Energy Conservation Standards
Rulemaking Framework Document for
Furnace Fans
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U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
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ACEEE	American Council for an Energy Efficient Economy
AECR	annual energy consumption rating
AEO	Annual Energy Outlook
AHRI	Air-conditioning, Heating, and Refrigeration Institute
AMCA	The Air Movement and Control Association International, Inc.
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BOH	burner operating hours
BOM	bill of materials
BT	Building Technologies Program
Btu	British Thermal Unit
CAC	central air conditioner
CAIR	Clean Air Interstate Rule
CAMR	Clean Air Mercury Rule
cfm	cubic feet per minute
CDD	cooling degree day
CFR	Code of Federal Regulations
CGS	cost of goods sold
CO_2	carbon dioxide
CSA	Canadian Standards Association
DC	District of Columbia
DOE	U.S. Department of Energy
DOJ	U.S. Department of Justice
EA	Environmental Assessment
ECM	electronically commutated motor
EGU	electricity generating unit
EIA	Energy Information Administration
EISA 2007	Energy Independence and Security Act of 2007
EPA	U.S. Environmental Protection Agency
EPACT 2005	Energy Policy Act of 2005
EPCA	Energy Policy and Conservation Act
FR	Federal Register
GDP	Gross Domestic Product
GHG	greenhouse gas emissions
GRIM	Government Regulatory Impact Model
HARDI	Heating, Air-Conditioning and Refrigeration International
HCL	house cooling load
HDD	heating degree-days
Hg	mercury
HHL	house heating load
hp	horsepower
HVAC	heating, ventilation, and air conditioning
Hz	Hertz
IEC	International Electrotechnical Commission

ImSET	Impact of Sector Energy Technologies
INPV	industry net present value
in.w.c.	inches water column
kWh	kilowatt hour
LCC	life-cycle cost
LPG	liquid petroleum gas
LSC	labor-scaling costs
MIA	manufacturer impact analysis
MPC	manufacturer production cost
MSP	manufacturer selling price
NCI	Navigant Consulting, Inc.
NEMS	National Energy Modeling System
NEMS-BT	National Energy Modeling System – Building Technologies
NES	national energy savings
NIA	national impact analysis
NLSC	non-labor scaling costs
NOPR	notice of proposed rulemaking
NO_X	oxides of nitrogen
NPV	net present value
OEM	original equipment manufacturer
OIRA	Office of Information and Regulatory Affairs
OMB	U.S. Office of Management and Budget
PBP	payback period
PM	particulate matter
PSC	permanent split capacitor
R&D	research and development
RECS	Residential Energy Consumption Survey
SCC	social cost of carbon
SEER	Seasonal Energy Efficiency Ratio
SG&A	selling, general, and administration costs
SO_2	sulfur dioxide
TSD	technical support document
TSL	trial standard level
U.S.C.	United States Code
W	watt

Rulemaking Framework Document for Furnace Fans

1 INTRODUCTION

The U.S. Department of Energy (DOE) Appliances and Commercial Equipment Standards Program, within the Office of Energy Efficiency and Renewable Energy's Building Technologies Program (BT), develops and promulgates test procedures and energy conservation standards for certain consumer appliances and commercial equipment. The process for developing standards involves analysis, public notice and comment, and consultation with interested parties. "Interested parties" include manufacturers, consumers, energy conservation and environmental advocates, State and Federal agencies, and any other groups or individuals with an interest in these standards and test procedures. A DOE Report to Congress,[a] initially submitted on January 31, 2006 and updated twice a year since first publication, identifies the numerous rulemakings for a variety of products that DOE has scheduled for completion by January 2015 and explains many of the techniques DOE will be applying during the rulemaking process to meet this schedule.

The purpose of this document is to describe the procedural and analytical approaches DOE anticipates using to evaluate potential new energy conservation standards or energy use standards for the use of electricity for purposes of circulating air through duct work in residential heating and cooling systems, hereinafter referred to as "furnace fans" (see section 1.1 below for a discussion of the statutory authority for this rulemaking). This framework document is intended to inform interested parties of the process DOE will follow for the standards rulemaking for these furnace fans and to encourage and facilitate the input of interested parties during the rulemaking. This document is merely the starting point for developing energy conservation standards or energy use standards and is not a definitive statement on any issue to be determined in the rulemaking.

Section 1.3 of this report provides an overview of DOE's rulemaking process. Sections 2 through 17 discuss analyses DOE intends to conduct to fulfill the statutory requirements and guidance for this particular energy conservation standards rulemaking. DOE will analyze furnace fans to determine whether new energy conservation standards or energy use standards are technologically feasible, economically justified, and would result in significant energy savings. DOE will maintain information about this rulemaking on its website at: www.eere.energy.gov/buildings/appliance_standards/residential/furnace_fans.html.

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[a] *Energy Conservation Standards Activities;* Submitted pursuant to Section 141 of the Energy Policy Act of 2005(EPACT 2005), Pub. L. 109-58, and in response to section 305 of the Energy Independence and Security Act of 2007 (EISA 2007), Pub. L. 110-140; U.S. Department of Energy (Feb. 2010). Available at: http://www.eere.energy.gov/buildings/appliance_standards/pdfs/2010_feb_report_to_congress.pdf.

While DOE invites comment on all aspects of the material presented in this document, several specific issues on which DOE seeks comment are set out in comment boxes like this one. DOE uses these comment boxes to highlight issues and ask specific questions on the approaches DOE plans to follow to conduct the analyses required for the energy conservation standards rulemaking. Such requests for feedback are numbered sequentially throughout the document and are repeated in Appendix A.

1.1 The Appliances and Commercial Equipment Standards Program

Title III of the Energy Policy and Conservation Act of 1975 (EPCA), Pub. L. 94-163, (42 United States Code (U.S.C.) 6291 *et seq*.) established an energy conservation program for major household appliances and certain industrial and commercial equipment. More specifically, Part A of Title III (42 U.S.C. 6291-6309) establishes the "Energy Conservation Program for Consumer Products Other Than Automobiles." Subsequent amendments to EPCA have given DOE the authority to regulate the energy efficiency of several additional kinds of products and equipment, including certain furnace fans, which are the focus of this document.

The discussion below sets the stage for the issues raised in the balance of this framework document. Through the framework document, DOE is initiating its first rulemaking to consider new energy conservation standards or energy use standards for furnace fans, as required under 42 U.S.C. 6295(f)(4)(D), which provides as follows:

> *Notwithstanding any other provision of this chapter, if the requirements of subsection (o) of this section are met, not later than December 31, 2013, the Secretary shall consider and prescribe energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work.*

The following statutory provisions (and associated rulemakings) are directly related to the furnace fan standards rulemaking. A test procedure that accounts for active, standby, and off mode energy consumption is required to develop standards. (42 U.S.C. 6295(r) and (gg)) Also, furnace fans are an integral component of the products covered in the ongoing residential furnace and boiler rulemaking and the residential central air conditioner and heat pump (CAC) rulemaking. Consequently, the technologies and analyses are linked.

- DOE published a final rule in the Federal Register (FR) in November 2007 amending the minimum energy conservation standards for furnaces. 72 FR 65136 (Nov. 19, 2007). However, this rule was the subject of litigation and was remanded by the court to DOE under the mandate that DOE publish a new final rule by May 1, 2011. Voluntary remand in the case of New York v. Department of Energy (Case Nos. 08-0311-ag(L); 08-0312-ag(con)).

- DOE is also determining whether to amend existing energy conservation standards for residential central air conditioners and heat pumps. DOE is required by a court-ordered consent decree to publish a final rule addressing the energy conservation standards for residential central air conditioners and heat pumps by June 30, 2011.

- Additionally, as discussed in section 1.3.2, DOE will complete a separate, concurrent test procedure rulemaking for furnace fans, as required by EPCA. (U.S.C 6295(r) and (gg)) DOE will publish a final rule for its test procedure in the *Federal Register* prior to the publication of the energy conservation standards final rule for furnace fans.

1.2 Overview of the Scope of Coverage for Furnace Fans

1.2.1 Preliminary Discussion of Scope of Coverage for the Test Procedures and Energy Conservation Standards Rulemaking

EPCA provides DOE authority to consider and prescribe new energy conservation standards or energy use standards for electricity used for purposes of circulating air through duct work. (42 U.S.C. 6295(f)(4)(D)) DOE is tentatively interpreting the preceding language as referring to the electricity used by any electrically-powered device used in residential central heating, ventilation, and air conditioning (HVAC) systems for the purposes of circulating air through duct work. A furnace fan consists of a fan motor and its controls, a centrifugal impeller, and sheet metal housing.

Furnace fans that fall within the intended scope of coverage of this rule are found in a variety of residential central HVAC products including, but not limited to, gas-fired and oil-fired furnaces, electric furnaces, air handlers, and modular fan coils. DOE seeks comment on any other residential central HVAC products that may also use furnace fans that should be included in the scope of coverage of this rule, such as small-duct, high-velocity systems or through-the-wall systems. DOE understands that through-the-wall systems have specialized condensing units that operate in conjunction with air handler units that are similar to conventional split-system air handler units. As for small-duct, high-velocity systems, DOE understand these units operate at higher external static pressures as compared to other central air conditioning equipment, which may pose additional challenges in the context of the furnace fan rulemaking. DOE plans to collectively refer to products covered by the rule as "furnace fans," because they meet the outlined criteria. However, DOE is interpreting the EPCA language as excluding the electricity used by draft inducer fans, exhaust fans, or heat/energy recovery ventilators; while they are also integral components in some of the same residential central HVAC products as furnace fans, these components do not circulate air through duct work. DOE seeks comment on its approach outlined above and the intended scope of coverage.

DOE notes that EPCA's standard-setting provision for furnace fans does not include a specific range of rated airflow capacities or rated motor horsepower, which would aid interested parties in defining the scope of coverage under DOE's regulations. (42 U.S.C. 6295(f)(4)(D)) DOE's initial market research indicates that furnace fans are used in products ranging from small CAC products with low cooling capacities to large oil-fired residential furnaces with high rated input capacities. These products have nominal airflow capacities ranging from 400 and 2,200 cubic feet per minute (cfm) and use motors with rated horsepower between 1/5 and 1 horsepower (hp). In addition, and as described in greater detail later in this document, DOE initially reviewed a draft of an industry standard being developed relating to furnace fans (*i.e.*, the Canadian Standard Association C823 *Performance Standard for Air Handlers in Residential Space Conditioning Systems*), which does not specify a range of coverage for furnace fan testing. DOE seeks comment on whether DOE should consider including a rated airflow capacity range or a range of motor horsepower to limit the test procedure applicability.

Item 1 *DOE welcomes comments on its approach interpreting the relevant language in EPCA as referring to electricity used by any electrically-powered device used in residential central HVAC systems for the purposes of circulating air through duct work. Residential HVAC systems include, but are not limited to, furnaces, split-system and packaged central air conditioner and heat pump air handlers, and modular fan coils.*

Item 2 *DOE seeks comment on any other residential central HVAC products that may also use furnace fans that should be included in the scope of coverage of this rule.*

Item 3 *DOE welcomes comments on its interpretation of the relevant language in EPCA as excluding electricity used by draft inducer fans, exhaust fans, and heat/energy recovery ventilators.*

Item 4 *DOE seeks comment on whether DOE should include a rated airflow capacity range or a rated horsepower range to help define test procedure applicability.*

1.3 Overview of the Rulemaking Process

1.3.1 Rulemaking Process and Participation of Interested Parties

EPCA specifies that any standard DOE prescribes for consumer products shall be designed to "achieve the maximum improvement in energy efficiency . . . which the Secretary [of Energy] determines is technologically feasible and economically justified." (42 U.S.C. 6295(o)(2)(A)) Moreover, EPCA states that the Secretary may not establish an amended standard if such standard would not result in "significant conservation of energy," or "is not technologically feasible or economically justified." (42 U.S.C. 6295(o)(3)(B)) When DOE evaluates any new or amended energy conservation standard for covered products under EPCA, DOE considers to the greatest extent practicable the following seven factors to determine whether a standard is economically justified:

(1) The economic impact of the standard on the manufacturers and on the consumers of the products subject to such standard;

(2) The savings in operating costs throughout the estimated average life of the covered products in the type (or class) compared to any increase in the price, or in the initial charges for, or maintenance expenses of the covered products which are likely to result from the imposition of the standard;
(3) The total projected amount of energy (or as applicable, water) savings likely to result directly from the imposition of the standard;
(4) Any lessening of the utility or the performance of the covered products likely to result from the imposition of the standard;
(5) The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the imposition of the standard;
(6) The need for national energy and water conservation; and
(7) Other factors the Secretary considers relevant.

(42 U.S.C. 6295(o)(2)(B)(i)(I)-(VII))

Additional statutory requirements of general applicability for prescribing new or amended standards are set forth in 42 U.S.C. 6295(o)(1)–(2)(A), (2)(B)(ii)-(iii), and (3)–(5).

The processes for developing energy conservation standards and test procedures involve analysis, public notice and comment, and consultation with interested parties. Interested parties generally include manufacturers, consumers, environmental advocates, State and Federal agencies, and other groups and individuals with an interest in energy conservation standards and test procedures. DOE considers the participation of interested parties to be a very important part of the rulemaking processes for setting energy conservation standards and establishing test procedures. Accordingly, DOE encourages the participation of all interested parties during the comment periods provided at each stage of both rulemakings. The broad array of interested parties who routinely provide comments promotes a balanced discussion of critical information required to conduct the standards and test procedure rulemakings, beginning with public comments on the framework document.

In conducting the test procedure rulemakings and the energy conservation standards rulemakings, DOE involves interested parties through a variety of means. As discussed in further detail below, the standards rulemaking process for furnace fans involves two public notices, which are published in the Federal Register. Specifically, after publication of this framework document and the notice of proposed rulemaking (NOPR), DOE will hold public meetings to solicit comment from interested parties in order to enhance the rulemaking process. The following outlines next steps for the furnace fan energy conservation standards rulemaking:

- *Notice of Proposed Rulemaking* (section 1.4). For this rulemaking, the NOPR will present: (1) a discussion of comments received in response to this framework document; (2) DOE's analysis of the impacts of potential standards on consumers, manufacturers, and the Nation; (3) DOE's weighting of these impacts; and (4) the proposed standard levels for public comment.

- *Final Rule* (section 1.5). The final rule will present: (1) a discussion of comments received in response to the NOPR; (2) the revised analysis of the impacts of standards;

(3) DOE's weighting of the impacts; and (4) the standard levels DOE is adopting. The final rule also establishes the compliance date for the adopted standards.

DOE is considering a compliance date five years after the date of publication of a final rule establishing any new energy conservation standards or energy use standards for furnace fans. The current round of EPCA rulemaking for furnaces provides that amended standards for those products provide a minimum of five years between publication of the final rule and the standards compliance date. (42 U.S.C. 6295(f)(4)(C)) In addition, when considering amended standards for furnaces under 42 U.S.C. 6295(m)(4)(A)(ii), DOE must provide a five-year lead time. DOE believes that five years would provide furnace fan manufacturers with adequate lead time and that it is also appropriate because these products are an integral part of the furnace itself. Maintaining a consistent timeline for these related products is appropriate from both a manufacturing and implementation perspective.

