ENERGY STAR Market & Industry Scoping Report
Packaged Terminal Air Conditioners and Heat Pumps
December 2011

U.S. Environmental Protection Agency (EPA) consistently looks for new opportunities to expand ENERGY STAR to new product categories that will deliver significant benefits to consumers and the environment in the form of energy and dollar savings plus greenhouse gas reductions. A key step in this evaluation is the development of a scoping report that provides a snapshot of the product market, energy use, and savings potential associated with an ENERGY STAR program for the scoped product type. EPA uses scoping findings to prioritize product specification development work. While scoping reports are drafted primarily for internal evaluation purposes, and are not intended to be exhaustive but rather a guidepost for the ENERGY STAR program, EPA makes the reports available with the interest of benefiting other efficiency programs evaluating similar opportunities. For more information about the ENERGY STAR specification development process, go to: www.energystar.gov/productdevelopment.

1. Product & Technology Overview

Packaged Terminal Air Conditioners (PTACs) are air conditioning units intended for mounting through the wall that have a wall sleeve and a separate unencased combination of heating and cooling assemblies. A PTAC includes refrigeration components, separable outdoor louvers, forced ventilation, and a heating system that may utilize hot water, steam, or electric resistance.[1] A Packaged Terminal Heat Pump (PTHP) (also known as a heat pump PTAC) is a type of PTAC that uses a reverse cycle refrigeration system for heating and includes a supplementary heat source. These supplementary heat sources can include hot water, steam, or electric resistance.[2]

According to the Department of Energy's Notice of Proposed Rulemaking (NOPR) Technical Support Document, the following are:

1. product features common to most or all PTACs/PTHPs, and
2. key components that manufacturers could employ to derive further energy efficiency gains from PTACs/PTHPs

Product Features[3]

- Direct Expansion Cooling System with Optional Supplemental Heat PTACs/PTHPs employ a Direct Expansion (DX) cooling system. The primary components of a Direct Expansion (DX) Cooling System include a compressor, evaporator coil and condenser coil.
- Energy Management Capability Some new models include the capability to integrate into commercial energy management systems to provide remote management capability. These systems typically include capability that automatically limits HVAC energy consumption in unoccupied rooms.

[1] From the Energy Policy and Conservation Act, 42 U.S.C. 6311(10)(A)

[2] From the Energy Policy and Conservation Act, 42 U.S.C. 6311(10)(B)

[3] From DOE, "Packaged Terminal Air Conditioners and Heat Pumps Energy Conservation Standard Notice of Proposed Rulemaking Technical Support Document, Market and Technical Analysis" at http://www1.eere.energy.gov/buildings/appliance_standards/commercial/ptacs_pthps_tsd.html

- Motion and Temperature Sensing Many PTACs/PTHPs include temperature and motion sensing capability in order to preserve user comfort and limit energy use.
- Remote Unit Operation Optional digital energy management interfaces allow for operation and control from a central energy management system. According to DOE, "an operations manager or energy management system can turn off or digitally set the temperature of the PTAC or PTHP units not in use to conserve energy. This control strategy is commonly found in hotels and motels."
- Energy Management Software Some new models (including Amana's) are sold with wireless energy management software. These systems include an in-room wireless thermostat that can be controlled by a single controller within a building through the use of proprietary software systems.
- Separate Energy Management Kits For some models, an energy management kit is sold separately, which can include an upgraded LED display to replace the knob-based controls on older units and upgrade the units to be compatible with the energy management systems and software described above.

Opportunities for Improved Energy Efficiency[4]

- Compressor Most PTAC/PTHP units employ a rotary compressor. However, other options include scroll compressors and scroll or rotary compressors with variable speed capability.
    - Rotary Compressors Rotary compressors are currently found in the majority of PTAC and PTHP models because of their small size and high efficiency. The high efficiency of the rotary compressor can be attributed to its ability to simultaneously take in and compress refrigerant.
    - Scroll Compressors According to the Department of Energy (DOE), a more efficient alternative to rotary compressors are scroll compressors. Scroll compressors are slightly larger and more costly than rotary compressors. Scroll compressors are mainly used in automotive applications and certain residential AC systems
    - Variable-Speed Capability Variable-speed-capable compressors were also identified by DOE as an opportunity for increased energy efficiency. The variable-speed function is electronically controlled, which allows the compressor output to vary to meet demand.

- Heat Exchanger A key method for reducing energy consumption in PTACs/PTHPs is to either increase the surface area of a conventional heat exchanger using additional cooling loops and/or to leverage advanced heat exchanger technologies including microgroove or microchannel heat exchangers.
    - Microchannel Heat Exchangers Microchannel heat exchangers employ several small channels to conduct refrigerant. Heat exchangers employing this design enable greater heat transfer per unit without allowing pressure to drop as far as in conventional heat exchangers. While conventional PTACs do not require condensate removal, microchannel heat exchangers used in PTHP applications do. This requirement for microchanel PTHPs to include condensate removal for efficient operation, may potentially limit the use of this technology in PTHP applications.
    - Microgroove Heat Exchangers Recent R&D efforts have also focused on a higher efficiency variation of conventional heat exchanger technology. These microgroove heat exchangers are characterized by smaller diameter copper tubes in a staggered arrangement. These copper tubes also include a "microgrooved" internal treatment to

[4] See Footnote 3

enhance heat transfer. According to the International Copper Association, these enhancements increase energy efficiency and durability while using less tube and fin material and less refrigerant. Both microchannel and microgroove heat exchanger technologies enable increased energy performance and/or smaller/lighter heat exchangers with equivalent performance to conventional designs.[5]

  - Expanding Surface Areas of Conventional Heat Exchangers Greater heat exchange area improves the efficiency of the refrigeration cycle. However, increasing the face area of the condenser coil can increase overall system size and add cost to the system.
  - Building Additional Cooling Loops into Heat Exchangers Manufacturers can design multiple and/or subcooling loops into a PTAC/PTHP's heat exchanger, which can enhance efficiency and system capacity.

- Fan Design and Thermal Bridging Airflow leakage and efficiency can be addressed by employing more efficient fan blade design, more effective insulation and sealants.
  - Fan Design Fan performance can be improved by modifying the fan diameter, shape and/or axis, as well as by adding additional fans to the unit itself. For example dual-fan PTACs or PTHPs allow manufacturers to include multiple fan blade types. In addition, multiple-fan units can also perform efficiently under diverse heating and cooling conditions.
  - Thermal Bridging Insulation and sealants can reduce the energy consumption of a PTAC and PTHP unit by reducing unnecessary heat transfer. More specifically, insulation, which often is made of rubber padding and extruded polystyrene, can curtail heat transfer between the condenser and evaporator assemblies.
- Heat Pipes Employing heat pipes in the design of a heat exchanger helps to improve the energy performance of the heat exchanger by eliminating the need for more energy-intensive pre-cooling.
- Corrosion Protection Weatherization of PTACs/PTHPs reduces the level of weather-related corrosion that can negatively impact the energy performance of the cooling system. More specifically, certain material coatings, including polyester powder coat paint, can assist in decreasing corrosion from water, salt and scratches, thereby enhancing energy performance. Energy performance can also be enhanced by substituting 1) polymers for steel in the production of wall sleeves (which also reduces operating noise) and 2) stainless steel for copper in the design of outdoor coils.
- Smart Grid Capability Based on feedback EPA received from stakeholders during the room air conditioner specification development and revision process, EPA should consider PTACs/PTHP smart grid capability requirements. These requirements include secure bi-directional communications capability for purposes of both energy management and smart gird capability. This capability could either be (1) optional, with compliant products indicated on the Qualified Products List (QPL), or (2) mandatory, if supported by the PTAC/PTHP market.

