

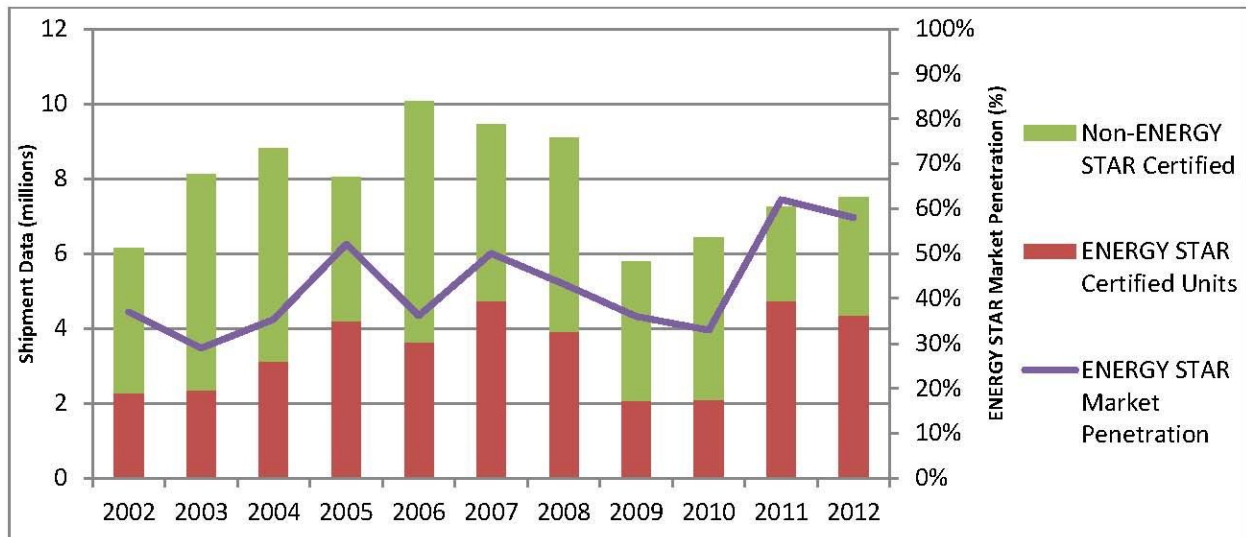


ENERGY STAR® Room Air Conditioners Framework Document November 2013

The U.S. Environmental Protection Agency (EPA) is evaluating energy savings for room air conditioners (ACs) that might be captured by a revision to the current ENERGY STAR Version 3.0 specification. The purpose of this Framework Document is to share EPA's initial thoughts on potential opportunities, outline areas where additional data and research is needed, and facilitate further discussions regarding the future of this ENERGY STAR product category. Stakeholders are encouraged to provide written comments to appliances@energystar.gov by December 9, 2013. Please direct any questions to Amanda Stevens, EPA, at stevens.amanda@epa.gov, 202-343-9106 or Jessica Lyman, ICF International, at jessica.lyman@icfi.com, 202-862-1557. Room AC test method questions should be directed to Ashley Armstrong, DOE, at Ashley.Armstrong@ee.doe.gov or (202) 586-6590.

Introduction

The Version 3.0 ENERGY STAR room ACs specification requires that products be at least 15 percent more energy efficient than the Federal standard in order to earn the ENERGY STAR. The specification covers window, through-the-wall, casement, slider-casement, and reverse-cycle room ACs (provided they do not include electric resistance heat). Sales of ENERGY STAR room ACs in the U.S. have grown steadily over the last decade with year-to-year fluctuations, while shipment-weighted energy use has declined by nearly 15% over this time period.



By 2012, nearly 60% of industry shipments were ENERGY STAR (Figure 1).

Figure 1: U.S. Room AC Shipment Trends.

Source: ENERGY STAR Unit Shipment Data, Appliance Magazine 2012 Industry Shipment Report

Amended room AC minimum efficiency standards set by the U.S. Department of Energy (DOE) will take effect in 2014. The new DOE standards are equal to, and in some cases more stringent than, the ENERGY STAR Version 3.0 specification levels. As a result, EPA is seeking input from manufacturers and other stakeholders on opportunities for further efficiency improvements to room ACs that could serve as the foundation for a revision to the ENERGY STAR Room AC specification. EPA summarizes these opportunities below and offers questions for further discussion. The Agency also welcomes stakeholder feedback on opportunities not captured below.

