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April 29, 2013

Ms. Brenda Edwards
US Department of Energy
Buildings Technologies Program
Mail Stop EE-2J
1000 Independence Ave, SW
Washington, DC 20585-0121

Re: Energy Conservation Program: Notice of Proposed Rulemaking for Energy Conservation Standards for Residential Water Heaters, Docket Number: EERE-2012-BT-STD-0022, RIN Number: 1904-AC78

Dear Ms. Edwards:

PJM provides these supplemental comments to underscore, from the perspective of the independent grid operator, the need for the Department to timely address the unintended consequences of the energy conservation standard for electric water heaters issued April 16, 2010 (75 FR 20112) scheduled to become effective on April 16, 2015. These unintended consequences arise as a result of advances in technology, grid integration of demand response resources, and market structures that place new value on energy storage---advances that had not matured at the time the April 16, 2010 final rule was established.

As a result of technological advances at the grid and appliance level, PJM, working with the Steffes Corporation, has now been able to demonstrate the value of grid interactive water heaters serving as a fast-responding resource to providing ancillary services such as frequency control to the transmission grid. By the same token, regulatory changes have occurred since the present electric water heater standard was first proposed. Specifically, through its Order 755¹, the Federal Energy Regulatory Commission (“FERC”) has directed the industry to provide incentives for the use of fast-responding resources, such as water heaters, to provide grid control

¹ Frequency Regulation Compensation in the Organized Wholesale Power Markets, Order No.755, FERC Stats. & Regs. ¶ 31,324 (2011); *order on reh’g*, Order No. 755-A, 138 FERC ¶ 61,123 (2012)



services. Accordingly, PJM urges the Department to acknowledge the need to recognize that a “grid interactive” component to an electric water heater provides markedly different and distinguishable value in terms of ensuring energy efficiency than the type of stand-alone electric water heaters at issue in proceeding of the April 16, 2010 rule.

The fate of development of this new class of “grid interactive” water heaters is, as a practical matter, tied to the sunset date in the April 16, 2010 final rule prohibiting the manufacture of large volume electric resistance water heaters after April 16, 2015. In response to the present standard, manufacturers will simply cease to manufacture this product. At that point, efforts to develop grid interactive water heaters will be set back significantly as the cost of starting up new manufacturing lines and developing supply chains will be higher than if modifications were able to be made *today* to permit this new technology to develop. In essence, the Department is at a cross-roads -- it can provide an avenue for the development of new “grid interactive” water heaters that build on existing manufacturing lines and supply chains or it can set back the development of grid interactive water heaters by driving those manufacturing lines to simply be shut down thus adding another costly hurdle to the development of a new line of “grid interactive” devices.

The Role of PJM

PJM is neither a retail utility or cooperative nor a manufacturer. Rather, PJM is the independent system operator of the bulk electric power grid charged with the duty of ensuring the reliability of the electric power grid and the operation of wholesale power markets to ensure the delivery of power at the least cost to consumers. As such, PJM is uniquely situated to lend its technical expertise and opinion to the Department to address fundamental questions such as:

- Is there an increased efficiency level associated with grid-interactive large volume water heaters and what is the value of such resources?
- How would a grid interactive “bolt on” feature provide value to system operators in providing ancillary and grid balancing services critical for the increasing integration of wind resources?



- Can the Department appropriately track the penetration of such devices in a manner which prevents undue leakage?

PJM alone serves over 60 million US citizens in a 13-state region including all or parts of New Jersey, Pennsylvania, Maryland, Delaware, Virginia, North Carolina, Tennessee, West Virginia, Kentucky, Ohio, Michigan, Indiana, Illinois and the District of Columbia. Over 21% of US gross domestic production is represented in the PJM region. As the independent system operator, PJM is charged with the responsibility of:

- Operating the bulk power grid in its footprint and ensuring system reliability;
- Operating a competitive market for electricity that allows for demand response and energy efficiency resources to be recognized as capacity resources, comparable to traditional generation resources; and
- Planning for the expansion of the bulk power grid including the interconnection of 18,000 MW of wind resources and 1,100 MW of solar resources presently in the PJM interconnection queue², as well as the approximately 40,000 MW of wind and 10,000 MW of solar that are expected to be needed to meet the PJM-states Renewable Portfolio Standard mandates by 2028.