1.3.2 Test Procedures

EPCA directs DOE to establish test procedures in conjunction with new or amended energy conservation standards, including furnace fans. (42 U.S.C. 6295(r)) To fulfill this requirement, DOE is simultaneously initiating a test procedure rulemaking for furnace fans in addition to the conservation standards rulemaking. DOE intends for the test procedure to include an efficiency descriptor and the methods necessary to adequately measure the performance of the covered products for the purposes of developing energy conservation standards.

Also relevant to the development of a furnace fan test procedure, section 310(3) of the Energy Independence and Security Act of 2001 (EISA 2007) amended EPCA to require that any new or amended energy conservation standard adopted after July 1, 2010, address standby mode and off mode energy use pursuant to 42 U.S.C. 6295(o). (42 U.S.C. 6295(gg)(3)) Specifically, when DOE adopts new or amended standards for certain covered products after July 1, 2010, the final rule must, if justified by the criteria for adoption of standards in section 325(o) of EPCA, incorporate standby mode and off mode energy use into a single standard if feasible, or otherwise adopt a separate standard for such energy use for that product. (42 U.S.C. 6295(gg)(3)) Section 310(2) of EISA 2007 also directs DOE to update its test procedures to account for standby mode and off mode energy consumption, with such energy consumption integrated into the overall energy efficiency, energy consumption, or other energy descriptor, unless the current test procedure already accounts for standby mode and off mode energy use; furthermore, if an integrated test procedure is technically infeasible, DOE must prescribe a separate standby mode and off mode test procedure for the covered product, if technically feasible. (42 U.S.C. 6295(gg)(2)(A)) Because the final rule for furnace fans is scheduled for issuance after July 1, 2010, DOE plans to address the standby mode and off mode energy use in both the test procedure and standards rulemaking.

When establishing or amending test procedures, DOE begins by reviewing existing industry test procedures or testing methods currently used to measure the energy use or energy efficiency of the covered product. DOE is aware that the Canadian Standard Association (CSA) is currently working on developing a test procedure for furnace fans titled CSA C823

Performance Standard for Air Handlers in Residential Space Conditioning Systems. [b] In addition, DOE understands the current DOE test procedure for residential furnaces, as detailed in the Code of Federal Regulations (CFR) at 10 CFR part 430, subpart B, appendix N, provides a method of test for estimating the blower electricity consumption when the furnace burner is on. DOE discusses its preliminary review of both approaches in the following subsections along with the issues for public comment.

1.3.2.1 Furnace Fan Modes of Operation and Electrical Energy Consumption

Pursuant to EPCA, the performance characteristic DOE intends to measure and regulate for this rulemaking is the electrical energy consumption of furnace fans. (42 U.S.C. 6295(f)(4)(D))

Furnace fans have distinct modes of operation, and each mode has a corresponding rate or rates of electrical energy consumption. DOE plans to label these modes as active mode, standby mode, and off mode. DOE tentatively plans to consider the following definitions as they relate to furnace fan modes of operation:

- "Active mode" is the mode of operation during which the residential central HVAC system in which the furnace fan is used, hereinafter referred to as the "furnace fan product," is powered and the impeller is in motion.
- "Standby mode" is the mode of operation during which the furnace fan product is powered and the impeller is not in motion.
- "Off mode" is the mode of operation during which the furnace fan product is not powered.

Some furnace fans are manufactured with multiple control speed settings that govern impeller speed and airflow to meet varying climate control demands during active mode operation. Consequently, DOE expects some furnace fans to have multiple rates of electrical energy consumption during active mode operation. DOE expects furnace fans will have a different electrical energy consumption rate for each of its factory-set control speeds. As defined above, the active mode consumption would account for the electrical consumption under different control speeds by the furnace fan while performing the heating, cooling, or circulation function.

As part of this rulemaking, EPCA, as amended by EISA 2007, requires that test procedures established for furnace fans must include standby mode and off mode energy consumption, taking into consideration the most current versions of Standards 62301 and 62087 of the International Electrotechnical Commission (IEC), with such energy consumption

[b] A copy of the December 22, 2009 draft version of CSA C823, *Performance Standard for Air Handlers in Residential Space Conditioning Systems* is available at: http://www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/draft_csa_c823.pdf.

integrated into the overall energy efficiency, energy consumption, or other energy descriptor for each covered product. (42 U.S.C. 6295(gg)(2)(A)) The most current versions of these test procedures are IEC Standard 62301, *Household electrical appliances—Measurement of standby power* (First Edition 2005–06), and IEC Standard 62087, *Methods of measurement for the power consumption of audio, video, and related equipment* (Second Edition, 2008–09). DOE reviewed both of the IEC standards referenced in EISA 2007 in consideration for this rulemaking. DOE found that IEC 62087 specifies methods of measurement for the power consumption of television receivers, video cassette recorders, set top boxes, audio equipment, and multi-function equipment for consumer use. IEC Standard 62087 does not, however, include measurement for the power consumption of appliances such as furnace fans. Accordingly, DOE has tentatively concluded that IEC Standard 62087 is not suitable for application to furnace fans and does not plan to consider it further in this rulemaking. DOE found that IEC 62301 specifies methods of measurement for electrical energy consumption in low-power modes for household appliances and equipment, including furnace fan products. Therefore, DOE believes IEC 62301 is applicable to this rulemaking.

Using DOE's definitions above for "active mode," "standby mode," and "off mode" for furnace fans, DOE anticipates that furnace fans will not have any standby mode electricity consumption that needs to be accounted for in this rulemaking. The furnace fan is an integral part of a larger system and is usually paired with a heating and/or cooling device in the field. Because the furnace fan controls are connected to the furnace product control boards, DOE believes that any electrical consumption by the furnace fan when the impeller is not in motion will be attributable to the furnace product. DOE further believes that this standby mode consumption for the furnace fans is already being addressed in separate energy conservation standards rulemakings that cover furnace products (*i.e.*, residential furnaces and central air conditioners and heat pumps). For example, in residential furnaces, the furnace fan controls are typically integrated into the main control board that governs many, if not all, of the furnace components. As a result, any energy consumption attributable to the furnace fan in standby mode, as defined above, is measured by the DOE test procedure for residential furnaces (10 CFR part 430, subpart B, appendix N), which references IEC 62301. Similarly, any standby mode energy consumption attributable to the furnace fans used in residential CAC products is measured by the DOE test procedure for residential CAC (10 CFR part 430, subpart B, appendix M) and is either already accounted for in the either the seasonal energy efficiency ratio (SEER) metric or heating season performance factor (HSPF) or will be addressed in a separate test procedure rulemaking for CACs.

DOE also anticipates that furnace fans will not have any off mode electrical energy consumption, as defined above. DOE believes that most consumers are unlikely to set their residential central HVAC systems to off mode. Therefore, furnace fans will never operate in the off mode, as defined above, because the furnace fan product will always be powered.

Since the furnace fan will spend time operating in active mode to perform heating, cooling, and circulation functions, DOE intends to use an efficiency metric that accounts for each electrical energy consumption rate for each operation and speed control setting. This annualized approach will consider the number of hours annually a furnace fan spends in each function/setting.

Item 5 *DOE requests comment on its assumptions for the electrical energy consumption expected in each mode of operation (i.e., active mode, standby mode, and off mode).*

Item 6 *DOE seeks input on the use of the annual electrical energy consumption rating for rating and regulating furnace fans, along with any other relevant efficiency descriptors.*

1.3.2.2 DOE's Preliminary Review of CSA C823

DOE has completed a preliminary review of the definitions, measurement accuracy requirements, test set-up, and testing methods detailed in CSA C823 (review draft). CSA C823 incorporates specific testing and set-up provisions from other industry standards such as the American National Standards Institute (ANSI)/Air Movement and Control Association AMCA 210-07 | ANSI/ American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 51-07 *Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating* and ANSI/ASHRAE Std 37-2005 *Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment*. CSA uses these two industry procedures along with the additional provisions it specifies to provide the definition, test set-up provisions, testing procedures, instrumentation requirements, and additional calculations to estimate the annual energy use of the furnace fan. DOE presents its initial review of CSA C823 in the subsections below along with various issues to which DOE seeks comments from interested parties. DOE believes that the draft CSA standard provides a useful frame of reference for the development of DOE's own furnace fan test procedure.

All of the standards that are referenced in CSA C823 are widely used in the HVAC industry to determine the performance of various fans and blowers. Consistent with its normal practice, where possible, DOE plans to develop its test procedure to measure the electrical energy consumption of furnace fans by adopting and modifying applicable portions of commonly-used industry test procedures, thereby minimizing the testing burden on manufacturers. DOE seeks comment as to what types of testing manufacturers currently conduct on furnace fans and what test set-ups and testing methods are used.

Item 7 *DOE welcomes comments on the use of Canadian Standard CSA C823 Performance Standard for Air Handlers in Residential Space Conditioning Systems, ANSI/AMCA 210-07 | ANSI/ASHRAE 51-07 Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating, and ANSI/ASHRAE Std 37-2005 Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment as reference test procedures.*

Item 8 *DOE seeks comment on the existence and applicability of any other industry test procedure that DOE could consider for use in measuring the airflow and electrical energy consumption of furnace fans. In addition, DOE seeks comment as to what types of testing manufacturers currently conduct on furnaces fans and what test set-ups and methods are used.*

1.3.2.2.1 Performance Curves

To circulate air through duct work, a furnace fan motor rotates the impeller, which increases the velocity of an airstream. As a result, the airstream gains kinetic energy. This kinetic energy is converted to a static pressure increase as the air slows at the entrance to the ducting. In order to supply enough conditioned air to adequately control the climate of a residence, this static pressure created by the motor must be enough to overcome the pressure losses the airstream will encounter throughout the duct work. To characterize how furnace fans perform under these physical demands, the CSA C823 test procedure begins with development of performance curves. According to CSA C823, performance curves are developed by measuring and plotting the furnace fan's airflow in cfm and fan power in watts (W) at each of its active mode speed control settings over a range of operating conditions (e.g., static pressures). This range of static pressures is intended to model the operating conditions the furnace fan encounters while in use. Performance curves illustrate static pressure and fan energy consumption as a function of the fan airflow. In general, furnace fan performance curves arc downward because, as the backpressure on the fan decreases, airflow increases. For furnace fans that have multi-stage capacity for heating and/or cooling, performance curves are required for each stage of air flow. For furnace fans that have variable capacity for heating and/or cooling, performance curves are required at the minimum and maximum stage of air flow.

CSA C823 states that, for the purpose of developing energy conservation standards for furnace fans, full performance curves that characterize performance from free airflow to shutoff are unnecessary. Typical furnace fan operation in the field results in a narrower range of operating points. For this reason, CSA C823 suggests using a narrower range of static pressures based on expected furnace fan operating conditions. DOE is aware that furnace fan product manufacturers provide performance data in their specification sheets that includes rated airflow measurements at static pressures ranging from 0.1 inches water column (in.w.c.) to 2 in.w.c. in roughly 0.1 to 0.25 in. w.c. increments per speed control setting. It is DOE's understanding that

CSA expects manufacturers to use all of the airflow measurements in the development of the performance curves. For example, a furnace fan that has 3 speed control settings and operates from 0.1 to 1.0 in. w.c. will be required to take 30 airflow measurements to develop the performance curves. Since these airflow measurements are currently included in furnace fan product specification sheets, DOE seeks comment about whether manufacturers currently test the furnace fan to produce the airflow measurement table or whether manufacturers use simulations to predict the performance of the furnace fan. DOE seeks comment on the approach CSA uses for developing the performance curves, which are generated through testing at various static pressures and speed controls. In an effort to minimize the testing burden on furnace fan product manufacturers, DOE seeks comment on the appropriate total number and range of test static pressures necessary to adequately represent a range of furnace fan operating conditions. DOE also seeks data, which will show that testing at a reduced number of static pressures will provide similar results as testing over the entire range of static pressures. In its test procedures, DOE will need to specify the static pressure range and increments for which measurements should be taken in order to ensure all manufacturers are using the same test data for developing the performance curves.

Section 6.1 of CSA C823 specifies the methods by which speed control settings should be selected during testing. According to CSA C823, the wiring of the furnace fan speed controls or speed taps are to be adjusted, as specified by the manufacturer, to obtain the desired speed operating setting. DOE is aware that furnace fan product manufacturers specify certain speed taps for cooling, heating, and circulation functions. However, DOE is also aware that these operations can be altered by installers depending on the climate and the location of the installation. As a result, manufacturer-specified pairings of speed setting and operation (heating, cooling, or circulation) may not provide a good representation of actual furnace fan operation. DOE seeks comment on CSA C823's specified method of selecting furnace fan speed control settings for testing. DOE also seeks comment on the relationship between speed control setting or speed tap and use in heating, cooling, or circulation functions of active mode furnace fan operation.

Item 9 *DOE welcomes comment on the CSA CS823 methodology used to develop performance curves.*

Item 10 *DOE seeks comment on the appropriate total number and range of static pressures necessary to encompass the expected operating conditions for furnace fans for the purposes of developing performance curves without being unduly burdensome. DOE also seeks data, which would show that testing at a reduced number of static pressures would provide similar results as testing over the entire range of static pressures.*

Item 11 *DOE seeks comment on the CSA C823-specified method of selecting furnace fan speed control settings for testing. DOE also seeks comment on the relationship between speed control setting or speed tap and use in heating, cooling, or circulation functions of active mode furnace fan operation.*

1.3.2.2.2 Reference System Load Curve

For the purposes of rating furnace fan performance, a reference system must be defined. The reference system is used to determine the expected furnace fan performance. It also serves as a starting point for comparing furnace fan performance across various manufacturers, models and efficiencies. For this rulemaking, DOE reviewed the method of test for determining the reference system used in CSA C823, which is a system that can achieve 0.5 in. w.c. in the default heating speed control setting. According to CSA C823, for a furnace fan product that does not have a designated default space heating control setting or speed tap, the heating setting shall be the lowest control setting that provides sufficient airflow at 0.5 in. w.c. that would be needed to achieve the midpoint or lower of the specified air temperature rise. The standard airflow required to achieve the midpoint of the specified temperature rise shall be calculated based on dry air at standard air conditions and the rated heating capacity of the unit. DOE understands that the CSA C823 reference system may be based on the Canadian climate and usage, where the majority of the time the furnace fan is used to perform the heating function. The heating function usually corresponds to the median fan speed settings. DOE seeks comment on whether the reference system needs to be modified for application to the U.S. climate and usage and what potential modifications should be considered.

Airflow and electrical energy consumption rate measurements for the furnace fan at its default heating speed control setting will be taken from the intersection of the performance curve for the default heating speed control setting and a static pressure of 0.5 in. w.c.. The purpose of defining a reference system is to provide a rating point based on the performance metrics being measured that is appropriate for furnace fans and from which system load curves can be determined.