Efficiency Opportunities

Improved Installation Practices: Recently, the National Renewable Energy Lab (NREL) published a report highlighting opportunities for energy savings based on investigative testing of room AC field performance (*Laboratory Performance Testing of Residential Window Air Conditioners*).¹ Considered in tandem with findings from Urban Green Council's report *There Are Holes in Our Walls*,² there appears to be a significant opportunity for energy savings derived from improvements to window AC installation practices. Both research reports note that excessive energy use in home HVAC systems (both room ACs and winter heating systems) is due to compromised building envelopes, specifically: air infiltration between the window sashes and around or through the installed room AC, and thermal bridging as heat is conducted through the room AC itself. NREL concluded that improved installation of room ACs can reduce air leakage by 65-85% resulting in cooling energy savings of 5-10% in the field. These savings would not be recognized through the DOE room AC test procedure (10 CFR 430, Subpart B, Appendix F). To save energy, NREL suggests that homeowners with existing room ACs remove the manufacturer-provided accordion panels and replace them with rigid foam boards and tape all potential air infiltration pathways (material cost of < \$15).³

EPA believes that efficiency gains from improved installation could be considered in developing a Version 4.0 specification, as research has shown it provides measurable energy savings and would also provide improved performance/comfort for consumers. At this time, EPA is seeking input from stakeholders regarding this opportunity for energy savings. Additionally, EPA welcomes stakeholder feedback on potential ENERGY STAR certification criteria that would differentiate room ACs that enable more energy efficient installation. For example, requiring that additional materials and instructions be provided by the manufacturer in the box and/or modified product designs that facilitate more energy-efficient installation.

Questions for Discussion:

- 1.) Are the NREL's findings of 5-10% energy savings from better installation consistent with other stakeholders' experience?

There would be some improvement with better installation; can NREL share the data of the finding?

- 2.) What are some of the ways manufacturers could design/package room ACs to improve installation quality for all window types? What installation materials/accessories would be practical for manufactures to include with a room AC, considering the variety of window types/sizes that a given room AC may be installed in? How can installation quality be improved while ensuring room ACs continue to be simple for consumers to install?

We provide different side curtains, sealing foams, installation kits for user to install a room AC for different size room AC. We are considering developing better heat insulation curtains, keeps the installation simple and with improvement.

- 3.) What tools do manufacturers and retailers currently use to educate consumers about installation? How might EPA support further customer engagement and education on installation, either through product packaging requirements, website resources, and/or other means?

We have installation manual to educate consumers. These can be found with the unit, also on the website. We're planning to have professional writer to overwrite the installation manual for better understanding from consumer.

Component Improvements: During the last room AC Federal standard rulemaking process in 2009, DOE conducted research, analysis and manufacturer outreach to assess room AC technology and possible energy efficiency improvements. This effort was concurrent with the industry transition from R-22 to other refrigerant options listed by the EPA Significant New Alternatives Policy (SNAP) program. Following this transition, most room ACs sold in the U.S. today use R-410A, a hydrofluorocarbon (HFC) blend with low ozone depletion but high global warming potential (GWP).

The information captured in the last DOE Technical Support Document (TSD) depicted that efficiency gains beyond

the levels ultimately adopted by DOE for 2014, for R-410A based systems, were not cost effective. However, DOE had also noted that R-410A room AC compressor availability was limited during that time period (with compressors efficiency topping out at 10.0 EER as opposed to 11.0 EER for models with R-22 compressors). With ongoing testing and the potential development of higher efficiency compressors, EPA is seeking additional feedback as to

Technology	Potential Areas of Stakeholder feedback
Heat Exchangers	<ul style="list-style-type: none"> - Cost versus efficiency improvements of microchannel coils - Grooving variations' impact on energy efficiency? - Impact to dehumidification? - Tradeoffs to efficiency: size, product cost, storage & transportation costs?
Compressor	<ul style="list-style-type: none"> - Variable speed compressor cost and efficiency characterization¹
Fan Blower Improvements/Airflow	<ul style="list-style-type: none"> - Tradeoffs to efficiency: noise? - Impact to dehumidification?

whether higher efficiency R-410A compressors are now available and whether stakeholders have identified new cost-effective improvement opportunities for R-410A based systems.

EPA is also interested in any additional data on potential efficiency improvements from higher-efficiency room AC components such as the ones listed in the table below, associated incremental costs, any ancillary benefits associated with improving efficiency and any potential performance tradeoffs.

