Appliance Standards Awareness Project
American Council for an Energy-Efficient Economy
National Consumer Law Center
Natural Resources Defense Council
Northwest Energy Efficiency Alliance
Northwest Power and Conservation Council

October 21, 2013

Ms. Brenda Edwards
U.S. Department of Energy
Building Technologies Program
1000 Independence Avenue, SW
Mailstop EE-2J
Washington, DC 20585

RE: Docket Number EERE–2009–BT–STD–0018/ RIN 1904–AC00: Notice of Proposed Rulemaking for Metal Halide Lamp Fixtures

Dear Ms. Edwards:

This letter constitutes the comments of the Appliance Standards Awareness Project (ASAP), American Council for an Energy-Efficient Economy (ACEEE), National Consumer Law Center (NCLC), Natural Resources Defense Council (NRDC), Northwest Energy Efficiency Alliance (NEEA), and Northwest Power and Conservation Council (NPCC) on the notice of proposed rulemaking (NOPR) for metal halide lamp fixtures. 78 Fed. Reg. 51464 (August 20, 2013). We appreciate the opportunity to provide input to the Department.

DOE has proposed standard levels based on more-efficient magnetic ballasts for all wattage ranges except >100 to <150W fixtures. We believe that there are two significant flaws in DOE's analysis, which we describe below, that have resulted in the analysis significantly underestimating the energy and economic savings from standard levels based on electronic ballasts. If DOE revises the analysis, we believe that the Department will find that standard levels based on electronic ballasts for both indoor and outdoor fixtures from 50-500W are cost-effective. According to DOE's analysis for the NOPR, the "max-tech" levels, which are based on commercially-available electronic ballasts, would more than double the national energy savings.

Lumen Maintenance and Lamp Lifetime Benefits of Electronic Ballasts

We believe that DOE has significantly underestimated the energy and economic savings from electronic ballasts. For the analysis for the NOPR, DOE assumed that installing an electronic ballast in place of a magnetic ballast in new fixtures would have no impact on the number of fixtures installed nor the lamp wattage. DOE also assumed that there is no difference in lamp lifetime between magnetic and electronic ballasts. These assumptions fail to account for the better lumen maintenance of lamps driven by electronic ballasts. Better lumen maintenance allows for installing fewer fixtures or lower-wattage lamps, which can both significantly reduce energy consumption (beyond the improved ballast efficiency) and, in the case of fewer fixtures, provide maintenance/repair cost savings as there are fewer lamps and ballasts that need to be replaced. Improved lumen maintenance can also reduce the need for frequent re-lamping, yielding additional maintenance/repair cost savings.

The NOPR states that DOE did not find a consistent description of the impact of an electronic ballast on lumen maintenance and therefore is not proposing an adjustment to electronic ballast input power to account for improved lumen maintenance relative to magnetic ballast operation.[1] However, multiple sources claim both better lumen maintenance and extended lamp lifetime when lamps are operated with electronic ballasts:

- Natural Resources Canada cites field tests that showed that a 400W metal halide lamp operated with an electronic ballast produced 15% more light output after 8,000 hours than the same lamp operated with a magnetic ballast. Natural Resources Canada also states that HID lamp life is up to 30% longer when operated with electronic ballasts.[2]
- GE claims that their UltraMax™ electronic ballast produces 13% higher mean lumens at 40% of rated life than a metal halide system using a pulse-start magnetic ballast. GE states that this improved lamp lumen maintenance allows for using lower-wattage lamps in retrofits or fewer fixtures in new construction. They further state that better lumen maintenance results in extending recommended re-lamping times.[3]
- Advance claims that their DynaVision® electronic ballast delivers a 20% improvement in lumen maintenance at 40% of rated life over a pulse-start metal halide system. Advance explains that with more maintained lumens, fixture count can be reduced, and the need for frequent re-lamping is also reduced.[4]
- Holophane claims that electronic ballast technology increases mean lumen output by 13% on pulse-start lamps, and states that improved lumen maintenance is the most fundamental benefit of electronic HID ballasts.[5]

In comments in response to the preliminary technical support document, the California IOUs provided similar examples of various manufacturers' claims that electronic ballasts can both allow for using lower-wattage lamps and extend lamp lifetime through improved lumen maintenance.[6] We recognize that it may be challenging to develop a single representative value for improved lumen maintenance or increased lamp lifetime for metal halide fixtures with electronic ballasts. However, this does not mean that these benefits of electronic ballasts should be ignored in the analysis. Even if DOE uses conservative estimates of improved lumen maintenance and increased lamp lifetime, this would allow the analysis to more accurately reflect the energy savings and reduced maintenance/repair costs of electronic ballasts relative to magnetic ballasts.

