization involves replacement of multiple, under-utilized servers with a single server operating at a higher utility level. Many data center servers operate at 10% of capacity or less, allowing their functions to be consolidated into "virtual" servers on one unit, operating in the range of 85% of capacity.

Smart Strips. Energy-saving products, such as power strips with an occupancy sensor, are found in workstations where power strips are commonly used. Sensor turn on and off power to all devices, such as computers, desk lights, and audio equipment, plugged into the power strip, based on occupancy within the work area.

Steam Cooker. Commercial ENERGY STAR electric steam cookers have a cooking efficiency of 50%, with idle energy rates varying depending on pan size.[43] The baseline efficiency is 35% for a standard commercial steam cooker.

Commercial 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 ground to cool and heat homes. Air and ground source heat pumps use a Coefficient of Performance (COP) ratio of the cooling effect produced (expressed in Btu/hr), divided by the energy input (expressed on the same basis and as an EER Ratio). Table B-2.9 displays different efficiency levels compared in this measure.

Table B-2.9. Heat Pump COP/EER Comparisons

kBTU / hr	Measure COP & EER	Baseline COP & EER
ASHP 65–135	11.5 EER, 3.4 COP	11.0 EER, 3.3 COP
ASHP 65–135	12.0 EER, 3.8 COP	11.0 EER, 3.3 COP
GSHP 65–135	16.2 EER, 4.0 COP	11.0 EER, 3.3 COP
ASHP 135–240	11.5 EER, 3.4 COP	10.6 EER, 3.2 COP
GSHP 135– 240	16.2 EER, 4.0 COP	10.6 EER, 3.2 COP

Centrifugal Chiller. A centrifugal chiller utilizes the vapor compression cycle to chill water and reject heat collected from the chilled water, plus heat from the compressor to a second water loop cooled by a cooling tower. The advantage of centrifugal compressors is their high flow rates' capability and good efficiency characteristics. This measure compares different efficiencies greater than 300 tons, rated in kW/ton, shown in Table B-2.10**Error! Reference source not found.**.

Table B-2.10. Centrifugal Chiller kW/ton Comparison

Measure kW / ton	Baseline kW / ton
0.55	0.576
0.52	0.576
0.47	0.576

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

Screw Chiller. Screw compressors are positive displacement devices. The refrigerant chamber is actively compressed to a smaller volume by the twisting motion of two interlocking, rotating screws. Refrigerant trapped in the space enclosed between the two rotating screws is compressed as it makes its way from the inlet to the outlet of the compressor. A slide valve adjusts the compression effect by varying the amount of compression occurring before refrigerant is discharged. Screw chillers generally are used for small- to medium-sized buildings. This measure compares different efficiencies, rated in kW/ton, as shown in Table B-2.11.

Table B-2.11. Screw Chiller kW/ton Comparison

Tons	Measure kW / ton	Baseline kW / ton
<150	0.71	0.775
<150	0.63	0.775
<150	0.58	0.775
150-300	0.65	0.68
150-300	0.57	0.68
150-300	0.50	0.68

DX Package. DX systems use a refrigerant piping circuit, compressor, and refrigerant coils to transfer heat. All components are in a single package, typically installed on the building roof. As a measurement of efficiency, commercial sized units are normally rated as an Energy Efficient Ratio (EER). Table B-2.12 displays the different models compared in this measure.

Table B-2.12. DX AC Unit EER / Advanced Technology Comparisons

kBTU / hr	Measure EER	Baseline EER
65–135	11.5	11.2
65–135	12.0	11.2
135–240	11.5	11.0
135–240	12.0	11.0
240–760	10.5	10.0 16 SEER, 8.8 HSPF 16.2 EER, 3.6 COP
240–760	10.8	10.0

Evaporative Cooler, Replaces DX Package. Evaporative coolers, also known as swamp coolers, cool air through simple evaporation of water. Evaporative cooling differs from standard air conditioning, which uses vapor-compression or absorption refrigeration cycles.[44] This measure replaces a DX package.