Microchannel coils requires larger size of heat exchangers, it is not suitable for current window AC. Grooving variation dose impact the energy efficiency, suitable grooving could help get better performance. Variable speed compressor requires large area to place, and special module to control, based on current size of window AC, only the largest one could try variable speed compressor, the cost up with variable speed compressor will be around \$100. We keep working on the improvement of fan blower every year, larger airflow will help get better efficiency but too big noise, so it's not easy to find the balance between airflow and noise.

Note: Energy savings from variable speed technology is not captured under Appendix F

In addition to efficiency gains that will captured in the current room AC energy test method (Appendix F), EPA is also interested in understanding if there are cost-effective opportunities that would not be captured under the current test method.

If applicable, DOE and EPA also welcome input as to how other existing industry test methods may be leveraged or modified—creating an additional, separate test from Appendix F—to capture efficiency impacts from these component changes. Additionally, EPA welcomes stakeholder feedback on component technology not captured in the table above.

Reducing Evaporator Recirculation: As noted earlier, the National Renewable Energy Lab (NREL) published a report highlighting opportunities for energy efficiency improvement based on investigative testing: *Laboratory Performance Testing of Residential Window Air Conditioners*. Through testing of commercially available and modified room ACs designed to reflect field conditions, NREL demonstrated that evaporator air recirculation can reduce energy efficiency of installed products by as much as 10%. Modified product designs, such as inverting the interior components (locating the evaporator supply at the bottom of the unit) and/or supplying an attachment fin to separate the supply and return airflows, were suggested by NREL as options for reducing the amount of conditioned air that is drawn-in and recirculated over the evaporator coil.

Questions for Discussion:

- 1.) The NREL testing was designed to reflect field operation of room ACs and was not carried out at the

standard rating conditions in the DOE room AC test (Appendix F). EPA is interested in stakeholder feedback on NREL's findings, in particular whether efficiency gains from designs intended to prevent recirculation would be measured under the DOE room AC test in Appendix F.

- 2.) What feedback do stakeholders have on the design modifications suggested by NREL? What additional design changes would prevent recirculation from occurring? What, if any, tradeoffs are associated with these design changes?

Reduce the evaporator recirculation will reduce the energy consume, but also will reduce the capacity, these need to be a balance between these two. Can NREL share the data of their finding, like what's cooling capacity, EER, airflow before and after reduce the evaporator recirculation.

We add some tube at bottom of the unit on some window AC platform for better efficiency, based on our test data tubes with fins at bottom of the unit didn't show better performance than without fins. Also, we have partial lower bottom pan for MS2 platform will help get better efficiency.

New Refrigerants: Due to the high GWP of HFCs used globally for HVAC products, hydrocarbon (HC) based refrigerants (e.g., propane and isobutane) are being explored for various applications including unitary AC equipment.⁴ Gree began manufacturing R290 ACs in 2011⁵ and cited a 15% energy savings Over a conventional unit⁶ and performance that exceeded the "A" rating for the EU efficiency label. Last year Godrej & Boyce introduced a new production line for split and window ACs with R290, with units for sale in several cities in India. They specified that a typical 1.5 ton split unit AC would use at least 23% less energy than current top of the line, 5-star models in India.⁷ Stakeholder comments submitted during the Version 3.0 ENERGY STAR room AC specification development process reviewed technical papers and found that in 90% of cases, HCs offered higher efficiency than non-HCs.⁸ Since there are no HC refrigerants currently approved for use in room ACs sold in the U.S., DOE's previous rulemaking analysis did not examine efficiency impacts of these refrigerants.

Given the high GWP potential of HFCs such as R-410A, as the policy landscape changes,⁹ the ENERGY STAR program is interested in additional stakeholder feedback on the potential energy savings associated with room ACs that use lower GWP refrigerants. Particularly, EPA is seeking additional energy efficiency data as well as information on the status of addressing safety considerations, technical challenges and performance considerations. EPA encourages manufacturers to share any plans to introduce room ACs with low GWP refrigerants to the U.S. market.

Questions for Discussion:

- 1.) What alternate refrigerants are being considered for U.S. room ACs and on what timelines? What impact will they have on room AC energy efficiency? How, if at all, is the alternative refrigerant landscape expected to change in the near future?
- 2.) What is the latest cost differential, if any, currently associated with the use of low GWP refrigerants? How is this expected to change in future years?
- 3.) What is the status of designs that address the technical challenges for room AC design associated with certain lower GWP refrigerants (e.g., flammability, toxicity)? What are some examples of necessary designs? What, if any, tradeoffs are associated with such design changes?
- 4.) What industry standards do manufacturers follow when manufacturing room ACs for the U.S. (e.g., UL, IEC, ISO, etc.)? Are there any provisions of these standards that, for practical purposes, may limit the use of new refrigerants in room ACs?