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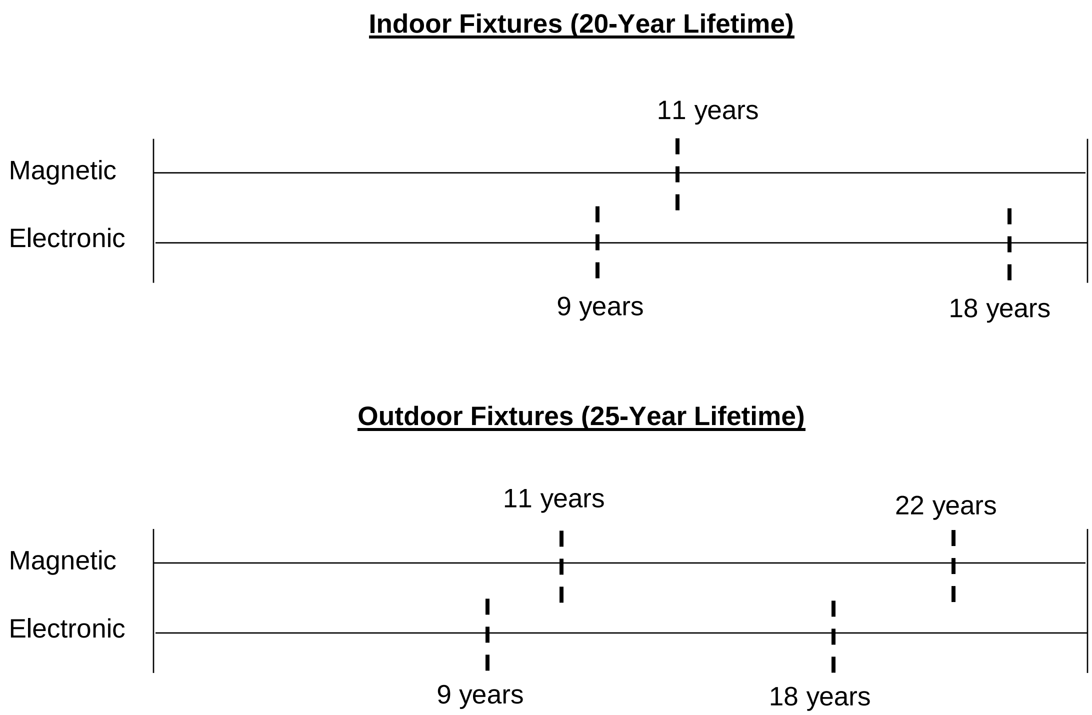
[1] 78 Fed. Reg. 51492-3.
[2] http://oee.nrcan.gc.ca/industrial/equipment/lighting/2528.
[3] http://genet.gelighting.com/LightingObjectRetrieval/Dispatcher?Catalog=Lighting&RequestType=PDF&RecId=221
[4] http://www.1000bulbs.com/pdf/Advance-HID-brochure.pdf.
[5] http://www.acuitybrandslighting.com/library/HLP/Documents/otherdocuments/Ballast%20Handbook.pdf.
[6] Comment ID: EERE-2009-BT-STD-0018-0032.

Fixture and Ballast Lifetimes

In the analysis for the NOPR, DOE assumed lifetimes for indoor and outdoor fixtures of 20 and 25 years, respectively,[7] and lifetimes of magnetic and electronic ballasts of 50,000 hours and 40,000 hours (or about 11 years and 9 years), respectively.[8] We understand that DOE has assumed in the analysis that a fixture is replaced at the end of its assumed lifetime regardless of when the fixture's current ballast was installed, which means that ballast replacements during a fixture's lifetime would occur at the intervals shown in Figure 1 below. For indoor fixtures, a magnetic ballast would be replaced after 11 years, while an electronic ballast would be replaced after 9 and 18 years during a fixture's 20-year lifetime. For outdoor fixtures, a magnetic ballast would be replaced after 11 and 22 years, while an electronic ballast would be replaced after 9 and 18 years during a fixture's 25-year lifetime.