Packaged Terminal Air Conditioner (PTAC) (10,000 BTU/HR). PTAC units house all components—compressor; condenser and evaporator coils; expansion device; condenser and evaporator fans; and associated operating and control devices—within a single cabinet. In most cases, this package unit is installed within a space, through the wall, as in the lodging segment. The baseline for this measure represents a 10.4 EER, upgraded to an 11.4 EER PTAC.

44 http://www.energysavers.gov/your_home/space_heating_cooling/index.cfm/mytopic=12360

Lighting

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-2.13 displays the different models compared in this measure.

Table B-2.13. Fluorescent Lighting Comparison

Measure	Baseline
Reduced Wattage T8	T8
High Performance T8	T8
T5	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-2.14 displays the different models compared in this measure.

Table B-2.14. HID and High Bay Lighting Comparison

Measure	Baseline
Metal Halide	High Pressure Sodium
Induction	High Pressure Sodium
Efficient Metal Halide	High Pressure Sodium
LED	High Pressure Sodium
T5 High Output	High Pressure Sodium

Lighting Interior Screw Base. 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. Table B-2.15 displays the different models compared in this measure.

Table B-2.15. Screw Base Lighting Comparison

Measure	Baseline
CFL	Incandescent
LED	Incandescent
CFL	EISA Incandescent
LED	EISA Incandescent

Lighting Package, High Efficiency. This measure represents the achievable lighting percentage decrease in lighting power density. The baseline lighting technology is representative of all available technologies making up the total watts per square foot for that particular building type.

This includes all overhead lighting (e.g., T12, T8, T5 tubes, canned CFLs). The lighting reduction package measures reduce the lighting power density (W/sqft) by installing higher-efficiency technologies, such as high-performance T8 or T5 tubes, high-efficiency ballasts, and reflective lighting fixtures. This measure only applies to new construction.

Water Heating

Storage and Heat Pump Water Heater. High-efficiency water heaters operate more efficiently than standard electric water heaters due to reduced standby losses. Table B-2.16 shows baseline and efficient measure EF values.

Table B-2.16. Water Heater EF Comparisons

Water Heater Capacity	Measure EF	Baseline EF
≤ 55 Gallons	Heat Pump Water Heater = 2.0	2004 Federal Standard = 0.92
≤ 55 Gallons	Heat Pump Water Heater = 2.0	2015 Federal Standard = 0.95
≤ 55 Gallons (WA Only)	RTF Market Standard = 0.93	2004 Federal Standard = 0.92
≤ 55 Gallons (WA Only)	RTF Tier 1 Heat Pump = 1.43	2004 Federal Standard = 0.92
≤ 55 Gallons (WA Only)	RTF Tier 2 Heat Pump = 2.08	2004 Federal Standard = 0.92
≤ 55 Gallons (WA Only)	RTF Tier 1 Heat Pump = 1.43	2015 Federal Standard = 0.95
≤ 55 Gallons (WA Only)	RTF Tier 2 Heat Pump = 2.08	2015 Federal Standard = 0.95
> 55 Gallons	Heat Pump Water Heater = 2.0	2004 Federal Standard = 0.87
> 55 Gallons	Heat Pump Water Heater = 2.0	2015 Federal Standard = 1.97
> 55 Gallons (WA Only)	RTF Market Standard = 1.99	2004 Federal Standard = 0.87
> 55 Gallons (WA Only)	RTF Tier 1 Heat Pump = 2.05	2004 Federal Standard = 0.87
> 55 Gallons (WA Only)	RTF Tier 2 Heat Pump = 2.08	2004 Federal Standard = 0.87
> 55 Gallons (WA Only)	RTF Tier 1 Heat Pump = 2.05	2015 Federal Standard = 1.97
> 55 Gallons (WA Only)	RTF Tier 2 Heat Pump = 2.08	2015 Federal Standard = 1.97

Other

Computer—ENERGY STAR. ENERGY STAR computers consume less than 2 watts in “sleep” and “off” modes, and operate more efficiently than conventional units in “idle” mode, resulting in 32% 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.[45]

Fax—ENERGY STAR. ENERGY STAR fax machines enter sleep mode after inactivity, reducing their total power consumption by 50%.[46]

Freezer—Residential. 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%

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

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

more efficient than the 2001 federal standard. Table B-2.17 shows baseline and efficient measures.

