Appliance Standards Awareness Project
Alliance to Save Energy
American Council for an Energy-Efficient Economy
Natural Resources Defense Council
Northeast Energy Efficiency Partnerships
Northwest Energy Efficiency Alliance

December 22, 2014

Ms. Brenda Edwards
U.S. Department of Energy
Building Technologies Program
Mailstop EE-5B
1000 Independence Avenue, SW
Washington, DC 20585

RE: Docket Number EERE–2013–BT–STD–0007/ RIN 1904–AC95: Notice of Proposed Rulemaking for Small, Large, and Very Large Air-Cooled Commercial Package Air Conditioning and Heating Equipment

Dear Ms. Edwards:

This letter constitutes the comments of the Appliance Standards Awareness Project (ASAP), Alliance to Save Energy (ASE), American Council for an Energy-Efficient Economy (ACEEE), Natural Resources Defense Council (NRDC), Northeast Energy Efficiency Partnerships (NEEP), and Northwest Energy Efficiency Alliance (NEEA) on the notice of proposed rulemaking (NOPR) for small, large, and very large air-cooled commercial package air conditioning and heating equipment. 79 Fed. Reg. 58948 (September 30, 2014). We appreciate the opportunity to provide input to the Department.

DOE has proposed strong standards for commercial air conditioners and heat pumps that would achieve very large energy savings for the nation and electricity bill savings for customers. DOE estimates that the proposed standards would save almost 12 quads of energy over 30 years of sales and yield life-cycle cost savings for customers of $3,500 to $16,500.[1] However, DOE's analysis shows that the max-tech levels would achieve 40% greater national energy savings compared to the proposed standards as well as higher life-cycle cost savings for customers.[2] As we describe below, there are large gaps between the proposed standard levels (EL 3) and the max-tech levels (EL 4). We encourage DOE to evaluate additional efficiency levels between EL 3 and EL 4 and to consider adopting higher levels than those proposed in the NOPR.

We support DOE's proposal to replace EER with IEER. While ideally DOE could retain the EER standards while adding IEER, we believe that in terms of a single metric, IEER better reflects annual energy consumption than EER since a commercial air conditioner or heat pump

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[1] 79 Fed. Reg. 58950.
[2] 79 Fed. Reg. 59000, Table V.12, comparing national energy savings at TSLs 3 and 4; 79 Fed. Reg. 58993-94, Tables V.2-V.4, comparing mean LCC savings at TSLs 3 and 4.

rarely operates at full load. Using IEER as the metric for energy conservation standards will encourage the adoption of technologies that can provide huge efficiency gains in part-load performance. We also note that DOE's analysis for the NOPR found that EER levels are likely to increase as IEER increases since several of the potential technology options including larger heat exchanger areas and higher efficiency fans and fan motors would increase both EER and IEER.[3]

We urge DOE to evaluate intermediate efficiency levels between EL 3 and EL 4. Table 1 below shows the IEER levels proposed in the NOPR (EL 3) and the max-tech levels (EL 4) for air conditioners. There are large gaps between the IEER levels at EL 3 and EL 4, ranging from 2 IEER points for very large equipment (≥240,000 and <760,000 Btu/h) up to 5 IEER points for small equipment (≥65,000 and <135,000 Btu/h).

Table 1. IEER levels proposed in the NOPR (EL 3) and max-tech levels (EL 4) for air conditioners.

Cooling Capacity (Btu/h)	Heating Type	IEER	
		NOPR (EL 3)	Max-Tech (EL 4)
≥65,000 and <135,000	Electric resistance or no heating	14.8	19.9
	All other types of heating	14.6	19.7
≥135,000 and <240,000	Electric resistance or no heating	14.2	18.4
	All other types of heating	14.0	18.2
≥240,000 and <760,000	Electric resistance or no heating	13.5	15.5
	All other types of heating	13.3	15.3

As shown in the graphs in the Appendix, there are models at various IEER levels available between EL 3 and EL 4 across the equipment classes. As noted above, DOE found that the max-tech levels would provide greater life-cycle cost savings for customers than the proposed levels. We would expect that levels between EL 3 and EL 4 would also provide large life-cycle cost savings for customers while achieving greater national energy savings than the proposed standards.

We urge DOE to reevaluate the max-tech levels. Table 2 below shows the max-tech levels (EL 4) for each of the air conditioner equipment classes compared to the maximum available IEER levels based on models in the AHRI directory. For each equipment class, the maximum available efficiency levels are higher than the max-tech levels, in some cases by more than 2 IEER points.

[3] See Figures 5.6.22, 5.6.23, and 5.6.24 in the Technical Support Document.

Table 2. Max-tech levels (EL 4) compared to maximum available IEER levels for air conditioners.