[5] For more information, please see http://www.microgroove.net/.

2. Market Assessment

As of 2005, the following companies comprised 100% of the standard-size market in PTACs and PTHPs[6]:

PTAC/PTHP Product Manufacturers

- General Electric
- Carrier Corporation
- Amana (Goodman Manufacturing)
- Trane (American Standard)
- McQuay International
- Friedrich Corporation
- Fedders Corporation
- Sanyo Fischer Corporation
- LG Electronics

PTAC/PTHP Product Manufacturers with AHRI-Certified Products[7]

- Eair LLC
- Friedrich
- General Electric
- Goodman Manufacturing
- Gree Electric Appliances Inc. of Zhuhai
- Heat Controller, Inc.
- LG Electronics
- McQuay International
- Sanyo Commercial Solutions

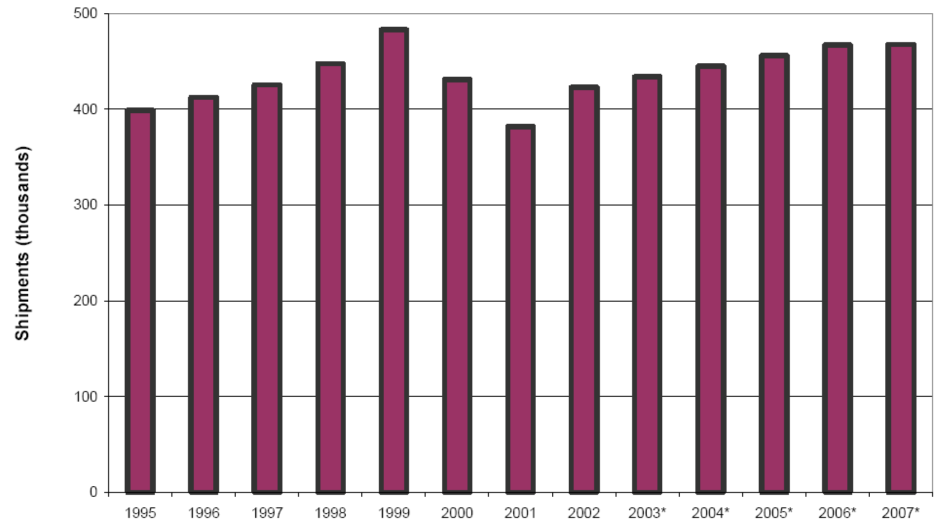
PTAC/PTHP Shipments and Sales

As of 2002, annual PTAC and PTHP sales were approximately 400,000, according to the Census Bureau and BSRIA. The volume of shipments from the Census Bureau's Current Industrial Reports: Refrigeration, Air Conditioning, and Warm Air Heating Equipment, and BSRIA in the U.S. Market for Residential and Specialty Air Conditioning: Packaged Terminal Air Conditioning differs by less than 40,000 units. More up-to-date market data from AHRI or others could further scope the market size as well as provide insight to shipment-weighted efficiencies.

Sales are largely driven by hotel and motel demand. Hotel/motel owners purchase units directly from manufacturers and distributors, either by regional or national affiliation. Multiple replacement models are purchased to keep on-hand should an existing PTAC malfunction. This practice keeps rooms available for business. Replacement and renovation of hotel rooms accounts for 50% of sales, newly constructed hotels account for 40%, with the remainder being installed in multi-family dwellings, nursing homes, and other small buildings. Shipment data from 2003 is shown below in Figure 1 and the corresponding market share of PTACs and PTHPs by heating option is shown in Figure 2.

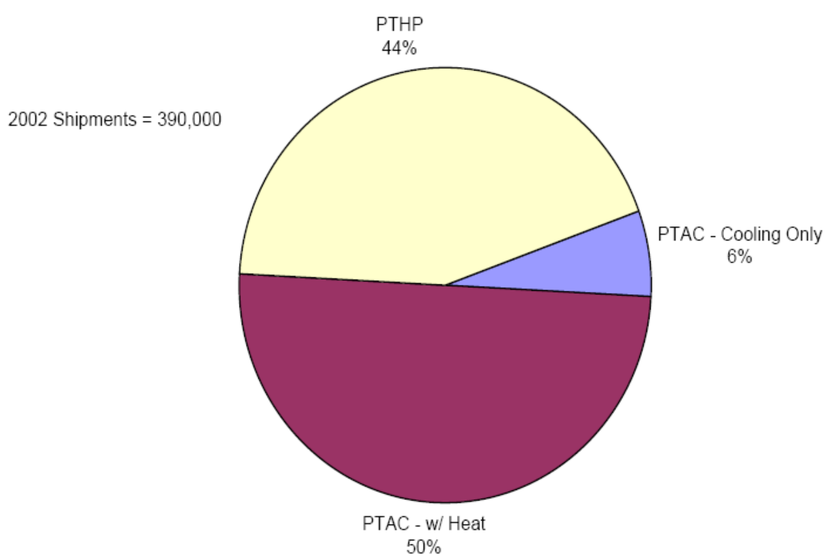
[6] From DOE Market and Technology Assessment TSD
[7] From the AHRI Directory, 21 March 2011

Figure 1: PTAC/PTHP Actual and Projected Unit Shipments



* -- Projection. Data taken from BSRIA, *U.S. Market for Residential and Specialty Air Conditioning: Packede Terminal Air Conditioning*, (Dec. 2003).

Figure 2: Percentage of PTACs/PTHPs of Units Shipped



Data taken from BSRIA, U.S. Market for Residential and Specialty Air Conditioning: Packede Terminal Air Conditioning, (Dec. 2003).