Each system load curve will represent the relationship between the test system static pressure and airflow. The test system consists of the furnace fan product and the simple distribution test duct system. The simple distribution duct system will remain consistent for each furnace fan tested. According to DOE's review of existing test procedures and industry literature, system static pressure is approximated as being proportional to the square of the airflow rate for furnace fans. The governing mathematical equation for the system load curve is as follows:

$$P_S = K \times Q^2$$

Where:

P_S = system static pressure (in.w.c.),
K = a constant that characterizes the system, and
Q = airflow in cfm.

For each furnace fan tested, the K and Q values will be different. Therefore, each furnace fan will have a different system load curve. The K value for each furnace fan will be derived using the reference system criteria described above. The CSA test procedure uses each furnace fan's default heating control setting performance curve to determine the airflow (Q) necessary to achieve 0.5 in. w.c. (P_S). A value for K can be derived by inputting these values into the governing equation. Once K has been determined, the system load curve can be plotted for a desired range of airflow rates or system static pressures. DOE understands that the reference system is not dependent on the HVAC products in which the furnace fan is incorporated since the system static pressure is held constant. Instead, the reference system is used to characterize the performance of each impeller and motor combination used in these HVAC products. DOE seeks comment on CSA's methodology for developing a reference system curve for each fan and motor combination.

Item 12 *DOE requests comment on the use of 0.5 in w.c. in the default heating speed control setting to define its reference system and resulting rating point. DOE requests comment on whether changes are necessary to the reference system to more accurately reflect furnace fan operation in the U. S.*

Item 13 *DOE welcomes comment on the methodology outlined in CSA C823 to develop system load curves.*

1.3.2.2.3 Operating Points

Next, the CSA test procedure specifies that each furnace fan's system load curve be superimposed onto a plot of its performance curves. The points at which the performance curves intersect the system load curve are the operating points of the furnace fan for a particular HVAC system. The performance measurements at these operating points represent the expected airflow and electricity consumption rate for each respective speed control setting of active mode operation. CSA C823 uses electrical power measurements at the operating points as inputs for the annual energy consumption rating (AECR) equation. The CSA C823 equation for AECR is defined and explained in the next section, section 1.3.2.2.4.

Item 14 *DOE welcomes comment on the methodology CSA C823 currently uses to identify furnace fan operating points.*

1.3.2.2.4 Annual Electrical Energy Consumption of Furnace Fans

Finally, the CSA C823 test procedure specifies the use of a time-weighted sum of each electricity consumption rate measurement taken at each of a furnace fan's operating points, referred to as the annual electricity consumption rating for the furnace fan. Multiplying the measured power consumption rate at each operating point by the number of hours in a year that the furnace fan operates in that respective speed control setting yields the amount of energy consumed annually by the furnace fan in that setting. Repeating this operation for each function and control setting, then summing the results, yields the total annual electrical energy consumption for a furnace fan. The mathematical equation for AECR, according to CSA C823, is as follows:

$$AECR = (AHeatH \times ECh) + (AHeatH_{reduced} \times ECh_{reduced}) + (ACoolH \times ECc) + (ACircH \times ECirc) + (AstbyH \times ECstdby)$$

Where:

AECR =	annual electricity consumption rating for the air handler in kilowatt hours (kWh);
AHeatH =	annual heating hours,
ECh=	electrical energy consumption rating while performing the heating function,
$AHeatH_{reduced}$ =	annual reduced capacity heating hours (air-handler operating),
$ECh_{reduced}$ =	electrical energy consumption rating for operation in performing the reduced heating function,
ACoolH=	annual cooling hours,
ECc =	electrical energy consumption rating while performing the cooling function;
ACircH =	annual circulating hours,
ECcirc=	electrical energy consumption rating while performing the circulation function;

AStdbyH = annual standby hours; and

ECstdby = electrical energy consumption rating for standby mode.

In order to calculate AECR, CSA C823 developed standardized values, referred to as annual hourly multipliers, for hours spent in each function and speed control setting. The values for the annual hourly multipliers used in CSA C823 are specified in Table 1.1 below. As shown, the values for each multiplier are dependent on the system configuration and are specific to Canada's climate. Since the U.S. climate is more diverse, DOE could consider developing annual hourly multipliers specific to the U.S. should it adopt a similar methodology. DOE requests comment on the annual hourly multiplier methodology specified in CSA C823, as well as how this methodology and annual hourly multiplier values could be modified, if necessary, to be specific to furnace fan operation in the United States.

Table 1.1. Standardized Annual Operating Hours for Canada as Specified in CSA C823

	AHeatH high	AHeatH reduced	ACoolH high	ACoolH reduced	ACircH	AstbyH
Single-stage Heating Without Constant Circulation	SNHHC	0	SNCHC	0	0	8760-AHeatHhigh-ACoolHhigh
Single-stage Heating With Constant Circulation	SNHHC	0	SNCHC	0	8760-AHeatHhigh-ACoolHhigh	0
Multi-stage Heating with Single-stage Cooling Without Constant Circulation	0.1*SNHHC	0.9*SNHHC/ HCR	SNCHC	0	0	8760-AHeatHhigh-$AHeatH_{reduced}$ -ACoolHhigh
Multi-stage Heating and Single-stage Cooling With Constant Circulation	0.1*SNHHC	0.9*SNHHC/ HCR	SNCHC	0	8760-AHeatHhigh-$AHeatH_{reduced}$ -ACoolHhigh	0
Single-stage Heating and Multi-stage Cooling Without Constant Circulation	SNHHC	0	0.1*SNCHC	0.9*SNCHC/ CCR	0	8760-AHeatHhigh-ACoolHhigh-$ACoolH_{reduced}$
Single-stage Heating and Multi-stage Cooling With Constant Circulation	SNHHC	0	0.1*SNCHC	0.9*SNCHC/ CCR	8760-AHeatHhigh-ACoolHhigh-$ACoolH_{reduced}$	0
Multi-stage Heating and Cooling Without Constant Circulation	0.1*SNHHC	0.9*SNHHC/ HCR	0.1*SNCHC	0.9*SNCHC/ CCR	0	8760-AHeatHhigh-$AHeatH_{reduced}$ - ACoolHhigh-$ACoolH_{reduced}$
Multi-stage Heating and Cooling With Constant Circulation	0.1*SNHHC	0.9*SNHHC/ HCR	0.1*SNCHC	0.9*SNCHC/ CCR	8760-AHeatHhigh-$AHeatH_{reduced}$ - ACoolHhigh-$ACoolH_{reduced}$	0

Where:

HCR = heating capacity ratio (rated heat output in the lowest capacity mode / rated full heat output). If HCR is ≤ 0.35, use 0.35,
CCR= cooling capacity ratio (rated cooling output in the lowest capacity mode / rated full cooling output) If CCR is ≤ 0.35, use 0.35,
SNHH = Standardized National Cooling Hours for Canada = 400 hours, and
SNCH = Standardized National Heating Hours for Canada = 2000 hours.

Item 15 *DOE seeks input on the CSA C823 equation for annual energy consumption rating (AECR).*

Item 16 *DOE requests comment on the annual hourly multiplier methodology specified in CSA C823, as well as if and how this methodology and the annual hourly multiplier values could be modified to more specifically address furnace fan operation in the United States.*

1.3.2.3 DOE's Preliminary Review of the Blower Electricity Consumption in the DOE Furnace Test Procedure

DOE also preliminarily explored the merits of developing a furnace fan test procedure that is based on the existing DOE test procedure for residential furnaces, as set forth in 10 CFR part 430, subpart B, appendix N. DOE's test procedure for residential furnaces, which incorporates by reference ANSI/ASHRAE Standard 103-1993, *Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers*, specifies a measurement of blower (furnace fan) power, BE, in watts. This wattage measurement is used in determining the annual blower electrical consumption in kilowatt hours (kWh) associated with the heating function. DOE would need to make modifications as well as add additional calculations to a furnace fan test procedure based on BE in order to develop a rating method appropriate for furnace fan operation in all modes, in all speed control settings, and for all products covered by this rulemaking. The need for such modifications is discussed in further detail below.

Currently, BE is a specified measurement for residential furnaces only. Because the scope of coverage of this rulemaking also includes furnace fans used in residential central HVAC products other than residential furnaces, DOE would need to develop additional methods for rating the blower electricity consumption of furnace fans used in those other products. DOE could do this by extending the existing BE measurements for residential furnaces to other products, if applicable, or develop separate testing procedures, which would also estimate the blower electricity consumption in the other products.

As mentioned above, BE is only measured while the furnace is performing the heating function (*i.e.*, while the burner is on). A furnace fan is also likely to periodically operate while the furnace is not actively heating the home to circulate air for ventilation. DOE would need to include calculations, in order to account for the furnace fan power consumption when performing these additional functions.

As an additional issue, BE is measured at a minimum specified external static pressure and at either a single airflow rate if the furnace has a single-stage burner or possibly two airflow rates if the furnace has a two-stage or modulating burner. However, DOE expects furnace fan operation in the field to span multiple external static pressures in multiple speed control settings. For this reason, DOE could either determine that the test conditions specified by DOE's furnace test procedure are adequate, or it would need to develop methods for determining BE at multiple external static pressures and airflow rates.

In addition, DOE would need to develop usage multipliers to determine the number of hours annually that the furnace fan operates in each speed control setting or function (*i.e.*, heating, cooling, and circulation).

DOE seeks comment on the merits of potentially using the BE measurement specified in DOE's existing residential furnaces test procedure as the basis for its furnace fan test procedure and subsequent energy conservation standards. Furthermore, DOE seeks comment on: (1) the need for additional rating methods that would be necessary to cover the power consumption of furnace fans used in residential central HVAC products other than furnaces; (2) how BE could also be used to rate the power consumption for furnace fans operating in the circulation function of residential furnaces; (3) how the measurements of BE and the power consumption for other furnace fans not used in residential furnaces could be altered to account for furnace fan operation within an appropriate range of static pressures and at an appropriate number of speed control settings; and (4) the appropriate annual hourly multipliers to determine the number of hours annually that the furnace fan operates in each speed control setting or function.

Item 17 *DOE seeks comment on the potential merits of using the BE measurement specified in DOE's existing residential furnaces test procedure (10 CFR part 430, subpart B, appendix N) as the basis for its furnace fan test procedure.*

Item 18 *DOE seeks comment on additional rating methods that would be necessary to cover the power consumption of furnace fans used in residential central HVAC products other than furnaces.*

Item 19 *DOE seeks comment on how these power measurements could estimate the power consumption of the furnace fan in the circulation function and account for the furnace fan operation within an appropriate range of static pressures and at an appropriate number of speed control settings.*

Item 20 *DOE seeks comment on the appropriate annual hourly multipliers to determine the number of hours annually that the furnace fan operates in each speed control setting or function.*

1.4 Notice of Proposed Rulemaking

In developing the separate NOPRs for the test procedure and energy conservation standards for furnace fans, DOE will consider all the comments it receives after publication of this framework document. For test procedures, DOE will publish a NOPR proposing test procedures for furnace fans, which will be followed by a 75-day public comment period that includes one public meeting. For energy conservation standards, DOE will publish a NOPR proposing standards for furnace fans, which will be followed by a 60-day public comment period that includes one public meeting.

This comment process may result in revisions to the planned methodology for each analysis related to the energy conservation standards rulemaking. For furnace fans, DOE is planning to conduct in-depth technical analyses for the energy conservation standards NOPR in the following areas: (1) engineering, (2) markups to determine product price, (3) energy-use characterization, (4) life-cycle cost (LCC) and payback period (PBP), (5) national impacts, (6) manufacturer impacts, (7) utility impacts, (8) environmental impacts, (9) employment impacts, and (10) regulatory impacts. DOE will describe the methodology used and make the results of all the analyses available on its website for review.

This part of the analytical process results in the proposed standard levels (if any) that DOE will present in the published NOPR document. DOE selects the proposed standard levels from the trial standard levels (TSLs) analyzed prior to publication of the NOPR document. The NOPR, published in the *Federal Register*, will document the evaluation and selection of any proposed standards levels, along with a discussion of other TSLs considered but not selected and the reasons DOE did not select them.

For each product class, DOE will identify the maximum efficiency level that is technologically feasible, hereinafter referred to as max-tech. If DOE proposes a lower level, it will sequentially explain the reasons for eliminating higher levels, beginning with the highest level considered. DOE will present the analytical results in the NOPR, and provide the details of the analysis in an accompanying technical support document (TSD).

DOE considers many factors in selecting proposed standards, as discussed in section 1.3.1. These factors are contained in EPCA and take into consideration the benefits, costs, and other impacts of energy conservation standards. DOE encourages interested parties to develop joint recommendations for standard levels. DOE will carefully consider such recommendations in its decision process.

When DOE publishes the NOPR proposing energy conservation standards for furnace fans, it will provide the U.S. Department of Justice (DOJ) with copies of the NOPR and TSD to solicit feedback on the impact of the proposed standard levels on competition in the furnace fan product industries. DOJ will review these standard levels in light of any lessening of competition likely to result from the imposition of standards (42 U.S.C. 6295(o)(2)(B)(i)(V) and (ii)). As noted above, publication of the NOPR for energy conservation standards for furnace fans will be followed by a 60-day public comment period that includes one public meeting.

1.5 Final Rule

After the NOPR is published, DOE will consider public comments it receives on the test procedures, proposed standards, and accompanying analyses. For the standards rulemaking, DOE will review the engineering and economic impact analyses and proposed standards based on these comments and consider modifications where necessary. Before the final rule is issued, DOE also will consider DOJ comments on the NOPR relating to the impacts of the proposed standard levels on competition to determine whether changes to these standard levels are needed. DOE will publish the DOJ comments and DOE's response as part of the final rule. The standards rulemaking will conclude with publication of the final rule. DOE will select the final standard level based on the complete record of the standards rulemaking. The final rule will promulgate the final standard level and the compliance date and explain the basis for their selection. The final rule will be accompanied by a final TSD. The test procedure rulemaking will conclude with the publication of a final rule, which considers all of the comments it receives on its proposed test procedures.

2 OVERVIEW OF ANALYSES FOR RULEMAKING

The purpose of the analyses is to ensure that DOE selects energy conservation standards that achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified and will result in significant energy savings, as required by EPCA. Economic justification includes the consideration of economic impacts on manufacturers and consumers, national benefits (including environmental impacts), issues of consumer utility, and impacts from any lessening of competition. DOE expects the selection of such standards to achieve the maximum energy savings that are technologically feasible and economically justified without imposing excessive financial burden on any particular party.

Figure 2.1 summarizes the analytical components of the DOE standard-setting process. The analyses are presented in the center column. Each analysis has a set of key inputs that are required data and information. Approaches are the methods that DOE will use to obtain key inputs, which may vary depending on the information in question. For example, some key inputs exist in public databases. DOE will collect other information from interested parties or experts with special knowledge, and DOE will develop yet other information independently in support of this rulemaking. The results of each analysis are key outputs that feed directly into the rulemaking. Arrows indicate the flow of information between the various analyses. DOE ensures a consistent approach to its analyses throughout the rulemaking by considering each analysis as a part of the overall standard-setting framework.