Cooling Capacity (Btu/h)	Heating Type	IEER	
		Max-Tech (EL 4)	Max Available[4]
≥65,000 and <135,000	Electric resistance or no heating	19.9	21.5
	All other types of heating	19.7	21.5
≥135,000 and <240,000	Electric resistance or no heating	18.4	20.1
	All other types of heating	18.2	20.1
≥240,000 and <760,000	Electric resistance or no heating	15.5	18.3
	All other types of heating	15.3	17.8

As shown in the graphs in the Appendix, in each equipment class there are multiple models at different capacities with IEER levels that exceed the max-tech levels. We also note that the it may be possible to achieve higher efficiency levels than the maximum available efficiency levels since models that represent the maximum available efficiency levels may not incorporate all potential technology options.

We encourage DOE to ensure that the technology options are properly ordered in developing the cost-efficiency curves. Figures 1 and 2 below show the cost-efficiency curves for small and large equipment, respectively. For both small and large equipment, the slope of the cost-efficiency curve going from EL 3 to EL 4 is significantly less steep than the slope of earlier efficiency increments. For example, for small equipment, the cost of going from EL 1 to EL 2 is almost identical to the cost of going from EL 3 to EL 4, yet going from EL 1 to EL 2 only represents an increase of 1.1 IEER points, while going from EL 3 to EL 4 represents an increase of more than 5 IEER points. Similarly, for large equipment, the increase in IEER going from EL 3 to EL 4 (4.2 points) is larger than the increase in IEER going from the baseline to EL 3 (3 points) and yet the incremental cost going from the baseline to EL 3 is almost four times larger than the incremental cost to go from EL 3 to EL 4.

[4] Based on models in the AHRI directory as of September 24, 2014. "SP-A" models were used to represent the "electric resistance or no heating" equipment classes and "SPY-A" models were used to represent the "all other types of heating" equipment classes.

Figure 1. Cost-efficiency curve for small equipment (≥65,000 and <135,000 Btu/h).[5]

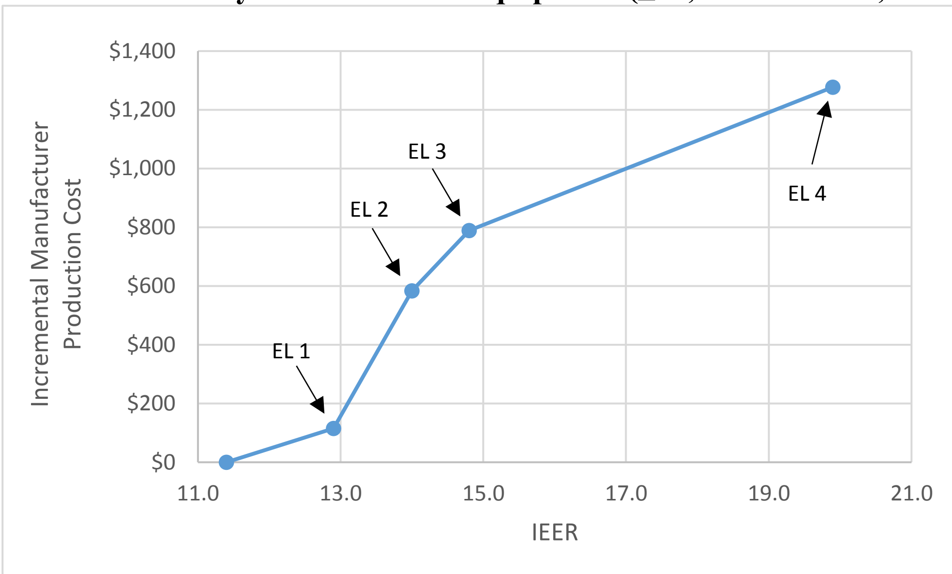
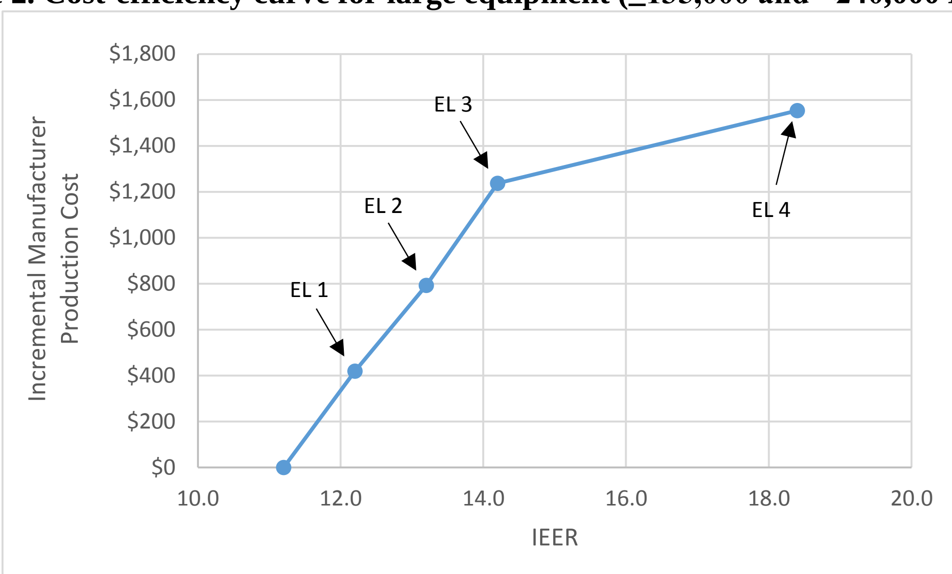


