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April 15, 2022

Via CM/ECF
Mark Langer, Clerk of Court
U.S. Court of Appeals for the D.C. Circuit
E. Barrett Prettyman Courthouse
333 Constitution Ave., NW
Washington, DC 20001

Re: *American Public Gas Association v. DOE*, No. 20-1068
(mandate issued March 14, 2022)

Dear Mr. Langer:

On January 18, 2022, the Court issued an opinion and judgment granting the petition and "remand[ing] the Final Rule to DOE for the agency to take appropriate remedial action within 90 days" (i.e., by April 18, 2022). Opinion 22. We write to inform the Court that, in accordance with its decision, DOE has published a supplement to the Final Rule providing additional explanation in response to the deficiencies identified in the Court's opinion. *See* Ex. 1 (available at https://energy.gov/sites/default/files/2022-04/boiler-fr.pdf (last visited April 15, 2022))

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Sincerely,

<u>*/s/ Jack Starcher*</u>
Jack Starcher
Attorney for Defendants-Appellees

Exhibit 1

This document, concerning Commercial Packaged Boilers is an action issued by the Department of Energy. Though it is not intended or expected, should any discrepancy occur between the document posted here and the document published in the Federal Register, the Federal Register publication controls. This document is being made available through the Internet solely as a means to facilitate the public's access to this document.

[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Part 431

[EERE-2013-BT-STD-0030]

RIN 1904-AD01

Energy Conservation Program: Energy Conservation Standards for Commercial Packaged Boilers; Response to United States Court of Appeals for the District of Columbia Circuit Remand in American Public Gas Association v. United States Department of Energy

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Final rule; supplemental response to comments.

SUMMARY: On January 10, 2020, a final rule amending energy conservation standards for commercial packaged boilers was published in the *Federal Register*. The American Public Gas Association, Air-conditioning, Heating, and Refrigeration Institute, and Spire Inc. filed petitions for review of the final rule in the United States Courts of Appeals for the District of Columbia Circuit ("D.C. Circuit"), Fourth Circuit, and Eight Circuit, respectively. These petitions were consolidated in the D.C. Circuit. In its January 18, 2022, opinion, the D.C. Circuit remanded the final rule to the Department of Energy ("DOE") to supplement its responses to the following three issues raised during the public comment period: the random assignment of boilers to buildings, forecasted fuel prices, and estimated burner operating hours. This document provides additional explanation regarding these three issues.

DATES: This supplemental response to comments document is effective [**INSERT DATE OF PUBLICATION IN THE *FEDERAL REGISTER***]. The effective date of the final rule was March 10, 2020. Compliance with the amended standards established for commercial packaged boilers in that final rule is required on and after January 10, 2023.

ADDRESSES:

Docket: The docket for this activity, which includes *Federal Register* notices, comments, and other supporting documents/materials, is available for review at *www.regulations.gov*. All documents in the docket are listed in the *www.regulations.gov* index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

The docket web page can be found at *www.regulations.gov/docket/EERE-2013-BT-STD-0030*. The docket web page contains instructions on how to access all documents, including public comments, in the docket.

FOR FURTHER INFORMATION CONTACT:

Ms. Julia Hegarty, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (240) 597-6737. E-mail: *Julia.Hegarty@ee.doe.gov*.

Mr. Pete Cochran, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC 20585-0121. Telephone: (202) 586-9496. E-mail: *Peter.Cochran@hq.doe.gov*.

For further information on how to review the docket, contact the Appliance and Equipment Standards Program staff at (202) 287-1445 or by e-mail: *ApplianceStandardsQuestions@ee.doe.gov*.

SUPPLEMENTARY INFORMATION:

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I. Overview

In its January 18, 2022, opinion, the United States Court of Appeals for the District of Columbia Circuit remanded to the Department of Energy ("DOE") the final rule, *Energy Conservation Program: Energy Conservation Standards for Commercial Packaged Boilers*, EERE-2013-BT-STD-0030. *See American Public Gas Association v. United States Department of Energy*, No. 20-1068 (Jan. 18, 2022), 2022 WL 151923. In its opinion, the court determined that DOE failed to provide meaningful responses to comments with respect to three distinct issues related to the modeling used during the rulemaking proceeding: (1) the random assignment of boilers to buildings; (2) forecasted fuel prices; and (3) estimated burner operating hours. As a result, the court concluded that DOE failed to adequately explain why the rule satisfies the applicable clear and convincing evidence standard. To afford DOE the opportunity to cure these "failures to explain," the court remanded the final rule to DOE for the agency to take appropriate remedial action within 90 days. In this document, DOE provides further explanation addressing the three issues the court identified.

II. Background

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers ("ASHRAE") Standard 90.1 (ASHRAE Standard 90.1), "Energy Standard for Buildings Except Low-Rise Residential Buildings," sets industry energy efficiency levels for, among other things, commercial packaged boilers ("CPBs"). The Energy Policy and Conservation Act ("EPCA") directs that if ASHRAE amends Standard 90.1, DOE must adopt amended standards at the new ASHRAE efficiency level, unless DOE determines, supported by clear and convincing evidence, that adoption of a more stringent level would produce significant additional conservation of energy and would be technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(A)(ii)) Under EPCA, DOE must also review energy efficiency standards for CPBs every six years and determine, based on clear and convincing evidence, whether adoption of a more stringent standard would result in significant additional conservation of energy and is technologically feasible and economically justified. (42 U.S.C. 6313(a)(6)(C)) In determining whether a proposed standard is economically justified, EPCA requires DOE to consider the following seven factors: (1) economic impacts on manufacturers and consumers; (2) changes in total installation and operating costs for the covered product, *i.e.*, life-cycle costs; (3) total energy savings; (4) any likely decrease in a product's utility or performance; (5) impacts on competition as determined by the Attorney General; (6) need for national energy conversation; and (7) other factors DOE considers relevant. (42 U.S.C. 6313(a)(6)(B)(ii))

As ASHRAE has not amended the standards for CPBs since 2007,[1] DOE initiated the required 6-year lookback review in 2013.[2] DOE proposed amended standards for CPBs in a notice of proposed rulemaking published on March 24, 2016. 81 FR 15836. Subsequently, DOE issued a final rule amending standards for CPBs that was published on January 10, 2020. 85 FR 1592 ("January 2020 Final Rule").

III. Supplemental Response to Comments

In response to the remand in *American Public Gas Association v. United States Department of Energy*, the following discussion supplements the January 2020 Final Rule explanation of and response to comments regarding the assignment of boiler efficiencies to buildings, forecasted fuel prices, and estimated burner operating hours. The following discussion provides additional detail of the analyses presented in the final technical support document ("TSD") accompanying the January 2020 Final Rule.

A. Random Assignment of Boiler Efficiency to Buildings

DOE's initial response to stakeholders regarding the assignment of boiler efficiencies to buildings in the Monte Carlo model used to calculate life-cycle cost ("LCC") changes is in section IV.F.11 of the January 2020 Final Rule. 85 FR 1592, 1637-1638.