Figure 1. Ballast Replacement Schedule Assumed in the NOPR for Indoor and Outdoor Fixtures.



We do not believe that it is realistic to assume that a fixture is replaced at the end of its assumed lifetime regardless of when the fixture's current ballast was installed. For example, for indoor fixtures with electronic ballasts, it seems unlikely that a customer would conduct a second ballast replacement after 18 years, and then replace the entire fixture just two years later even though 7 years of the ballast's lifetime remain. Similarly, for outdoor fixtures with magnetic ballasts, it seems unlikely that a customer would conduct a second ballast replacement after 22 years, and then replace the entire fixture just three years later even though 8 years of the ballast's lifetime remain. Instead, it seems likely that a customer would either replace the entire fixture earlier than

[7] Technical Support Document. p. 8-14.
[8] *Ibid*. p. 8-15.

its assumed lifetime (e.g. after 18 years in the case of indoor fixtures with electronic ballasts) or extend the life of the fixture given the significant cost of replacing a ballast. Table 1 below shows that the total cost of replacing a 250W ballast for an indoor fixture (including installation costs) at both the baseline and "max-tech" levels is roughly 40% of the total cost of installing a new fixture.

Table 1. Total Fixture Installed Cost and Ballast Replacement Cost for 250W Indoor Fixtures.

Efficiency Level	Post-Tax Fixture Price (Including Ballast)	Fixture Install. Cost	Post-Tax Ballast Price	Ballast Install. Cost	Post-Tax Lamp Price	Lamp Install. Cost	**Total Fixture Installed Cost**	**Total Ballast Replacement Cost**
Baseline	$220	$281	$85	$208	$46	$164	**$711**	**$292**
EL 4	$293	$281	$123	$208	$46	$164	**$783**	**$331**

Source: DOE Life-Cycle Cost Analysis Spreadsheet.

We understand that it would be difficult to capture all the possible customer responses to ballast failures in the analysis. However, DOE's current approach is not a reasonable approximation, and, as a result, DOE's analysis understates the cost-effectiveness of electronic ballasts in indoor applications. We suggest that DOE take one of two approaches to better reflect what we believe to be more likely customer responses to ballast failures. The first approach would be to use a distribution of fixture lifetimes. In other rulemakings, DOE has typically used distributions of product lifetimes for the lifecycle cost analyses, while in this rulemaking, we understand that DOE has used single values for indoor and outdoor fixture lifetimes of 20 and 25 years, respectively.[9] In the case of indoor fixtures with electronic ballasts, for example, using a distribution of fixture lifetimes would reflect that in some cases, the fixture lifetime would be shorter than 18 years, which would mean that the second ballast replacement would not occur, while in other cases, the fixture lifetime would be longer than 20 years, which would mean that the second ballast replacement would take place many years before the end of the fixture lifetime. The second approach would be to assign a salvage value to ballasts in cases where a ballast has not reached the end of its lifetime when the fixture is assumed to be replaced. With this approach, the salvage value should be based on the total ballast replacement cost (including installation costs). Assigning a salvage value would be a proxy to reflect that customers are unlikely to replace a fixture soon after they replace the fixture's ballast.

Electronic Ballasts in Outdoor Applications

At the public meeting on September 27, some manufacturers and other stakeholders raised concerns with applying electronic ballasts in outdoor applications.[10] In comments in response to the preliminary technical support document, the California IOUs provided examples of electronic ballasts from multiple manufacturers that are rated for outdoor use.[11] Osram Sylvania's comments on the preliminary technical support document noted that they "agree that electronic

[9] Technical Support Document. p. 8-14.
[10] DOE NOPR Public Meeting Transcript, pp. 33, 206, 232-33.
[11] Comment ID: EERE-2009-BT-STD-0018-0032.