Table B-2.17. Freezers Comparison

State	Measure	Baseline
CA, ID, UT, and WY	ENERGY STAR	Federal Standard 2001
CA, ID, UT, and WY	ENERGY STAR	Federal Standard 2015
WA	RTF Market Standard	Federal Standard 2001
WA	RTF Tier 1	Federal Standard 2001
WA	RTF Tier 2	Federal Standard 2001
WA	RTF Tier 3	Federal Standard 2001
WA	RTF Market Standard	Federal Standard 2015
WA	RTF Tier 1	Federal Standard 2015
WA	RTF Tier 2	Federal Standard 2015
WA	RTF Tier 3	Federal Standard 2015

Monitors—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.[47]

Printers—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.[48]

Refrigerator—Residential. 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-2.18 shows baseline and efficient measures.

Table B-2.18. Refrigerator Comparison

State	Measure	Baseline
CA, ID, UT, and WY	ENERGY STAR / CEE Tier 1	Federal Standard 2001
CA, ID, UT, and WY	CEE Tier 2	Federal Standard 2001
CA, ID, UT, and WY	CEE Tier 3	Federal Standard 2001
CA, ID, UT, and WY	ENERGY STAR / CEE Tier 1	Federal Standard 2015
CA, ID, UT, and WY	CEE Tier 2	Federal Standard 2015
CA, ID, UT, and WY	CEE Tier 3	Federal Standard 2015
WA	RTF Market Standard	Federal Standard 2001
WA	RTF Tier 1 (ENERGY STAR)	Federal Standard 2001
WA	RTF Tier 2	Federal Standard 2001
WA	RTF Tier 3	Federal Standard 2001

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

48 http://www.energystar.gov/ia/products/fap/IE_Prog_Req.pdf

State	Measure	Baseline
WA	RTF Market Standard	Federal Standard 2015
WA	RTF Tier 1 (ENERGY STAR)	Federal Standard 2015
WA	RTF Tier 2	Federal Standard 2015
WA	RTF Tier 3	Federal Standard 2015

Server—ENERGY STAR. Servers must meet energy use guidelines in "off" (less than 2 watts) and "idle" (either 50 watts or 65 watts, according on the category) modes of operation, ensuring energy savings when computers are used and performing a range of tasks as well as when turned off or in a low-power mode.[49]

Vending Machines—High Efficiency. ENERGY STAR new and rebuilt refrigerated beverage vending machines operate 36% more energy efficiently than standard models, using more efficient compressors, fan motors, lighting systems, and low-power mode options during non-use periods.[50]

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

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

APPENDIX B-3. INDUSTRIAL, IRRIGATION, AND STREET LIGHTING MEASURE DESCRIPTIONS

Fans

Circulating Fans: Circulating fans move ventilation air through buildings efficiently, ensuring adequate temperature control and ventilation. Fans meeting performance standards provide required ventilation efficiently, and use less energy than fans not meeting these performance standards

Fan System Improvements (Fan Equipment Upgrade, Fan System Optimization, Efficient Centrifugal Fan): Includes savings from equipment upgrades (such as using variable-speed drives rather than single-speed drives), and/or improved design of the fan system, such as better fans, ducting, flow designs, and adjustments to system parameters.

Properly Sized Fans: This measure achieves energy savings through improved matching of fan size to system load. This eliminates over- and undersized fans, allowing the system to operate at its peak efficiency.

HVAC

Air Source Heat Pump 65 to 135 kBTU/hr—High Efficiency and Premium Efficiency: Air Source Heat Pump, 65 to 135 kBTU/hr—High Efficiency at 11.5 EER, 3.4 COP or Premium Efficiency at 12.0 EER, 3.8 COP replacing a standard efficiency unit at 11.0 EER, 3.3 COP.

Chillers <150 tons (screw)—High Efficiency, Advanced Efficiency, and Premium Efficiency: Chillers <150 tons (screw)—Advanced Efficiency at 0.58 kW/ton, Premium Efficiency at 0.63 kW/ton, or High Efficiency at 0.71 kW/ton (full load), replacing a standard chiller at 0.775 kW/ton (full load).