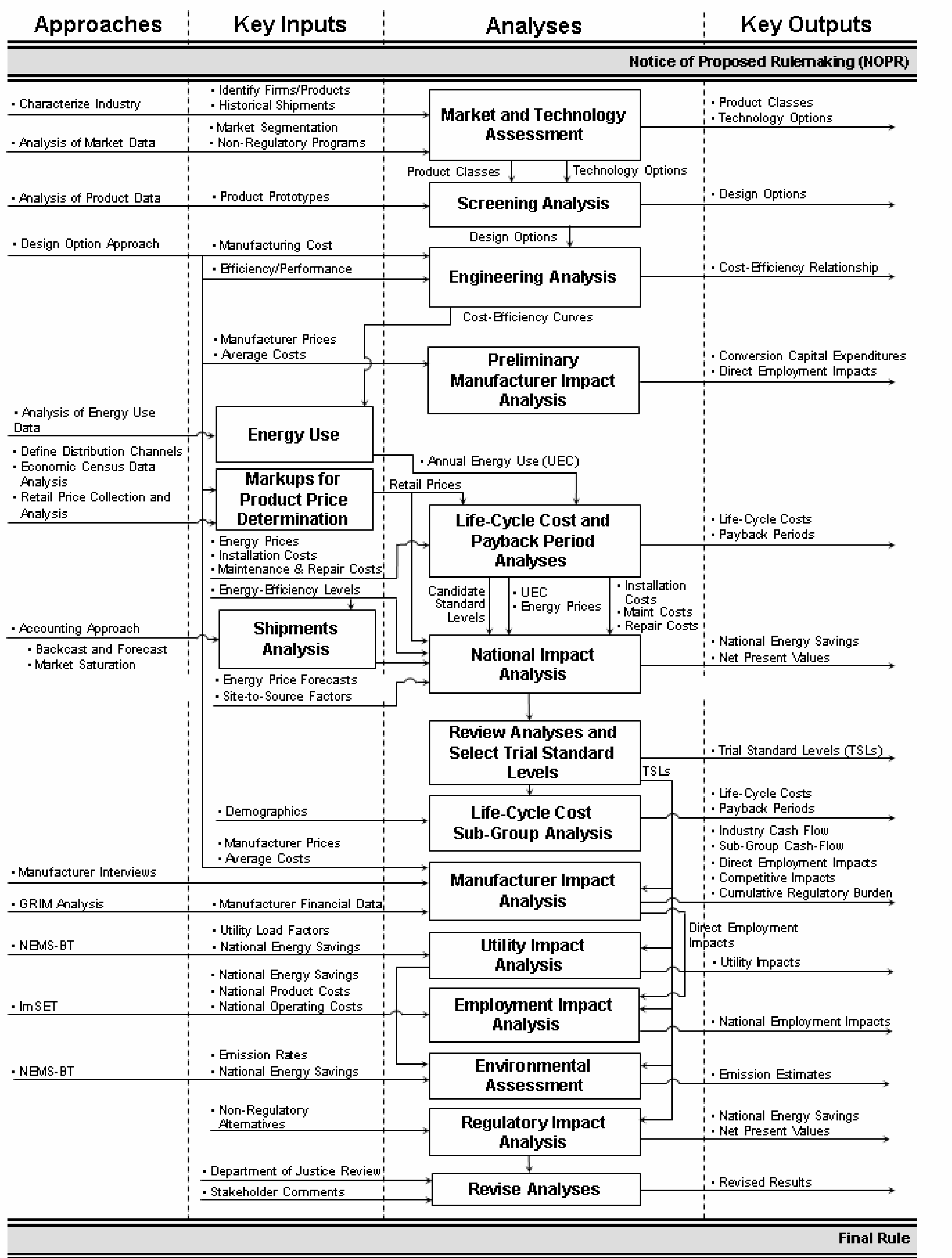

Figure 2.1. Flow Diagram of Analyses Conducted for an Energy Conservation Standard Rulemaking

3 MARKET AND TECHNOLOGY ASSESSMENT

The market and technology assessment will provide information about the manufacturers of furnace fans and the performance attributes of these products. Based on analyses done for the associated residential CAC and furnaces energy conservation standards rulemakings, DOE believes that, in most cases, the manufacturer of the product in which the furnace fan is used, hereinafter referred to as a "furnace fan product," purchases the furnace fan impeller and motor and fabricates the furnace fan assembly in house (*i.e.*, the sheet metal assembly). The furnace fan impeller, motor, controls and sheet metal housing are produced separately by different manufacturers. DOE also believes these components are typically replaced separately, as needed. Since the individual manufacturers of residential CAC/HP and furnaces ultimately assemble all of the components into one furnace fan assembly, DOE believes that furnace fan product manufacturers are ultimately responsible for the design and performance, including efficiency, of the furnace fan assembly. Consequently, manufacturers of furnace fan products will experience the impacts that result from having to meet energy conservation standards for furnace fans. For this reason, the market and technology assessment will focus on providing information about the manufacturers of the furnace fan products and furnace fan product performance attributes. This market and technology assessment is particularly important at the outset of the rulemaking for developing product classes and for identifying technology options that improve furnace fan efficiency.

3.1 Market Assessment

DOE will qualitatively and quantitatively characterize the structure of the markets for furnace fans. In the market assessment, DOE will identify and characterize the manufacturers of furnace fan products, estimate market shares and trends, address regulatory and non-regulatory initiatives intended to improve the efficiency or reduce the energy consumption of covered furnace fans, and explore the potential for technological improvements in the design and manufacturing of such products.

This market assessment will establish the context for this rulemaking, and it will serve as a resource to guide the analyses that follow. For example, DOE may use historical shipments and prices as an indicator of future shipments and prices. Similarly, DOE plans to use market structure data for the manufacturer impact analysis, data that will be particularly useful for assessing competitive impacts. During this phase, DOE also begins to identify design options by reviewing product literature and industry publications.

DOE recognizes that there may be limited public information on national shipments, manufacturing costs, channels of distribution, and manufacturer market shares of furnace fans. This type of data is an important input for analyses that determine if energy conservation standards or energy use standards are economically justified and will result in significant energy savings. Therefore, DOE encourages interested parties to submit data that will improve DOE's understanding of the furnace fan markets. These data may be provided under a confidentiality agreement with DOE's contractor responsible for this part of the rulemaking analysis, Navigant

Consulting, Inc. (NCI). In other rulemakings, NCI routinely works with confidential data provided by manufacturers and other organizations in preparing aggregated results for DOE's analysis. These aggregated results do not divulge the sensitive, individual raw data, but enable other interested parties to comment on the aggregated dataset.

Alternatively, interested parties may submit confidential data to DOE, indicating in writing which data should remain confidential. Interested parties must submit confidential information to DOE according to the procedures outlined in 10 CFR 1004.11. Under 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies. One copy of the document shall include all the information believed to be confidential, and the other copy shall have the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it accordingly.[c]

DOE is tracking commonly-available products based on recent literature from small and large furnace fan and furnace fan product manufacturers. This information will enable DOE to understand which furnace fans are used in the residential HVAC market and in order to better assess which furnace fans fall within the scope of this rulemaking (section 1.2). DOE will use the resulting knowledge about product availability to evaluate how the market may respond to various standard levels and to gain insight on the performance attributes of various commercially-available furnace fan technologies.

Item 21 *DOE seeks comment on whether the manufacturers of the products in which furnace fans are used, herein referred to as "furnace fan products," are also the manufacturers of the furnace fan.*

Item 22 *DOE welcomes input on estimates of market shares, products, features, and trends related to electricity consumption for the furnace fans covered in this rulemaking.*

[c] Factors that DOE considers when evaluating requests to treat submitted information as confidential include: (1) a description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other public sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) a date after which such information might lose its confidential character; and (7) why disclosure of the information would be contrary to the public interest.

3.1.1 Product Classes

As mentioned previously, DOE tentatively defines the term "furnace fan" to mean an electrically-powered device used in residential central HVAC systems for the purposes of circulating air through duct work. This would include the air distribution fan used in oil-fired, gas-fired, and electric furnaces, split-system and packaged air conditioner and heat pump air handlers, and modular fan coils. The scope of this standard does not include draft inducer fans, exhaust fans, or heat/energy recovery ventilators. When necessary, DOE divides covered products into classes by: (a) the type of energy used; (b) the capacity of the product; or (c) any other performance-related feature that justifies different standard levels, such as features affecting consumer utility. (42 U.S.C. 6295(q)) DOE then conducts its analysis and considers establishing standards so as to provide separate standard levels for each product class.

DOE does not plan to differentiate product classes based on the type of energy used because all furnace fans are powered by electricity. DOE will consider differentiating product classes based on performance-related features impacting the energy efficiency of the furnace fan. Even though motor type affects efficiency, DOE does not believe the overall utility of the product is affected. Instead, DOE believes that a more-efficient motor is a technology option to improve the efficiency of the furnace fan. DOE has found in its preliminary review of furnace fan product specification sheets that the achievable heating or cooling capacity of a furnace fan product is independent of motor type. Therefore, at this time, DOE has tentatively decided not to use motor type to differentiate furnace fan product classes. Instead, DOE is initially considering differentiating product classes for furnace fans based on either rated airflow capacity (cfm) or rated motor horsepower. DOE believes each is a performance-related feature that affects product efficiency and, therefore, falls under one of the statutory bases for establishing a product class.

An initial review of furnace fan product specification sheets shows that furnace fans are available with rated airflow capacities from approximately 400 cfm to 2,200 cfm. The rated airflow capacity of the furnace fan will vary depending on the application. Furnace fans intended for use in lower-capacity furnace fan products, such as a product with a 1 to1.5 ton (18,000 British thermal units per hour (Btu/h)) cooling capacity and 40,000 Btu/h heating input rate, typically have nominal airflow capacities around 400 cfm. Furnace fans intended for use in higher-capacity furnace fan products, such as a product with a 5 ton (60,000 Btu/h) cooling capacity and 150,000 Btu/h heating input rate, typically have nominal airflow capacities around 2,200 cfm. DOE is aware that some oil-fired furnaces with heating input rates around 220,000 Btu/h achieve nominal airflow rates of around 4,000 cfm by integrating two furnace fans.

Similarly, an initial review of furnace fan product specification sheets shows that furnace fans are available with rated motor hp ranging from around 1/5 hp to 1 hp. The rated motor horsepower of the furnace fan will vary depending on the application. Furnace fans intended for use in lower-capacity furnace fan products, such as a product with a 2 ton (24,000 Btu/h) cooling capacity or 40,000 Btu/h heating input rate, typically use a 1/5 hp motor. Furnace fans intended for use in higher-capacity furnace fan products, such as a product with a 5 ton (60,000 Btu/h) cooling capacity or 126,000 Btu/h heating input rate, typically use 3/4 to 1 hp motors. However, DOE also noted models currently available on the market with the same rated airflow capacity and different horsepower ratings.

DOE believes rated airflow capacity and rated motor horsepower can impact the amount of conditioned air the furnace fan product can provide. Furnace fan product manufacturer specification sheets show that, in general, furnace fans with higher rated airflow capacities have the potential to consume more energy because a more powerful motor is required. DOE seeks comment on whether to use rated airflow capacity, rated motor horsepower, or another characteristic of the furnace fan to differentiate product classes. DOE also seeks comment on how these specifications are considered in furnace fan product design processes.

If DOE determines that either rated airflow capacity or rated motor horsepower is an appropriate product class differentiator, it plans to establish product classes by dividing the typical range into bins based on market data and product characteristics. The bin ranges will be set so as to include furnace fans that use components with similar specifications to achieve similar heating and cooling capacities. An important goal of the market assessment is to determine the appropriate number of bins and their respective ranges. DOE seeks comments on the approach described above for differentiating between product classes and any other potential methods for establishing product classes corresponding to the requirements of 42 U.S.C. 6295(q).

Item 23 *DOE welcomes comments on whether to use rated airflow capacity, rated motor horsepower or an alternative approach to defining product classes in accordance with the requirements of 42 U.S.C. 6295(q.). DOE also seeks comment on how each of these specifications influences furnace fan product design decisions.*

Item 24 *DOE seeks input on appropriate rated airflow or rated motor horsepower bins. Specifically, DOE is interested in information that could be used to determine the number of bins or range of each bin.*

3.2 Technology Assessment

The technology assessment centers on understanding how furnace fans use energy and how potential efficiency measures would be expected to reduce their energy consumption. Measures that improve the energy efficiency of the product are called "technology options," and they are based on existing technologies, as well as prototype designs and concepts. In consultation with interested parties, DOE will develop a list of technology options for consideration in this rulemaking. Following research into this list of technology options, DOE will consider each one against four screening criteria: (1) technological feasibility; (2) practicability to manufacture, install, and service; (3) adverse impacts on product utility or availability; and (4) adverse impacts on health or safety (see section 4). Those technology options that pass the four screening criteria are called "design options" and will be considered as appropriate ways of improving the efficiency of the product in the engineering analysis, and will assist DOE in determining the max-tech design.

DOE is studying technology options by reviewing furnace fan product manufacturer specification sheets, recent trade publications, technical journals, and patent filings. DOE also intends to consult with technical experts who have worked on furnace fan designs and to conduct manufacturer interviews about these technology options. At this time, DOE is aware of a limited set of technology options (discussed in further detail below) that could improve furnace fan efficiency: (1) high-efficiency furnace fan motors; and (2) improved impellers. DOE intends to study both as possible technology options.

3.2.1 High-Efficiency Furnace Fan Motors

Furnace fan manufacturers typically use either a permanent split capacitor (PSC) motor or a more-efficient, electronically-commutated motor (ECM). (DOE is aware that "ECM" may be a trade name specific to a certain motor manufacturer. DOE is using "ECM" to refer to any brushless permanent magnet furnace fan motor.) Both are types of electric motors which operate based on the interaction of the magnetic fields produced by the stator (the stationary portion of the motor) and the rotor (the rotating portion of the motor). These magnetic fields can be produced by electromagnets or permanent magnets.

PSC motors are a type of induction motor. In induction motors, the stator is an electromagnet that consists of electrical wire windings. Current is driven through the windings to produce a magnetic field. Through electromagnetic induction, this magnetic field induces current in the conductor bars of the rotor. The conductor bars of the rotor, often made of copper or aluminum, are arranged in such a manner that they produce another magnetic field once current is induced. The interaction of the magnetic field of the electromagnet and the magnetic field of the rotor results in rotation of the rotor. In a PSC motor, a smaller, start-up winding is present in addition to the main winding in the stator. The start-up winding is electrically connected in parallel with the main winding and in series with a capacitor. At startup, the interactions between the magnetic field generated by the start-up winding and that generated by the main winding induce rotation. Because of the capacitor, however, the current to the start-up winding is cut off as the motor reaches steady state.