The LCC calculates, at the consumer level, the discounted savings in operating costs (less maintenance and repair costs) throughout the estimated life of the covered equipment, compared to any increase in the installed cost for the equipment likely to result directly from the imposition

[1] DOE adopted the 2007 ASHRAE standards in a final rule published on July 22, 2009. 74 FR 36312.
[2] DOE initiated the rulemaking process with a preliminary framework document that was published on September 3, 2013. 78 FR 54197.

of the standard. In conducting the LCC analysis, DOE first forecasts equipment shipments in the absence of new or amended standards ("no-new-standards case"), including the distribution of equipment efficiency across all consumers. To estimate the impact that new or amended standards would have on LCC (and energy savings), DOE then uses a "roll-up" scenario, which takes into consideration the same market failures as in the no-new-standards scenario, as discussed further below, to determine what changes will occur under the new standards. A roll-up scenario assumes that equipment efficiencies in the no-new-standards case, which do not meet the standard level under consideration, would "roll up" to the lowest efficiency required to meet the new efficiency standard level. For example, the January 2020 Final Rule established a minimum thermal efficiency of 84 percent for small gas-fired hot water CPBs (the product class with the largest number of shipments). But DOE estimates that in 2020 approximately 81.3 percent of the market for small gas-fired hot water CPBs already meets this minimum thermal efficiency.[3] As a result, DOE's analysis rolls up only the remaining 18.7 percent of the market, comprised of the least-efficient CPBs available, to the new minimum thermal efficiency of 84%. This roll-up in efficiencies results in the projected LCC and energy savings from the amended standard by forcing the less than 20% segment of the market that purchases lower efficiency CPBs to purchase a more-efficient, minimally compliant CPB. Consumers already purchasing higher efficiency equipment, more than 80% of the market in this example, are not impacted by a new or amended standard set at a lower efficiency level and, as a result, do not account for any of the LCC or energy savings projected to result from the amended rule.

To conduct its LCC analysis, DOE has developed spreadsheet models combined with a

[3] *See* appendix 8H of the final rule TSD.

commercially available program (*i.e.,* Crystal Ball). This allows DOE to explicitly model both the uncertainty and the variability in the inputs to the model using Monte Carlo simulation and probability distributions. The LCC results are displayed as distributions of impacts compared to the baseline conditions. Results are based on 10,000 samples per Monte Carlo simulation run.

As discussed in the January 2020 Final Rule[4] and the accompanying TSD,[5] to develop the no-new-standards case, DOE assembled data on the share of models in each equipment class, separated by draft type,[6] based on the Air-Conditioning, Heating and Refrigeration Institute ("AHRI") certification directory and on shipments data submitted by AHRI for small gas-fired hot water ("SGHW") and large gas-fired hot water ("LGHW") equipment classes broken down by efficiency. DOE utilized these data to develop the no-new-standards case efficiency distribution for each CPB equipment class. The efficiency distribution developed by DOE for each product class resulted in a shipment-weighted average efficiency that was consistent with the shipment-weighted values submitted by AHRI. This efficiency distribution was then used in assigning the efficiencies of installed CPBs under the no-new standards case.

To conduct the Monte Carlo simulation for the LCC analysis of a given product class in which the efficiencies of installed models are forecast over the analysis period, DOE developed a building sample from the Energy Information Administration's ("EIA") 2012 Commercial Building Energy Consumption Survey ("CBECS 2012")[7] and the 2009 Residential Energy

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[4] 85 FR 1592, 1635-1636.
[5] *See* section 8.2.2.9 of chapter 8 of the final rule TSD, and appendix 8H of the final rule TSD.
[6] The regulations for commercial packaged boilers prior to the January 2020 Final Rule listed 10 equipment classes with corresponding energy efficiency standards for each. 10 CFR 431.87; January 2019 edition. These equipment classes were based on (1) size (rated input), (2) heating media (hot water or steam), and (3) type of fuel used (oil or gas). Commercial packaged boilers are further classified according to draft type (*i.e.,* the means by which combustion gases are moved through the unit's stack.).
[7] EIA, 2012 Commercial Building Energy Consumption Survey, *www.eia.gov/consumption/commercial/* (Last accessed January 20, 2022).

Consumption Survey ("RECS 2009").[8] CBECS is a national sample survey that collects information on the stock of U.S. commercial buildings, including their energy-related building characteristics and energy usage data (consumption and expenditures). Commercial buildings include all buildings in which at least half of the floorspace is used for a purpose that is not residential, industrial, or agricultural. Similarly, RECS is a nationally representative sample of housing units that collects energy characteristics on the housing unit, usage patterns, and household demographics. This information is combined with data from energy suppliers to these homes to estimate energy costs and usage for heating, cooling, appliances and other end uses.

Each building in the sample was then assigned a boiler efficiency sampled from the no-new-standards case efficiency distribution for the appropriate equipment class. DOE was not able to assign a CPB efficiency to a building in the no-new-standards case based on building characteristics, since CBECS 2012 and RECS 2009 did not provide enough information to distinguish installed boilers by application type, distribution system, or return water temperature, and there were no shipments data disaggregating boiler efficiency by region or other criteria. The efficiency of a boiler was assigned based on the forecasted efficiency distribution (which is constrained by the shipment and model data collected by DOE and submitted by AHRI) and accounts for consumers that are already purchasing efficient CPBs.[9]

For example, as previously discussed, the January 2020 Final Rule established a minimum thermal efficiency of 84 percent for small gas-fired hot water CPBs (the product class

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[8] EIA, 2009 Residential Energy Consumption Survey, *www.eia.gov/consumption/residential/* (Last accessed January 20, 2022).

[9] Appendix 8H of the final rule TSD shows the no-new-standards case efficiency distributions for all product classes.

with the largest number of shipments), but DOE estimates that in 2020 approximately 81.3 percent of the market for small gas-fired hot water CPBs already meets this minimum thermal efficiency and thus will not be impacted by the final rule. The assignment of CPB efficiency in the LCC accounts for this distribution (*e.g.*, as models with at least an 84 percent efficiency represent approximately 81.3 percent of the market, there was an 81.3-percent chance that a building would be assigned a boiler with an 84 percent efficiency or higher).

As noted in the January 2020 Final Rule, AHRI and Burnham Holdings commented that the random assignment of no-new-standards case efficiencies (sampled from the developed efficiency distribution) in the LCC model is not correct, as this inherently assumes that the purchasers do not pay attention to costs and benefits in a world without standards. 85 FR 1592, 1637-1638. Instead, AHRI proposed an alternate approach that assigned the highest boiler efficiencies to scenarios involving the shortest payback periods. 85 FR 1592, 1637. In other words, AHRI assumed there were no market failures affecting consumer boiler purchases.

While DOE acknowledges that economic factors may play a role when building owners or builders decide on what type of boiler to install, assignment of boiler efficiency for a given installation, based solely on economic measures such as life-cycle cost or simple payback period, most likely would not fully and accurately reflect actual real-world installations. There are a number of commercial sector market failures discussed in the economics literature, including a number of case studies, that illustrate how purchasing decisions with respect to energy efficiency are likely to not be completely correlated with energy use, as described below. DOE noted some of these market failures affecting purchasing decisions in sections IV.F.11 and VI.A of the

January 2020 Final Rule, such as information asymmetry and the high costs of gathering and analyzing relevant information, the misaligned incentives between building owners (or landlords) and building operators, and the external benefits of improved energy efficiency (such as climate and health benefits) not captured by users of the equipment. 85 FR 1592, 1638, 1676. DOE also noted these same market failures in the March 2016 notice of proposed rulemaking. 81 FR 15836, 15913. The following discussion further expands on these market failures impacting the commercial sector and supplements DOE's discussion from the January 2020 Final Rule. Additionally, DOE has since become aware of several case studies and sources of data specific to the commercial packaged boiler market that support DOE's conclusion regarding the existence of market failures and DOE's assignment of boiler efficiency in the no-new-standards case. These case studies and sources of data further supplement and expand upon DOE's conclusion in the January 2020 Final Rule that an assignment of boiler efficiency based solely on calculated payback, without consideration of these market failures, "reflects an overly optimistic and unrealistic working market" and "may unreasonably bias the results." 85 FR 1592, 1637.