Benefits of Grid Interactive Water Heaters to Wind Integration

Aggregated and controllable residential electric water heaters can help grid operators integrate renewable energy, particularly wind energy, primarily by heating water in response to a signal that there is an abundance of wind energy on the system, perhaps too much, to be used. In those instances when supply of wind power exceeds demand (principally in the early morning

² The current status of all resources in the PJM interconnection queue can be found at: <http://www.pjm.com/about-pjm/renewable-dashboard.aspx>



hours when wind generation is at its peak but demand is at its trough), wind resources need to be curtailed (i.e. wind is “spilled”), an action grid operators take for reliability purposes given limited resources for electricity storage. Not only is “spilling wind” unpopular as it is counter to federal, state and local policies that encourage maximum production and use of renewable energy, but it also is an inefficient solution as it fails to harness the value of an emissions-free, zero fuel cost resource. In addition to these curtailment costs, the prevalence of negative prices highlights the importance of flexible load and energy storage, particularly at night. In PJM’s western ComEd zone, a region of PJM with significant wind development, negative prices have persisted. Today, these negative prices are a market signal that reflects the operating scenario of having too much generation and not enough load. In the future, in the absence of cost-effective energy storage and flexible load, they represent a persistent operational challenge for grid operators and a barrier to the further development of wind energy due to increased curtailments.

Benefits of Grid Interactive Water Heaters Providing Ancillary Services

Operating an electric system reliably with a high penetration of renewable and variable energy resources is an increasing challenge for grid operators. Doing so at least-cost, will take vision and appropriate steps along the way to achieve operating protocols and services that meet the demands of a new grid. Innovative approaches to procuring and providing ancillary services – the flexible reserves and balancing needs of the grid – are being developed and implemented across the country. In response to FERC Order 755, ISO/RTOs are incentivizing the flexibility and responsiveness of resources that provide frequency regulation – the second-by-second service that corrects short-term imbalances on the grid, imbalances that increase as the amount of renewable energy on the system increases³⁴. California is proposing new, specified ramping services, defined as the amount of power a generator can increase or decrease per minute

3 Eto, J.H. et al. Use of frequency response metrics to assess the planning and operating requirements for reliable integration of variable renewable generation. Lawrence Berkeley National Laboratory. LBNL-4142E, December 2010; “Eastern Wind Integration and Transmission Study”. Enernex Corporation prepared for the National Renewable Energy Laboratory. February 2011.

4 Eastern Wind Integration and Transmission Study”. Enernex Corporation prepared for the National Renewable Energy Laboratory. February 2011.



(MW/min), intended to incentivize greater electric system flexibility to be able to respond to rapid changes in renewable generation output (either increases or sudden decreases)⁵. Texas is piloting the use of energy storage to better manage the demands of a grid increasingly reliant on wind generation. The PJM region and New York have begun making dispatch decisions based on fast-response capability in the Regulation Market to correct short-term system imbalances quicker, requiring less total Megawatts to provide the same level of service. This innovative approach is important because providing the same level of service with less Megawatts lowers the total cost of providing the service, and thus the total cost to all ratepayers. For example, currently in PJM's Regulation market, fast-response resources provide 2.6 times the level of service that slower resources provide. In other words, 1 Megawatt of fast-response substitutes the need for 2.6 Megawatts of slow response. Therefore, on average, each Megawatt of fast-response resource comes with approximate savings of \$387,104 per year⁶.

Fast-response Megawatts also decrease the power plant emissions associated with providing this service. Using demand side resources, such as grid-interactive water heaters, which do not burn a fuel and which provide the Regulation service simply by adjusting how they were already using electricity further reduce emissions because they displace the need for a generator to provide that service⁷.

The demand-side has much to offer in this new operating paradigm that places a premium on flexibility. Grid-interactive water heaters are but one load that can offer added flexibility to system operators; however, they may be the most efficient, cost effective, and easily deployable.

An electric resistance water heater can provide 50 millisecond reaction time in response to a Regulation signal by adjusting the electrical throughput of the heating elements, either

⁵ California ISO's proposal for a flexible capacity product can be found here: <http://www.caiso.com/informed/Pages/StakeholderProcesses/FlexibleRampingProduct.aspx>

⁶ Using PJM's average price of Regulation in April 2013 of \$27.62/MW, this figure is calculated as follows: [2.6MW (\$27.62/MW) – 1MW (\$27.62/MW)] * 8,760 hours per year = \$387,104/year.