ballasts can be applied reliably in a wide variety of both indoor and outdoor applications provided they are appropriately designed for the application."[12] Finally, the Technical Support Document (TSD) notes that DOE found that "electronic ballasts have been successfully applied to a variety of both indoor and outdoor applications where temperature and other limiting conditions could hinder their implementation."[13] While applying electronic ballasts in outdoor applications does require addressing thermal management and voltage transient protection, DOE has accounted for these additional costs in the engineering analysis by adding price adders to the empty fixture and ballast manufacturing production costs (MPCs).[14]

At the public meeting, some manufacturers also stated that the surge protection applied to fixtures with electronic ballasts designed for use in outdoor applications may need to be replaced during the life of the fixture as a result of multiple lighting strikes, for example.[15] From what we heard at the public meeting, it appears as though this may be an issue only in certain areas of the country, such as areas prone to lighting strikes. If the surge protection for fixtures with electronic ballasts does need to be replaced during a fixture's lifetime in some cases, we do not believe that this is a reason by itself not to consider potential standard levels based on electronic ballasts. Rather, if DOE determines that the surge protection may need to be replaced during a fixture's lifetime for some fraction of fixtures, this additional maintenance/repair cost can be incorporated in the analysis.

Compatibility of High-Frequency Electronic Ballasts and Ceramic Metal Halide Lamps

For the equipment classes encompassing 50-250W fixtures, the "max-tech" levels (EL 4) are based on low-frequency electronic ballasts, while for the >250 to ≤500W equipment class, DOE used a high-frequency electronic ballast to represent the "max-tech" level. In the NOPR, DOE notes that there is limited compatibility between high-frequency ballasts and high-efficiency ceramic metal halide (CMH) lamps, which could potentially limit energy savings opportunities through the use of CMH lamps.[16] To address this concern, we urge DOE to evaluate an additional TSL, which would be identical to TSL 5, except that the levels for the >250 to ≤500W equipment class would be based on EL 3, which represents low-frequency electronic ballasts.[17] This additional TSL is illustrated in Table 2 below.

Table 2. Recommended Additional TSL.

Equipment Class	Efficiency Level
≥50 to ≤100 W	EL 4
>100 to <150 W	EL 4
≥150 to ≤200 W	EL 4
>250 to ≤500 W	EL 3
>250 to ≤2000 W	EL 2 + DS

[12] Comment ID: EERE-2009-BT-STD-0018-0027.
[13] Technical Support Document. p. 3-43.
[14] *Ibid*. pp. 5-6, 5-7.
[15] DOE NOPR Public Meeting Transcript, p. 235.
[16] 78 Fed. Reg. 51546.
[17] Technical Support Document. p. 5-44.