DX Package 65 to 135 kBTU/hr - High Efficiency & Premium Efficiency: DX Package 65 to 135 kBTU/hr—High Efficiency at 11.5 EER or Premium Efficiency at 12.0 EER replacing a DX Package 65 to 135 kBTU/hr—Standard Efficiency—11.2 EER.

Evaporative Cooler replaces DX Package 65 to 135 kBTU/hr—Advanced Efficiency: Evaporative Cooler replaces DX Package 65 to 135 kBTU/hr—Advanced Efficiency replacing a DX Package 65 to 135 kBTU/hr—Standard Efficiency—11.2 EER.

Ground Source Heat Pump replaces and Air Source Heat Pump 65 to 135 kBTU/hr—Advanced Efficiency: Ground Source Heat Pump replacing Air Source Heat Pump 65 to 135 kBTU/hr—Standard Efficiency replacing an Air Source Heat Pump 65 to 135 kBTU/hr—Standard Efficiency at 11.0 EER, 3.3 COP

Recommissioning/Facility Energy Management: This measure achieves energy savings for HVAC systems through improved monitoring and verification of building systems. Measurements of operating parameters, analysis of systems, and performance monitoring all lead to energy and demand savings opportunities.

Lighting

Lighting High Bay Improvements (Metal Halide, Induction, Efficient Metal Halide, LED, Linear Florescent): Lighting measures achieve energy savings by replacing high-pressure sodium bulbs.

Lighting Linear Fluorescent Improvements (T8 Reduced Wattage, T8 High Performance, T8, T5): Linear fluorescent lighting measures achieve energy savings by replacing standard T12 linear florescent lamps.

Lighting Screw Base Socket Improvements (EISA Compliant Incandescent, EISA Backstop Incandescent, CFL, LED): Screw base lighting measures achieve energy savings by replacing standard incandescent bulbs.

Motors

Motors Other: Efficiency measures improve motor lubrication and mechanical energy recovery.

Motor Rewinds (Rewind 20–500+): This measure involves rewinding to motors in a controlled environment to minimize or eliminate efficiency losses. Motor rewinds assume rewind techniques consistent with the Green Motors Practices Group™.

Switch from Belt Drive to Direct Drive: This measure improves efficiency through reduction of losses associated with belt drive systems.

Other

Building Improvements: Improvements to the physical plant result in improved efficiency, productivity, or equipment usage.

Transformers: Energy-efficient transformers provide improved power quality while minimizing losses.

Process (Air Compressor, Cooling, Heating, Refrigeration, Other)

Air Compressor Improvements (Demand Reduction, Optimization, Equipment Upgrade)—Process Air Compressor: These measures involve overall improvement of the compressed air system, including 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)—Process Cooling: These measures aim to save energy through improved clean room equipment and practices. Savings result from optimization of chiller operating parameters, upgrading to more efficient equipment, and improving filter replacement strategies.

Cold Storage Retrofit—Process Refrigeration: Upgrading mechanical equipment to provide cooling to cold storage areas within each facility type. Retrofits may include compressors, heat rejection equipment, evaporators and fans, or other equipment resulting in greater system efficiency.

Cold Storage Tune-up—Process Refrigeration: Maintaining and enhancing equipment responsible for providing cooling to cold storage areas within each facility type. Tune-up may include refrigerant charge, equipment cleaning, general maintenance, and improved practices.

Electric Chip Fab Improvements (Eliminate Exhaust, Exhaust Injector, Reduce Gas Pressure, Solidstate Chiller)—Process Other: These general improvements increase efficiency in the electric chip fabrication process.

Equipment: Chillers (Process Cool): This measure involves upgrading chilling systems providing process cooling. Savings results from improved chiller efficiencies.

General Process Improvements (Paper: Premium Fan, Paper: Large Material Handling, Paper: Material Handling, Paper: Premium Control Large Material, Panel: Hydraulic Press, Paper: Efficient Pulp Screen, Kraft: Efficient Agitator, Kraft: Effluent Treatment System, Mechanical Pulp: Premium Process, Mechanical Pulp: Refine Plate Improvement, Wood: Replace Pneumatic Conveyor, Metal: New Arc Furnace, Material Handling, Material Handling VFD): Generic process improvements/O&M measures that include: upgrading equipment, replacing hydraulic/pneumatic equipment with electrical equipment, and using optimum size and capacity equipment.