⁷ To the best of the authors' knowledge, an in-depth emissions analysis has not been completed for water heaters providing ancillary services. However, the National Renewable Energy Laboratory found significant emissions savings in Texas by using another distributed energy storage resources for ancillary services, the electric vehicle: Sioshansi and Denholm, Emissions Impacts and Benefits of Plug-in Hybrid Electric Vehicles and Vehicle-to-Grid Services, Environ. Sci. Technol., 2009, 43 (4), pp 1199–1204. DOI: 10.1021/es802324j

increasing or decreasing the throughput, to provide the service, and do so with *negligible wear and tear on the equipment* and with the *same efficiency as under normal operating conditions*.

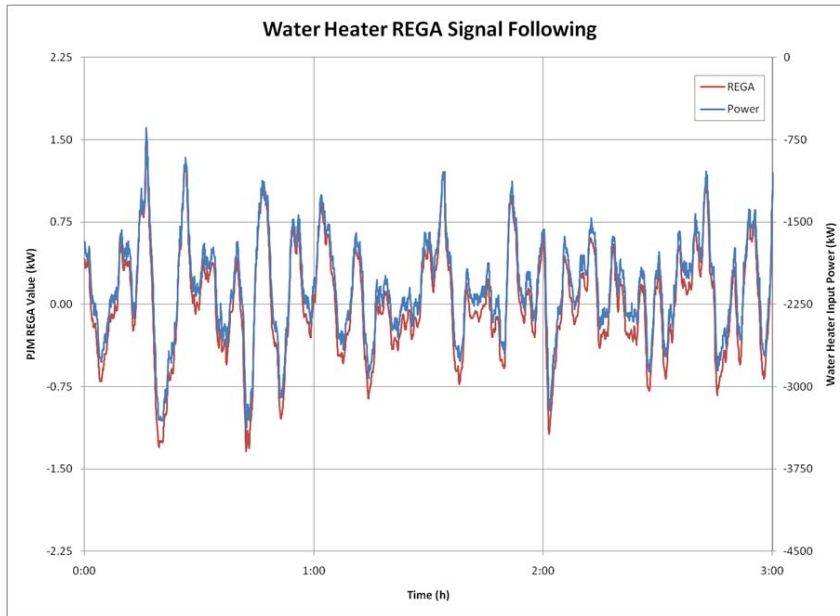


Figure 1: Load-frequency control with a water heater. Here, the water heater adjusts the rate at which it heats water based on PJM's signal used to balance generation and load, responding in milliseconds. The red line is PJM's signal and the blue line is the response of the water heater. In most cases, the red line is not visible because the water heater is accurately following the signal. This level of performance is not typically seen with many of today's sources of Regulation.

This responsiveness is a significant difference from the steam (fossil) power plants that provide these services today, as mentioned above. These highly attractive operating parameters are also not possible to achieve with the heat pump water heaters (HPWHs) prescribed under the 2010 energy conservation standards as the replacement for the large volume electric resistance water heater. As has been well documented in this proceeding, HPWHs operating in heat pump mode are not a good "fit" for providing this fast-response regulation service. HPWHs devices are not able to cycle as frequently as electric resistance water heaters. The frequent cycling



would damage the heat pump equipment and therefore not be cost-effective. Ironically, a HPWH could *potentially* provide this service only if it was using the electric resistive elements as part of a hybrid design. Operating in this manner would cause two problems: 1) when following a balancing signal from a grid operator, the HPWH might not be able to heat water fast enough for customer demand because the resistive elements are not sized to handle the ‘full load’, but rather as a supplemental heat source; and 2) IF the resistive element operating mode were capable of providing ancillary services, then the water heater will not meet the efficiency conservation standard when operating (an unforeseen outcome of the April 16, 2010 final rule), essentially turning the device into the product outlawed in the April 16, 2010 final rule.

The maturity of evidence to support the capability of large capacity electric resistance water heaters providing ancillary services has been amply demonstrated by PJM and others. Without timely and appropriate action by the Department to allow development of “grid interactive” electric resistance water heaters, the kind of technology which is being deployed will be inevitably setback.

Need for Creation of a New Classification of Grid-Interactive Water Heaters

Much has been made in this docket concerning the degree to which the “grid interactive” feature of the large volume water heater can distinguish the new appliance from the large volume water heaters intended to be outlawed under the April 16, 2010 final rule.

PJM posits that there is a viable and more effective legal route that is available to the Department to accommodate the technological advances in bulk electric system grid management that have enhanced the overall value of grid interactive water heaters. Specifically, we urge consideration and use of Section 6295(o)(2) to create a new classification of “grid interactive water heaters”. Although we note that the Department had, in the NOPR, reached a “tentative” conclusion against use of this statutory vehicle, the Department’s conclusion was only tentative and should be reconsidered based on the full record before it⁸.

⁸ In the Joint Comments submitted by NRECA, PJM et al. , the Joint Commenters point out that return to the “new classification” justification is entirely in keeping with applicable law including the fair notice doctrine.



The Energy Policy and Conservation Act of 1992, prescribed energy conservation standards for certain major household appliances, and required the Department of Energy (DOE) to administer an energy conservation program, referred to as the Energy Conservation Program for Consumer Products other than Automobiles, for these products. Water heaters, *e.g.*, storage water heaters,⁹ instantaneous water heaters¹⁰ and unfired hot water storage tanks,¹¹ are considered a covered product subject to the Program.

Under the Act, the Secretary is authorized to prescribe amended or new energy conservation standards for each type (or class) of covered product. However, under the Act, the Secretary may not prescribe any amended standard which increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product.¹² The Act further provides that “[t]he failure of some types (or classes) to meet this criterion shall not affect the Secretary’s determination of whether to prescribe a standard for other types of classes.”¹³

Any new or amended standard must be designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified.¹⁴ In determining whether a standard is economically justified, the Secretary must, after receiving comments on the proposed standard, determine whether the benefits of the standard exceed its burdens by, to the greatest extent practicable, considering: (i) economic impact of the standard on the manufacturers and on the consumers of the products subject to such standard; (ii) the savings in operating costs throughout the estimated average life of the covered product in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered product which are likely to result from the imposition of the standard; (iii) the total

9 The term “storage water heater” means a water heater that heats and stores water within the appliance at a thermostatically controlled temperature for delivery on demand. Such term does not include units with an input rating of 4000 Btu per hour or more per gallon of stored water. See Energy Policy Act of 1992, Sec. 122(a)(12)(A).

10 The term “instantaneous water heater” means a water heater that has an input rating of at least 4000 Btu per hour per gallon of stored water. See *Id.*, at 122(a)(12)(B).

11 The term “unfired hot water storage tank” means a tank used to store water that is heated externally. See *Id.*, at 122(a)(12)(C).

12 Neither the maximum allowable energy use nor minimum required energy efficiency is defined in the Act. See Energy Policy Act of 1992, Sec. 342 (a)(6)(B)(ii).

13 *Id.*

14 See 42 U.S.C. 6295(o)(2)(A).



projected amount of energy or water savings likely to result directly from the imposition of the standard; (iv) any lessening of the utility or the performance of the covered products likely to result from the imposition of the standard; (v) the impact of any lessening of competition, as determined in writing to the Attorney General, that is likely to result from the imposition of the standard; (vi) *the need for national energy and water conservation*; and (vii) *other factors, the Secretary considers relevant*.¹⁵ (Emphasis added)

Based on the current maximum standard level of 55 gallons as adopted in the 2010 Final Rule, the proposed Grid-Interactive Renewable Water Heaters, which require capacity greater than 55 gallons, would not qualify under the current standards. However, the Act allows the DOE to amend or propose a new standard for other types or classes of a consumer product.

Precedent exists for the DOE to create separate product classes. For example, the Department recently created an energy efficiency standard for “built in” residential refrigerators that was separate from its standard for top-freezer, bottom-freezer, and side-by-side residential refrigerators¹⁶. The mere fact that both the “built in” residential refrigerators performed the same function (i.e. refrigeration) as stand-alone refrigerators did not preclude the Department from finding that a new classification was in order. By the same token, during the hearing and in the comments stemming from the notice of rulemaking issued by the DOE, the DOE (at the request of the Gas Suppliers Manufacturing Association) established a separate product class for tabletop water heaters, with no change to standards because this class of heaters could not be made any larger.

Grid-Interactive Renewable Water Heaters are clearly distinguishable from the water heaters currently identified as a covered product. Specifically, the Grid-Interactive Renewable Water Heater is a dual function product that provides (i) uninterrupted hot water to consumers, and (ii) provides storage for large quantities of energy during times when there is an excess of currently unused, available renewable energy. Such product utilizes and integrates renewable energy to support grid optimization strategies by utilities and consumers. Both grid interactive water heaters and today’s electric resistance water heaters provide hot water to consumers.