More-Efficient Magnetic Ballasts

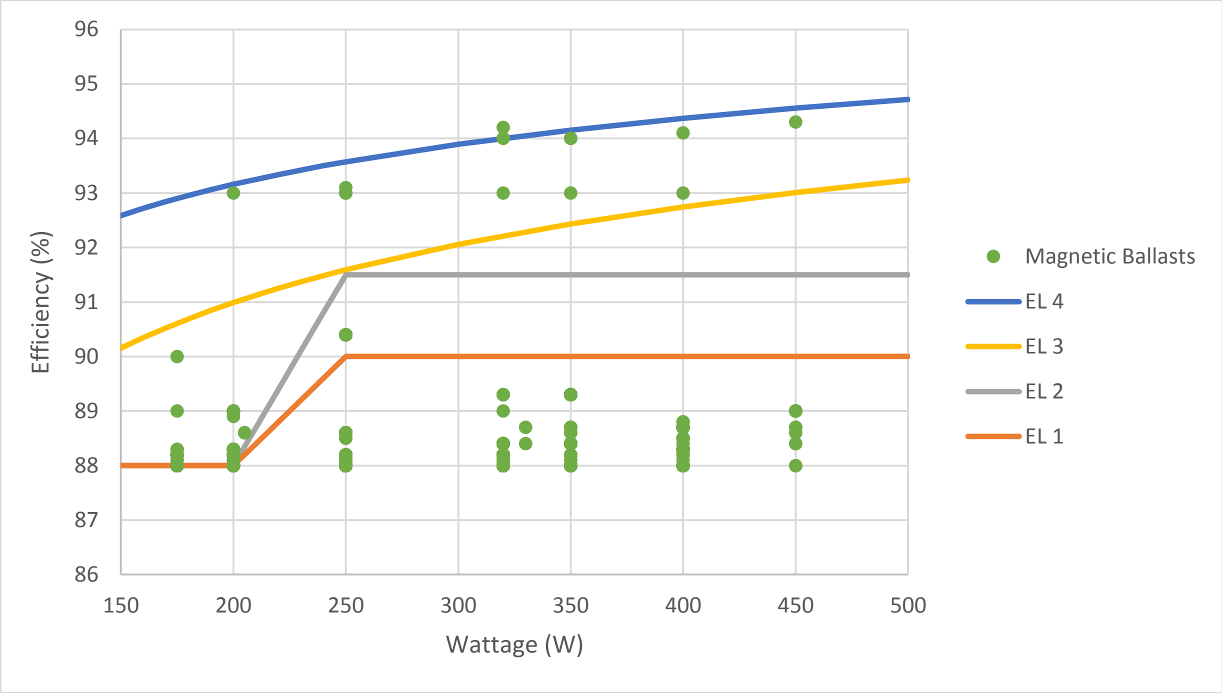
At the DOE public meeting on September 27, manufacturers expressed concerns about the modeled magnetic ballasts used to represent EL 2 for wattages up to 500W, and claimed that meeting EL 2 levels would increase ballast size.[18] We believe that DOE's approach of modeling magnetic ballasts to represent EL 2 is appropriate. While DOE concluded that magnetic ballasts meeting EL 2 are not commercially available, DOE identified readily-available design options such as better grade core steel and copper wiring that can improve the efficiency of magnetic ballasts.

In the analysis for the NOPR, DOE evaluated whether fixtures would have to be altered to accommodate higher-efficiency ballasts. The TSD states that "for all ELs analyzed, DOE found that each fixture type was capable of physically containing the ballast with minimal modification."[19] While increasing stack height can improve the efficiency of magnetic ballasts in some cases, DOE did not assume any change in stack height in its modeling of more-efficient magnetic ballasts that would meet EL 2. The modeled magnetic ballasts that DOE used to represent EL 2 kept both the ballast's footprint and stack height constant.[20] DOE explains in the TSD that "a decrease in steel thickness due to the steel grade and no change in the stack height equates to additional laminations and thus an improvement in efficiency."[21]

Furthermore, review of the DOE Compliance Certification Database (CCD) and manufacturer product literature indicates that there are single-voltage (277V) linear reactor magnetic ballasts for pulse-start metal halide lamps that exceed EL 2 across a wide range of wattages. (We note that DOE determined that 277V is the most common voltage for ballasts at and above 150W.[22]) Figure 2 below shows the metal halide ballasts in the CCD that are clearly identified as magnetic ballasts.[23] Of these, there are 13 magnetic ballasts that both significantly exceed EL 2, which represents "max-tech" magnetic ballasts, and also exceed EL 3, which represents baseline electronic ballasts. Two of these magnetic ballasts even meet EL 4, which represents "max-tech" electronic ballasts. There are also 175W and 200W magnetic ballasts that exceed EL 2. (See Appendix A for detailed information on these high-efficiency magnetic ballasts.)

[18] DOE NOPR Public Meeting Transcript, pp. 36, 66, 67.
[19] Technical Support Document. p. 5-13.
[20] *Ibid*. p. 5-23.
[21] *Ibid*. p. 5-26.
[22] *Ibid*. p. 5-18, 5-19.
[23] CCD accessed October 7, 2013. The ballasts included in the graph are those identified as "Mag," "Magnetic," or "Pulse Start Magnetic." These ballasts likely represent only a fraction of all the magnetic ballasts in the CCD since they do not include ballasts identified as "Pulse" or "Pulse Start," which may in fact be magnetic ballasts.

Figure 2. Efficiency Levels of Magnetic Ballasts in the DOE Compliance Certification Database and Efficiency Levels Analyzed for the NOPR.