High-Efficiency Compressor motors (Process Air Compressor): Upgrading air compressor motors to higher name plate efficiency values.

Low Pressure-drop Filters (Process Air Compressor): A type of coalescing filter designed to remove solids and aerosols from compressed air systems. These filters induce a lower pressure drop, compared to standard air filters, therefore requiring less fan energy to move air across them. These filters also have a longer useful life than standard filters.

Outside Air Intake (Process Air Compressor): An air compressor system design retrofit, pulling in air from a cooler outside environment (as opposed to the warmer room, in which the air compressor is located). Cooler air is denser, increasing the mass flow rate of air into the compressor, and improving system efficiency.

Process Heat O&M (Process Heating): Operation and maintenance practices for process heating equipment, including equipment maintenance, using optimum size and capacity equipment, and developing best-practices guidelines.

Receiver Capacity Addition (Process Air Compressor): Adding receiver volume to a compressed air system allows the compressor to cycle less frequently, permits the system to operate at lower average pressures, and reduces average compressor power.

Refrigeration Improvements (Food: Cooling and Storage, Optimization of Operating Parameters)—Process Cooling: Refrigeration improvements can include: isolating hot equipment from refrigerated area; using highest allowable temperature for refrigerated space; or modifying refrigeration system to operate at a lower pressure.

Refrigerated Cycling Dryers (Process Air Compressor): When compressed air flow runs at less than the full rated capacity, a cycling refrigerated dryer shuts off, using less energy than a non-cycling dryer (which runs continuously, regardless of air flow).

VFD Controlled Compressor (Process Air Compressor): This measure improves energy efficiency of compressed air systems by modulating compressors to match facility demand for compressed air. Energy is saved by throttling compressors back during non-peak periods.

Zero Loss Condensate Drain (Process Air Compressor): Condensate drains are used to remove liquid water from compressed air systems. Zero loss drains allow condensate water to drain out of the system as needed, without venting compressed air, thus improving system efficiency.

Pumps

Pump Equipment Upgrade: Efficient pumps achieve energy savings through improved pump design and sizing.

Pump System Optimization: This measure involves overall optimization of the pump system, including: improved system design, enhanced flow design, better maintenance practices, and adjustments to system parameters.

Multiple End Uses

Facility Energy Management (Fans, Lighting, Motors, Other, Process, Pumps): Includes synergistic savings opportunities of plant-wide energy management and improvements across multiple systems, such as compressed air, pumping, and fan systems. For this study, facility energy management only includes operational and maintenance (non-equipment) measures.

High-Efficiency Motors (Fans, Motors, Process Air Compressors, Pumps): This measure involves upgrading motors to higher name plate efficiency values. As NEMA Premium motors became the baseline code requirement in 2010, this measure has been based on Super Premium motors, which have efficiency levels at least one efficiency band above NEMA Premium.

Improved Controls (Fans, HVAC, Motors, Process-Air Compressors, Process-Cooling, Process Heat): These measures include savings from equipment upgrades (such as variable-speed drives) as well as energy improvements from enhanced monitoring, data collection, and load matching for each system.

Synchronous Belts (Fans, Motors, Process-Refrigeration, Pumps): Synchronous belts contain grooves that mate with corresponding grooves in the drive sprocket, preventing slip, thus reducing energy losses.

Irrigation Electric Measure Descriptions

High-Efficiency Motors (Irrigation): This measure involves upgrading motors to higher name plate efficiency values. As NEMA Premium motors became the baseline code requirement in 2010, this measure has been based on Super Premium motors, which have efficiency levels at least one efficiency band above NEMA Premium.

Scientific Irrigation Scheduling (SIS): SIS allows irrigators to use a scientific approach to their irrigation practices, including timing and volume.

System Improvements: These irrigation improvements include: replacing worn equipment; fixing leaks; adopting low-pressure irrigation systems; and other general irrigation maintenance and upgrades.