In 2008, the US market for PTACs was approximately $143 million.[8] As of an assessment undertaken in 2003, total sales were anticipated to grow 2.5% per year until 2008.[9] Without including the costs of installation, a standard PTAC costs approximately $575, while a PTHP costs $650. Incremental costs for more efficient units are approximately $75. According to RS Means, total costs of installation of a unit in a newly constructed building costs $1,150 to $1,400 per unit.[10]

Utility Incentives for Energy Efficient PTACs/PTHPs

Dozens of public and investor-owned electric utilities across all regions of the United States offer purchase incentives for PTACs and PTHPs. Incentives for PTACs/PTHPs are typically offered through standard-offer HVAC or commercial programs that favor units under 65,000 btu/hr (~5 tons). Sample incentives are detailed in the table below:

Table 1: Sample Packaged Terminal Air Conditioners (PTACs) Incentive Levels

Utility	Qualifying Unit Size (BTU/hr)	Minimum EER	Incentive
JEA (formerly Jacksonville[11] Electric Authority)	8,000 or less	11.8	$50/ton[12]
	8,000-10,500	11.4	
	10,500-13,500	10.7	
	13,500 or more	10.0	
Pacific Gas and Electric[13]	7,000 or less	11.29	$100/unit
	7,000-15,000	10.27	
	15,000 or more	9.25	
Tennessee Valley Authority (TVA)[14]	8,000 or less	11.8	$20/ton
	8,000-10,500	11.4	
	10,500-13,500	10.7	
	13,500 or more	10.0	
Salt River Project (SRP)[15]	8,000 or less	11.8	$50/ton
	8,000-10,500	11.4	
	10,500-13,500	10.7	
	13,500 or more	10.0	
Consolidated Edison[16]	All Sizes	13.1 - (0.213 x (Btu/h/1000)	$50/ton
Commonwealth Edison[17]	All Sizes	13.08 – (0.2556*Btu/h/1000)	$50/ton
Duke Energy[18]	All Sizes	12.8 – (0.213*Btu/h/1000)	$10/unit
Southern California Edison[19]	24,000 or less	10.9 – (0.213*Btu/h/1000)	$100/unit

[8] According to 2008 US Census Current Industrial Reports for Refrigeration, Air Conditioning and Warm Air Heating Equipment data
[9] BSRIA, US Market for Residential and Specialty Air Conditioning: Packaged Terminal Air Conditioning (2003)
[10] R.S. Means, 2003 Residential Cost Data
[11] See http://www.jea.com/community/conservcenter/business/heating_measures.asp
[12] 1Ton = 12,000 btu/hr
[13] See http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/incentivesbyindustry/hvac_catalog_final.pdf
[14] See http://www.energyright.com/commercial/forms/StandardRebateApplication-HVAC.PDF
[15] See http://www.srpnet.com/energy/powerwise/business/standardrebate.aspx
[16] See http://www.conedci.com/HVAC.aspx
[17] See https://www.comed.com/Documents/BusinessSavings_Programs/HVACApp.pdf
[18] See http://www.duke-energy.com/pdfs/NC_HVAC.pdf
[19] See http://asset.sce.com/Documents/Business%20-%20Energy%20Management%20Solutions/100721_Hospitality.pdf

Table 2: Sample Packaged Terminal Heat Pumps (PTHPs) Incentive Levels

Utility	Qualifying Unit Size (BTU/hr)	Minimum EER (COP if Specified)	Incentive
JEA (formerly Jacksonville Electric Authority)	8,000 or less	11.8 (3.3)	$50/ton
	8,000-10,500	11.4 (3.2)	
	10,500-13,500	10.7 (3.1)	
	13,500 or more	10.0 (3.0)	
Pacific Gas and Electric	7,000 or less	11.29	$100/unit
	7,000-15,000	10.27	
	15,000 or more	9.25	
Tennessee Valley Authority (TVA)	8,000 or less	11.8 (3.3)	$20/ton
	8,000-10,500	11.4 (3.2)	
	10,500-13,500	10.7 (3.1)	
	13,500 or more	10.0 (3.0)	
Salt River Project (SRP)	8,000 or less	11.8	$50/ton
	8,000-10,500	11.4	
	10,500-13,500	10.7	
	13,500 or more	10.0	
Consolidated Edison	All Sizes	13.1-(.213* Cap(kBTU/h /1000)	$50/ton
Commonwealth Edison	All Sizes	13.08-(.2556* Cap(kBTU/h /1000)	$50/ton
Southern California Edison	24,000 or less	10.8-(.213* Cap(kBTU/h/1000)	$100/unit

3. Energy Efficiency Assessment

Available Test Procedures

- ANSI/AHRI 310/380-2004 (formerly ARI 310/380-2004) CSA C744-04 This is the most up-to-date test method published by the Air Conditioning, Heating and Refrigeration Institute (AHRI) and the Canadian Standards Association (CSA) on PTAC/PTHPs. The 2004 test method was the result of a joint effort of AHRI and CSA to combine AHRI 310-90 (for PTACs) and AHRI 380-90 (for PTHPs). Using this standard, PTACs/PTHPs can be tested at standard rating conditions (and are tested by AHRI in its Certification Program) to derive the following efficiency metrics:

Table 3: Metrics Derived from ANSI/AHRI 310/380-2004

Product Type	AHRI Certified Ratings
PTACs	• Cooling Capacity, Btu/h • Energy Efficiency Ratio (EER), Btu/W.h • Heating Capacity, Btu/h
PTHPs	• Cooling Capacity, Btu/h • Energy Efficiency Ratio (EER) , Btu/W.h • High-Temperature Heating Capacity, Btu/h • High-Temperature Coefficient of Performance (COP), W/W • Low-Temperature Heating Capacity, Btu/h • Low-Temperature Coefficient of Performance (COP), W/W

Available Products and Efficiency Thresholds

PTACs and PTHPs are regulated by the Department of Energy under the Energy Policy and Conservation act of 1974. In 2008, the Department of Energy amended these standards to increase the efficiency baselines for both PTACs and PTHPs. In this rulemaking, DOE classified the PTAC and PTHP products into standard and non-standard sized equipment. It is important to note for this analysis that though AHRI does not distinguish between standard and non-standard size equipment in its directory of certified products, manufacturers claim that all the units listed in the AHRI directory are standard size units. Furthermore, most standard size PTACs for sale in the US are listed in the directory, and manufacturers consider the directory to cover the range of available efficiencies. There was no analogous directory for non-standard size PTACs readily available. Anecdotally, standard size units are about 85% of the market, including all new construction. Non-standard size units are used only in the replacement market.