ECM motors are brushless permanent magnet motors. Like a PSC motor, the stator of an ECM motor is an electromagnet used to produce a magnetic field. Unlike the PSC motor, the rotor of an ECM motor consists of a permanent magnet. The interaction of the magnetic field of the electromagnet and the magnetic field of the permanent magnet rotor result in rotation of the rotor. ECM motors generally operate more efficiently than PSC motors. While PSC motors operate most efficiently at a single speed with significantly diminishing operating efficiency at others, ECM motors are capable of maintaining a high operating efficiency at multiple speeds.

Typical furnace fan motor sizes range from 1/5 hp to 1 hp, depending on the required airflow capacity of the furnace fan. The furnace fan motor accounts for the majority of electricity consumption in furnace fan products, approximately 80 percent in residential furnaces. Consequently, increased fan motor efficiency could yield significant electricity savings. PSC fan motors are used in a large majority of furnace fan products. Currently 95 percent of furnace fans used in residential furnaces use a PSC motor. In contrast, only 2.5 percent of furnace fans used in residential furnaces incorporate an ECM motor. A 1/2 hp ECM running at typical speed for the heating function in residential furnaces operates at over 70-percent motor efficiency, compared to a similarly-sized multi-speed PSC, which achieves an efficiency level of only 34 percent to 39 percent.[d]

3.2.2 High-Efficiency Impellers

High-efficiency fan blades (impellers) move air more efficiently, yielding energy consumption savings by reducing the required fan motor shaft power. The impellers typically used in furnace fan products are centrifugal impellers with thin, stamped, forward-curved sheet metal blades. These impellers are compact, inexpensive, and easy to manufacture. Required fan shaft power could be reduced if the impeller blades were optimized for each specific application.

> ***Item 25*** *DOE welcomes comments on the preliminary technology options identified in this section (i.e., high-efficiency furnace fan motors and high-efficiency impellers) and whether there are other technology options it should consider. In commenting on technology options, please discuss their impacts, if any, on safety, performance, and consumer utility.*

4 SCREENING ANALYSIS

The purpose of the screening analysis is to eliminate, or screen out, technology options from further consideration in the engineering analysis that do not meet four key criteria. DOE will follow the process set forth below to screen out technology options.

DOE will develop a list of technology options (through its own research and in consultation with interested parties) for consideration in the engineering analysis (section 5). This initial list of identified candidate technology options will encompass all those technologies that may be technologically feasible. Thereafter, DOE will review each technology option or best available technology in light of the following four criteria, as provided in sections 4(a)(4) and 5(b) of the Process Rule[e] and tailored to the current rulemaking:

1. *Technological feasibility.* DOE will screen out technologies that are not incorporated in commercially-available products or working prototypes.

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[d] Sachs, H.M. and Smith, S. *Saving Energy with Efficient Residential Furnace Air Handlers: A Status Report and Program Recommendations* (2003), American Council for an Energy-Efficient Economy (ACEEE): Washington, D.C. Report No. A033.

[e] The Process Rule establishes procedures, interpretations, and policies to guide DOE in the consideration and promulgation of new or amended energy conservation standards under EPCA and is found at 10 CFR part 430, subpart C, appendix A.

2. *Practicability to manufacture, install, and service.* If DOE determines that mass production of a technology in commercial products and reliable installation and servicing of the technology could not be achieved on the scale necessary to serve the relevant market by the time of the compliance date of the standard, it will not consider that technology further.

3. *Adverse impacts on product or equipment utility or availability.* If DOE determines a technology has a significant adverse impact on the utility of the product for significant consumer subgroups, or results in the unavailability of any covered product type with performance characteristics (including reliability), features, size, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not consider that technology further.

4. *Adverse impacts on health or safety.* If DOE determines that a technology will have significant adverse impacts on health or safety, it will not consider that technology further.

DOE will fully document its reasons for eliminating any technology options during the screening analysis and will publish this documentation for interested parties to review as part of the NOPR. Technology options that are not screened out by the above four criteria will be considered design options in the development of cost-efficiency curves in the engineering analysis.

Item 26 *DOE welcomes comments on how the above four screening criteria might apply to any additional technology option(s) that an interested party recommends to DOE.*

5 ENGINEERING ANALYSIS

After conducting the screening analysis described above, DOE will perform an engineering analysis based on the remaining design options that are available to improve product efficiency. The engineering analysis consists of estimating the energy consumption and cost of products at various levels of increased efficiency. Section 5.1 provides an overview of the engineering analysis. Section 5.2 discusses baseline models. Section 5.3 describes DOE's planned approach. Section 5.4 addresses proprietary designs. Section 5.5 discusses cumulative regulatory burdens that might affect the engineering analysis.

5.1 Engineering Analysis Overview

The purpose of the engineering analysis is to determine the relationship between furnace fan efficiency and the portion of the manufacturer selling price (MSP) of the furnace fan product that is attributable to the furnace fan. This relationship between price and efficiency serves as the basis for cost/benefit calculations to individual consumers in the LCC analysis and to the Nation in the national impact analysis (NIA).

The engineering analysis will focus on identifying and evaluating commercially-available furnace fans that incorporate design options that improve efficiency. The engineering analysis will also identify the highest efficiency that is technologically feasible within each product class (*i.e.*, the max-tech model). DOE may determine the max-tech model by investigating the existence of any furnace fan prototypes with higher efficiency than those commercially available.

5.2 Baseline Models

For each product class, DOE will identify a baseline model furnace fan that will serve as a reference point against which DOE can measure changes resulting from potential energy conservation standards. DOE will develop a separate engineering analysis for each product class and a separate efficiency curve for each baseline model directly analyzed. Should DOE develop a scaling method, as described in more detail in section 5.3, a separate curve for each baseline model and product class may not be necessary.

Selection of the baseline model is a critical aspect of DOE's analytical approach. The baseline model should represent the characteristics of a typical furnace fan in a given product class used in common residential HVAC products. Normally, the baseline model would be a model that just meets current energy conservation standards. However, energy conservation standards for furnace fans do not currently exist. As a result, DOE will select baseline models typical of the furnace fans used in the least-efficient residential HVAC models offered for sale in the market. For furnace fans, selection of the baseline model for each product class will encompass consideration of furnace fan features and performance characteristics, such as motor type, rated fan motor horsepower, number of fan motor control speeds, and fan motor efficiency.

Item 27 *DOE welcomes comments on the selection and appropriate features and performance characteristics of baseline models for each product class.*

5.3 Cost-Efficiency Relationship and Analysis

The engineering analysis primarily involves estimating the energy consumption and cost of products at various levels of increased efficiency. These estimates are then used to identify the cost-efficiency relationship for the products. DOE typically structures its estimation of the cost-efficiency relationship around one of three methodologies: (1) the design-option approach, which calculates the incremental cost of adding specific design options to the baseline model; (2) the efficiency-level approach, which calculates the incremental costs of achieving increases in energy efficiency, without regard to the particular design options used to achieve such increases; and (3) the reverse engineering cost-assessment approach, which involves a "bottom-up" manufacturing cost assessment based on a detailed bill of materials (BOM) derived from teardowns of products being analyzed. Deciding which methodology to use for the engineering analysis depends on the product, the technologies under study, and any historical data DOE can draw upon. Due to the limited availability of public information on the cost and efficiency of furnace fans, DOE has tentatively decided to use both the efficiency-level approach to identify incremental improvements in efficiency for each product and the cost-assessment approach to develop a cost for each efficiency level. If a relationship between airflow capacity and electricity consumption can be quantified, DOE may select a representative product class to analyze and develop a scaling method to derive results for the remaining product classes. If not, DOE could conduct a separate analysis for each product class.

Prior to the engineering analysis, DOE plans to test a number of furnace fans according to the DOE test procedure being developed in order to gather measured data on furnace fan efficiency. In the engineering analysis, DOE will use the test results to select a series of furnace fans with incrementally increasing efficiency from the baseline model to max-tech for either each product class or a representative product class, depending on whether electricity consumption is scalable. After selecting both the baseline furnace fan and incrementally more-efficient substitutes, DOE will generate BOMs by disassembling multiple manufacturers' furnace fans spanning a range of efficiency levels. The BOMs describe the products in detail, including all manufacturing steps required to make and/or assemble each part. DOE will then develop a cost model to convert the BOMs and efficiency levels into manufacturer production costs (MPCs). By applying derived manufacturer markups to the MPCs, DOE will calculate the manufacturer selling prices and construct industry cost-efficiency curves. For each furnace fan for which DOE is not able to generate a BOM, DOE will evaluate retail prices and estimate an MSP.

DOE will select furnace fans for the analysis such that potential substitutions maintain airflow of the residential HVAC system in which it is used within the range specified by the product class. In identifying more-efficient substitutes, DOE will use a database of commercially-available residential HVAC products. There are limited publicly-available data on efficiency and costs of furnace fans. Therefore, DOE encourages interested parties to submit data that would improve DOE's understanding of the furnace fan cost-efficiency relationship. These data may be provided under a confidentiality agreement with NCI. As discussed previously, DOE presents aggregated results and does not divulge sensitive raw data from interested parties.

After identifying the more-efficient substitutes for each of the baseline furnace fans, DOE will develop TSLs. TSLs are a set of efficiency levels considered in the NOPR analysis that span the range of furnace fan efficiencies from baseline products to the maximum technologically feasible. Each TSL is analyzed in the LCC and NIA analyses. At the NOPR stage of the rulemaking process, DOE will propose energy conservation standard levels for each product class by selecting a TSL for each product class and invite public comment.

Item 28 *DOE seeks comments on its approach to calculating the cost-efficiency relationship for furnace fans.*

Item 29 *DOE welcomes comments on the selection of commercially-available furnace fans with incrementally increasing efficiency from the baseline model to max-tech for characterizing the efficiencies of furnace fans currently offered for sale.*

Item 30 *DOE welcomes comments on how furnace fan efficiency varies with airflow capacity, motor type, motor rated horsepower, number of speed control settings, or any other furnace fan parameter.*

5.4 Proprietary Designs

DOE will consider in its engineering and economic analyses all design options that are commercially available or present in a working prototype, including proprietary designs, that meet the screening criteria discussed in section 4. However, DOE will consider a proprietary design in the subsequent analyses only if it does not represent a unique path to a given efficiency level. If the proprietary design is the only approach available to achieve a given efficiency level, then DOE will eliminate the efficiency level from further analysis. DOE will reject a standard level that can only be met with a single proprietary technology because it could result in an anti-competitive market, a principle consistently applied in past DOE rulemakings as economically unjustifiable. However, if a given energy efficiency level can be achieved by a number of design approaches, including a proprietary design, DOE will continue to examine the given efficiency level, in spite of the proprietary nature of that one design.

DOE is sensitive to manufacturer concerns about proprietary designs and will take steps to maintain the confidentiality of any proprietary data provided by manufacturers. This information will provide input to the competitive impacts assessment and other economic analyses.

Item 31 *DOE seeks information on proprietary designs of which it should be aware for the furnace fans under consideration in this rulemaking and, if such proprietary designs exist, how DOE can acquire the cost data necessary for evaluating these designs.*

5.5 Outside Regulatory Changes Affecting the Engineering Analysis

In conducting an engineering analysis, DOE considers the effects of regulatory burdens outside DOE's statutory energy conservation standards rulemaking process that can affect manufacturers of the covered products. Some regulatory requirements could potentially affect the energy efficiency or energy consumption of the furnace fans covered under this rulemaking. DOE will attempt to identify all outside regulatory requirements that could affect the engineering analysis. The consideration of these requirements is closely related to the cumulative regulatory burden assessment that DOE will conduct as part of the manufacturer impact analysis. Based on consideration of the comments received on the engineering analysis, DOE will make any necessary changes to its analysis. Those changes will be reflected in the NOPR.

Item 32 *DOE welcomes comments on regulatory burdens and changes that should be considered in the engineering analysis of furnace fans.*

Item 33 *DOE welcomes comments on other engineering issues that could affect the engineering analysis.*

6 MARKUPS FOR PRODUCT PRICE DETERMINATION

DOE uses manufacturer-to-customer markups to convert the manufacturer selling price estimates from the engineering analysis to customer prices, which are then used in the LCC and PBP analysis, as well as the manufacturer impact analysis. Retail prices are necessary for the baseline efficiency level and all other efficiency levels under consideration. DOE will obtain these retail prices by applying manufacturer-to-customer markups (consisting of distribution channel markups and sales tax) to the manufacturer selling price estimates which will be calculated as part of the engineering analysis.

6.1 Description of Market Participants and Distribution Channels

Before developing markups, DOE must first define key market participants and identify distribution channels. Because a furnace fan is a component of a furnace, DOE plans to use the same distribution channels for furnace fans as it intends to use for furnaces.

Generally, the furnace distribution chain includes six market participants: (1) distributors, (2) dealers, (3) general contractors, (4) mechanical contractors, (5) installers, and (6) builders. Based on DOE's 2007 furnace and boiler rulemaking, DOE will consider three distinct categories of market participants: "distributors," "mechanical contractors," and "general contractors." DOE combined mechanical contractors, dealers and installers in a single category labeled "mechanical contractors" because these terms are used interchangeably by the industry. Since builders serve the same function in the HVAC marketplace as general contractors, DOE included the builders in the "general contractors" category.

Distributors receive shipments from manufacturers and resell the products at a markup to contractors. No other participant in the channel carries significant inventory, so distributors absorb imbalances between manufacturer supply and consumer demand.

Most contractors compete at the local level, and the majority of them are small businesses. Many contractors carry products fabricated by more than one manufacturer. Contractors interface with the end user by installing new furnace systems to their specifications, as well as inspecting, servicing, or repairing the existing system. In the residential furnace market, contractors sell products as part of an installation package and do not list retail product prices separately from installation cost. Furthermore, differences in local markets, weather conditions, and many other factors can affect the price contractors charge for furnaces.

Most residential furnaces pass through the following distribution channel: the original equipment manufacturer (OEM) assembles the system and sells it to a distributor; the distributor sells the unit to a contractor; the contractor sells the unit to the end user and performs the installation. After installation, the contractor performs all service on the system, including inspection, maintenance, and repair.

6.2 Markup Estimation Using Financial Statements and Regression Analysis

DOE will determine typical markups in the distribution chain using publicly-available corporate and industry data. DOE will rely on Economic Census data from the United States Census Bureau[f] and input from industry trade associations such as the Heating, Air-Conditioning, and Refrigeration Distributors International (HARDI)[g] to define how furnaces are marked up from the manufacturer to the consumer.

Along the distribution chain, companies mark up the price of products to cover their business costs and profit margin. In financial statements, gross margin is the effective markup on

[f] U.S. Census Bureau. Plumbing, Heating, and Air-Conditioning Contractors: 2002. Report EC02-231-238220

[g] Heating, Air-Conditioning, and Refrigeration Distributors International (HARDI) Regional Analysis, Profit Report: 1999, 2002, 2005, 2008, and 2009.

a company's cost of goods sold (CGS). It includes: all corporate overhead costs; sales, general and administration costs; research and development (R&D); interest expenses; depreciation and taxes; and profits. For sales of a product to contribute positively to company cash flow, its markup must be greater than the corporate gross margin less the company's operating profit margin.