Figure 2. Cost-efficiency curve for large equipment (≥135,000 and <240,000 Btu/h).[6]



We note that equipment on the market today with IEER levels above the baseline levels may not necessarily incorporate the most cost-effective technology options for reaching those higher efficiency levels. In particular, since the current efficiency metric for DOE standards is EER, many models on the market today may be optimized for EER rather than IEER. DOE's engineering analysis must reflect the least-cost suite of technology options for reaching each efficiency level regardless of whether products on the market today incorporate those same combinations of technology options.

[5] Technical Support Document. p. 5-49. Table 5.6.9.
[6] Technical Support Document. p. 5-49. Table 5.6.10.

We encourage DOE to consider microchannel heat exchangers for small and large equipment in the engineering analysis. DOE considered microchannel heat exchangers as a technology option,[7] and the technical support document (TSD) notes that there are products on the market that utilize microchannel heat exchangers for small, large, and very large equipment.[8] However, while microchannel heat exchangers are incorporated in the outdoor coils at each of the efficiency levels in the engineering analysis for very large equipment,[9] microchannel heat exchangers are not included at any level for small and large equipment.[10] As DOE notes in the TSD, microchannel heat exchangers can increase heat transfer while reducing pressure drop.[11] Microchannel heat exchangers can also allow for reductions in heat exchanger size, potentially leading to cost savings. For example, DOE found that the heat transfer area for the outdoor coil of the 30-ton representative unit is actually smaller than that of both the 7.5- and 15-ton representative units due to the fact that the 30-ton unit utilizes a microchannel condenser coil.[12]

DOE's approach for the energy use analysis is appropriate. At the public meeting on November 6, several manufacturers suggested that the energy use analysis should not capture supply fan savings outside of cooling mode. While IEER captures the performance of commercial air conditioners and heat pumps only in cooling mode, the energy use analysis must reflect the annual energy use of the equipment, which includes energy use in heating and ventilation modes in addition to cooling mode. Since higher-efficiency and variable-speed supply fans achieve energy savings outside of cooling mode in addition to savings in cooling mode, the energy use analysis must capture all of these savings at efficiency levels that are based on improved supply fan efficiency. Therefore, DOE's approach for the energy use analysis, which incorporates energy savings in all modes of operation, is appropriate.

We believe that DOE has overestimated the impact of higher efficiency levels on shipments. DOE projects that at the proposed efficiency levels, cumulative shipments would decrease by 22.8%.[13] DOE's estimates of the impact of higher efficiency levels on shipments are based on a repair/replace decision model which incorporates the assumption that when a unit's compressor fails, the customer has the option of either repairing the unit by installing a new compressor or purchasing a new unit.[14] DOE estimates that 20% of commercial air conditioning equipment is purchased for the new construction market,[15] where customers by definition do not face a repair/replace decision, which means that DOE's shipment projections show that cumulative shipments of units for the replacement market would decrease by 28.5% at the proposed efficiency levels.[16]

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[7] Technical Support Document. p. 4-3.
[8] Technical Support Document. p. 5-29.
[9] Technical Support Document. p. 5-44.
[10] Technical Support Document. pp. 5-37, 5-40.
[11] Technical Support Document. p. 3-16.
[12] Technical Support Document. p. 5-48. Figure 5.6.26.
[13] 79 Fed. Reg. 58999.
[14] 79 Fed. Reg. 58982.
[15] Technical Support Document. p. 6-3.
[16] If the projections show that total shipments would decrease by 22.8%, and shipments to the replacement market make up 80% of total shipments, the decrease in shipments to the replacement market is 22.8% / 0.8 = 28.5%.

We are concerned that the data on which the repair/replace decision model is based are not appropriate nor sufficient and are resulting in model outputs that are overestimating the impact of higher efficiency levels on shipments. The data for the repair/replace decision model are from only three years and are from 15 years ago (1999-2001). Further, the data are not in fact data on repair/replace decisions, but rather data on the market share and cost of models at different efficiency levels.[17] A customer's decision about whether to repair or replace a unit when the unit fails is far more complex than the decision of whether to purchase a baseline model or a higher-efficiency model. We do not believe that limited data on market share and cost of baseline and higher-efficiency units is sufficient to adequately model repair/replace decisions.