There are several market failures or barriers that affect energy decisions generally. Some of those that affect the commercial sector specifically are detailed below. However, more generally, there are several behavioral factors that can influence the purchasing decisions of complicated multi-attribute products, such as boilers. For example, consumers (or decision makers in an organization) are highly influenced by choice architecture, defined as the framing of the decision, the surrounding circumstances of the purchase, the alternatives available, and how they're presented for any given choice scenario.[10] The same consumer or decision maker may make different choices depending on the characteristics of the decision context (*e.g.*, the timing of the purchase, competing demands for funds), which have nothing to do with the characteristics of the alternatives themselves or their prices. Consumers or decision makers also face a variety of other behavioral phenomena including loss aversion, sensitivity to information salience, and other forms of bounded rationality.[11] Thaler, who won the Nobel Prize in Economics in 2017 for his contributions to behavioral economics, and Sunstein point out that these behavioral factors are strongest when the decisions are complex and infrequent, when feedback on the decision is muted and slow, and when there is a high degree of information asymmetry.[12] These characteristics describe almost all purchasing situations of appliances and equipment, including CPBs. The installation of a new or replacement CPB in a commercial building is a complex, technical decision involving many actors and is done very infrequently, as evidenced by the CPB mean lifetime of nearly 25 years. 85 FR 1592, 1634. Additionally, it would take at least one full heating season for any impacts on operating costs to be fully apparent. Further, if the purchaser of the CPB is not the entity paying the energy costs (*e.g.,* a building owner and tenant), there may be little to no feedback on the purchase. These behavioral factors are in addition to the more specific market failures described as follows.

It is often assumed that because commercial and industrial customers are businesses that

[10] Thaler, R.H., Sunstein, C.R., and Balz, J.P. (2014). "Choice Architecture" in *The Behavioral Foundations of Public Policy*, Eldar Shafir (ed).

[11] Thaler, R.H., and Bernartzi, S. (2004). "Save More Tomorrow: Using Behavioral Economics in Increase Employee Savings," *Journal of Political Economy* 112(1), S164-S187. *See also* Klemick, H., et al. (2015) "Heavy-Duty Trucking and the Energy Efficiency Paradox: Evidence from Focus Groups and Interviews," *Transportation Research Part A: Policy & Practice*, 77, 154-166. (providing evidence that loss aversion and other market failures can affect otherwise profit-maximizing firms).

[12] Thaler, R.H., and Sunstein, C.R. (2008). Nudge: Improving Decisions on Health, Wealth, and Happiness. New Haven, CT: Yale University Press.

have trained or experienced individuals making decisions regarding investments in cost-saving measures, some of the commonly observed market failures present in the general population of residential customers should not be as prevalent in a commercial setting. However, there are many characteristics of organizational structure and historic circumstance in commercial settings that can lead to underinvestment in energy efficiency.

First, a recognized problem in commercial settings is the principal-agent problem, where the building owner (or building developer) selects the equipment and the tenant (or subsequent building owner) pays for energy costs.[13, 14] Indeed, more than a quarter of commercial buildings with a boiler in the CBECS 2012 sample are occupied at least in part by a tenant, not the building owner (indicating that, in DOE's experience, the building owner likely is not responsible for paying energy costs). Additionally, some commercial buildings have multiple tenants. There are other similar misaligned incentives embedded in the organizational structure within a given firm or business that can impact the choice of a CPB. For example, if one department or individual within an organization is responsible for capital expenditures (and therefore equipment selection) while a separate department or individual is responsible for paying the energy bills, a market failure similar to the principal-agent problem can result.[15] Additionally, managers may have other responsibilities and often have other incentives besides operating cost minimization, such

[13] Vernon, D., and Meier, A. (2012). "Identification and quantification of principal–agent problems affecting energy efficiency investments and use decisions in the trucking industry," *Energy Policy*, 49, 266-273.

[14] Blum, H. and Sathaye, J. (2010). "Quantitative Analysis of the Principal-Agent Problem in Commercial Buildings in the U.S.: Focus on Central Space Heating and Cooling," Lawrence Berkeley National Laboratory, LBNL-3557E. (Available at: *escholarship.org/uc/item/6p1525mg*) (Last accessed January 20, 2022).

[15] Prindle, B., Sathaye, J., Murtishaw, S., Crossley, D., Watt, G., Hughes, J., and de Visser, E. (2007). "Quantifying the effects of market failures in the end-use of energy," Final Draft Report Prepared for International Energy Agency. (Available from International Energy Agency, Head of Publications Service, 9 rue de la Federation, 75739 Paris, Cedex 15 France).

as satisfying shareholder expectations, which can sometimes be focused on short-term returns.[16] Decision-making related to commercial buildings is highly complex and involves gathering information from and for a variety of different market actors. It is common to see conflicting goals across various actors within the same organization as well as information asymmetries between market actors in the energy efficiency context in commercial building construction.[17]

Second, the nature of the organizational structure and design can influence priorities for capital budgeting, resulting in choices that do not necessarily maximize profitability.[18] Even factors as simple as unmotivated staff or lack of priority-setting and/or a lack of a long-term energy strategy can have a sizable effect on the likelihood that an energy efficient investment will be undertaken.[19] U.S. tax rules for commercial buildings may incentivize lower capital

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[16] Bushee, B. J. (1998). "The influence of institutional investors on myopic R&D investment behavior," *Accounting Review*, 305-333.
DeCanio, S.J. (1993). "Barriers Within Firms to Energy Efficient Investments," *Energy Policy*, 21(9), 906–914. (explaining the connection between short-termism and underinvestment in energy efficiency).
[17] International Energy Agency (IEA). (2007). Mind the Gap: Quantifying Principal-Agent Problems in Energy Efficiency. OECD Pub. (Available at: *www.iea.org/reports/mind-the-gap*) (Last accessed January 20, 2022)
[18] DeCanio, S. J. (1994). "Agency and control problems in US corporations: the case of energy-efficient investment projects," *Journal of the Economics of Business*, 1(1), 105-124.
Stole, L. A., and Zwiebel, J. (1996). "Organizational design and technology choice under intrafirm bargaining," *The American Economic Review*, 195-222.
[19] Rohdin, P., and Thollander, P. (2006). "Barriers to and driving forces for energy efficiency in the non-energy intensive manufacturing industry in Sweden," *Energy*, 31(12), 1836-1844.
Takahashi, M and Asano, H (2007). "Energy Use Affected by Principal-Agent Problem in Japanese Commercial Office Space Leasing," In *Quantifying the Effects of Market Failures in the End-Use of Energy*. American Council for an Energy-Efficient Economy. February 2007.
Visser, E and Harmelink, M (2007). "The Case of Energy Use in Commercial Offices in the Netherlands," In *Quantifying the Effects of Market Failures in the End-Use of Energy*. American Council for an Energy-Efficient Economy. February 2007.
Bjorndalen, J. and Bugge, J. (2007). "Market Barriers Related to Commercial Office Space Leasing in Norway," In *Quantifying the Effects of Market Failures in the End-Use of Energy*. American Council for an Energy-Efficient Economy. February 2007.
Schleich, J. (2009). "Barriers to energy efficiency: A comparison across the German commercial and services sector," *Ecological Economics*, 68(7), 2150-2159.
Muthulingam, S., et al. (2013). "Energy Efficiency in Small and Medium-Sized Manufacturing Firms," *Manufacturing & Service Operations Management*, 15(4), 596-612. (Finding that manager inattention contributed to the non-adoption of energy efficiency initiatives).

expenditures, since capital costs must be depreciated over many years, whereas operating costs can be fully deducted from taxable income or passed through directly to building tenants.[20]

Third, there are asymmetric information and other potential market failures in financial markets in general, which can affect decisions by firms with regard to their choice among alternative investment options, with energy efficiency being one such option.[21] Asymmetric information in financial markets is particularly pronounced with regard to energy efficiency investments.[22] There is a dearth of information about risk and volatility related to energy efficiency investments, and energy efficiency investment metrics may not be as visible to investment managers,[23] which can bias firms towards more certain or familiar options. This market failure results not because the returns from energy efficiency as an investment are inherently riskier, but because information about the risk itself tends not to be available in the

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Boyd, G.A., Curtis, E.M. (2014). "Evidence of an 'energy management gap' in US manufacturing: Spillovers from firm management practices to energy efficiency," *Journal of Environmental Economics and Management*, 68(3), 463-479.