PTAC Efficiency Standards

Through an October 2008 rulemaking, DOE amended PTAC minimum standards. Table 4 shows the current standards for PTACs and the standards that will take effect in 2012[20]

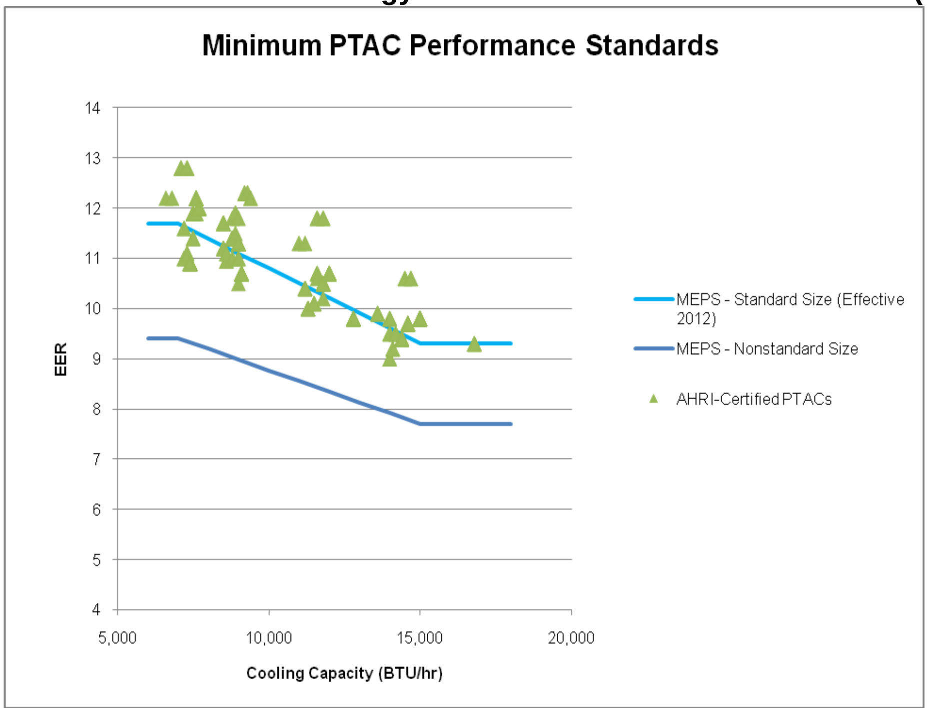
Table 4: Federal Minimum Energy Performance Standards (MEPS) for PTACs

Cooling Capacity (BTU/h)	Minimum Standards for Standard Size (Effective October 2012)	Minimum Standards for Non-Standard Size (Effective October 2010)
≤7,000	EER = 11.7	EER = 9.4
7,000-15,000	EER = 13.8 – (0.3*Cap (kBTU/h))	EER = 10.9-(0.213*(Cap (kBTU/h))
≥15,000	EER = 9.3	EER = 7.7

[20] Standard size is defined by DOE as "PTAC or PTHP equipment with wall sleeve dimensions having an external wall opening greater than or equal to 16 inches high or greater than or equal to 42 inches wide, and a cross-sectional area greater than or equal to 670 square inches." Nonstandard-size is defined by DOE as "PTAC or PTHP equipment with existing wall sleeve dimensions having an external wall opening of less than 16 inches high or less than 42 inches wide, and a cross-sectional area less than 670 square inches." See PTAC/PTHP Final Rule at http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/ptac_pthp_final_rule_fr.pdf for more information.

Figure 3 illustrates the EER of AHRI-certified PTACs as compared to the federal standards promulgated in 2008 for standard size units. The figure also includes the federal standards promulgated in 2008 for non-standard size units.

Figure 3: Federal Minimum Energy Performance Standards for PTACs (EER)

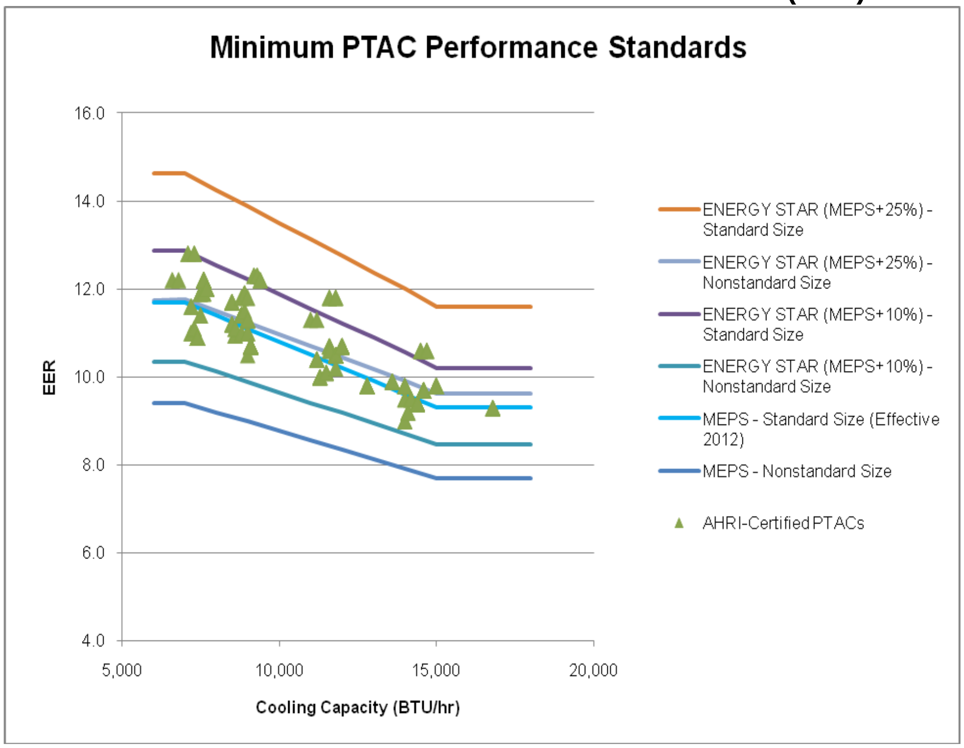


Product Availability and Potential ENERGY STAR Levels

This section contains an analysis of ENERGY STAR criteria set at 10% and 25% better than the 2012 MEPS for standard size and 2010 MEPS for non-standard size units for EER and COP.

Figure 4 shows where the AHRI products fall as compared to the federal minimum standards and the suggested ENERGY STAR PTAC criteria for standard size. The figure also includes the federal minimum standards and the suggested ENERGY STAR PTAC criteria for non-standard size units.

Figure 4: Federal Minimum Energy Performance Standards and Recommended ENERGY STAR Levels for PTACs (EER)



Tables 4 and 5 list the number of models, by manufacturer, that would meet the two potential criteria for standard size. As both tables make clear, the only current AHRI-certified models that would meet an ENERGY STAR level of 10% above the federal standard for standard-size units are manufactured by General Electric under its Zoneline brand. No models are currently available at the 25% level.