In addition, DOE's repair/replace model assumes that replacing the compressor extends the lifetime of the unit for another lifetime,[18] or 18.4 years on average.[19] We do not believe that this assumption reflects reality since there are a variety of components that could fail well before the new compressor fails including fan motors, fan wheels, heat exchangers, control systems, and actuators for dampers. As a unit reaches or extends past its useful lifetime, cascading failures can result in expensive repairs. If a compressor replacement could actually extend the lifetime of a unit by another 18.4 years on average,[20] it would seem likely that customers would almost always choose to repair rather than replace their units. Further, the assumption that a compressor repair extends the life of a unit for another lifetime would mean that units would routinely last for 36 years or more. However, DOE's survival function used to develop the distribution of lifetimes predicts that less than one-half of one percent of units last more than 22 years.[21]

DOE emphasizes in the NOPR that the repair/replace decision is very sensitive to the installed cost of new equipment.[22] However, if many or most customers are in fact very sensitive to first cost, we would expect that these customers would *already* be choosing to repair rather than replace their equipment since repairing their equipment should always be the less expensive option. Therefore, it is not clear to us that the model is appropriately capturing the *incremental* impact of higher efficiency levels on customer decisions to repair rather than replace their units.

Finally, we believe that DOE's repair/replace model is failing to capture a number of complex factors affecting purchase and repair decisions including the following:

- At least some major manufacturers offer leasing options for new equipment, which may include no upfront costs.[23] Manufacturer financing provides an option for customers to replace their units who ordinarily may not have the capital to do so and minimizes the impact of any increase in equipment price.

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[17] Technical Support Document. p. 9-2.
[18] Technical Support Document. pp. 9-2, 9-3.
[19] Technical Support Document. p. 8-21.
[20] Technical Support Document. p. 8-21. DOE estimates that the average lifetime of 18.4 years.
[21] Technical Support Document. p. 8-21. P(23) = 0.4%.
[22] 79 Fed. Reg. 58999.
[23] See, for example: http://www.lennoxcommercial.com/pdfs/Lennox_Planned_Replacement_Owner.pdf; http://www.trane.com/content/dam/Trane/Commercial/global/markets/retail/Retail/RTL-SLB004-EN.PDF.

- The repair/replace decision model does not appear to account for the portion of units that are replaced before failure. In these cases, since the customer is choosing to replace the unit before failure, the repair/replace decision does not apply.
- In some cases a customer may choose to repair rather than replace their unit primarily because they need to have the unit back on line quickly and repairing the unit is the faster option. In other cases a customer may choose to repair their unit because there are plans to retrofit the building's complete HVAC system in the near future and it does not make sense to purchase a new unit that would only be in operation for a few years. In these cases, the price difference between repairing and replacing the unit is not the key consideration.
- Many existing units use R-22 as the refrigerant. Since R-22 is being phased out, it will become more expensive to service and repair these units in the future. It is likely that customers with existing R-22 units will be more likely to replace rather than repair their units compared to customers with existing R-410A units since the cost to repair and maintain R-22 units will increase.
- As noted above, while DOE's repair/replace model assumes that the compressor is the only component that fails and that replacing the compressor extends the life of the unit for another lifetime,[24] in reality there are a variety of components that could fail. When deciding whether to replace the compressor or replace the whole unit, the customer must take into account that if they choose to replace the compressor, something else may cause the unit to fail well before the new compressor fails. In reality, the value of repairing a unit is not equivalent to the value of replacing the unit since the additional lifetime that comes with a repair may be very uncertain and on average will be shorter than the lifetime of a new unit. DOE should model a range of lifetimes for repaired units, with the average lifetime shorter than the lifetime of a new unit, rather than assuming that a compressor replacement will extend the life of the unit for another lifetime.

In sum, there are many factors that affect when customers choose to make equipment purchases and decisions about whether to repair or replace failed equipment, and many of these decisions are either unrelated to the price of new units or will not be impacted by a modest increase in the price of new units. Combined with the fact that price-sensitive customers are likely *already* choosing to repair rather than replace their units since repairing a unit is the cheaper option, we believe that DOE has overestimated the impact of higher efficiency levels on shipments.

We encourage DOE to attempt to capture price trends of technologies that can improve the efficiency of commercial air conditioners and heat pumps. For the analysis for the NOPR, DOE applied constant equipment price trends because the PPI index for "unitary air conditioners, except heat pumps" has been flat since 2004.[25] While the incorporation of equipment price trends (when trends are evident) is a significant improvement over the approach of assuming constant price trends, analyzing price trends of whole categories of equipment fails to capture the price trends of the actual technologies that are employed to improve efficiency. We would expect the prices of technologies used in high-efficiency equipment to decline much faster than the total

[24] Technical Support Document. pp. 9-2, 9-3.
[25] Technical Support Document. p. 8-11.

price of the equipment. In the case of commercial air conditioners and heat pumps, we would expect the prices of brushless permanent magnet fan motors and variable-speed supply fans, for example, to decline faster than the total price of the equipment. In the recently issued preliminary TSD for ceiling fans, DOE adopted a component-based approach to price learning and incorporated a price trend for the electronic controls for DC motors, which is one of the technologies that can improve ceiling fan efficiency.[26] We encourage DOE to attempt to utilize a similar component-based price learning approach for commercial air conditioners and heat pumps.