[20] Lovins, A. (1992). Energy-Efficient Buildings: Institutional Barriers and Opportunities. (Available at: *rmi.org/insight/energy-efficient-buildings-institutional-barriers-and-opportunities/*) (Last accessed January 20, 2022).

[21] Fazzari, S. M., Hubbard, R. G., Petersen, B. C., Blinder, A. S., and Poterba, J. M. (1988). "Financing constraints and corporate investment," *Brookings Papers on Economic Activity*, 1988(1), 141-206.

Cummins, J. G., Hassett, K. A., Hubbard, R. G., Hall, R. E., and Caballero, R. J. (1994). "A reconsideration of investment behavior using tax reforms as natural experiments," *Brookings Papers on Economic Activity*, 1994(2), 1-74.

DeCanio, S. J., and Watkins, W. E. (1998). "Investment in energy efficiency: do the characteristics of firms matter?" *Review of Economics and Statistics*, 80(1), 95-107.

Hubbard R.G. and Kashyap A. (1992). "Internal Net Worth and the Investment Process: An Application to U.S. Agriculture," *Journal of Political Economy,* 100, 506-534.

[22] Mills, E., Kromer, S., Weiss, G., and Mathew, P. A. (2006). "From volatility to value: analysing and managing financial and performance risk in energy savings projects," *Energy Policy*, 34(2), 188-199.

Jollands, N., Waide, P., Ellis, M., Onoda, T., Laustsen, J., Tanaka, K., and Meier, A. (2010). "The 25 IEA energy efficiency policy recommendations to the G8 Gleneagles Plan of Action," *Energy Policy*, 38(11), 6409-6418.

[23] Reed, J. H., Johnson, K., Riggert, J., and Oh, A. D. (2004). "Who plays and who decides: The structure and operation of the commercial building market," U.S. Department of Energy Office of Building Technology, State and Community Programs. (Available at: *www1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/who_plays_who_decides.pdf*) (Last accessed January 20, 2022).

same way it is for other types of investment, like stocks or bonds. In some cases energy efficiency is not a formal investment category used by financial managers, and if there is a formal category for energy efficiency within the investment portfolio options assessed by financial managers, they are seen as weakly strategic and not seen as likely to increase competitive advantage.[24] This information asymmetry extends to commercial investors, lenders, and real-estate financing, which is biased against new and perhaps unfamiliar technology (even though it may be economically beneficial).[25] Another market failure known as the first-mover disadvantage can exacerbate this bias against adopting new technologies, as the successful integration of new technology in a particular context by one actor generates information about cost-savings, and other actors in the market can then benefit from that information by following suit; yet because the first to adopt a new technology bears the risk but cannot keep to themselves all the informational benefits, firms may inefficiently underinvest in new technologies.[26]

In sum, the commercial and industrial sectors face many market failures that can result in an under-investment in energy efficiency. This means that discount rates implied by hurdle rates[27] and required payback periods of many firms are higher than the appropriate cost of capital for the investment.[28] The preceding arguments for the existence of market failures in the

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[24] Cooremans, C. (2012). "Investment in energy efficiency: do the characteristics of investments matter?" *Energy Efficiency*, 5(4), 497-518.
[25] Lovins 1992, op. cit.
The Atmospheric Fund. (2017). Money on the table: Why investors miss out on the energy efficiency market. (Available at: *taf.ca/publications/money-table-investors-energy-efficiency-market/*) (Last accessed January 20, 2022).
[26] Blumstein, C. and Taylor, M. (2013). Rethinking the Energy-Efficiency Gap: Producers, Intermediaries, and Innovation. Energy Institute at Haas Working Paper 243. (Available at: *haas.berkeley.edu/wp-content/uploads/WP243.pdf*) (Last accessed April 6, 2022).
[27] A hurdle rate is the minimum rate of return on a project or investment required by an organization or investor. It is determined by assessing capital costs, operating costs, and an estimate of risks and opportunities.
[28] DeCanio 1994, op. cit.

commercial and industrial sectors are corroborated by empirical evidence. One study in particular showed evidence of substantial gains in energy efficiency that could have been achieved without negative repercussions on profitability, but the investments had not been undertaken by firms.[29] The study found that multiple organizational and institutional factors caused firms to require shorter payback periods and higher returns than the cost of capital for alternative investments of similar risk. Another study demonstrated similar results with firms requiring very short payback periods of 1-2 years in order to adopt energy-saving projects, implying hurdle rates of 50 to 100 percent, despite the potential economic benefits.[30] A number of other case studies similarly demonstrate the existence of market failures preventing the adoption of energy-efficient technologies in a variety of commercial sectors around the world, including office buildings,[31] supermarkets,[32] and the electric motor market.[33]

The existence of market failures in the commercial and industrial sectors is well supported by the economics literature and by a number of case studies. If DOE developed an efficiency distribution that assigned boiler efficiency in the no-new-standards case solely according to energy use or economic considerations such as life-cycle cost or payback period, the resulting distribution of efficiencies within the building sample would not reflect any of the

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[29] DeCanio, S. J. (1998). "The Efficiency Paradox: Bureaucratic and Organizational Barriers to Profitable Energy-Saving Investments," *Energy Policy*, 26(5), 441-454.
[30] Andersen, S.T., and Newell, R.G. (2004). "Information programs for technology adoption: the case of energy-efficiency audits," *Resource and Energy Economics*, 26, 27-50.
[31] Prindle 2007, op. cit.
Howarth, R.B., Haddad, B.M., and Paton, B. (2000). "The economics of energy efficiency: insights from voluntary participation programs," *Energy Policy*, 28, 477-486.
[32] Klemick, H., Kopits, E., Wolverton, A. (2017). "Potential Barriers to Improving Energy Efficiency in Commercial Buildings: The Case of Supermarket Refrigeration," *Journal of Benefit-Cost Analysis*, 8(1), 115-145.
[33] de Almeida, E.L.F. (1998). "Energy efficiency and the limits of market forces: The example of the electric motor market in France", *Energy Policy*, 26(8), 643-653.
Xenergy, Inc. (1998). United States Industrial Electric Motor Systems Market Opportunity Assessment. (Available at: *www.energy.gov/sites/default/files/2014/04/f15/mtrmkt.pdf*) (Last accessed January 20, 2022).

market failures or behavioral factors above. DOE thus concludes such a distribution would not be representative of the CPB market. Further, even if a specific building/organization is not subject to the market failures above, the purchasing decision of CPB efficiency can be highly complex and influenced by a number of factors not captured by the building characteristics available in the CBECS or RECS samples. These factors can lead to building owners choosing a CPB efficiency that deviates from the efficiency predicted using only energy use or economic considerations such as life-cycle cost or payback period (as calculated using the information from CBECS 2012 or RECS 2009).

DOE notes that EIA's Annual Energy Outlook[34] ("AEO") is another energy use model that implicitly includes market failures in the commercial sector. In particular, the commercial demand module[35] includes behavioral rules regarding capital purchases such that in replacement and retrofit decisions, there is a strong bias in favor of equipment of the same technology (*e.g.*, boiler efficiency) despite the potential economic benefit of choosing other technology options. Additionally, the module assumes a distribution of time preferences regarding current versus future expenditures. For space heating, approximately half of the total commercial floorspace is assigned one of the two highest time preference premiums. This translates into very high discount rates (and hurdle rates) and represents floorspace for which equipment with the lowest capital cost will almost always be purchased without consideration of operating costs. DOE's assumptions regarding market failures are therefore consistent with other prominent energy consumption models.