Agriculture Measure Descriptions

Agricultural Engine Block Heater Timers: Block heaters are electrical heaters, designed to keep tractors and other diesel engines warm, protecting them from freeze damage and to ease starting in cold weather. A block heater is only required for a few hours to sufficiently warm an engine block, but they typically operate overnight. A block heater timer saves energy by reducing the number of hours the heater runs.

Automatic Milker Takeoffs: The automatic take-off system presets flow levels at which milking claws are removed, preventing over-milking, and reducing run-times of vacuum systems.

Heat Lamps: This measure provides radiant heat to warm pigs, chicks, lambs, or calves. Changing to lower wattage, higher-efficiency heat lamps helps save electricity.

Heat Lamp Setback (Microzone): This measure saves energy by automatically adjusting power to heat lamps, compensating for fluctuations in room temperatures. Lamp life is also extended due to reduced usage. An additional benefit results from power being restored slowly after a power outage, reducing peak demand on the power utility or a backup generator.

Heat Lamp/Heating Pad Controller: This measure allows producers to adjust the heat output of bulbs or pads. By only applying the minimum power needed, energy waste is reduced and equipment life extended.

Heat Reclaimer: Hot water is used to clean milk pipes and sanitize work areas. A heat reclaimer takes waste heat from the milk refrigeration process, using it to preheat water to reduce heating loads on primary water heaters.

High-Efficiency Ventilation System: These ventilation systems ensure adequate temperature controls and ventilation for livestock by bringing in or exhausting air to facilities. Fans meeting performance standards provide the required ventilation efficiently, using less energy than fans not meeting these performance standards.

Livestock Waterers: Energy-efficient livestock waterers have 2 inches or more of insulation, completely surrounding the inside of the waterer, and an adjustable thermostat.

Milk Precooler: Milk coming from an automatic milker must be cooled to help preserve it, and to prepare it for processing and shipment. The milk pre-cooler is a heat exchanger, using well water to begin cooling milk before it enters the bulk cooling tank. Precooling lowers the load on the refrigeration system, and is more efficient. Additional pump energy is more than offset by reductions in compressor energy consumption.

Programmable Ventilation Controller: Programmable ventilation controllers vary the speed of ventilation fans to meet a facility's immediate needs. Ventilation controllers ensure proper ventilation and temperature control, while minimizing run times of ventilation fans.

VFDs—Potato/Onion Shed: These measures improve energy efficiency by matching energy used by pumps and fans with required loads. Energy is saved when systems operate at a partial load, precluding the need for full pump/fan capacity.

VFDs for Dairy Vacuum Pumps: These measures improve energy efficiency by matching energy used by pumps and fans with required loads. Energy is saved when systems operate at a partial load, precluding the need for full pump/fan capacity.

Street Lighting Measure Descriptions

LED Street Lights: LED street lights can replace standard high-pressure sodium (HPS) street lights, with similar lumens achieved with less wattage. Table B-3.1 compares HPS and LED wattages considered in this study.

Table B-3.1. Comparison of HPS and LED Street Light Bulbs

HPS Bulb Wattage	LED Equivalent Bulb Wattage
100	78
150	106
250	166
400	258

APPENDIX B-4. ADMINISTRATIVE COST BENCHMARKING

The following table provides data from the review of recent annual reports to estimate administrative costs as a portion of incremental measure cost for utility energy-efficiency portfolios.

Table B-4.1. Summary of Administrative Costs by Utility

Year	Utility	State	Administrative Cost	Incremental Measure Cost	Admin/Incremental Measure Cost
2011	Alliant	Iowa	$8,361,779	$62,452,088	13.4%
2010	Avista	Washington	$2,329,501	$18,486,571	12.6%
2010	Avista	Idaho	$1,581,520	$7,592,795	20.8%
2010	National Grid	Massachusetts	$9,106,873	$51,172,384	17.8%
2010	Nstar	Massachusetts	$30,537,198	$103,486,701	29.5%
2010	Puget Sound Energy	Washington	$17,576,267	$97,161,866	18.1%
2011	Xcel Energy	Colorado	$22,685,018	$52,648,545	43.1%
2010	Xcel Energy	Minnesota	$19,300,845	$71,306,374	27.1%
Average (including Xcel Energy Colorado)					22.8%
Average (excluding Xcel Energy Colorado)					19.9%