To estimate markups, DOE categorizes expenses into two categories: (1) labor-scaling costs (LSC), which are fixed labor and occupancy expenses that increase in proportion to the amount of labor required to produce or sell the product; and (2) non-labor-scaling costs (NLSC), which are variable operating costs that do not scale with labor and vary in proportion to CGS. Together, LSC and NLSC represent the gross margin.

DOE develops baseline and incremental markups to transform the manufacturer selling price into a consumer product price. DOE uses the baseline markups, which cover all of a distributor's or contractor's costs, to determine the sales price of baseline models. DOE considers baseline models to be products sold in the absence of new energy conservation standards. DOE calculates the baseline markup (MU_{BASE}) using the following equation:

$$MU_{BASE} = \frac{CGS + GM}{CGS} = \frac{CGS + (LSC + NLSC)}{CGS}$$

Where:

MU_{BASE} = Baseline markup,
CGS = Cost of goods sold,
GM = Gross margin,
LSC = Labor-scaling costs, and
NLSC = Non-labor-scaling costs.

Incremental markups are coefficients that relate the change in the manufacturer sales price of higher-efficiency models to the change in the final sales price. Incremental markups cover only those costs that scale with a change in the manufacturer's sales price (*i.e.*, NLSC). DOE considers higher-efficiency models to be products sold under market conditions with new or amended energy conservation standards. It calculates the incremental markup (MU_{INCR}) using the following equation:

$$MU_{INCR} = \frac{CGS + NLSC}{CGS}$$

Where:

MU_{INCR} = Incremental markup,
CGS = Cost of goods sold, and
NLSC = Non-labor-scaling costs.

Because detailed financial data are not available for general and mechanical contractors, DOE relies on an alternative method of markup estimation. Using U.S. Economic Census data on the value of construction, cost of materials, payroll costs, and cost of subcontracted work, DOE calculates the baseline markup for contractors using the following equation:

$$MU_{BASE} = \frac{V_{CONSTRUCT}}{Pay + MatCost + SubCost}$$

Where:

MU_{BASE} = Baseline contractor markup,
$V_{CONSTRUCT}$ = Value of construction,
Pay = Payroll,
$MatCost$ = Cost of materials, and
$SubCost$ = Cost of subcontracted work.

DOE estimates the incremental contractor markup using regression analysis of per-firm revenue on per-firm cost of goods sold and payroll, estimating the coefficients for the equation:

$$R_i = \alpha CGS_i + \beta Pay_i$$

Where:

α = An estimate of the incremental builder markup,
R_i = Revenue of firm i,
CGS_i = Cost of goods sold of firm i, and
Pay_i = Payroll of firm i.

The overall markups will include an average multiplier to account for any sales tax applied at the last stage of the distribution channel. The State Tax Clearinghouse[h] is an Internet source that DOE intends to use to calculate applicable sales taxes.

Item 34 *DOE requests comments on the planned distribution path for the furnace fans covered under this rulemaking and whether DOE should consider any additional paths. DOE also requests information on the relative fraction of shipments expected for each path.*

Item 35 *DOE requests feedback on the overall markups for the furnace fans covered under this rulemaking for each path in the distribution chain.*

[h] Sales Tax Clearinghouse, Inc., State sales tax rates along with combined average city and county rates. Available at: http://thestc.com/STrates.stm.

7 ENERGY USE CHARACTERIZATION

7.1 Overview of Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of furnace fans in representative U.S. homes and to assess the energy savings potential of increased fan efficiency. DOE will estimate the annual energy consumption of furnace fans at specified energy efficiency levels across a range of climate zones. The annual energy consumption will include the electricity use by the fan and the change in natural gas, liquid petroleum gas (LPG), electricity, or oil use for heat production as result of change in the amount of useful heat provided to the conditioned space as a result of the furnace fan. It will also include the impact of the heat delivery by the fan on the house cooling system operation. The annual energy consumption of furnace fans will be used in subsequent analyses, including the LCC and PBP analysis and the national impact analysis.

To determine the energy consumption of furnace fans, DOE plans to use DOE's furnace fan test procedure established in conjunction with this rulemaking. DOE also intends to use the Energy Information Administration's (EIA) Residential Energy Consumption Survey (RECS)[i] to establish a sample of households with furnace fans for each furnace fan product class. Specifically, DOE plans to use the 2005 version of the RECS (RECS 2005), which is the most current survey available at this time. RECS survey data provide information on the age of furnaces with furnace fans, as well as heating and cooling energy use in each household. The survey also includes household characteristics such as the physical characteristics of housing units, household demographics, information about other heating and cooling products, fuels used, energy consumption and expenditures, and other relevant data. DOE plans to use the household samples not only to determine furnace fan annual energy consumption, but also as the basis for conducting the LCC and PBP analysis (see section 8).

Details on how DOE will determine the annual energy consumption of furnace fans are provided below.

7.2 Estimating Annual Energy Consumption of Furnace Fans

The furnace fan moves heated air through the house whenever the furnace burner is on (adjusted for delay times between burner and fan operation) and also operates in the cooling season (summer) if the house is air-conditioned. Using RECS household data, DOE will determine for each sample household whether it has a central furnace and central air conditioning system. DOE intends to estimate the annual energy consumption of furnace fans used during the active mode (heating, cooling, continuous ventilation). For these calculations, DOE plans to use DOE's furnace fan test procedure established in conjunction with this rulemaking, along with

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[i] Energy Information Administration (EIA), 2005 Residential Energy Consumption Survey. Available at: http://www.eia.doe.gov/emeu/recs.

relevant heating and cooling characteristics for each RECS household. DOE's test procedure will specify the annual energy consumption rating, which is a time-weighted sum of the electricity consumed in each mode of operation. In addition, DOE plans to take into account the furnace fan heat contribution, which affects the house heating and cooling load.

The power consumption (and overall efficiency) of a furnace fan depends on the speed at which the motor operates, the external static pressure difference across the fan, and the airflow through the fan. To calculate furnace fan electricity consumption, DOE intends to determine the operating conditions (the pressure and airflow) at which a particular furnace fan will operate in each RECS housing unit when performing heating, cooling, and continuous ventilation functions. These operating conditions can be described as the intersection of a system curve of the ducts in the housing unit (which represents the airflow across the supply and return air ducts as a function of static pressure) with the fan curve of the furnace fan (which represents the airflow through the furnace as a function of static pressure). The intersection of these two curves is the airflow and the static pressure at which the furnace fan operates in that housing unit, which determines the furnace fan power consumption. DOE plans to take into account field data on static pressures of duct systems, as well as airflow curves for furnace fans from manufacturer literature.

DOE intends to determine furnace fan operating hours in each operating mode by first determining heating and cooling operating hours and then assigning the remaining hours to continuous ventilation. To determine the furnace fan heating operating hours, DOE will calculate the furnace burner operating hours and adjust them for delay times between burner and fan operation. Burner operating hours (BOH) are a function of annual house heating load (HHL), furnace efficiency, and furnace input capacity. To determine the furnace fan cooling function operating hours, DOE will calculate the cooling operating hours and adjust them for delay times between compressor and fan operation. Cooling operating hours are a function of annual house cooling load (HCL), cooling system efficiency, and the capacity of the cooling system.

To calculate burner and compressor operating hours, DOE will determine the house heating and cooling loads based on the RECS estimates of the annual energy consumption of the furnace and air conditioner for each household. RECS estimates the furnace and air conditioner annual energy consumption from the household's utility bills. DOE will determine the house heating and cooling load by reference to the existing furnace's and cooling system's characteristics, specifically its efficiency and capacity, and will also consider the heat generated from the furnace fan and other electrical components. Calculation of furnace and cooling system efficiency in each home will be based on product vintage data from RECS 2005[j] and data on the average efficiency by year published by the Air-conditioning, Heating, and Refrigeration Institute (AHRI).[k] RECS house characteristics, such as house size and location, will be used to determine the product capacity. The ratio of furnace fan on-time to burner on-time and the ratio of furnace fan on-time to compressor on-time will be determined from the test procedures. The required delay time values will be determined from manufacturer product literature.

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[j] The term "vintage" refers to the year of installation of the equipment in question.
[k] Air Conditioning, Heating & Refrigeration Institute Industry Statistics is the reference source for the shipped efficiency data by vintage year. Available at: http://www.ahrinet.org/Content/EquipmentStatistics_118.aspx.

DOE will make adjustments to the house heating and cooling loads based on information indicating that housing units in the year in which compliance with the standards is expected to be required will have a somewhat different heating or cooling load than the housing units in the RECS 2005. The adjustment will consider projected improvements in building thermal efficiency (due to improvement in home insulation and other thermal efficiency practices) and changes in house floor area between 2005 and the compliance date of the standards. DOE will also consider market trends that would cause some housing units in the year of compliance to have a different furnace or air conditioner than the housing units in the RECS 2005. DOE will apply these adjustments to both the replacement and new construction markets using data from EIA's *Annual Energy Outlook 2010* (*AEO 2010*) residential sector forecast, as well as data from RECS 2005 and American Housing Survey.

To account for the effect of annual weather variations, the RECS 2005 household heating and cooling consumption values will be adjusted based on 30-year average heating degree-day (HDD) and cooling degree-day (CDD) data for the nine Census Divisions and four large States (California, Florida, New York, and Texas).[1]

Item 36 *DOE seeks comments on the planned approach for determining the energy consumption of furnace fans in residential buildings.*

8 LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSES

8.1 Overview

Energy conservation standards usually decrease products' operating expenses and usually increase consumer prices for the products. DOE analyzes the effect of amended standards on consumers by evaluating changes in the LCC of owning and operating the product, as well as the PBP of higher-efficiency products. The LCC of a product is the cost a product incurs over its lifetime, taking into account both purchase price and operating expenses. The PBP represents the time it takes to recover the additional installed cost of the more-efficient device through annual operating cost savings.

DOE analyzes the net effect on consumers by calculating the LCC and PBP using the engineering performance data (section 8), the energy-use and end-use load characterization data (section 7), and the markups for product price determination (section 6). Inputs to the LCC calculation include the installed cost to the consumer (purchase price plus installation cost), operating expenses (energy expenses, and, if applicable, repair costs and maintenance costs), the

[1] National Oceanic and Atmospheric Administration (NOAA), 30 year Cooling and Heating Degree Data. Available at: http://www.noaa.gov/.

lifetime of the product or other defined period of analysis, and a discount rate. Inputs to the payback period calculation include the installed cost to the consumer and first-year operating costs.

DOE considers both LCC and PBP to determine the impacts of potential energy conservation standards on consumers of the covered products. However, because calculation of LCC uses a discount rate (that depends on consumers' cost of financing) and takes into account changing energy prices over time, it is considered by DOE to be a better indicator of the economic impacts of standards on consumers.

DOE will perform the LCC and PBP analyses using a spreadsheet model combined with Crystal Ball (a commercially-available software add-on program to Microsoft Excel used to conduct stochastic analysis using Monte Carlo simulation and probability distributions) to account for uncertainty and variability among the input variables. Each Monte Carlo simulation will consist of 10,000 LCC and PBP calculations. The models will perform each calculation using input values that are either sampled from probability distributions and household samples or characterized with single point values. The analytical results will be a distribution of 10,000 data points showing the range of LCC savings and PBPs for a given efficiency level relative to the base-case efficiency forecast. For any sensitivity analyses it conducts, DOE will account for correlations that may exist between inputs.

DOE does not intend to take into account the rebound effect associated with more-efficient furnace fans because this effect will be accounted for in the rulemakings for residential furnaces and central air conditioners and heat pumps. In the latter rulemakings, the energy consumption considered will include the electricity used by the fan.

The following sections discuss the methodologies DOE plans to use to develop several of the inputs to the LCC and PBP analysis, including: (1) energy prices; (2) discount rates; (3) maintenance, repair, and installation costs; and (4) product lifetime. The other inputs to the LCC and PBP analysis—namely, manufacturer costs, annual energy consumption, and markups for the determination of consumer retail prices—have been discussed previously.

Item 37 *DOE welcomes comments from interested parties as to whether a more-efficient furnace fan would be expected to be used more and whether such a rebound effect should be considered separately for this product.*

8.2 Energy Prices

Energy prices are used to calculate the annual energy cost savings at different efficiency levels. DOE will derive average monthly energy prices using recent EIA data[m] for each of the nine Census Divisions and four large States to establish appropriate energy prices for each sample household.

In contrast to the situation with residential air conditioners and heat pumps, for which the appliance's load primarily occurs during utility "on peak" periods during the summer, electricity consumption of furnaces is not concentrated during peak periods. Therefore, DOE does not see a compelling reason to use marginal electricity prices.

DOE will use projections of national average electricity prices to residential consumers to estimate future energy prices (from the assumed compliance date of a new standard to 30 years after compliance is required). DOE will use the most recent available edition of EIA's *AEO* as the source of projections for future energy prices.

8.3 Consumer Discount Rates

The calculation of LCC requires use of an appropriate discount rate to determine the present value of operating expenses during the product lifetime. The discount rate used in the LCC analysis represents the rate from an individual consumer's perspective.

For consumers of furnace fans, DOE plans to use the same approach that it relied on to develop discount rates for the November 2007 residential furnaces and boilers standards rulemaking (*i.e.*, deriving the discount rates from estimates of the "finance cost" to purchase residential products).[n] The finance cost can be interpreted as: (1) the financial cost of any debt incurred to purchase products (principally interest charges on debt), or (2) the opportunity cost of any equity used to purchase products (principally interest earnings on household equity). Much of the data DOE uses to determine the cost of debt and equity comes from the Federal Reserve Board's triennial Survey of Consumer Finances.[o]

Item 38 *DOE welcomes input on the planned approaches for estimating discount rates for consumers of the furnace fans covered under this rulemaking.*

[m] EIA's 2008 Form 861 data and EIA's Form 826. Available at: http://www.eia.doe.gov/cneaf/electricity/epm/table5_3.html.
[n] See http://www.eere.energy.gov/buildings/appliance_standards/residential/furnace_boiler_fr.html.
[o] See http://www.federalreserve.gov/pubs/oss/oss2/scfindex.html.

8.4 Installation, Maintenance, and Repair Costs

DOE does not currently plan to consider installation costs for furnace fans because: (1) the installation of a fan in a new furnace is included in the manufacturing cost of a furnace; and (2) installation of a replacement fan in an existing furnace is considered part of the repair/replacement cost.

DOE will evaluate how any maintenance and repair costs change with increased efficiency for the furnace fans. Often, small incremental changes in product efficiency would incur little or no change in maintenance and repair costs over baseline products. For products with significant energy-efficiency improvements over the baseline, there may be increased maintenance and repair costs, because such products are more likely to incorporate technologies that are not widely available or used.