¹⁵ See 66 FR 4474 at 4475 (Jan. 17, 2001).
¹⁶ 74 FR 58914 (Nov. 16, 2009)



However, the dual-use features of grid interactivity allow it to provide additional efficiencies to both electric consumers in their homes as well as the grid overall which justifies there being treated as an entirely separate classification. With appropriate packaging and installation of grid interactive features as discussed below, the product is clearly distinguishable from the electric resistance water heater manufactured today.

An Alternative Approach: Use of the Secretary's Waiver Authority

For the reasons stated in the Joint Comments filed by PJM, NRECA et al., PJM believes that use of the Secretary's waiver authority, if properly crafted, is an acceptable albeit sub-optimal approach. PJM below describes the attributes of the waiver, as outlined in the NOPR which are workable and those which are not.

Demonstration of Compatibility of the "Bolt-On" Device with Utility Demand Side Programs

Although the Department should resist requiring a specific design or a requirement that the manufacturer somehow demonstrate that the "bolt-on" device is actually being utilized, PJM suggests that as part of its waiver application, *manufacturers describe and document the steps they have taken to consult with the electric industry so as to be able to document that they have installed a device that is interactive with and capable of connecting to a wide range of utility demand response programs*. The manufacturer should be given the option of documenting, with letters from industry associations, the consultations that have occurred; and for illustrative purposes, manufacturers should have the ability to describe the type of programs, broadly, with which these water heaters are compatible. PJM would be willing to assist manufacturers in undertaking such communications with utilities in our 13-state footprint.¹⁷

¹⁷ The Department should not undertake, through this rulemaking, to proscribe the exact interactive capabilities of that device other than requiring that it be able to accept an electronic signal that controls the cycling of its water heating function. In the Energy Independence and Security Act of 2007, Congress assigned the development of the exact specifications and internet protocols associated with such devices to the National Institute of Standards and Technology ("NIST") (42 U.S.C. § 17385). DOE should reference



Armed with this information, along with the agreement by utilities to supplement their EIA forms to report on the penetration of such programs on an annual basis, the Department would be able to track the penetration of these water heaters and the overall success of the program. The Department would retain the right to reopen this docket and sunset the program, after appropriate advanced notice to the industry and an opportunity for the industry to cure any identified problems, causing “leakage” concerns.¹⁸

Addressing “Leakage”: The Practical and Legal Limitations on the Department’s Authority.

PJM has outlined below proposed conditions that would be appropriate for the Department to add as part of its Final Rule permitting the manufacture and sale of grid interactive electric resistance water heaters. Before reviewing the specifics of the proposal, PJM wishes to raise concerns with attempts in the proposed rule to limit the waiver period to one year or place limits on the distribution of these appliances as a means to address Department concerns about leakage.

The Point of Manufacture Nature of the Department’s Regulatory Program

The appliance efficiency program is, by its very nature, a point of manufacture/point of shipment regulatory program. Any attempt by the Department to place conditions on the actual use of the product or its distribution would represent a significant overreach in Department authority in administering the appliance efficiency program. Moreover, as a practical matter, the proposals to address leakage in the proposed rule would prove unenforceable as they run afoul of state laws prohibiting utilities selling appliances¹⁹ or be so onerous as to destroy the incentive for manufacturers to invest in development of this new product.

that process in its Final Rule but not attempt to encroach on this specialized activity which Congress assigned to NIST.

¹⁸ In their Joint Comments, NRECA et al. have proposed a minimum three year notice period prior to any sunset of the authorization to manufacture provided through a specific waiver.

¹⁹ In addition to outright bans, utilities in a number of states are prohibited from recovering their costs of advertising such products. See e.g. *East Ohio Gas v. Pub. Util. Comm.*, 1 Ohio St. 3d 1988.



Although PJM understands the Department's concerns with water heaters not being used in the manner intended, PJM notes that Congress' regulatory scheme *already* limited the Department's reach beyond the manufacturing process. In short, Congress envisioned the possibility that consumers may operate a given appliance in a manner that disables certain of its most energy efficient features. Nevertheless, Congress was satisfied that a *point of manufacture* regulatory program would be sufficient thus indicating that some tolerance for "leakage" already exists under the statutory scheme.