Table 4: PTAC Models Compared to Proposed ENERGY STAR (MEPS+10% at Standard Size)

OEM	Eair	Friedrich	GE	Goodman	Gree	Heat Controller	LG	McQuay
Total No. of AHRI-Certified Models	**20**	**29**	**26**	**37**	**47**	**20**	**12**	**59**
Number that Meet Proposed EER	0	0	16	0	0	0	0	0

Table 5: PTAC Models Compared to Proposed ENERGY STAR (MEPS+25% at Standard Size)

OEM	Eair	Friedrich	GE	Goodman	Gree	Heat Controller	LG	McQuay
Total No. of AHRI Models	**20**	**29**	**26**	**37**	**47**	**20**	**12**	**59**
Number that Meet Proposed EER	None							

PTHP Efficiency Standards

The amended minimum standards for PTHPs were also promulgated in October 2008. Table 5 describes current standards for PTHPs and the standards that go in effect in 2012 (EER and COP):

Table 6: Federal Energy Conservation Standards for PTHPs

Cooling Capacity (BTU/h)	Minimum Standards for Standard Size (Effective October 2012)		Minimum Standards for Non-Standard Size (Effective October 2010)	
	EER	COP	EER	COP
≤7,000	11.9	3.3	9.3	2.7
7,000-15,000	13.8 – (0.3*Cap(kBTU/h)	3.7-(0.052*Cap (kBTU/h)	10.9-(0.213*Cap(kBTU/h)	10.8-(0.213*Cap(kBTU/h)
≥15,000	9.5	2.9	7.6	2.5

Figures 5 and 6 illustrate the EER and COP of AHRI-certified PTHPs, as compared to the federal standards promulgated in 2008 for standard size units. The figures also include the federal standards promulgated in 2008 for non-standard size units.

Figure 5: Federal Minimum Energy Performance Standards for PTHPs (EER)

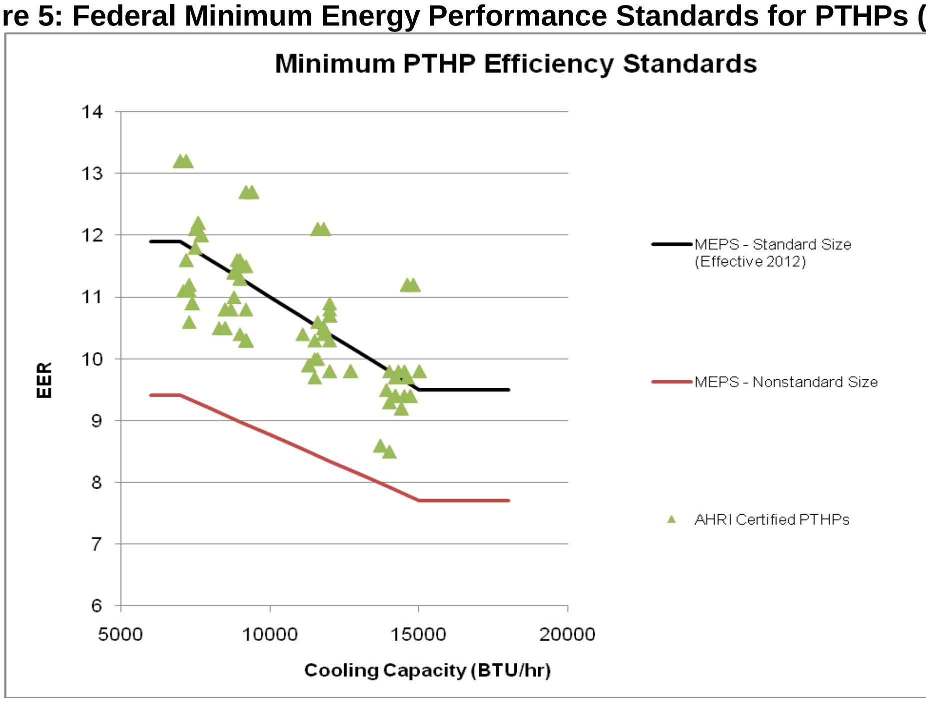
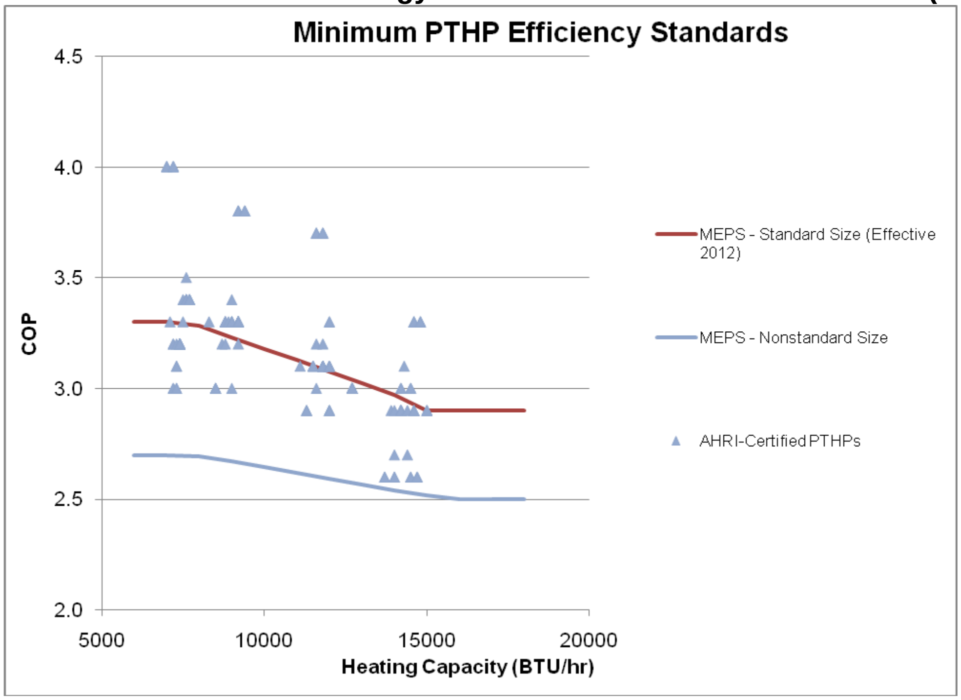


Figure 6: Federal Minimum Energy Performance Standards for PTHPs (COP)



Product Availability and Potential ENERGY STAR Levels

This section contains an analysis of ENERGY STAR criteria set at 10% and 25% better than 2012 MEPS for standard size and 2010 MEPS for non-standard size units for EER and COP.

Figures 7 and 8 show where the AHRI products fall as compared to the relevant federal standards and the recommended PTHP criteria for standard size units. The figure also includes the federal minimum standards and the suggested ENERGY STAR PTHP criteria for non-standard size units. Tables 7 and 8 lists the number of models, by manufacturer, that would meet the two potential criteria for standard size units.