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[34] EIA, Annual Energy Outlook, *www.eia.gov/outlooks/aeo/* (Last accessed January 25, 2022).
[35] For further details, see: *www.eia.gov/outlooks/aeo/assumptions/pdf/commercial.pdf* (Last accessed January 25, 2022).

Although the January 2020 rulemaking record sufficiently supports DOE's approach, DOE conducted an additional search after the January 2020 Final Rule was issued for documentation of actual recent gas-fired commercial hot water boiler installations that included efficiency details, to further supplement DOE's conclusions that market failures cause consumers to base purchasing decisions on factors other than minimizing payback periods.[36] This additional documentation, as discussed in more detail below, further reinforces the validity of DOE's approach to assigning boiler efficiencies in the January 2020 Final Rule.

First, DOE obtained data from the Federal Energy Management Program ("FEMP")[37] on commercial gas-fired hot water boiler installations in government buildings from 2000 to 2013. DOE divided the data into the same North and Rest of Country regions[38] as considered in the 2007 residential furnace final rule. 72 FR 65136, 65146–65147 (Nov. 19, 2007). One might

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[36] DOE issued the January 2020 Final Rule in December 2016. In accordance with the error correction process in 10 CFR 430.5, DOE did not immediately submit the rule to the *Federal Register* for publication in order to allow the public and DOE the opportunity to identify any errors in the regulatory text. Following litigation in the Ninth Circuit, *see Natural Res. Def. Council, Inc. v. Perry*, 940 F.3d 1072 (9th Cir. 2019), the Department submitted the rule that was issued in December 2016 to the *Federal Register* for publication in December 2019. The rule was subsequently published on January 10, 2020.

[37] Prior to 2014, FEMP had separate minimum energy efficiency designations for condensing and non-condensing gas-fired commercial hot water boilers, meaning that under Federal requirements for procuring energy efficient equipment the initial decision of whether to install a condensing or non-condensing unit was left to the Federal agency. (Available at *web.archive.org/web/20130114025912/http://www1.eere.energy.gov:80/femp/technologies/eep_boilers.html*) (Last accessed January 20, 2022). Since 2014, FEMP mandates condensing gas-fired commercial hot water boilers, except when an agency demonstrates that selecting the FEMP designated efficiency level may not be cost effective. (Available at: *energy.gov/eere/femp/federal-energy-management-program*) (Last accessed January 20, 2022).

[38] The Northern region comprises states with population-weighted heating degree days (HDD) equal to or greater than 5,000. This includes Alaska, Colorado, Connecticut, Idaho, Illinois, Indiana, Iowa, Kansas, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Dakota, Ohio, Oregon, Pennsylvania, Rhode Island, South Dakota, Utah, Vermont, Washington, West Virginia, Wisconsin, and Wyoming. Rest of Country region comprises states with population-weighted HDD less than 5,000. This includes Alabama, Arizona, Arkansas, California, Delaware, Florida, Georgia, Hawaii, Kentucky, Louisiana, Maryland, Mississippi, Nevada, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and the District of Columbia.

expect that highly efficient condensing boilers would be more common in colder climates. However, these data show that in warm climates in the Rest of Country states, including California, Texas, Oklahoma, Hawaii, and others, condensing boilers, which are generally more efficient, were typically installed (95 percent of buildings had a condensing boiler installation out of 60 buildings, with one building installing both condensing and non-condensing boilers). In contrast, in colder climates in the North, including West Virginia, New Jersey, Washington, and others, non-condensing boilers, which are generally less efficient, are not uncommon (47 percent of buildings had a non-condensing boiler installation out of 19 buildings).[39] DOE acknowledges that condensing fractions are likely higher for the buildings in the FEMP data during this time period compared to other commercial buildings due to Federal mandates and management goals related to energy efficiency and conservation. DOE also acknowledges the small sample size of buildings with CPB installations obtained from FEMP. However, using economic criteria based on energy use or payback period alone, one might not predict that non-condensing gas-fired boilers would be more likely installed in colder climates. These real-world installations are indicative of complex decision-making.

DOE also gathered recent installation data and case studies for areas within the North region that demonstrate a significant fraction of installations are for non-condensing commercial boilers. Data on building permits from Milwaukee[40] indicate that there are many installations of gas-fired non-condensing hot water boilers in a very cold climate (46 percent of buildings had a

[39] FEMP gas-fired hot water boiler building data (Available at: *www.regulations.gov/document/EERE-2013-BT-STD-0030-0101*).

[40] DOE examined building permit data from several jurisdictions in different states, however only the City of Milwaukee data contained the necessary information to determine boiler efficiency for individual permits.

non-condensing boiler installed out of 50 remodeled buildings).[41,42] In a study in Massachusetts, interviewed manufacturers stated that they expect the market for non-condensing boilers to persist for some replacement situations.[43] In a study of 105 multifamily buildings in Minnesota (ranging in size from 5 units to over 50 units), 85 percent of buildings with a gas-fired boiler have a non-condensing gas boiler despite the cold climate.[44] These studies indicate that a cold climate (and therefore a large heating load) does not necessarily mean that high-efficiency boilers will predominate. Additionally, in the case of an emergency replacement (*e.g.*, a boiler failing in the middle of winter), buildings are likely to adopt a familiar "like-for-like" replacement with the same technology. If the existing technology is non-condensing, then these emergency replacements are likely to be non-condensing as well, even in a cold climate.

Finally, DOE also examined the data available in Northwest Energy Efficiency Alliance's 2019 Commercial Building Stock Assessment "CBSA"), published in May 2020.[45] The CBSA is a regional study characterizing the energy consumption and building characteristics of commercial buildings throughout the Northwest region of the country. The study consists of detailed site visits to 932 commercial buildings across 12 building types and includes on-site assessments, building staff interviews, and utility submission of energy consumption data. The rated boiler efficiency is a key variable captured by CBSA, with efficiencies of installed boilers

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[41] City of Milwaukee Land Management System. Boiler New Permit (10/24/2016-08/11/2017). (Available at: *aca-prod.accela.com/MILWAUKEE/Default.aspx*) (Last accessed January 20, 2022).
[42] Boiler model data was used to determine efficiency and type.
[43] DNV-GL. (2017). Gas Boiler Market Characterization Study Phase II - Final Report. (Available at: *ma-eeac.org/wp-content/uploads/Gas-Boiler-Market-Characterization-Study-Phase-II-Final-Report.pdf*) (Last accessed January 20, 2022).
[44] Minnesota Department of Commerce. (2013). Minnesota Multifamily Rental Characterization Study. (Available at: *slipstreaminc.org/sites/default/files/documents/research/minnesota-multifamily-rental-characterization-study.pdf*) (Last accessed January 20, 2022).
[45] The final report and all data files are available at: *neea.org/data/commercial-building-stock-assessments* (Last accessed January 25, 2022). The data file specific to boilers is *hydronic_systems-boilers.xlsx*.

ranging from below 80 percent to 97 percent. For gas-fired hot water boilers, an efficiency of 85 percent and below is generally considered to be non-condensing.

DOE specifically examined the subset of buildings with gas-fired, mechanical draft, hot water boilers whose function includes space heating. DOE limited the subset of buildings to those with a boiler input capacity equal to or greater than 300,000 Btu/h to match the CPB equipment class definitions. Building characteristics include the conditioned floor area and the annual, weather-normalized gas consumption in therms[46] (*i.e.*, normalized to the weather in a typical year). Some buildings have multiple identical boilers staged together into one system (with a boiler system input capacity equal to the sum of each individual boiler's input capacity).[47] Some buildings are served by multiple boiler systems, likely servicing different sections of the building. In these cases, the conditioned floor area and facility gas consumption were split evenly among the number of boiler systems for ease of comparison. In total this subset represents 53 boiler systems, although not every building includes a complete set of data. Table III.1 shows the number of boiler systems above and below a rated efficiency of 86 percent, across a number of different characteristics. For each characteristic, the sample is approximately divided into two similarly sized subsets, with an additional subset showing the extreme end of the distribution.