We recognize that there are limitations to the use of reactor ballasts, particularly in heavy use environments and over long wiring runs. However, these ballasts represent a high-efficiency magnetic alternative to electronic ballasts for many applications.[24] Since linear reactor magnetic ballasts may have a lower up-front cost than electronic ballasts and are appropriate for many applications, DOE should model these ballasts as the equipment selected in many cases when the standard is set at EL 3 or EL 4.

Ballasts for Replacement Applications

At the DOE public meeting on September 27, several manufacturers stated that new standards for metal halide lamp fixtures will effectively impact all metal halide ballasts, including ballasts for replacement applications, because manufacturers will not maintain two product lines.[25] We do not believe that new standards would effectively impact ballasts for replacement applications. It is a business decision for manufacturers as to whether to produce a separate product line for replacement applications. As NEEA stated at the public meeting, if there is demand for replacement ballasts, we believe that some manufacturers would fill this niche.[26] Furthermore, new standards would not necessarily mean that the same ballasts could not be used in both new fixtures and as replacements. As described above, based on DOE's analysis, the size of magnetic ballasts would not need to be increased to meet EL 2, and there are linear reactor magnetic

[24] http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/hid_lamps/advance_2003i.pdf.
[25] DOE NOPR Public Meeting Transcript, pp. 65, 67.
[26] *Ibid*. p. 72.

ballasts that meet EL 3 and even EL 4. In addition, it appears that some manufacturers offer electronic ballasts as retrofit replacements for magnetic ballasts.[27]

Standards for >500 to ≤2,000 W Fixtures

We continue to support establishing standards for high-wattage (>500 to ≤2,000W) fixtures. DOE's analysis for the NOPR indicates that about 40% of the total potential national energy savings from the proposed standards would come from these high-wattage fixtures. In addition to a ballast efficiency standard, DOE proposes in the NOPR to adopt a design standard for >500 to ≤2,000W fixtures that would prohibit probe-start ballasts in new fixtures. As DOE notes in the TSD, probe-start lamps tend to exhibit poorer lumen maintenance than pulse-start lamps, which means that a space lit with probe-start fixtures needs either more or higher-wattage fixtures compared to the same space lit with pulse-start fixtures.[28] We agree with DOE that a design standard prohibiting probe-start ballasts in new >500 to ≤2,000W fixtures could yield additional energy savings by allowing a customer to install fewer or lower-wattage pulse-start fixtures.

However, we are not convinced that DOE has appropriately captured the potential energy savings from this design standard. In the analysis for the NOPR, DOE assumed that the design standard would result in a 5.6% reduction in normalized input power.[29] We understand that metal halide lamps are only available in fixed wattages. In contrast to the assumption of a 5.6% reduction in input power, DOE notes that a customer could, for example, replace a 1,000W probe-start fixture with an 875W pulse-start fixture.[30] These 875W pulse-start lamps are currently available. For example, Venture Lighting produces 875W pulse-start lamps advertised as replacements for 1,000W probe-start systems.[31] In this case, the savings in input power would be 12.5%, or more than double the savings that DOE has assumed in the NOPR.

At the public meeting on September 27, Musco Lighting stated that there are no pulse-start lamps above 1,000W currently available.[32] Manufacturers also stated that high-wattage pulse-start lamps in high-mast applications may require the addition of an igniter.[33] We believe that if a design standard prohibited the use of probe-start ballasts in high-wattage fixtures including fixtures above 1,000W, manufacturers would introduce lower-wattage pulse-start replacements. If a significant portion of fixtures above 1,000W would require an igniter in order to operate pulse-start lamps, the additional cost of the igniter can be incorporated in the analysis. However, if DOE concludes that a design standard prohibiting probe-start ballasts in fixtures above 1,000W is not feasible or is not cost-effective, we urge DOE to split the highest-wattage equipment class into two classes—one for >500 to ≤1,000W fixtures, and one for >1,000 to ≤2,000W fixtures—such that the design standard could be applied to >500 to ≤1,000W fixtures.

[27] See, for example, http://www.venturelighting.com/Literature/RetrofitAndSave_2007.pdf and http://www.empowerelec.com/wp-content/uploads/2010/10/EE_CaseStudy_Firewheel_Rnd2.pdf.
[28] Technical Support Document. p. 5-20.
[29] *Ibid*. p. 5-21.
[30] *Ibid.*
[31] http://www.venturelighting.com/literature/875W_2013_VLI-1039_v5.pdf.
[32] DOE NOPR Public Meeting Transcript. p. 181.
[33] *Ibid*. p. 167, 169.