DOE will estimate maintenance and repair costs at each considered efficiency level using a variety of sources, including RS Means,[p] manufacturer literature, and information from expert consultants. DOE will account for regional differences in labor costs by using RS Means data.

Item 39 *DOE welcomes comments on appropriate maintenance and repair costs for furnace fans.*

8.5 Product Lifetime

Product lifetime is the age at which a product is retired from service. DOE plans to use information from various literature sources and industry experts and input from manufacturers and other interested parties to determine a range for the lifetime of furnace fans.

Item 40 *DOE welcomes comments on appropriate lifetimes for the furnace fans covered in this rulemaking.*

8.6 Energy Efficiency in the Base Case

To estimate the share of consumers that would be affected by a standard at a particular efficiency level, DOE's LCC and PBP analysis will consider the projected distribution (*i.e.*, market shares) of product efficiencies that consumers will purchase in the first compliance year

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[p] See http://rsmeans.reedconstructiondata.com/.

under the base case (*i.e.*, the case without amended energy conservation standards). The projection will use available data on recent market trends in furnace efficiency and will take into account the potential impacts of the ENERGY STAR program and other programs or policies that may affect the demand for more-efficient furnaces (such as consumer rebate programs or State tax credits to consumers that encourage the purchase of more-efficient products, and manufacturer tax credits that encourage the production of more-efficient products). DOE will consider how the trends in furnace and central air conditioner efficiency are likely to influence the distribution of furnace fan efficiency.

Item 41 *DOE seeks comments on the appropriate distribution of energy efficiencies for furnace fans in the absence of amended energy conservation standards.*

8.7 Rebuttable Presumption Analysis

In addition to the LCC and PBP calculations discussed above, DOE also conducts a rebuttable presumption analysis for covered products. Under 42 U.S.C. 6295(o)(2)(B)(iii), the statute establishes a rebuttable presumption that a standard is economically justified "[i]f the Secretary finds that the additional cost to the consumer of purchasing a product complying with an energy conservation standard level will be less than three times the value of the energy … savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure…." While the rebuttable presumption calculation is helpful in understanding that certain standard levels have short payback periods, DOE routinely conducts a full economic analysis that considers the full range of impacts, including those to the consumer, manufacturer, Nation, and environment, as required under 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). Economic justification is based on a weighing of the seven EPCA factors described in section 1.3.1. The LCC and PBP analyses described in the following section reflect field conditions and are, therefore, a more accurate depiction of consumer impacts.

9 SHIPMENTS ANALYSIS

DOE develops shipment forecasts of products to calculate the national impacts of potential energy conservation standards on energy consumption, net present value (NPV), and future manufacturer cash flows. DOE plans to develop shipments forecasts (from the assumed compliance date of a new standard to 30 years after compliance is required) based on an analysis of key market drivers for furnace fans.

9.1 Base-Case Forecast

To evaluate the impacts of potential energy conservation standards, DOE will develop a base-case shipments forecast against which to compare forecasts for higher efficiency levels. (The latter are also referred to as standards-case forecasts). DOE designs the base-case forecast to depict what it anticipates would happen to energy consumption and costs over time if DOE does not adopt new energy conservation standards for the products covered under this rulemaking. When it develops base-case shipments forecasts, DOE plans to calibrate its shipments model against historical shipments. DOE will also consider the distribution of efficiencies in the absence of new standards and how that mix might change over time.

Item 42 *DOE seeks input on historical shipments data for furnace fans, including the distribution of shipments by efficiency.*

9.2 Accounting Methodology

DOE intends to use an accounting model to prepare shipment scenarios for the base case and the standards cases. DOE plans to determine annual shipments in the base case by accounting for: (1) furnace and cooling product replacements due to failure; (2) furnaces and cooling products installed in new homes; (3) furnaces and cooling products installed in homes that convert to central heating and cooling; and (4) fan retrofits into existing furnaces and cooling products if the fan fails.

To forecast furnace fan replacement shipments, DOE will develop retirement functions for furnace and cooling products from the lifetime estimates and apply them to the existing products in the housing stock. The existing stock of products will be tracked by vintage and will be developed from historical shipments data. To establish historical shipments by product class, DOE plans to rely on public sources including Appliance Magazine[q] and data from AHRI.

To forecast shipments to the new construction market, DOE plans to utilize estimates of forecasted new housing construction and saturation rates of various furnace and cooling product types in new housing. DOE plans to rely on the latest available edition of EIA's *AEO* for forecasts of new residential construction. New housing saturation rates are provided by the U.S. Census Bureau's Characteristics of New Housing.[r] In projecting future new housing saturation rates of residential furnaces and cooling products, DOE will consider expected trends in builder and consumer preferences, including competition among space heating and cooling products.

[q] Available at: http://www.appliancemagazine.com/.
[r] Available at: http://www.census.gov/const/www/charindex.html.

DOE also plans to consider the market segment consisting of existing households that do not already own a product with a furnace fan. In the case of furnaces, this would primarily refer to homes built without central heating in which a furnace is later installed. DOE plans to derive a historical rate of product adoption for the non-centrally-heated market. DOE plans to project future adoption rates by considering the historical trend, as well as market saturation effects based on American Housing Survey data.[s]

Lastly, DOE will analyze shipments of fans for retrofit into existing furnaces and cooling products (*i.e.*, replacement of failed fans). DOE will estimate these shipments by taking into account the fan lifetime distribution developed for the LCC analysis.

Item 43 *DOE welcomes comments on the methodology described to forecast shipments of furnace fans.*

9.3 Impacts of Standards on Furnace Fan Shipments

DOE intends to evaluate whether standards that require more-efficient furnace fans would have an impact on the number of fans shipped. DOE will consider application of elasticity parameters that relate changes in shipment quantities to changes in the installed cost of products with furnace fans.

Item 44 *DOE welcomes comments on whether energy conservation standards might affect shipments of furnace fans, as well as the anticipated extent of such impacts, if any.*

10 NATIONAL IMPACT ANALYSIS

The national impact analysis assesses the aggregate impacts at the national level of potential energy conservation standards for each of the considered products, as measured by the NPV of total consumer economic impacts and the national energy savings (NES). DOE determines the NPV and NES for the standard levels considered for each of the product classes analyzed. To make the analysis more accessible and transparent to all interested parties, DOE prepares a spreadsheet model to forecast NES and the national consumer economic costs and

[s] Available at: http://www.census.gov/hhes/www/housing/ahs/ahs.html.

savings resulting from new standards. The spreadsheet model uses typical values as inputs (as opposed to probability distributions). To assess the effect of input uncertainty on NES and NPV results, DOE may conduct sensitivity analyses by running scenarios on specific input variables.

10.1 Inputs to the NIA

Analyzing impacts of potential energy conservation standards for residential furnace fans requires comparing projections of U.S. energy consumption with new or amended energy conservation standards against projections of energy consumption without the standards. The forecasts include projections of annual appliance shipments, the annual energy consumption of new appliances, and the purchase price of new appliances.

A key component of DOE's NIA analysis is the energy efficiencies forecasted over time for the base case (without new standards) and each of the standards cases. The forecasted efficiencies represent the annual shipment-weighted energy efficiency of the products under consideration during the forecast period (*i.e.*, from the assumed compliance date of a new standard to 30 years after compliance is required).

Section 9 described how DOE plans to develop a base-case energy efficiency distribution (which yields a shipment-weighted average efficiency) for each of the furnace fan product classes for the first year of the forecast period. To forecast base-case efficiencies over the entire forecast period, DOE intends to extrapolate from the historical trends to the extent that is reasonable.

To develop shipment-weighted efficiencies for the various standards cases, DOE will utilize the efficiency market share data for each product class. Once DOE establishes the shipment-weighted efficiencies for the assumed compliance date of the standard, it plans to estimate future shipment-weighted efficiencies using the same rate of forecasted efficiency growth as in the base-case efficiency trend.

To estimate the impact that standards may have in the year compliance becomes required, DOE has used "roll-up" and/or "shift" scenarios in its standards rulemakings. Under the "roll-up" scenario, DOE assumes: (1) product efficiencies in the base case that do not meet the standard level under consideration would "roll-up" to meet the new standard level; and (2) product efficiencies above the standard level under consideration would not be affected. Under the "shift" scenario, DOE retains the pattern of the base-case efficiency distribution but re-orients the distribution at and above the new minimum energy conservation standard. DOE will evaluate whether one of these approaches is more reasonable for furnace fans, or whether it would be preferable to use both scenarios in its calculation of national impacts.

Item 45 *DOE seeks comments on the appropriate assumptions to use regarding long-run changes in furnace fan energy efficiency independent of amended energy conservation standards.*

Item 46 *DOE seeks comments on the use of the "roll-up" and "shift" efficiency scenarios to characterize the impact that potential standards would have on the product efficiency distributions.*

10.2 Calculation of National Energy Savings

DOE will calculate national energy consumption for each year in the forecast period. DOE will calculate national energy consumption by fuel type for the base case and each standards case analyzed. DOE plans to perform this calculation through the use of a spreadsheet model that multiplies the stock of products (which is determined by the shipments forecasts) by unit energy savings, accounting for the stock of products affected by the energy conservation standards. In response to comments by stakeholders in prior rulemakings who asked for a simple, transparent model, DOE has developed NIA spreadsheet models to forecast energy savings from standards at different efficiency levels.

To estimate the primary energy savings resulting from fuel and/or electricity savings at building sites, DOE will develop annual site-to-source conversion factors based on the version of the National Energy Modeling System (NEMS) that corresponds to the *AEO 2010*. The factors that DOE develops are marginal values, which represent the response of the system to an incremental decrease in consumption. Natural gas losses include pipeline leakage, pumping energy, and transportation fuel. For electricity, the conversion factors change over time in response to projected changes in generation sources (*i.e.*, the types of power plant projected to provide electricity).

10.3 Net Present Value of Consumer Savings

The inputs for determining NPV of the total costs and benefits experienced by consumers of the considered appliances are: (1) total annual installed cost; (2) total annual savings in operating costs; (3) a discount factor; (4) present value of costs; and (5) present value of savings. DOE calculates net savings each year as the difference between the base case and each standards case in terms of the total savings in operating costs and total increases in installed costs. DOE calculates savings over the life of each product. DOE calculates NPV as the difference between the present value of operating cost savings and the present value of total installed costs.

DOE calculates increases in total installed costs as the product of the difference in total installed cost between the base case and a standards case. DOE expresses savings in operating costs as decreases associated with the lower energy consumption of products bought in the standards case compared to the base case. Total savings in operating costs are the product of savings per unit and the number of units of each vintage that survive in a given year.

According to U.S. Office of Management and Budget (OMB) guidelines for Federal agencies, DOE will conduct two NPV calculations, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent (OMB, Circular A-4: Regulatory Analysis (2003)). The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "societal rate of time preference," which is the rate at which society discounts future consumption flows to their present value.

11 LIFE-CYCLE COST CONSUMER SUBGROUP ANALYSIS

At the NOPR stage of this rulemaking, DOE will conduct a LCC subgroup analysis. In this analysis, DOE assesses consumer impacts by dividing consumers into subgroups and accounting for variations in key inputs to the LCC analysis. A consumer subgroup comprises a subset of the population likely to be affected disproportionately by new or revised energy conservation standards (*e.g.*, low-income consumers, seniors). The purpose of a subgroup analysis is to determine the extent of any such disproportional impact. DOE will work with industry and other interested parties early in the rulemaking process to identify any subgroups for consideration.

Item 47 *DOE welcomes comments from interested parties on which, if any, consumer subgroups should be considered when developing energy conservation standards for furnace fans.*

12 MANUFACTURER IMPACT ANALYSIS

DOE intends the manufacturer impact analysis (MIA) to provide an assessment of the potential impacts of energy conservation standards on manufacturers of furnace fans. A wide range of quantitative and qualitative effects may occur following the adoption of a standard that may require changes to manufacturing practices. DOE will identify these potential effects through interviews with manufacturers and other experts.

For the NOPR, DOE will conduct an industry-wide cash-flow analysis using the Government Regulatory Impact Model (GRIM), identify and analyze subgroups of manufacturers whose businesses vary significantly from the industry as a whole, perform a competitive impacts assessment, and review the cumulative regulatory burden for the industry.

12.1 Sources of Information for the Manufacturer Impact Analysis

Many of the analyses described earlier provide important information that DOE will use as inputs for the MIA. Such information includes financial parameters developed in the market assessment (section 3.1), cost data developed in the engineering analysis (section 5), and shipments forecasts (section 9). DOE will supplement this information with information gathered during manufacturer interviews, as discussed below.

DOE will conduct detailed interviews with manufacturers to gain insight into the range of possible impacts from potential energy conservation standards. The interview process plays a key role in the MIA, because it provides an opportunity for directly-affected parties to express their views on important issues. During the interviews, DOE will solicit information on the possible impacts of potential standards on manufacturing costs, product prices, sales, direct employment, capital assets, and industry competitiveness. Both qualitative and quantitative information are valuable in this analysis. DOE will schedule interviews well in advance to provide every opportunity for key individuals to participate. In addition, DOE will provide manufacturers with questionnaires before the interviews to facilitate information gathering. Although a written response to the questionnaire is acceptable, DOE prefers an interactive interview process, because it helps to clarify responses and provides the opportunity to identify additional issues.

DOE will ask interview participants to identify confidential information, and will consider the information gathered in the energy conservation standard decision-making process. DOE will also ask participants to identify any information they wish to have included in the public record, but do not want to have associated with their interview (thereby identifying that particular manufacturer). DOE will incorporate this information into the public record, but will report it without attribution.

DOE will collate the interview results and prepare a summary of the major issues and outcomes. This summary will become part of the technical support document for this rulemaking.

12.2 Industry Cash-Flow Analysis

The industry cash-flow analysis will rely primarily on the GRIM. DOE uses the GRIM to analyze the financial impacts of new or more-stringent energy conservation standards on the industry that produces the products covered by the standard.

The GRIM uses a number of factors—annual expected revenues; manufacturer costs such as costs of goods sold; selling, general, and administrative (SG&A) costs; research and development costs; product conversion costs; taxes; capital expenditures (both ordinary capital expenditures and those related to standards); and working capital requirements—to determine annual cash flows associated with a new standard, beginning from the announcement of the standard and continuing for several years after its implementation. DOE compares the results against base-case projections that involve no new standards. The financial impact of new standards is the difference between the two sets of discounted annual cash flows, or the differences between the base-case and standards-case industry net present values (INPV). Other performance metrics, such as return on invested capital, are also available from the GRIM.

DOE will gather the inputs needed for the GRIM from two primary sources: (1) the analyses conducted to this point; and (2) interviews with manufacturers and other interested parties. As discussed above, information gathered from previous analyses will include financial parameters, manufacturing costs, price forecasts, and shipment forecasts. Interviews with manufacturers and other interested parties will be essential in supplementing this information.