We encourage DOE to require reporting of the EER values at each of the four IEER test points. In order for utilities and other efficiency program administrators to accurately estimate annual energy savings from higher-efficiency commercial air conditioners and heat pumps, it is important to have not just the IEER ratings of equipment but the efficiency ratings at various part-load operating points. We encourage DOE to require reporting of the EER values at each of the four IEER test points and to include this information in the Certification Compliance Database.

Thank you for considering these comments.

Sincerely,

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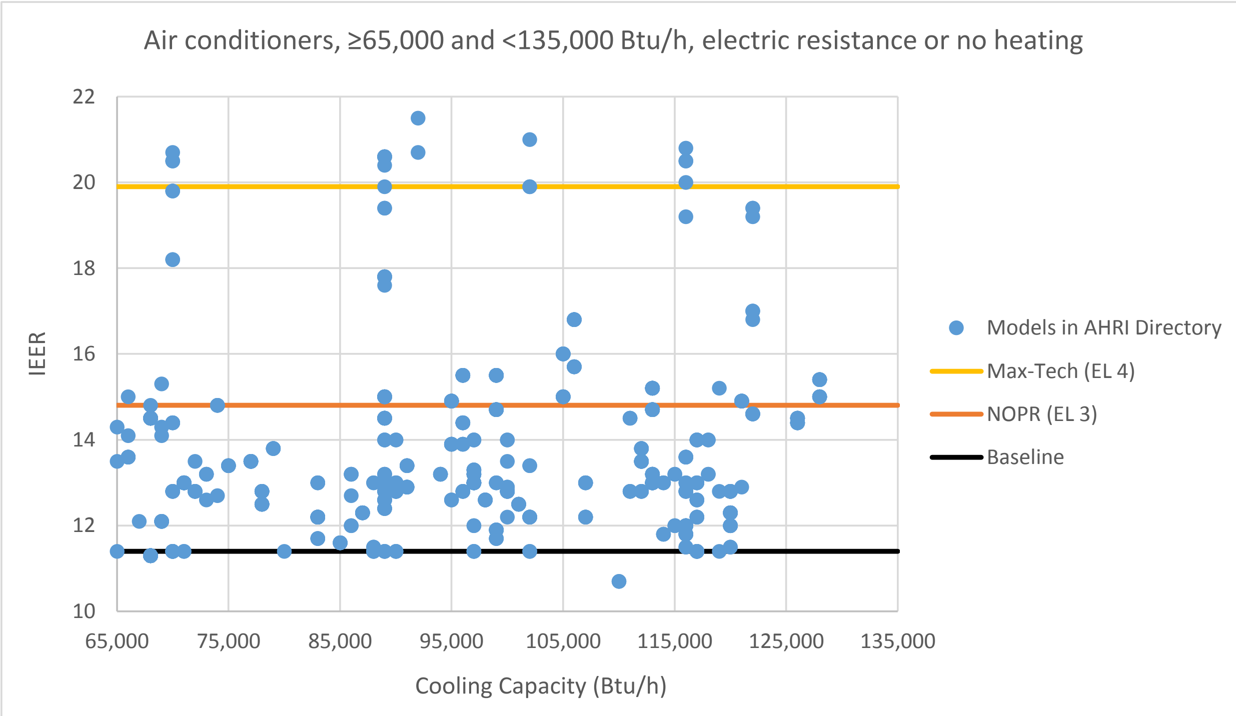
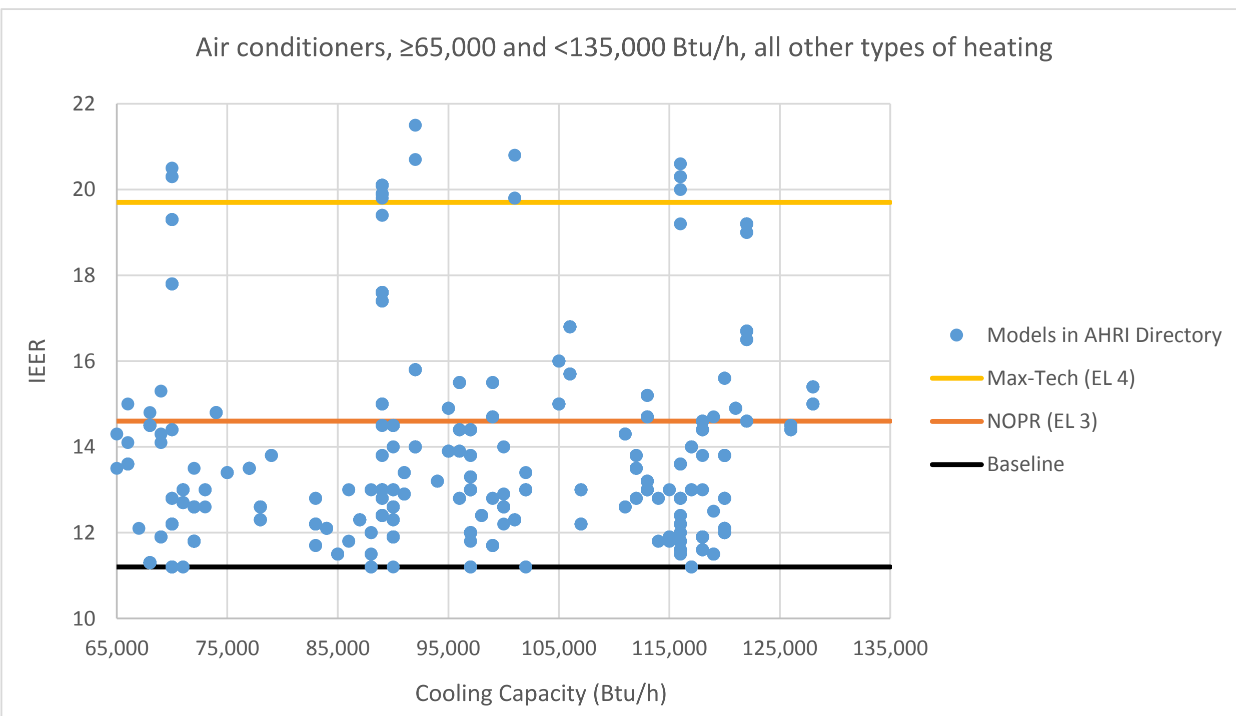
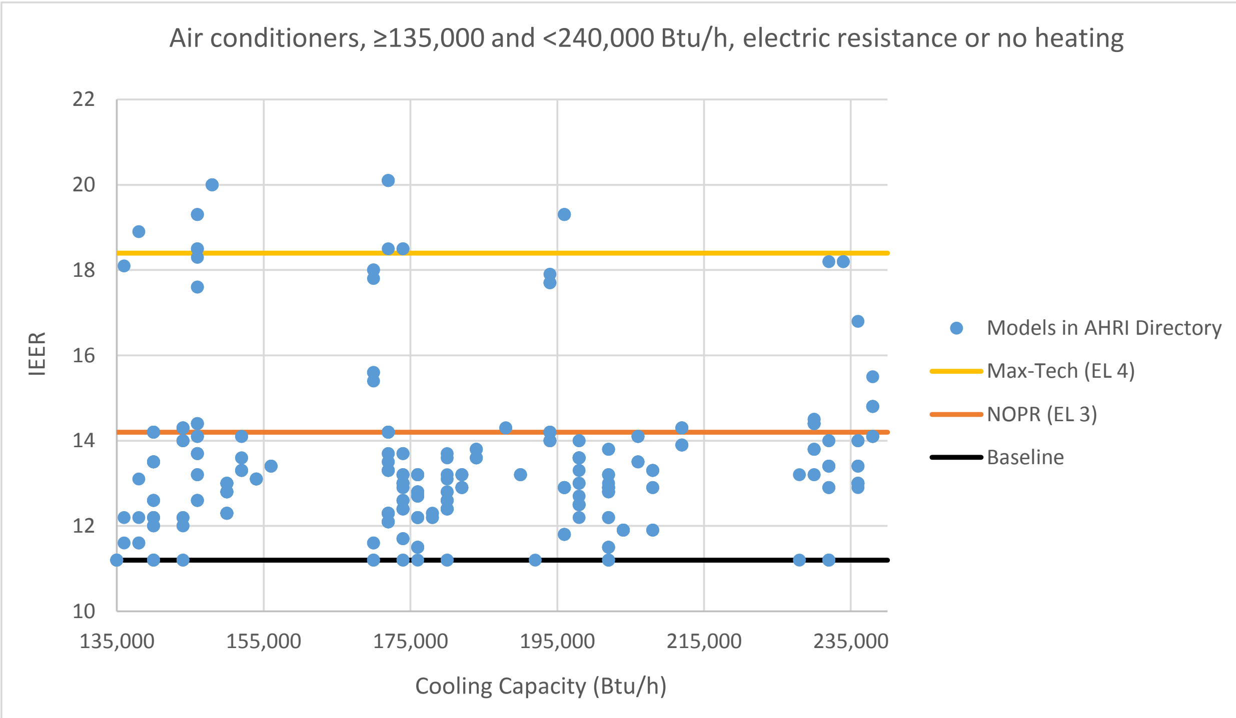
[26] Ceiling Fans Preliminary Technical Support Document. pp. 8-9, 8-10.