Currently-Exempted 150W Fixtures

At the public meeting on September 27, manufacturers stated that including the currently-exempted 150W fixtures in the scope of coverage could result in customers switching from 150W fixtures to 175W or 200W fixtures, which would increase energy consumption.[34] We continue to support the inclusion of currently-exempted 150W fixtures in the scope of coverage. We believe that continuing to exempt these fixtures may create market distortions and may also hinder the transition to LEDs for this wattage category.

We recognize the concern raised by manufacturers about potential switching to higher-wattage fixtures, especially in the context of the standards proposed in the NOPR, which are based on electronic ballasts for currently-exempted 150W fixtures and on magnetic ballasts for 175W and 200W fixtures. However, we believe that several factors must be taken into account in order to evaluate the magnitude of any impact on energy savings. First, especially in new installations, switching to higher-wattage fixtures does not necessarily increase energy consumption if fewer fixtures are installed to account for the higher light output of each individual fixture. Second, in cases where a customer did switch from a 150W fixture to a 175W fixture without reducing the number of fixtures installed, the additional energy use would be offset in part by the increase in ballast efficiency. Table 3 below shows that the difference in system wattage between a baseline 150W fixture and a baseline 175W fixture is only 14W.

Table 3. Ballast Input Power for 150W and 175W Baseline Fixtures.

Lamp Wattage (W)	Baseline Ballast Efficiency (%)[35]	Ballast Input Power (W)[36]
150	81.0	185
175	88.0	199

Third, any switching to higher-wattage fixtures will depend in large part on the cost differential between a 150W fixture and a 175W fixture, for example. We understand that higher-wattage fixtures are generally somewhat more expensive than lower-wattage fixtures, which means that even if the incremental cost of the standard is lower for a 175W fixture than for a 150W fixture, the total installed cost for a 175W fixture may still be higher than that of a 150W fixture. For example, Table 4 below shows DOE's estimates of baseline installed cost for the 150W and 250W representative outdoor fixtures and the incremental and total installed costs for the efficiency levels proposed in the NOPR, where the proposed level for the 150W fixture is based on electronic ballasts and the proposed level for the 250W fixture is based on magnetic ballasts. The table shows that even though the incremental cost is higher for the 150W fixture, the total installed cost for the 150W fixture is still lower than that of the 250W fixture.[37]

[34] DOE NOPR Public Meeting Transcript pp. 33-34.
[35] The baseline ballast efficiency for the 150W fixture is from Table 5.11.5 of the TSD. The baseline ballast efficiency for the 175W fixture is based on the current minimum standard of 88%.
[36] Ballast input power is calculated as the lamp wattage divided by the ballast efficiency.
[37] Technical Support Document. pp. 8-26, 8-27.

Table 4. Baseline, Incremental, and Total Installed Cost of 150W and 250W Outdoor Fixtures.

Representative Wattage	Baseline Installed Cost	Incremental Installed Cost	Total Installed Cost
150W	$641	$73	$714
250W	$690	$37	$728

Finally, if DOE adopts standards based on electronic ballasts for all wattage ranges from 50-500W, we believe that potential switching from 150W fixtures to higher-wattage fixtures would no longer be a significant concern since both 150W fixtures and higher-wattage fixtures would be subject to equivalent standards.

Effective Date

This rulemaking has been significantly delayed. The statute specified a final rule date of January 1, 2012, which means that the final rule will likely be published two years after the statutory deadline. The statute also specifies an effective date of January 1, 2015. A delayed effective date relative to the effective date specified in the statute would decrease the potential energy savings from this rulemaking. However, we recognize that requiring compliance with new and amended standards one year after the final rule is published may not be feasible for manufacturers given the steps that both ballast and fixture manufacturers must take before the effective date. We urge DOE to attempt to balance additional energy savings from an earlier effective date with impacts on manufacturers.