12.3 Manufacturer Subgroup Analysis

Average industry cost values may not reveal differential impacts among furnace fan manufacturer subgroups. Smaller manufacturers, niche players, and manufacturers exhibiting a cost structure that differs significantly from the industry average may be affected differently by standards. Ideally, DOE would consider the impact on every firm individually. In highly-concentrated industries, this may be possible. In industries having numerous participants, however, DOE uses the results of the market and technology assessment to group manufacturers into subgroups, as appropriate. For furnace fans, DOE does not intend to assess the impacts on every manufacturer individually, and therefore, is interested in feedback about potential subgroups. However, the detailed manufacturer subgroup impact analysis will calculate cash flows separately for each class of manufacturer.

Item 48 *DOE seeks comments on the subgroups of furnace fan and furnace fan product manufacturers that it should consider in a manufacturer subgroup analysis.*

12.4 Competitive Impacts Analysis

EPCA directs DOE to consider any lessening of competition likely to result from the imposition of standards. (42 U.S.C. 6295(o)(2)(B)(i)(V)) It further directs the Attorney General to determine in writing the impacts, if any, of any lessening of competition likely to result from standards. (42 U.S.C. 6295(o)(2)(B)(ii))

DOE will make a determined effort to gather firm-specific financial information and impacts and report the aggregated impact of the amended standard on manufacturers. The competitive impacts analysis will focus on assessing the impacts on smaller manufacturers. DOE will base the assessment on manufacturing cost data and information collected from interviews with manufacturers. The manufacturer interviews will focus on gathering information that would help in assessing asymmetrical cost increases to some manufacturers, increased proportion of fixed costs potentially increasing business risks, and potential barriers to market entry (*e.g.*, proprietary technologies). DOE will provide the Attorney General with a copy of the NOPR for consideration in his evaluation of the impact of standards on the lessening of competition. DOE will publish the Attorney General's letter and address any related comments in the final rule.

12.5 Cumulative Regulatory Burden

Other regulations (Federal, State, local, or international) may apply to the furnace fan product manufacturers covered under this rulemaking, and to other products made by furnace fan and furnace fan product manufacturers. Multiple regulations may result in a significant, cumulative regulatory burden on these manufacturers. DOE will consider the impact on these manufacturers of multiple, product-specific regulatory actions. Regulations that could impact the industry affected by this rulemaking include:

- Energy Conservation Standards for Residential Furnaces and Boilers
- Energy Conservation Standards for Residential Central Air Conditioners and Heat Pumps

Item 49 *DOE welcomes comments on what other existing regulations or pending regulations it should consider in its examination of cumulative regulatory burden.*

13 UTILITY IMPACT ANALYSIS

To estimate the impacts of potential energy conservation standards for furnace fans on the electric utility industry, DOE will use a variant of the EIA's National Energy Modeling System called NEMS-BT.[t] NEMS is a large, multi-sectoral, partial-equilibrium model of the U.S. energy sector that EIA has developed over several years, primarily for the purpose of preparing the *AEO*. NEMS produces a widely-recognized Reference-Case forecast for the United States through 2035 and is available to the public.

[t] For more information on NEMS, please refer to the U.S. Department of Energy, Energy Information Administration documentation. A useful summary is *National Energy Modeling System: An Overview 2000*, DOE/EIA-0581 (March 2000), available at: http://tonto.eia.doe.gov/ftproot/forecasting/05812000.pdf. EIA approves use of the name NEMS to describe only an official version of the model without any modification to code or data. Because this analysis entails some minor code modifications and the model is run under various policy scenarios that are variations on EIA assumptions, DOE refers to the model by the name NEMS-BT. ("BT" refers to DOE's Building Technologies Program, under whose aegis this work is performed.)

The utility impact analysis is a comparison between the NEMS-BT model results for the base case and standard cases. Outputs of the utility impact analysis usually parallel results that appear in the latest *AEO*, with some additions. The utility impact analysis reports the changes in installed capacity and generation that result from each standard level by plant type. DOE will model the anticipated energy savings impacts from potential amended energy conservation standards using NEMS-BT to generate forecasts that deviate from the *AEO* Reference Case.[u]

Item 50 *DOE seeks input on its plans to use NEMS-BT to conduct the utility impact analysis for the products covered under this rulemaking.*

14 EMPLOYMENT IMPACT ANALYSIS

The adoption of energy conservation standards can affect employment both directly and indirectly. Direct employment impacts are changes in the number of employees at the plants that produce the covered products, along with affiliated distribution and service companies. DOE will evaluate direct employment impacts in the MIA (section 12).

Indirect employment impacts may result from expenditures shifting between goods (the substitution effect) and changes in income and overall expenditure levels (the income effect) that occur due to standards. DOE defines indirect employment impacts from standards as net jobs eliminated or created in the general economy as a result of increased spending driven by increased product prices and reduced spending on energy.

The combined direct and indirect employment impacts will be investigated in the employment impact analysis using the Pacific Northwest National Laboratory's "Impact of Sector Energy Technologies" (ImSET) model.[v] The ImSET model was developed for DOE's Office of Planning, Budget, and Analysis to estimate the employment and income effects of energy-saving technologies in buildings, industry, and transportation. Compared with simple economic multiplier approaches, ImSET allows for more complete and automated analysis of the economic impacts of energy conservation investments.

[u] Several descriptions of NEMS-BT models from previous rulemakings, including residential furnaces and boilers, can be found on DOE's website at: www.eere.energy.gov/buildings/appliance_standards/residential/pdfs/fb_fr_tsd/chapter_13.pdf.
[v] Roop, J. M., M. J. Scott, and R. W. Schultz, ''ImSET: Impact of Sector Energy Technologies,'' PNNL–15273. (Pacific Northwest National Laboratory, Richland, WA)(2005).

Item 51 *DOE requests comments on its approach to assessing employment impacts on the products covered under this rulemaking.*

15 ENVIRONMENTAL ASSESSMENT

The intent of the environmental assessment (EA) is to quantify and consider the environmental effects of potential energy conservation standards for furnace fans. The primary environmental effects of these standards would be reduced power plant emissions resulting from reduced consumption of electricity. DOE will assess these environmental effects by using NEMS-BT to provide key inputs to its analysis. The portion of the environmental assessment that will be produced by NEMS-BT considers carbon dioxide (CO_2), nitrogen oxides (NO_X), and mercury (Hg). The environmental assessment also considers impacts on sulfur dioxide (SO_2) emissions. After a brief discussion of general methodology, this section will address each of the relevant emissions. This section then explains how DOE plans to monetize the benefits associated with emissions reductions.

15.1 Carbon Dioxide

In the absence of any Federal emissions control regulation of power plant emissions of CO_2, a DOE standard is likely to result in reductions of these emissions. The CO_2 emission reductions likely to result from a standard will be estimated using NEMS-BT and national energy savings estimates drawn from the NIA spreadsheet model. The net benefit of the standard is the difference between emissions estimated by NEMS-BT at each standard level considered and the *AEO* Reference Case. NEMS-BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects.

15.2 Sulfur Dioxide

DOE has preliminarily determined that SO_2 emissions from affected Electric Generating Units (EGUs) are subject to nationwide and regional emissions cap-and-trade programs that are likely to eliminate the standards' impact on SO_2 emissions. The costs of meeting such emission cap requirements are reflected in the electricity prices and forecasts used in DOE's analysis of the standards. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for all affected EGUs. SO_2 emissions from 28 eastern States and the District of Columbia (DC) are also limited under the Clean Air Interstate Rule (CAIR, published in the Federal Register on May 12, 2005. 70 FR 25162 (May 12, 2005)), which creates an allowance-based trading program that will gradually replace the Title IV program in those States and DC. (The recent legal history surrounding CAIR is discussed below.) The attainment of the emissions caps is flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emission allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the standard resulted in a permanent increase in the quantity of unused emission allowances, there would be an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap-and-trade system, the NEMS-BT modeling system that DOE plans to use to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2.

15.3 Nitrogen Oxides

NEMS-BT also has an algorithm for estimating NO_X emissions from power generation. The impact of these emissions, however, will be affected by the CAIR, which the U.S. Environmental Protection Agency (EPA) issued on May 12, 2005. CAIR will permanently cap emissions of NO_X in 28 eastern States and the District of Columbia (DC). 70 FR 25162 (May 12, 2005).

Much like SO_2 emissions, a cap on NO_X emissions means that the furnace fan standards may have little or no physical effect on these emissions in the 28 eastern States and DC covered by CAIR. Although CAIR has been remanded to the EPA by the U. S. Court of Appeals for the District of Columbia Circuit, it will remain in effect until it is replaced by a rule consistent with the Court's July 11, 2008, opinion in North Carolina v. EPA. 531 F.3d 896 (DC Cir. 2008); see also North Carolina v. EPA, 550 F.3d 1176 (DC Cir. 2008). Because all States covered by CAIR opted to reduce NO_X emissions by participating in cap-and-trade programs for electric generating units, emissions from these sources are capped across the CAIR region.

DOE plans to use NEMS-BT to estimate the emissions reductions from possible standards in the 22 States where emissions are not capped.

15.4 Mercury

Similar to emissions of SO_2 and NO_X, future emissions of Hg would have been subject to emissions caps. In May 2005, EPA issued the Clean Air Mercury Rule (CAMR). 70 FR 28606 (May 18, 2005). CAMR would have permanently capped emissions of mercury for new and existing coal-fired power plants in all States by 2010. However, on February 8, 2008, the United States Court of Appeals for the DC Circuit issued its decision in New Jersey v. Environmental Protection Agency, in which the Court, among other actions, vacated the CAMR. 517 F.3d 574 (DC Cir. 2008). EPA has decided to develop emissions standards for power plants under the Clean Air Act (Section 112), consistent with the Court's opinion on the CAMR. See http://www.epa.gov/air/mercuryrule/pdfs/certpetition_withdrawal.pdf. Pending EPA's forthcoming revisions to the rule, DOE is excluding the CAMR from its environmental assessment. In the absence of CAMR, a DOE standard would likely reduce Hg emissions and DOE plans to use NEMS-BT to estimate these emission reductions. However, DOE continues to review the impact of rules that reduce energy consumption on Hg emissions, and may revise its assessment of Hg emission reductions in future rulemakings.

15.5 Particulate Matter

DOE acknowledges that particulate matter (PM) impacts are of concern because exposure can impact health. However, the impacts of PM emissions reduction are much more difficult to estimate than other emissions reductions due to the complex interactions between PM, other power plant emissions, meteorology, and atmospheric chemistry that affect human exposure to particulates. Human exposure to PM usually occurs at a significant distance from the power plants that emit particulates and particulate precursors. When power plant emissions travel significant distances through the atmosphere, they undergo highly complex chemical reactions, ultimately producing secondary sulfates. Although the EPA does record inventories of direct PM emissions of power plants, in its source attribution reviews, the EPA does not separate direct PM emissions from power plants from the sulfate particulates indirectly produced through complex atmospheric chemical reactions. The great majority of PM emissions from power plants are of these secondary sulfates. Thus, it is not useful to examine how the amended standard impacts direct PM emissions independent of indirect PM production and atmospheric dynamics. Therefore, DOE is not planning to assess the impact of these standards on particulate emissions. Further, even the cumulative impact of PM emissions from power plants and indirect emissions of pollutants from other sources is unlikely to be significant.

Item 52 *DOE seeks input on its plans to use NEMS-BT to conduct the environmental assessment for the products covered by this rulemaking.*

16 MONETIZATION OF EMISSIONS REDUCTIONS

For those emissions for which real national emission reductions are anticipated (CO_2, Hg, and NO_X for 22 States), only ranges of estimated economic values based on environmental damage studies of varying quality and applicability are available. Therefore, DOE intends to report estimates of monetary benefits derived using these values and consider these benefits in weighing the costs and benefits of each of the standard levels considered.

In order to estimate the monetary value of benefits resulting from reduced emissions of CO_2 emissions, DOE intends to use in its analysis the most current Social Cost of Carbon (SCC) values developed and/or agreed to by interagency reviews. The SCC is intended to be a monetary measure of the incremental damage resulting from greenhouse gas (GHG) emissions, including, but not limited to, net agricultural productivity loss, human health effects, property damage from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the harms associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide estimates of the social benefits of reductions in GHG emissions.

At the time of this notice, the most recent interagency estimates of the potential global benefits resulting from reduced CO_2 emissions in 2010 were $4.7, $21.4, $35.1, and $64.9 per metric ton in 2007 dollars. These values are then adjusted to 2009$ using the standard gross domestic product (GDP) deflator value for 2008 and 2009. For emissions (or emission reductions) that occur in later years, these values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate domestic effects, although DOE will give preference to consideration of the global benefits of reducing CO_2 emissions. To calculate a present value of the stream of monetary values, DOE will discount the values in each of the four cases using the discount rates that had been used to obtain the SCC values in each case.

DOE recognizes that scientific and economic knowledge continues to evolve rapidly as to the contribution of CO_2 and other GHG to changes in the future global climate and the potential resulting damages to the world economy. Thus, these values are subject to change.

DOE also intends to estimate the potential monetary benefit of reduced NO_X emissions resulting from the standard levels it considers. For NO_X emissions, available estimates suggest a very wide range of monetary values for NO_X emissions, ranging from $370 per ton to $3,800 per ton of NO_X from stationary sources, measured in 2001$ (equivalent to a range of $447 to $4,591 per ton in 2009$). Refer to the OMB, Office of Information and Regulatory Affairs (OIRA), "2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities," for additional information. In accordance with OMB guidance, DOE will conduct two calculations of the monetary benefits derived using each of the economic values used for NO_X, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent.[w]

DOE does not plan to monetize estimates of Hg in this rulemaking. DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it once again monetizes Hg in its rulemakings.

Item 53 *DOE requests comments on the approach it plans to use for estimating monetary values associated with emissions reductions, or any widely-accepted values that could be used in DOE's analyses.*

[w] OMB, Circular A-4: Regulatory Analysis (Sept. 17, 2003).

17 REGULATORY IMPACT ANALYSIS

DOE will prepare a regulatory impact analysis at the NOPR and final rule stages of this rulemaking. This analysis will address the potential for non-regulatory approaches to supplant or augment potential energy conservation standards to improve the efficiency of furnace fans on the market. DOE recognizes that voluntary and other non-regulatory efforts by manufacturers, utilities, and other interested parties can result in substantial efficiency improvements. DOE intends to analyze the likely effects of non-regulatory initiatives on product energy use, consumer utility, and LCCs. DOE will try to base its assessment on the actual impacts of any such initiatives to date, but also will consider information presented on the impacts that any existing initiative might have in the future.

If DOE determines that energy conservation standards for furnace fans would constitute a significant regulatory action, DOE will prepare and submit to OMB the assessment of costs and benefits required under section 6(a)(3) of Executive Order 12866, "Regulatory Planning and Review," 58 FR 51735 (Oct. 4, 1993).

APPENDIX A – LIST OF ITEMS FOR COMMENT

This appendix lists all the items for comment contained in this framework document and the page numbers on which those items can be found.