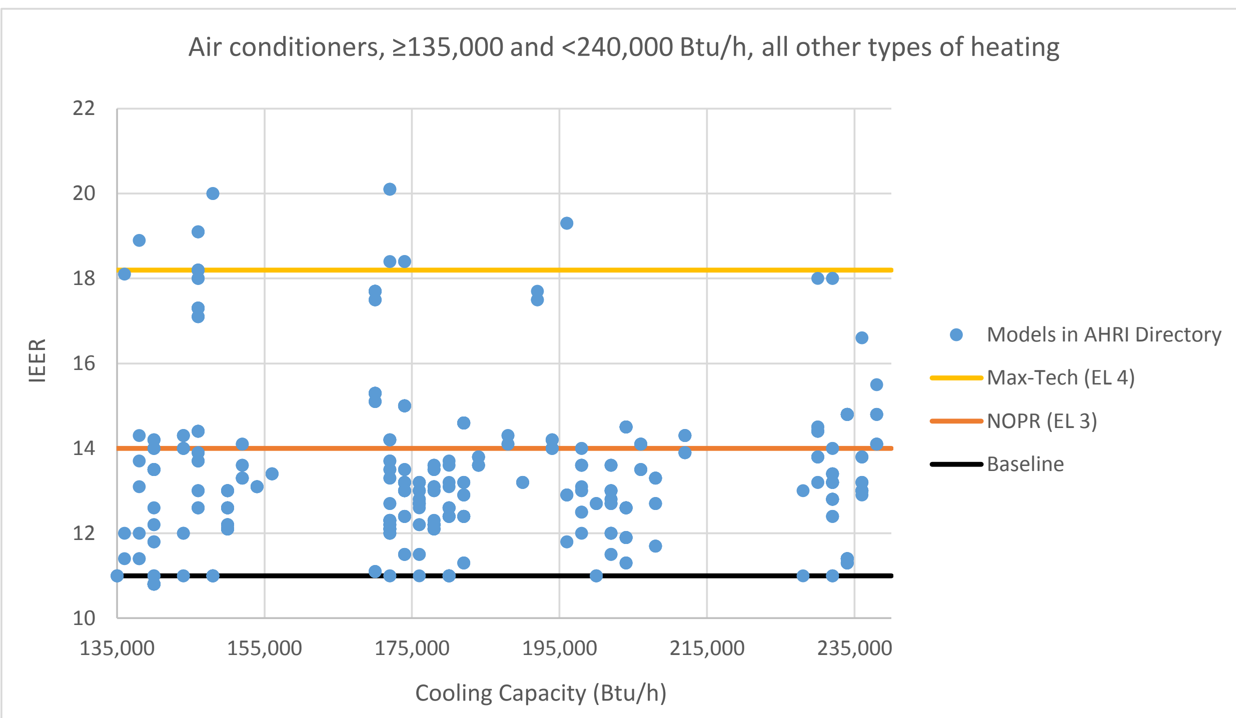
Appendix[27]





[27] Models in the AHRI directory as of September 24, 2014. "SP-A" models were used to represent the "electric resistance or no heating" equipment classes and "SPY-A" models were used to represent the "all other types of heating" equipment classes.


Air conditioners, ≥135,000 and <240,000 Btu/h, electric resistance or no heating
IEER
22
20
18
16
14
12
10
135,000
155,000
175,000
195,000
215,000
235,000
Cooling Capacity (Btu/h)
Models in AHRI Directory
Max-Tech (EL 4)
NOPR (EL 3)
Baseline