Table III.1 Number of Buildings* in CBSA By Boiler Efficiency Across Selected Characteristics

	rated efficiency below 86 percent	**rated efficiency at or above 86 percent**
conditioned floor area per boiler system		

[46] One therm is equal to 100,000 BTUs.
[47] Staging multiple boilers together may be desired in order to provide redundancy, or to manage average and peak heating loads.

< 70,000 sq ft	9	14
≥ 70,000 sq ft	13	14
≥ 100,000 sq ft	5	6
boiler system input capacity		
< 2,500,000 Btu/h	10	17
≥ 2,500,000 Btu/h	14	12
≥ 5,000,000 Btu/h	8	6
annual, weather-normalized facility gas consumption per boiler system		
< 35,000 therms	12	14
≥ 35,000 therms	11	14
≥ 100,000 therms	6	6

* Buildings with a gas-fired, hot water, mechanical draft boiler whose function includes space heating and with an input capacity equal to or greater than 300,000 Bth/h.

Across each characteristic, there is a lack of any strong correlation with the efficiency of the existing boiler system. Buildings with boilers servicing a larger conditioned floor area do not preferentially have higher efficiency boilers. The same is true for buildings with higher capacity boilers installed, and for buildings with higher annual gas consumption. Additionally, neither the buildings with the largest conditioned floor area, the buildings with the largest capacity boilers, nor the buildings with the highest annual weather-normalized gas consumption have a systematic preference for high efficiency boilers. Without the consideration of potential market failures, one would expect a correlation with boiler efficiency.[48]

These examples indicate that CPB purchasing decisions are most likely subject to several market failures. These decisions can be complex and are not always made based on total building energy use, life-cycle cost, or payback period estimates. The data show that condensing and non-condensing boilers are installed in a variety of building types and that the building

[48] The 2019 CBSA also includes 7 buildings with a gas-fired, hot water, natural draft boiler system; 24 buildings with a gas-fired steam boiler system; and 5 buildings with an oil-fired, hot water boiler system. Of the 24 buildings with steam boilers, only 3 have boiler efficiencies greater than 85 percent. Only 1 building has a higher efficiency oil-fired boiler.

characteristics do not correlate strongly with the existing boiler efficiency.

For these reasons, DOE selected a random assignment of CPB boiler efficiency (sampled from the developed efficiency distribution, which is consistent with the overall shipment-weighted efficiency data submitted by AHRI) as a more appropriate representation of the market than if that assignment was based on energy use or payback period only. DOE acknowledges that a random sampling from a distribution of boiler efficiency is an approximation of what takes place in the commercial boiler market. However, given the factors discussed in the preceding paragraphs, DOE explains that an approach that relied only on apparent cost-effectiveness criteria using the information available in the CBECS or RECS samples would lead to a more unrepresentative estimate of the potential impact on the CPB market from an energy conservation standard compared to DOE's current approach.

At the present time, there are insufficient data to analyze site-specific economics that take into account a multitude of technical and other non-economic decision-making criteria in the analyses, as well as model the effects of various market failures, on a building-by-building level. In the absence of such a model and the necessary supporting data, DOE concludes that using a random assignment sampled from the developed efficiency distributions (consistent with stakeholder-submitted data) is a reasonable approach, one that simulates behavior in the CPB market, where market failures result in purchasing decisions not being perfectly aligned with economic interests, more realistically than relying only on apparent cost-effectiveness criteria derived from the limited information in CBECS or RECS. DOE further emphasizes that its approach does not assume that all purchasers of CPBs make economically irrational decisions (*i.e.*, the lack of a correlation is not the same as a negative correlation). As part of the random assignment, some buildings with large heating loads will be assigned higher efficiency CPBs, and some buildings with particularly low heating loads will be assigned baseline CPBs, which aligns with the available data. By using this approach, DOE acknowledges the uncertainty inherent in the data and minimizes any bias in the analysis by using random assignment, as opposed to assuming certain market conditions that are unsupported given the available evidence.

Finally, even if DOE were to assume the random assignment approach produced some overstatement of the economic benefits of the new standards—because one were to conclude that even with all of those market failures there may be more strictly rational purchasers in the market than the random distribution accounts for—for all of the reasons discussed above any such overstatement would be small and would not alter DOE's conclusion that the revised standards are economically justified. That is particularly clear given that DOE considers numerous factors in addition to any savings to consumers. For instance, the January 2020 Final Rule is expected to result in cumulative emission reductions of 16 million metric tons of carbon dioxide and 41 thousand tons of nitrogen oxides, among other pollutants. The present monetized value of the nitrogen oxide emissions reduction, for example, is estimated to be $35 million at a 7-percent discount rate and $99 million at a 3-percent discount rate. 85 FR 1592, 1597. There are also many significant unquantified benefits from the Rule, including additional environmental and public health benefits. When considering these benefits together with the other statutory factors listed in 42 U.S.C. 6313(a)(6)(B)(ii), DOE has an abiding conviction that its determination that the benefits of the standard exceed its burdens, *i.e.*, the standard is economically justified, is highly probable to be true. As a result, DOE found clear and convincing evidence that the standard was economically justified.

B. Fuel Prices

DOE clarifies its response to stakeholders in section IV.F.4 of the January 2020 Final Rule regarding the estimation of energy prices in the LCC analysis. 85 FR 1592, 1631-32.

As described in the January 2020 Final Rule and final rule TSD, DOE developed marginal energy prices (electricity, natural gas, and fuel oil) for use in the LCC analysis.[49] A marginal energy price reflects the cost or benefit of adding or subtracting one additional unit of energy consumption. The starting point for the estimation of marginal energy prices is with publicly available average energy prices published by the EIA in various publications (Form 826 data, natural gas prices, and State Energy Data System).[50] These data are disaggregated by state and by month and can be aggregated into the same reportable domains used in RECS and census divisions used in CBECS. The price data by month allow DOE to separately estimate winter (heating season) and non-winter (cooling season) energy prices. The detailed breakdown of these average energy prices by fuel type, region, and month is available in appendix 8C of the final rule TSD.

[49] *See* section IV.F.4 of the January 2020 Final Rule, sections 8.2.2.2 and 8.2.2.3 of chapter 8 of the final rule TSD, and appendix 8C of the final rule TSD.
[50] Form EIA-826 is now Form EIA-861M. Available at: *www.eia.gov/electricity/data/eia861m/* (Last accessed January 25. 2022).
Natural gas prices available at: *www.eia.gov/naturalgas/* (Last accessed January 25, 2022).
State Energy Data System available at: *www.eia.gov/state/seds/* (Last accessed January 25, 2022).

EIA data additionally provides historical monthly energy consumption and total energy expenditures by state. By analyzing how total expenditures change with changes in energy consumption, DOE can estimate seasonal marginal energy price factors. These changes in expenditures are due to the marginal changes in energy consumption and exclude, for example, fixed costs, connection fees, and other surcharges. In a regression of total expenditures versus total energy consumption, the slope represents the marginal price. DOE used a 10-year average across the same regional divisions in either RECS or CBECS to determine seasonal marginal price factors in order to transform the average energy prices into marginal energy prices. The detailed breakdown of these marginal energy price factors by fuel type and region, for both winter and non-winter months, is available in appendix 8C of the final rule TSD.

These detailed estimates of marginal energy prices are then used in the LCC and NIA analyses. To project energy prices in future years, DOE relied on energy price projections from EIA's AEO to develop energy price indices over time and scaled marginal prices accordingly.