The Laws of Economics Work to Temper Any Leakage Issues

Although the legal limitations on the Department's reach should itself be sufficient to temper attempts to regulate who can distribute the appliance or tie the number of appliances to specific utility programs, the Department should also be comforted by the fact that the laws of economics work to temper the "leakage" that might otherwise occur. Installation of a "bolt-on" grid interactive feature that is compatible with utility demand response programs will increase the cost of the appliance and make it less competitive with the electric heat pump. The only way for the consumer to offset this increased cost would be to enroll in a demand response program which can provide rebates based on the actual use of the appliance and the utility's establishing a means to control and cycle its use during peak periods. In the organized markets that make up two-thirds of the nation, as well as in many service areas covered by utility cooperatives, those rebates are substantial reflecting the real time value of curtailment of the product at peak periods. As system demand increases, the value of those rebates increases making it even more compelling for the consumer to utilize the product in the manner for which it was intended.

In short, legal limitations, the forces of economics and the impossibility of attempting to tie the manufacture of water heaters one for one to utility programs all compel a conclusion that the Department's restrictive provisions such as the one year waiver and limitations on distribution of the appliance are ill-advised.

The One Year Waiver Process Is Incompatible With Recognition of Water Heaters as a Demand Response Resource



From PJM’s perspective there is in fact a very specific legal “Catch-22” in the proposed rule related to the one-year waiver provision which will defeat the very purpose of using storage water heaters to meet future reliability needs and balance variable generation resources. PJM’s capacity market is designed to ensure that sufficient resources are procured *three years prior* to the actual year they will be called upon to serve reliability needs. This three year forward market has benefitted demand response resources greatly---it not only provides PJM with certainty of supplies but also provides a fixed revenue stream that customers can use to finance deployment of these resources²⁰.

A year by year renewal process is incompatible with the three year forward nature of PJM’s capacity market (and similar markets in other RTOs) as no entity will be willing to bid these resources into the market and face substantial penalties from PJM should at some point in the future DOE withdraw its approval for the future manufacture of the product. Nor can PJM rely upon a Demand Response program based on water heater controls to meet the region’s future reliability needs if PJM cannot count on the existence of that program in the three year forward delivery year. In short, the forward capacity market, which has provided a recognized source of certainty for utilities and revenue streams for demand response resources, will not be available to the very type of resource the capacity market was designed to incent as a result of the uncertainty associated with an annual renewal process. As noted below, PJM would urge a process which provides certainty for a period that is longer in length so as to be compatible with these existing markets and the realities associated with lead time to manufacture and market these water heaters.

Appropriate Conditions on Waiver Applications

PJM recognizes that appropriate conditions are needed on the proposed waiver. As a result, PJM proposed that the Final Rule detailing the contents of any waiver application should contain the conditions as set forth below. Moreover, the final rule should make clear that

²⁰ More information about PJM’s Capacity Market, called the Reliability Pricing Model, can be found here: <http://www.pjm.com/markets-and-operations/rpm.aspx>



manufacturers seeking waivers are free to propose means which are “equal or superior to” these conditions in order to address the requirements of the rule. Specifically, the Final Rule should:

- Require a demonstration by the manufacturer that the proposed product is able to receive an electronic signal that controls the heating elements;
- Demonstrate that the manufacturer has engaged in consultations with electric industry trade associations that the bolt on enhancements to the water heater make it fully usable in a number of demand response programs across the nation;
- Require that the product be packaged with information that it is to be used as part of a utility demand side response program;
- Provide that the authority for manufacture of the product may be revoked by the Department after 5 years notice and an opportunity to cure any identified Department concerns; and
- Note the Department’s intent to rely upon data provided to the EIA by utilities with demand response programs concerning penetration of grid interactive water heaters; and
- Signal the Department’s intent to monitor the program over the next five years including periodically seeking information from RTOs/ISOs and the utility industry and manufacturers on whether the program is achieving its intended results.

Conclusion

As noted above, PJM believes that the Department and the industry are at a critical cross-road. A timely and clear signal needs to be sent to manufacturers that they should retool their manufacturing lines and commit their capital resources to developing grid interactive electric resistance water heaters. Unfortunately, given the workings of the present standard, absent prompt action, the exact opposite message will be sent merely by inaction. PJM is grateful that



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the Department recognizes the changes in technology and the need to address this important issue. PJM stands ready as a key independent resource to assist the Department in the kind of product transformation that will meet the efficiency needs in a 21st century economy.

Respectfully submitted:

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