1> We tried R32 refrigerant before on US room ACs in 2011, this will help improve the energy efficiency, but this is flammable refrigerant. R290 refrigerant has charging qty requirement since it's easily exploded, so will be used on small unit like dehumidifier

2> Currently, price of new refrigerant R32, R290 is similar to R410A

3> The refrigeration system with new refrigerant are not difficult to design, the problem is the flammability of the R32, and explosive of R290, and also the compressor design with these new refrigerant.

4> US room AC, we use UL standard, even product could pass the UL standard, these're no safety rules for transportation, storage of this kind of unit, we're afraid this refrigerant won't be able to be largely used.

Connected Functionality

A placeholder for connected criteria was included in the Version 3.0 ENERGY STAR Room AC specification. Due to timing of Version 3.0 specification, EPA was unable to incorporate connected criteria into this specification, but would plan to incorporate optional connected criteria, including an allowance (for products certified using a TBD

ENERGY STAR test method for demand response), in a Version 4.0 specification. As with other product specifications where connected criteria have been developed, EPA would tailor key elements to capture the energy management, consumer convenience/control, and load control opportunities unique to room ACs.

EPA is aware that room ACs with communication capabilities are beginning to be introduced to the market.¹⁰ There has also been at least one utility sponsored room AC demand response pilot program (Con Edison) that used an add-on communication device, the ThinkEco Modlet.¹¹ Considering both room ACs with manufacturer-provided built-in communications and aftermarket add-on communication devices are available, EPA is interested in better understanding how stakeholders anticipate the market will evolve and how ENERGY STAR might best support and recognize the energy savings, convenience/comfort and demand responsiveness opportunities that new communication capabilities can enable for room ACs.

We're working on room AC with wifi function, which could be controlled through internet while people are not at home, this will help reduce the waste of energy when no one's in the room, and also more convenient for people to set their AC before going home.

Is there any EER buffer for unit with wifi function, could be 10% lower to ES EER or some percent?

By the way, is there detail definition for "Connected Functionality"?

Potential to Include Portable ACs: EPA is aware that the U.S. market for portable ACs has been growing; shipments of portable ACs were estimated to be nearly 1 million units in 2012. Portable ACs are unitary, refrigeration-based products that provide room cooling and dehumidification. They are designed for both residential and commercial spaces and typically have wheels, allowing them to be easily moved to provide focused cooling where it is desired.¹² DOE has recently published a notice of proposed coverage in July 2013 that proposed covering portable ACs under the Energy Policy Conservation Act. If DOE issues a final determination that portable ACs are a covered product, DOE may then also develop a test procedure and standards for this product.¹³

EPA welcomes stakeholder feedback that will help the Agency assess the efficiency opportunity associated with expanding the ENERGY STAR program in the future to include portable ACs once a DOE or ENERGY STAR test procedure is available. EPA anticipates this would be a follow-up effort to a Version 4.0 specification development process.

Questions for Discussion:

- 1.) What is the relationship between room ACs and portable ACs in the market?
- 2.) Could portable ACs be rated/tested such that consumers could compare capacity and efficiency with stationary room ACs?
- 3.) If so, would it make sense to include portable ACs under the room AC ENERGY STAR spec in the future?

1> Room Acs are fixed unit, portable AC is movable, portable AC does better on spot cooling, window Ac dose better on whole room cooling.

2> Currently, there's three standard for portable AC, ASHARE, AHAM and C370, we don't know which standard you're pointed to, unless DOE publish the test standard.

3> Since Portable Acs do not have same heat exchange efficiency as Room Acs, it doesn't make sense to include portable AC under the room AC ENERGY STAR spec in the future.

Remark: Singe hose portable exchange heat within one room, does not have heat exchange with outdoor environment.

Next Steps

Stakeholders are encouraged to provide feedback on the concepts presented in this document and identify other areas for consideration in developing a Version 4.0 specification. Following EPA review of stakeholder feedback on this framework document, EPA will engage with stakeholders on next steps.

If the new ES standard (Version 4.0) published, all the room AC need to raise EER which will lead to cost up obviously, this is both cost adder to end user and manufacture, can there be any bonus form Federal for either consumer or manufacture like what split unit have been doing, and last the policy for several years.