Air conditioners, ≥135,000 and <240,000 Btu/h, all other types of heating
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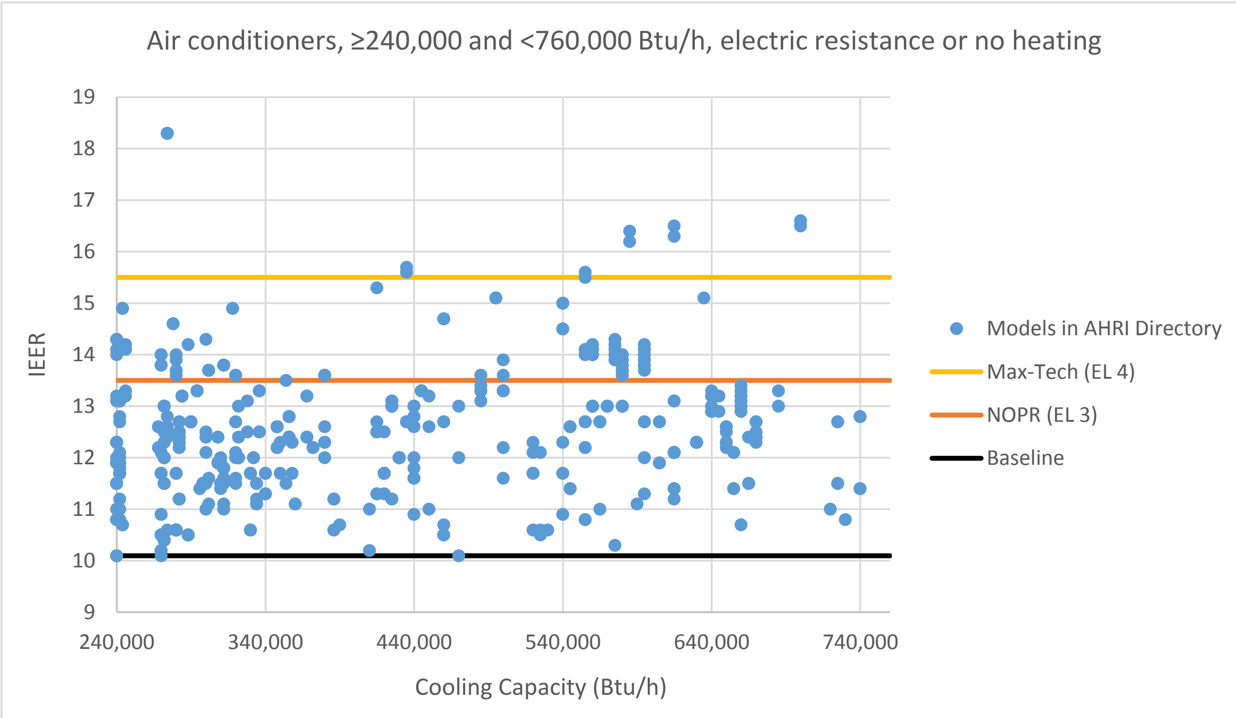
Air conditioners, ≥240,000 and <760,000 Btu/h, electric resistance or no heating
IEER
19
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240,000
340,000
440,000
540,000
640,000
740,000
Cooling Capacity (Btu/h)
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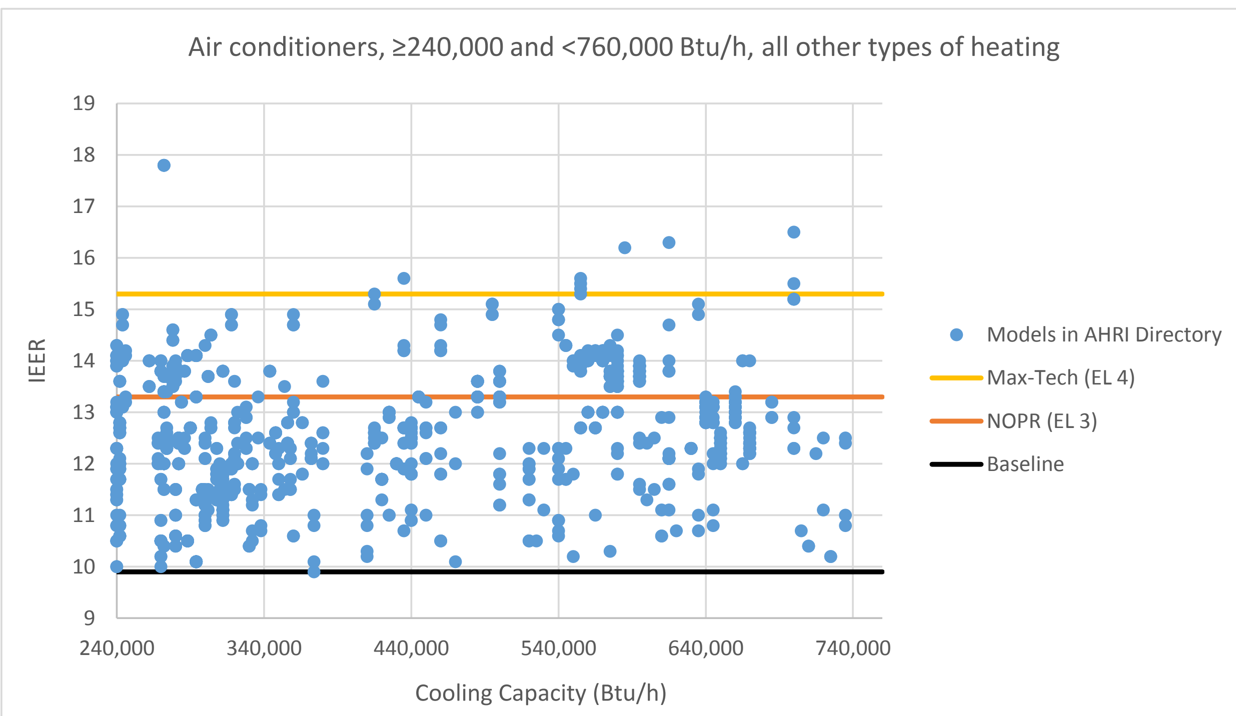
NOPR (EL 3)
Baseline


Air conditioners, ≥240,000 and <760,000 Btu/h, all other types of heating
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