In response to the notice of proposed rulemaking published prior to the January 2020 Final Rule, DOE received comments on marginal energy prices and, in particular, on the accuracy of the marginal rates paid by larger load consumers. DOE noted that the Gas Associations (American Gas Association, American Public Gas Association) commented that the analysis should adjust the energy price calculation methodology using marginal prices to use a tariff-based approach to make the analysis more robust. Spire commented that DOE used erroneous utility marginal energy pricing and forecasts in its analysis resulting in overstated benefits, and that consumers with large loads do not pay the same marginal rates as an average commercial consumer. PG&E agreed with Spire that larger consumers pay less for utilities. And AHRI commented that the marginal gas rates do not accurately reflect what larger consumers pay. 85 FR 1592, 1632. DOE further acknowledged comments from Spire asserting that EIA data is completely inaccurate for its largest consumers and that transport rates are typically used, and from Phoenix Energy Management stating that the largest consumers also hedge gas prices by buying and selling futures and commenting that it is extremely difficult to figure out what the true cost of the energy is. *Id.*

Regarding the usage of EIA data and comparisons to tariff data, DOE emphasizes that the EIA data provide complete coverage of all utilities and all customers, including larger commercial and industrial utility customers that may have discounted energy prices. The actual rates paid by individual customers are captured and reflected in the EIA data and are averaged over all customers in a state. DOE has previously compared these two approaches for determining marginal energy price factors in the residential sector. In a September 2016 supplemental notice of proposed rulemaking for residential furnaces, DOE compared its marginal natural gas price approach using EIA data with marginal natural gas price factors determined from residential tariffs submitted by stakeholders. 81 FR 65719, 65784 (Sept. 23, 2016). The submitted tariffs represented only a small subset of utilities and states and were not nationally representative, but DOE found that its marginal price factors were generally comparable to those computed from the tariff data (averaging across rate tiers).[51] DOE noted that a full tariff-based analysis would require information on each household's total baseline gas

[51] *See* appendix 8E of the TSD for the 2016 supplemental notice of proposed rulemaking for residential furnaces for a direct comparison, available at: *www.regulations.gov/document/EERE-2014-BT-STD-0031-0217* (Last accessed January 25, 2022).

consumption (to establish which rate tier is applicable) and how many customers are served by a utility on a given tariff. These data were not available in the public domain. By relying on EIA data, DOE noted, its marginal price factors represented all utilities and all states, averaging over all customers, and was therefore "more representative of a large group of consumers with diverse baseline gas usage levels than an approach that uses only tariffs." 81 FR 65719, 65784. While the above comparative analysis was conducted for residential consumers, the general conclusions regarding the accuracy of EIA data relative to tariff data remain the same for commercial consumers. DOE uses EIA data for determining both residential and commercial electricity prices and the nature of the data is the same for both sectors. DOE further notes that not all operators of CPBs are larger load utility customers. As reflected in the building sample derived from CBECS 2012 and RECS 2009 data, there are a range of buildings with varying characteristics, including multi-family residential buildings, that operate CPBs. The buildings in the LCC sample have varying heating load, square footage, and boiler capacity. Operators of CPBs are varied, some large and some smaller, and thus the determination of the applicable marginal energy price should reflect the average operator of CPBs.

DOE's approach is based on the largest, most comprehensive, most granular national data sets on commercial energy prices that are publicly available from EIA. The data from EIA are the highest quality energy price data available to DOE. The resulting estimated marginal energy prices do represent an average across all commercial customers in a given region (state or group of states for RECS, census division for CBECS). Some customers may have a lower marginal energy price, while others may have a higher marginal energy price. With respect to large customers who may pay a lower energy price, no tariffs were submitted to DOE during the rulemaking for analysis. Tariffs for individual non-residential customers can be very complex and generally depend on both total energy use and peak demand (especially for electricity). These tariffs vary significantly from one utility to another. While DOE was unable to identify data to provide a basis for determining a potentially lower price for larger commercial and industrial utility customers, either on a state-by-state basis or in a nationally representative manner, the historic data on which DOE did rely includes such discounts. The EIA data include both large non-residential customers with a potentially lower rate as well as more typical non-residential customers with a potentially higher rate. Thus, to the extent larger consumers of energy pay lower marginal rates, those lower rates are already incorporated into the EIA data, which would drive down EIA's marginal rates for all consumers. If DOE were to adjust downward the marginal energy price for a small subset of individual customers in the LCC Monte Carlo sample as suggested by commenters, it would also have to adjust upward the marginal energy price for all other customers in the sample to maintain the same marginal energy price averaged over all customers. Even assuming DOE could accomplish those adjustments in a reliable or accurate way, this upward adjustment in marginal energy price would affect the majority of buildings in the LCC sample. Operational cost savings would therefore both decrease and increase for different buildings in the LCC sample, yielding substantially the same overall average LCC savings result as DOE's current estimate.

In summary, DOE's current approach utilizes an estimate of marginal energy prices and captures the impact of actual utility rates paid by all customers, including those that enjoy lower marginal rates for whatever reason, in an aggregated fashion. Adjustments to this methodology are unlikely to change the average LCC results and therefore the conclusions of the January 2020 Final Rule are insensitive to this issue.

C. Burner Operating Hours

DOE clarifies its response to stakeholders in section IV.F.11 of the January 2020 Final Rule regarding the estimation of burner operating hours ("BOHs") in the LCC analysis. 85 FR 1592, 1637

BOHs are used to estimate energy consumption of elements other than the heating element (*e.g.*, electronic controls, fans). The BOHs are not used to estimate the amount of fuel consumed to meet a heating load but are the result of a separate heating load estimation and an assumed CPB capacity. Instead, heating load and the efficiency of the CPB are used to determine fuel consumption. As a result, CPBs with the same efficiency level, but different capacities will have different BOHs in meeting the same heating load. For example, in meeting a specific heating load a CPB with a lower capacity will have higher BOHs than a similarly efficient CPB with a higher capacity. The lower capacity CPB will burn fuel at a lower rate so it will need to be on longer to meet the heating load as compared to a larger capacity CPB, which will burn fuel at a higher rate. While the hours of operation differ between the CPBs of different capacities, the amount of fuel burned is the same (*i.e.*, the heating load and unit efficiency, not hours of operation, dictate fuel consumption). BOHs are therefore not a crucial component of determining operating costs in the LCC analysis. Operating costs are dominated by fuel consumption to meet the heating load, which as described in further detail below, is not dependent on any assumptions regarding BOHs.

A full discussion of boiler energy use and the determination of BOHs is available in chapter 7 and appendix 7B of the final rule TSD.[52] BOHs represent the amount of time the burner operates at full load. BOHs are not a primary input parameter separately estimated by DOE, but rather a derived quantity that is largely determined from the space heating fuel consumption reported in CBECS 2012 or RECS 2009. As described previously, CBECS and RECS are large, nationally representative surveys and the energy consumption and expenditure estimates are derived directly from utility billing data. CBECS and RECS data are the most robust energy consumption data for space heating available to DOE. CBECS and RECS form the basis of the LCC Monte Carlo sample for CPBs and both CBECS and RECS report space heating fuel consumption for each building in the surveys (determined from utility bill data). DOE estimated each building's heating load from this reported fuel consumption, coupled with estimates of the historical boiler efficiency, building shell efficiency, and adjustments for average climate conditions in each region.[53] BOHs are then calculated using the building heating load and the efficiency of the CPB of that building. BOHs are utilized to estimate auxiliary electricity consumption for the circulating pump, draft inducer (if applicable), igniter, and standby power.[54]

In the January 2020 Final Rule DOE included comments from AHRI in which AHRI

[52] Figure 7.3.1 in chapter 7 of the final rule TSD provides an overview of the energy use methodology.
[53] *See* equation 7.4 in the final rule TSD. Equation 7.5 shows the adjustment to average climate conditions. *See* appendix 7B for the derivation of existing boiler efficiency in 2012 and 2009 (the sample years for CBECS and RECS).
[54] *See* equation 7.9 and section 7.3.3 of the final rule TSD.

posited that either due to DOE's sizing assumption and/or due to the use of the CBECS energy use data in the sample itself, the energy use model produced excessively high operating hours in some instances and that these distort the economic results; and that AHRI's consultant suggested that a more logical approach for estimating may be to use directly measured data or estimated load data. 85 FR 1592, 1637.