Figure 7: Federal Minimum Energy Performance Standards and Proposed ENERGY STAR Levels for PTHPs (EER)

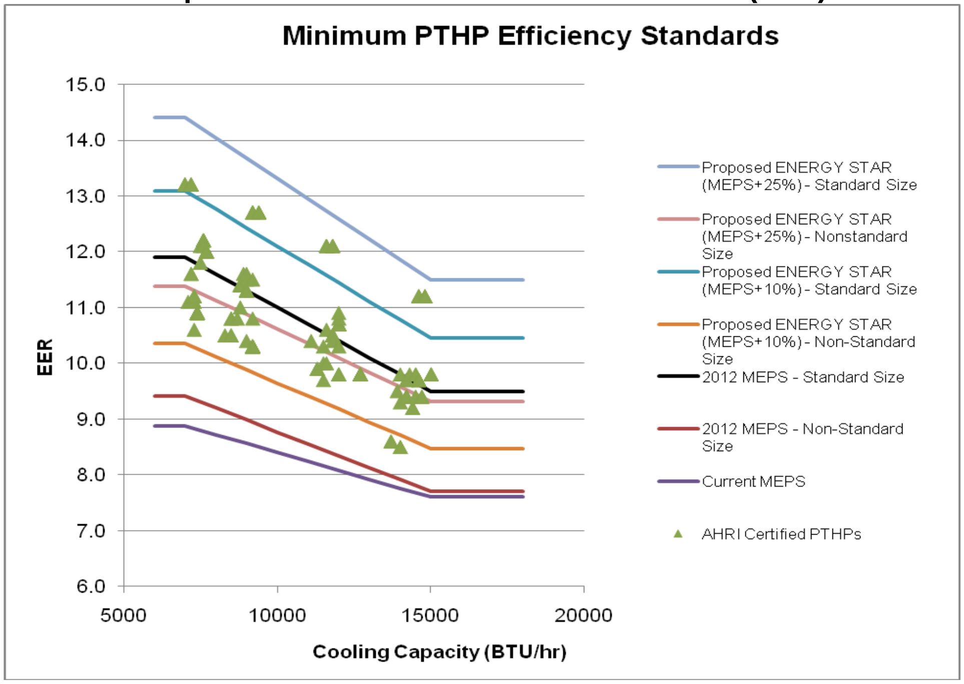
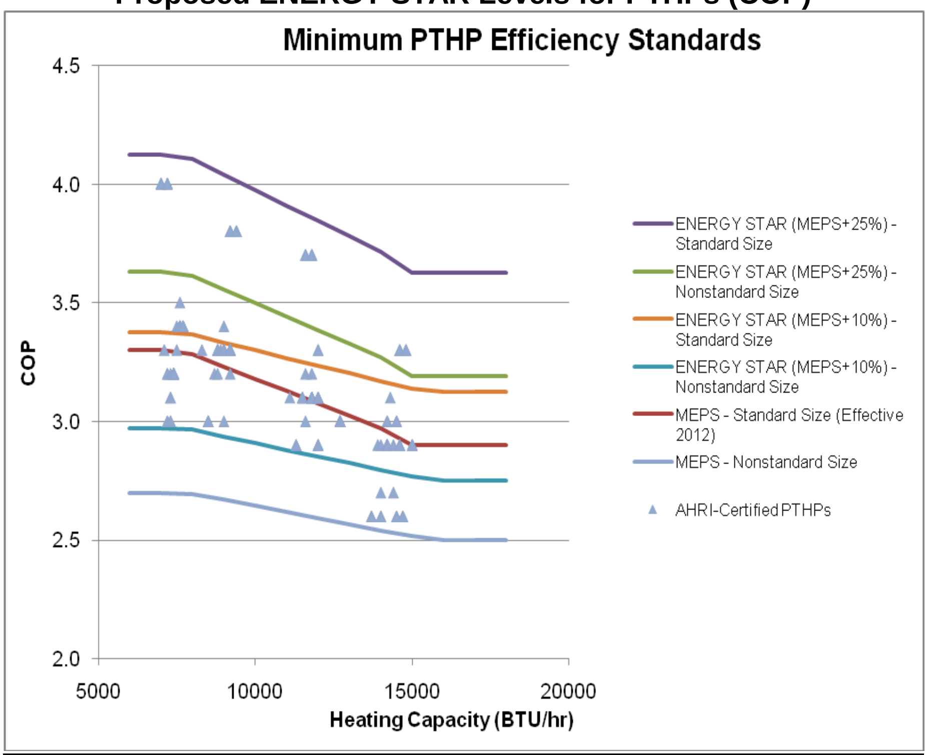


Figure 8: Federal Minimum Energy Performance Standards and Proposed ENERGY STAR Levels for PTHPs (COP)



As Table 7 below indicates, the only models the meet an ENERGY STAR level set 10% above the new federal MEPS for EER are manufactured by General Electric under its Zoneline brand. No models currently meet the 10% level for COP. Table 8 also shows that no models meet an ENERGY STAR level of 25% above the federal MEPS for either EER or COP.

Table 7: PTHP Models Compared to Proposed ENERGY STAR (MEPS+10% - Standard Size)

OEM	Eair	Friedrich	GE	Goodman	Gree	Heat Controller	LG	McQuay	Sanyo
Total Number of AHRI-Certified Models	**8**	**26**	**24**	**8**	**21**	**8**	**20**	**52**	**2**
Number that Meet Proposed EER Criteria	0	0	24	0	0	0	0	0	0
Number that Meet Proposed COP Criteria	None								

Table 8: PTHP Models Compared to Proposed ENERGY STAR (MEPS+25% - Standard Size)

OEM	Eair	Friedrich	GE	Goodman	Gree	Heat Controller	LG	McQuay	Sanyo
Total Number of AHRI-Certified Models	**8**	**26**	**24**	**8**	**21**	**8**	**20**	**52**	**2**
Number that Meet Proposed EER Criteria	None								
Number that Meet Proposed COP Criteria	None								

4. Energy and Cost Savings Potential

PTAC Energy Consumption Methodology

The electricity consumption of PTACs and PTHPs can be estimated using a bin temperature methodology for air conditioners and heat pumps outlined in ACCA's Manual J, Residential Load Calculation. Bin temperature data was taken from ACCA's Manual J, Residential Load Calculation.

From ACCA's Manual J, electricity consumption for space cooling can be measured using the following formula:

$$AEC = \frac{\sum Cooling\ Load * BinWeather}{SEER}$$

For this analysis, Seasonal Energy Efficiency Ratio (SEER) can be replaced with Energy Efficiency Ratio (EER). EER is rated cooling efficiency units provided by manufacturers and AHRI for PTACs and PTHPs.

PTHP Energy Consumption Methodology

The bin temperature method for estimating space heating energy consumption by PTHPs involves changes in efficiency of the heat pump as temperatures drop. The COP and electricity draw of heat pumps drops as the outside air temperatures drop. Additionally, supplementary resistance heating is engaged when temperatures drop below 35F. Time that the heat pump operates versus supplementary heating is a function of outside temperatures. The method for estimating annual electricity consumption for space heating and cooling can be estimated in the following manner:

$$AEC = HeatPumpEnergy_{(CoolingMode+HeatingMode)} + SupplementEREnergy$$

where

$$HeatPumpEnergy_{CoolingMode} = \sum\left(\frac{\frac{BinWeather * Load_{Building}}{3413}}{EER}\right)$$

$$HeatPumpEnergy_{HeatingMode} = \sum\left(\frac{\frac{BinWeather * Load_{Building}}{3413}}{COP}\right)$$

$$SupplementEREnergy = \sum(BinWeather * Power_{ResistanceHeat})$$

PTAC Savings Analysis[21]

The tables below show the Annual Electricity Consumption (AEC) and estimated savings by city for standard size PTACs. The AEC includes only energy for cooling. The "Federal Standard" column shows the maximum electricity that can be used by a PTAC. The "Proposed ENERGY STAR" column shows the electricity consumption of PTACs at the suggested ENERGY STAR criteria above the federal standard for standard-size equipment and without electric resistance heating. The "Savings/Unit" columns list the difference in dollars and kWh per year for each unit between "Federal Standard" and "Proposed ENERGY STAR".

As the tables below indicate, a proposed ENERGY STAR level of either 10% or 25% for standard-size equipment would result in long payback periods and low levels of energy and financial savings for

[21] Regional electricity prices are from EIA from ENERGY STAR 2011 Databook. Savings analysis is based on the assumption of a 9,000 BTU/hr average unit.

qualifying PTACs, except in climates such as Honolulu and Las Vegas that experience year-round warm weather. A level at 25% over the MEPS might be justified, but no manufacturers currently make such efficient equipment. (See tables 4 and 5.) As the market responds to the 2012 standards, that may change. In that case, an ENERGY STAR program for high efficiency PTACs may make sense.

Table 9: Energy and Financial Savings Associated With Proposed ENERGY STAR Level of MEPS+10% for Standard-Size PTACs

City	2012 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Estimated Energy Savings/Unit (kWh/yr)	Estimated Cost Savings/Unit ($/yr)	Payback (Years)
Atlanta	987	897	90	8	9.1
Chicago	627	570	57	4	16.9
Dallas	1,541	1,401	140	13	6.0
Kansas City	962	874	87	6	12.5
Honolulu	2,337	2,124	212	57	1.3
Houston	1,526	1,387	139	12	6.1
Miami	2,494	2,267	227	23	3.3
New Orleans	1,651	1,501	150	14	5.3
New York	442	402	40	6	11.9
Phoenix	1,692	1,539	154	13	5.7
San Francisco	127	116	12	1	57.5
Tampa	1,860	1,691	169	17	4.4
Washington	809	736	74	10	7.6
Las Vegas	2,522	2,292	229	22	3.5

Table 10: Energy and Financial Savings Associated With Proposed ENERGY STAR Level of MEPS+25% for Standard-Size PTACs

City	2012 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Estimated Energy Savings/Unit (kWh/yr)	Estimated Cost Savings/Unit ($/yr)	Payback (Years)
Atlanta	987	790	197	18	4.2
Chicago	627	502	125	10	7.7
Dallas	1,541	1,233	308	28	2.7
Kansas City	962	769	192	13	5.7
Honolulu	2,337	1,869	467	126	0.6
Houston	1,526	1,220	305	27	2.8
Miami	2,494	1,995	499	51	1.5
New Orleans	1,651	1,321	330	31	2.4
New York	442	354	88	14	5.4
Phoenix	1,692	1,354	338	29	2.6
San Francisco	127	102	25	3	26.1
Tampa	1,860	1,488	372	38	2.0
Washington	809	647	162	22	3.5
Las Vegas	2,522	2,017	504	47	1.6

The tables below show the Annual Electricity Consumption (AEC) and estimated savings by city for non-standard size PTACs. While shorter payback periods and energy and financial savings are more difficult to achieve with an ENERGY STAR level of 10% or 25% for standard size PTACs, savings associated with non-standard size units are greater in consistently warm climates such as Honolulu, Las Vegas, and southeastern US cities such as Tampa and Miami. Potential non-standard size ENERGY STAR units operating year round in these cities would also incur shorter payback periods than standard size units operating under the same conditions and in the same geographical locations. If data regarding the availability of non-standard PTACs at various efficiencies becomes available, they may be considered for labeling.

Table 11: Energy and Financial Savings Associated With Proposed ENERGY STAR Level of MEPS+10% for Non-Standard Size PTACs

City	2010 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Estimated Energy Savings/Unit (kWh/yr)	Estimated Cost Savings/Unit ($/yr)	Payback (Years)
Atlanta	1,218	1,107	111	10	7.4
Chicago	773	703	70	7	13.7
Dallas	1,901	1,728	173	16	4.9
Kansas City	1,186	1,078	108	10	10.1
Honolulu	2,882	2,620	262	25	1.1
Houston	1,882	1,711	171	16	4.9
Miami	3,076	2,796	280	26	2.6
New Orleans	2,036	1,851	185	17	4.3
New York	546	496	50	5	9.7
Phoenix	2,087	1,898	190	18	4.6
San Francisco	157	143	14	1	46.6
Tampa	2,295	2,086	209	20	3.5
Washington	998	907	91	9	6.2
Las Vegas	3,110	2,827	283	27	2.8

Table 12: Energy and Financial Savings Associated With Proposed ENERGY STAR Level of MEPS+25% for Non-Standard Size PTACs

City	2010 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Estimated Energy Savings/Unit (kWh/yr)	Estimated Cost Savings/Unit ($/yr)	Payback (Years)
Atlanta	1,218	974	244	22	3.4
Chicago	773	619	155	12	6.2
Dallas	1,901	1,521	380	34	2.2
Kansas City	1,186	949	237	16	4.6
Honolulu	2,882	2,306	576	155	0.5
Houston	1,882	1,505	376	34	2.2
Miami	3,076	2,461	615	62	1.2
New Orleans	2,036	1,629	407	38	2.0
New York	546	436	109	17	4.4
Phoenix	2,087	1,670	417	36	2.1
San Francisco	157	126	31	4	21.2
Tampa	2,295	1,836	459	46	1.6
Washington	998	798	200	27	2.8
Las Vegas	3,110	2,488	622	58	1.3

Potential PTAC National Savings

Based on unit shipment data referenced above, potential national energy savings levels associated with varying penetrations (10%, 25% and 100%) of ENERGY STAR qualified PTACs can be found in Tables 13-14 below.

Table 13: National Savings Associated With Proposed ENERGY STAR Level of MEPS+10% for Standard Size PTACs

Total ENERGY STAR Shipments (% Penetration)	AEC (kWh/yr)[22]			Annual Energy Savings (MWh/yr)
	2012 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Saving/Unit (kWh/yr)	
22,400 (10%)	1,398	1,271	127	2,848
56,000 (25%)				7,119
224,000 (100%)[23]				28,477

[22] All consumption figures in kWh are computed from the 14-city averages listed above.
[23] Assumption of 224,000 units based on 56% penetration of PTACs of a total PTAC/PTHP shipment population of 400,000 units

Table 14: National Savings Associated With Proposed ENERGY STAR Level of MEPS+25% for Standard Size PTACs

Total ENERGY STAR Shipments (% Penetration)	AEC (kWh/yr)			Annual Energy Savings (MWh/yr)
	2012 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Saving/Unit (kWh/yr)	
22,400 (10%)	1,398	1,119	280	6,265
56,000 (25%)				15,662
224,000 (100%)				62,649

PTHP Savings Analysis[24]

The tables below show the Annual Electricity Consumption (AEC) and estimated savings by sample city for standard-size PTHPs. The "Federal Standard" column shows the maximum electricity that can be used by a PTHP. The "Proposed ENERGY STAR" column shows the electricity consumption for PTHPs at the suggested ENERGY STAR criteria above the federal standard for standard size equipment and without electric resistance heating. The "Savings/Unit" columns list the difference in dollars and kWh per year for each unit between "Federal Standard" and "Proposed ENERGY STAR".

From the tables below, there is evidence that greater energy and financial savings (and reduced payback periods) are possible from potential ENERGY STAR qualified PTHPs than from similarly situated PTACs. These savings are more considerable in areas with year-round mild climates or mild winter seasons (San Francisco, Dallas) or more truncated summer heating seasons (New York, Washington). Particularly at MEPS + 25%, the payback is in line with ENERGY STAR principles. However, the number of models available at these higher efficiencies is small (see tables 7 and 8). If this changes as the market responds to the 2012 MEPS, this product category may be a good candidate for labeling.

[24] Regional electricity prices are from EIA from ENERGY STAR 2011 Databook. Savings data based on the assumption of a 1 ton (12,000 BTU/hr) average unit.

Table 15: Savings Associated With Proposed ENERGY STAR Level of MEPS+10% for Standard Size PTHPs

City	2012 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Estimated Energy Savings/Unit (kWh/yr)	Estimated Cost Savings/Unit ($/yr)	Payback (Years)
Atlanta	3,210	3,021	189	17	4.3
Chicago	8,205	8,073	132	10	7.3
Dallas	3,083	2,906	177	16	4.7
Kansas City	6,429	6,285	145	10	7.5
Honolulu	922	841	81	22	3.4
Houston	2,087	1,925	162	14	5.2
Miami	1,415	1,290	124	13	5.9
New Orleans	1,957	1,792	165	15	4.8
New York	5,493	5,304	189	30	2.5
Phoenix	2,518	2,311	207	18	4.3
San Francisco	4,801	4,381	420	47	1.6
Tampa	1,816	1,659	157	16	4.7
Washington	4,753	4,563	190	25	3.0
Las Vegas	3,196	2,973	223	21	3.6

Table 16: Savings Associated With Proposed ENERGY STAR Level of MEPS+25% for Standard Size PTHPs

City	2012 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Estimated Energy Savings/Unit (kWh/yr)	Estimated Cost Savings/Unit ($/yr)	Payback (Years)
Atlanta	3,210	2,781	429	39	1.9
Chicago	8,205	7,905	299	23	3.2
Dallas	3,083	2,681	402	36	2.1
Kansas City	6,429	6,101	328	23	3.3
Honolulu	922	737	184	50	1.5
Houston	2,087	1,719	367	33	2.3
Miami	1,415	1,132	283	29	2.6
New Orleans	1,957	1,582	374	35	2.1
New York	5,493	5,064	429	67	1.1
Phoenix	2,518	2,049	469	40	1.9
San Francisco	4,801	3,849	952	107	0.7
Tampa	1,816	1,459	357	36	2.1
Washington	4,753	4,322	432	58	1.3
Las Vegas	3,196	2,691	505	47	1.6

The table below shows the Annual Electricity Consumption (AEC) and estimated savings by city for non-standard size PTHPs. The findings for non-standard size equipment are similar to that of standard size equipment, however, it is clear that greater savings and shorter paybacks are possible for non-standard size units. If data regarding the availability of non-standard PTACs at various efficiencies becomes available, they may be considered for labeling.

Table 17: Savings Associated With Proposed ENERGY STAR Level of MEPS+10% for Non-Standard Size PTHPs

City	2010 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Estimated Savings/Unit (Proposed ENERGY STAR) (kWh/yr)	Estimated Savings/Unit (Proposed ENERGY STAR) ($/yr)	Payback (Years)
Atlanta	3,641	3,407	234	21	3.5
Chicago	8,505	8,341	163	13	5.9
Dallas	3,499	3,278	221	20	3.8
Kansas City	6,763	6,583	179	12	6.1
Honolulu	1,143	1,039	104	28	2.7
Houston	2,469	2,267	202	18	4.2
Miami	1,734	1,577	158	16	4.7
New Orleans	2,348	2,142	206	19	3.9
New York	5,915	5,681	233	36	2.1
Phoenix	3,000	2,743	257	22	3.4
San Francisco	5,719	5,202	516	58	1.3
Tampa	2,195	1,998	197	20	3.8
Washington	5,184	4,949	235	31	2.4
Las Vegas	3,712	3,435	277	26	2.9

Table 18: Savings Associated With Proposed ENERGY STAR Level of MEPS+25% for Non-Standard Size PTHPs

City	2010 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Estimated Savings/Unit (Proposed ENERGY STAR) (kWh/yr)	Estimated Savings/Unit (Proposed ENERGY STAR) ($/yr)	Payback (Years)
Atlanta	3,641	3,126	515	47	1.6
Chicago	8,505	8,145	359	28	2.7
Dallas	3,499	3,014	485	43	1.7
Kansas City	6,763	6,368	395	27	2.8
Honolulu	1,143	915	229	62	1.2
Houston	2,469	2,025	444	40	1.9
Miami	1,734	1,388	347	35	2.1
New Orleans	2,348	1,895	453	43	1.8
New York	5,915	5,401	514	80	0.9
Phoenix	3,000	2,435	565	48	1.6
San Francisco	5,719	4,583	1,136	128	0.6
Tampa	2,195	1,762	433	44	1.7
Washington	5,184	4,666	518	69	1.1
Las Vegas	3,712	3,103	609	57	1.3

Potential PTHP National Savings

Based on unit shipment data referenced above, potential national energy savings levels associated with varying penetrations (10%, 25% and 100%) of ENERGY STAR qualified PTHPs can be found in Tables 19-20 below. As with PTACs, the greatest potential level of energy savings can be found with increasing penetrations within the non-standard size markets at ENERGY STAR levels of both 10% and 25%.

Table 19: National Savings Associated With Proposed ENERGY STAR Level of MEPS+10% for Standard Size PTHPs

Total ENERGY STAR Shipments (% Penetration)	AEC (kWh/yr)[25]			Annual Energy Savings (MWh/yr)
	2012 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Saving/Unit (kWh/yr)	
17,600 (10%)	3,563	3,380	183	3,220
44,000 (25%)				8,049
176,000 (100%)				32,198

[25] All consumption figures in kWh are computed from the 14-city averages listed above.

Table 20: National Savings Associated With Proposed ENERGY STAR Level of MEPS+25% for Standard Size PTHPs

Total ENERGY STAR Shipments (% Penetration)	AEC (kWh/yr)			Annual Energy Savings (MWh/yr)
	2012 Federal Standard (kWh/yr)	Proposed ENERGY STAR (kWh/yr)	Saving/Unit (kWh/yr)	
17,600 (10%)	3,563	3,148	415	7,307
44,000 (25%)				18,267
176,000 (100%)				73,068