Social Cost of Carbon

The benefits of the proposed standards outweigh the costs even before accounting for the benefits from reduced power sector emissions. As discussed above, we believe that revisions to the technical aspects of the lifecycle cost analysis will show that even higher standards are cost-effective for product purchasers than those proposed in the NOPR. As in prior standards rulemakings, DOE also quantifies the economic benefits of pollutant reductions, including carbon dioxide. DOE states in the NOPR that it plans to consider the monetary value of reduced carbon dioxide emissions from the standard using the most recent interagency social cost of carbon (SCC) values.[38] We support the use of these updated SCC values which are based on the interagency working group's most recent review of peer-reviewed models on the subject.[39] Indeed, these SCC values are still likely to be an underestimate of the costs associated with carbon dioxide emissions, as many of the damages from climate change are not accounted for in models, such as forests fires, drought, smog, and increasing food prices.[40]

[38] Technical Support Document, pp. 2-13.

[39] http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf.

[40] See: http://www.epa.gov/otaq/climate/regulations/420r10012a.pdf, Roberto Roson & Dominique Van der Mensbrugghe, *Climate change and economic growth: Impacts and interactions*, 4 INTERNATIONAL JOURNAL OF SUSTAINABLE ECONOMY, 270 (2012), and INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE. CLIMATE CHANGE 2007: IMPACTS, ADAPTATION AND VULNERABILITY. CONTRIBUTION OF WORKING GROUP II TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-spm.pdf.

Thank you for considering these comments.

Sincerely,

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Appendix A

Table A1. High-Efficiency Magnetic Ballasts in DOE Compliance Certification Database.[41]

Brand	Basic Model Number	Individual Model Number	Ballast Type	Design Lamp Wattage	Minimum Ballast Efficiency
Universal	P175277RCEM	000C, 500K, 518C, 718C	Magnetic	175	90
Universal	P175MLTAC3L	000C, 500K, 518C, 718C	Magnetic	175	89
Philips Advance	71A5637-BPEE	-001D, 500D, 510D	Magnetic	200	93
Philips Advance	71A5637-BPEE	-001D, 500D, 510D	Magnetic	200	93
RAB Lighting	BMHH200PSQ	WP3XXH200PSQXXXX	Magnetic	200	89
RAB Lighting	BMHH200PSQ	MEGH200XXPSQXXXX	Magnetic	200	89
RAB Lighting	BMHH200PSQ	FZH200XXPSQXXXX	Magnetic	200	89
RAB Lighting	BMHH200PSQ	FXLH200XXPSQXXXX	Magnetic	200	89
RAB Lighting	BMHH200PSQ	ALXH200XXPSQXXXX	Magnetic	200	89
RAB Lighting	BMHH200PSQ	ALH200XXPSQXXXX	Magnetic	200	89
Philips Advance	71A5693-EE	-001D, 500D, 510D, 600, 610, 900D, 910D	Magnetic	200	88.9
Philips Advance	71A5737-BPEE	-001D, 500D, 540D, 600	Magnetic	250	93.1
GE	GERB25E**	GERB25E**	Magnetic	250	93
Universal	P250277RCEM	000C, 500K, 518C, 718C	Magnetic	250	93
Philips Advance	71A5837-BPEE	-001D, 500D, 600, 540D	Magnetic	320	94.2
Universal	71A5837BPEE	000C, 500K, 518C, 718C	Magnetic	320	94
GE	GERB32E**	GERB32E**	Magnetic	320	93
Philips Advance	71A5937-BPEE	-001D, 500D, 540D, 600	Magnetic	350	94
Universal	P350277RCEM	000C, 500K, 518C, 718C	Magnetic	350	94
GE	GERB35E**	GERB35E**	Magnetic	350	93
Philips Advance	71A6137-BPEE	-001D, 500D, 540D, 600, 640	Magnetic	400	94.1
GE	GERB402E**	GERB402E**	Magnetic	400	93
Philips Advance	71A6337-BPEE	-500D, 600	Magnetic	450	94.3

[41] CCD accessed October 7, 2013. The ballasts included in the graph are those identified as "Mag," "Magnetic," or "Pulse Start Magnetic." These ballasts likely represent only a fraction of all the magnetic ballasts in the CCD since they do not include ballasts identified as "Pulse" or "Pulse Start," which may in fact be magnetic ballasts.