As discussed, DOE derived the BOHs from CBECS and RECS data. BOH values are determined from building heating loads, which are themselves derived from reported fuel consumption data taken form large, nationally representative surveys. DOE therefore has a high degree of confidence in the resulting building heating loads. The presence of high BOHs in some instances is not an indication of an error, but due to the representative boiler capacity assigned in that instance.[55] However, the building heating load and resulting fuel consumption are fixed and these are the primary determinant of operating costs. Furthermore, adjusting the BOHs downward in some instances would require adjusting upward the BOHs in other instances to maintain the same average capacity, yielding the substantially the same overall average LCC results.

Once each building's heating load is determined, DOE can estimate BOHs in both the no-new-standards case and all potential standards cases using the assigned boiler efficiency, boiler capacity, and the number of boilers assigned to each building, with adjustments made for

[55] The engineering analysis and all downstream analyses utilize a representative capacity (or rated input) that aligns with the highest number of shipments. Using a representative capacity allows DOE to analyze certain equipment characteristics as a proxy for that equipment class. *See* section 5.2.1 in chapter 5 of the final rule TSD.

estimated return water temperatures and part load operation.[56] BOHs are constrained in the model to be, at most, 5,840 hours per year (two thirds of a year), although the vast majority of boilers have BOHs that are significantly lower than this maximum value.[57] For all but one product class, the median BOHs are below 1,000 hours. For context, 1,000 hours of operation represents approximately 8-9 hours per day for 4 months or 5-6 hours per day for 6 months. These median values are not unreasonable expectations for when the burner is on during the winter heating season in a commercial building, depending on the local climate. Furthermore, some commercial buildings may require heating for longer periods during the day during winter, including possibly 24 hours a day (*e.g.*, hospitals). BOHs of over 2000 hours represent one end of the distribution and only apply to a subset of buildings where heating loads are driven higher by climate, size, age, etc.; similarly, some buildings have BOHs under 500 hours, representing the other end of the distribution. Given that the median BOHs derived from the estimated building heating loads represent reasonable operating conditions, DOE therefore has no reason to suspect the building heating loads derived from CBECS and RECS are erroneous.

BOHs are inversely related to the number of boilers and overall boiler capacity assigned to each building. This means that in a building with multiple boilers, each individual boiler has fewer BOHs to meet the building heating load compared to another building with a similar building heating load with only a single boiler at the same capacity. The same is also true when comparing two single boilers of different capacity; the higher capacity boiler will have lower BOHs to meet the same building heating load. Larger capacity CPBs are typically installed in

[56] *See* equation 7.3 in the final rule TSD. See appendix 7B for a detailed discussion of adjustments made for return water temperature and part-load operation.
[57] Table 7B.2.8 in appendix 7B of the final rule TSD displays the distribution of BOHs for each CPB equipment class.

buildings with larger heating loads, but these loads are not necessarily proportional to the increase in CPB capacity. Therefore, it is not unusual for the larger capacity CPB equipment classes to have lower median BOHs in some instances.

Because BOHs are a derived quantity and not a primary input parameter, the estimated fuel consumption of each building in the LCC sample would be the same regardless of the assigned boiler capacity and number of boilers in a given building. BOHs do not affect the fuel consumption of the sample building. The annual fuel consumption in the no-new-standards and standards cases is largely set by the building heating load determined from CBECS or RECS, coupled with the assigned boiler efficiency. There may be individual buildings in the LCC sample at the extreme ends of the distribution with high or low BOHs due to the assigned boiler capacity. If, in the field, a larger capacity boiler (or multiple boilers) with the same efficiency were installed instead in that building, BOHs would go down but overall fuel consumption would remain the same to match the building heating load. Similarly, at the low end of the distribution, if a lower capacity boiler were installed in the field instead, BOHs would increase but fuel consumption would remain the same. The only impact of changes to BOHs would be with electricity consumption. Electricity consumption while the boiler is on would decrease with decreasing BOHs and increase with increasing BOHs; however, electricity consumption is a minor component of overall operating costs.[58] Adjustments to these BOHs at either end of the distribution would yield an overall average LCC savings result substantially the same as DOE's current estimate. In summary, higher and lower capacities may be present in the field (with

[58] The number of standby hours would increase with decreasing BOHs. Total standby electricity consumption (for those CPBs with standby power) would therefore increase, however this represents an even smaller fraction of total operating costs and would have a negligible impact on LCC results.

correspondingly lower and higher BOHs), however the net result of any adjustments would be a minimal impact to average LCC savings and the percentage of negatively impacted consumers.

As an illustration of the small impact of electricity consumption adjustments, a small gas-fired hot water CPB at a thermal efficiency of 84 percent with a typical heating load has an estimated average annual fuel use of 863.7 million Btus per year ("MMBtu/yr") and an estimated average annual electricity consumption of 683.5 kilowatt-hours per year ("kWh/yr").[59] Assuming this CPB is in New England, with a commercial natural gas price of $10.56/MMBtu and a commercial electricity price of $0.15/kWh,[60] this results in an annual operating cost of $9,121 for natural gas and $103 for electricity. The electricity consumption of the auxiliary equipment and standby power accounts for approximately 1 percent of total energy costs. The difference in electricity consumption between efficiency levels is an even smaller fraction, compared to the difference in natural gas consumption between efficiency levels. Changes to BOHs both upward and downward would have a negligible impact on overall LCC savings results given that the fuel consumption is the dominant factor and it is determined by the heating load and assigned boiler efficiency. Therefore, the conclusions of the January 2020 Final Rule are insensitive to adjustments to BOHs.

IV. Procedural Issues and Regulatory Review

DOE has concluded that the determinations made pursuant to the various procedural requirements applicable to the January 2020 Final Rule remain unchanged for this supplemental response to comments. These determinations are set forth in the January 2020 Final Rule. 85

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[59] *See* table 7.4.1 in chapter 7 of the final rule TSD.

[60] *See* section 8.2.2.2 in chapter 8 of the final rule TSD.

FR 1592, 1676–1681. Because the rule was remanded without vacatur for further explanation, DOE was able to provide this explanation without opening another notice and comment period. *See Chamber of Commerce v. SEC*, 443 F.3d 890, 900 (D.C. Cir. 2006).

In the alternative, however, DOE finds that, pursuant to the Administrative Procedure Act, 5 U.S.C. 553(b), there is good cause to not issue a separate notice to solicit public comment on the supplemental responses to comments contained in this document. This document does not change the determinations made by DOE in the January 2020 Final Rule, but is a supplement to that final rule, which already went through notice and comment. This document provides further explanation to the response to comments already provided. In addition, this supplement to the January 2020 Final Rule is issued pursuant to a court order directing DOE to provide supplemental responses to certain comments within 90 days. Issuing a separate notice to solicit public comment during that time period would be impracticable, unnecessary, and contrary to the public interest.

Signing Authority

This document of the Department of Energy was signed on April 14, 2022, by Kelly J. Speakes-Backman, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the *Federal Register*.

Signed in Washington, DC, on April 14, 2022.

X Kelly Speakes-Backman

Digitally signed by Kelly Speakes-Backman
Date: 2022.04.14 15:19:00 -04'00'

Kelly J. Speakes-Backman
Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy