Preliminary Analysis Public Meeting on Energy Conservation Standards for Residential Furnace Fans

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Welcome

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- Introductions
- Role of the Facilitator
- Ground Rules (norms)
  - Listen as an ally
  - Use short, succinct statements – keep to the point
  - Hold sidebar conversations outside the room
  - Focus on issues, not personalities
  - One person speak at a time (raise hand to be recognized; state your name for the record)
  - Set cell phones to silent/vibrate
- Housekeeping Items

Listening Via the Webcast

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- The Department is broadcasting this meeting live over the Internet.
- DOE is providing the webcast to accommodate interested parties who are unable to attend the public meeting in person.
- The web broadcast allows interested parties to listen in and view the presentation slides.
- All interested parties are encouraged to submit written comments after the public meeting.

Purpose of the Public Meeting

- To present methodologies and characterize results for analyses to date.
- To discuss specific issues related to each analysis.
- To seek input from attendees on methodologies, assumptions and data sources.
- To describe upcoming analyses and next steps.

Interested parties who contacted DOE to request an opportunity to issue an opening statement may do so now.

Comments from Interested Parties

Issue Box: Throughout this presentation, specific issues will be brought up for discussion on slides such as this, with identifying numbers corresponding to those in the **Executive Summary of the TSD**.

- Comments concerning each issue are welcome.
- Participants are invited to raise additional issues for discussion today.
- Interested parties may provide comments on the preliminary analyses through September 10, 2012.

Comments From Interested Parties

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- **In all correspondence, please include all of the following:**
  - Energy Conservation Standards for Residential Furnace Fans
  - Docket Number: EERE-2010-BT-STD-0011
  - Regulatory Identification Number (RIN): 1904–AC22

- **Contact Information**

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Comment period closes: September 10, 2012

Public Meeting Agenda

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

1. Introduction and Overview
2. Market and Technology Assessment and Screening Analysis
3. Engineering Analysis
4. Markups, Energy Use Characterization, LCC and Payback Period Analysis
5. National Impact Analysis
6. Preliminary Manufacturer Impact Analysis
7. Next Steps

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Energy Policy and Conservation Act (EPCA) of 1975 (Public Law 94-163), as amended by the Energy Policy Act (EPACT) of 2005 (Public Law 109-58) and the Energy Independence and Security Act of 2007 (Public Law 110-140)

- *"…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."* (42 U.S.C. 6295(f)(4)(D))
- *"Any new or amended energy conservation standard adopted after July 1, 2010, shall address standby mode and off mode energy use pursuant to 42 U.S.C. 6295(o)."* (42 U.S.C. 6295(gg)(3))

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DOE has no current energy conservation standard or test procedure for residential furnace fans.

- Test Procedure
  - DOE is developing a test procedure in a parallel rulemaking.
  - DOE published test procedure NOPR on May 15, 2012.
  - DOE held the test procedure NOPR public meeting on June 15, 2012.
  - The test procedure NOPR comment period ends July 30, 2012.

- Energy Conservation Standard
  - DOE published the Notice of Public Meeting and Availability of the Framework Document on June 3, 2010.
  - DOE held the Framework Document public meeting on June 18, 2010.
  - DOE published the Notice of Public Meeting and Availability of the Preliminary Technical Support Document on July 10, 2012
  - The test preliminary analysis comment period ends September 10, 2012.

- DOE conducted the preliminary analysis on the basis of the test procedure proposed in the test procedure NOPR. 77 FR 28674, May 15, 2012

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The proposed Fan Efficiency Rating (FER) is the estimated annual electrical energy consumption normalized by the annual rated operating hours and the airflow in the maximum airflow-control setting.

$$FER = \frac{\sum_{x=rated\ modes}(Operating\ Hours_x \times Power\ Consumption_x)}{(\sum_{x=rated\ modes} Operating\ Hours_x) \times (Maximum\ Airflow)} \times 1000$$

- FER for non-hydronic air handler furnace fans:

$$FER = \frac{(CH \times E_{max}) + (HH \times E_{heat}) + (CCH \times E_{circ})}{(\mathrm{CH} + \mathrm{HH} + \mathrm{CCH}) \times Q_{max}} \times 1000$$

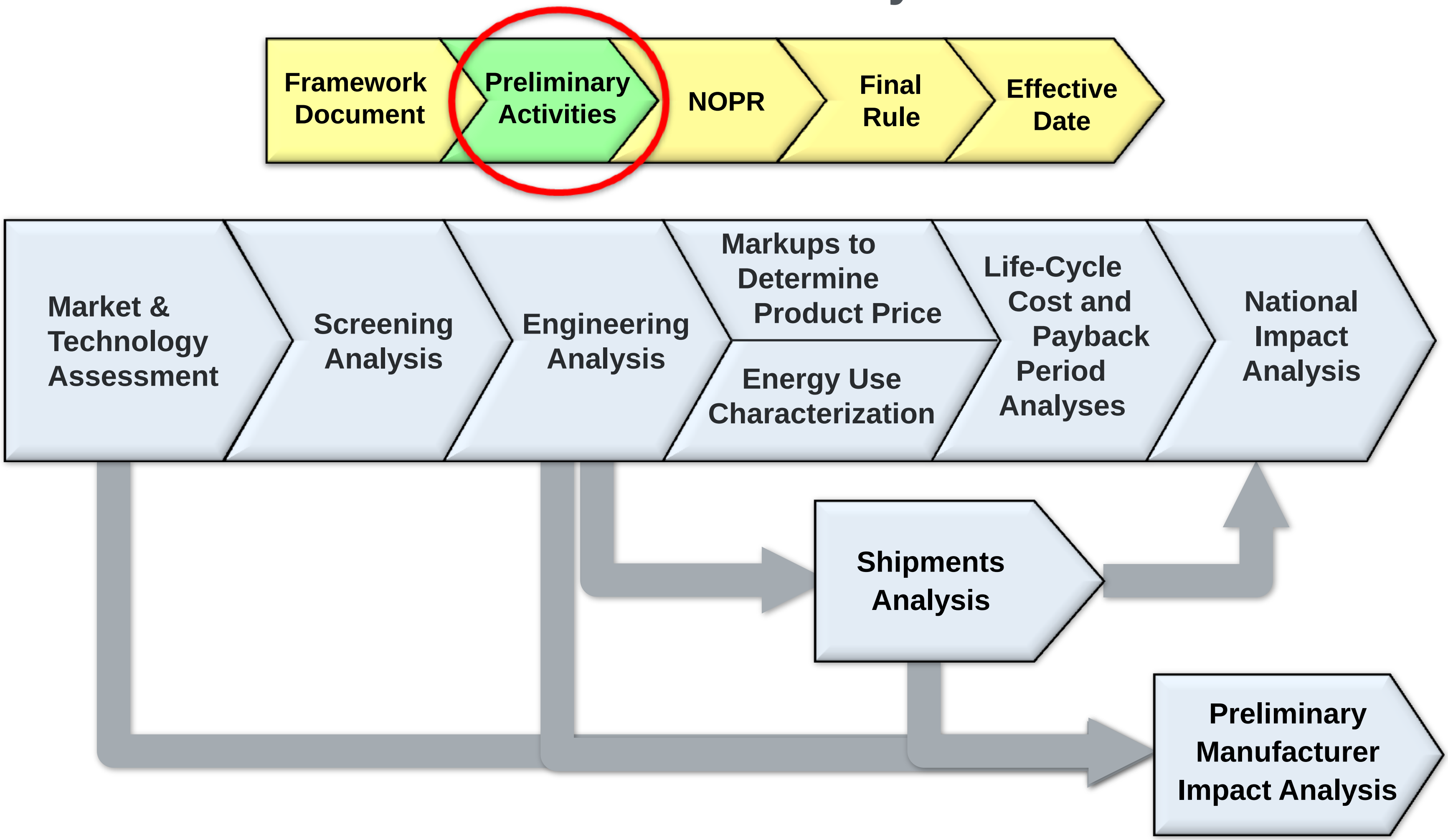
- Integrated FER (IFER) for hydronic air handlers, which includes standby and off mode:

$$IFER_{hydronic} = \frac{(CH \times E_{max}) + (HH \times E_{heat}) + (CCH \times E_{circ}) + (SBH \times E_{SB}) + (OH \times E_{OFF})}{(\mathrm{CH} + \mathrm{HH} + \mathrm{CCH} + \mathrm{SBH} + \mathrm{OH}) \times Q_{max}} \times 1000$$

The Energy Policy and Conservation Act (EPCA) directs DOE to consider seven factors when setting energy conservation standards.

Factor	Analysis
1. Economic impact on consumers and manufacturers	Life-cycle cost analysis Manufacturer impact analysis
2. Lifetime operating cost savings	Life-cycle cost analysis
3. Total projected energy savings	National impact analysis
4. Impact on utility or performance	Screening analysis Engineering analysis
5. Impact of any lessening of competition	Manufacturer impact analysis
6. Need for national energy conservation	National impact analysis
7. Other factors the Secretary considers relevant	Environmental assessment Utility impact analysis Employment impact analysis

Steps for the Standards Rulemaking: Preliminary Activities and Analyses



The following are key documents that describe the Preliminary Analysis activities:

- **The Executive Summary, which includes:**
  - An overview of the preliminary activities and preliminary technical support document (TSD);
  - Key results of the analyses; and
  - Issues on which DOE seeks comment from interested parties.
- **Chapter 2 of the preliminary TSD provides a summary of the preliminary activities and includes:**
  - A review of the analyses conducted; and
  - A discussion of comments on the framework document from interested parties and DOE's responses to those comments.
- **Notice of Public Meeting (NOPM) and Availability of the Preliminary TSD includes:**
  - Details of the public meeting for the preliminary activities and analyses; and
  - A description of the preliminary analyses, results, and documentation available on the website for interested parties to review.

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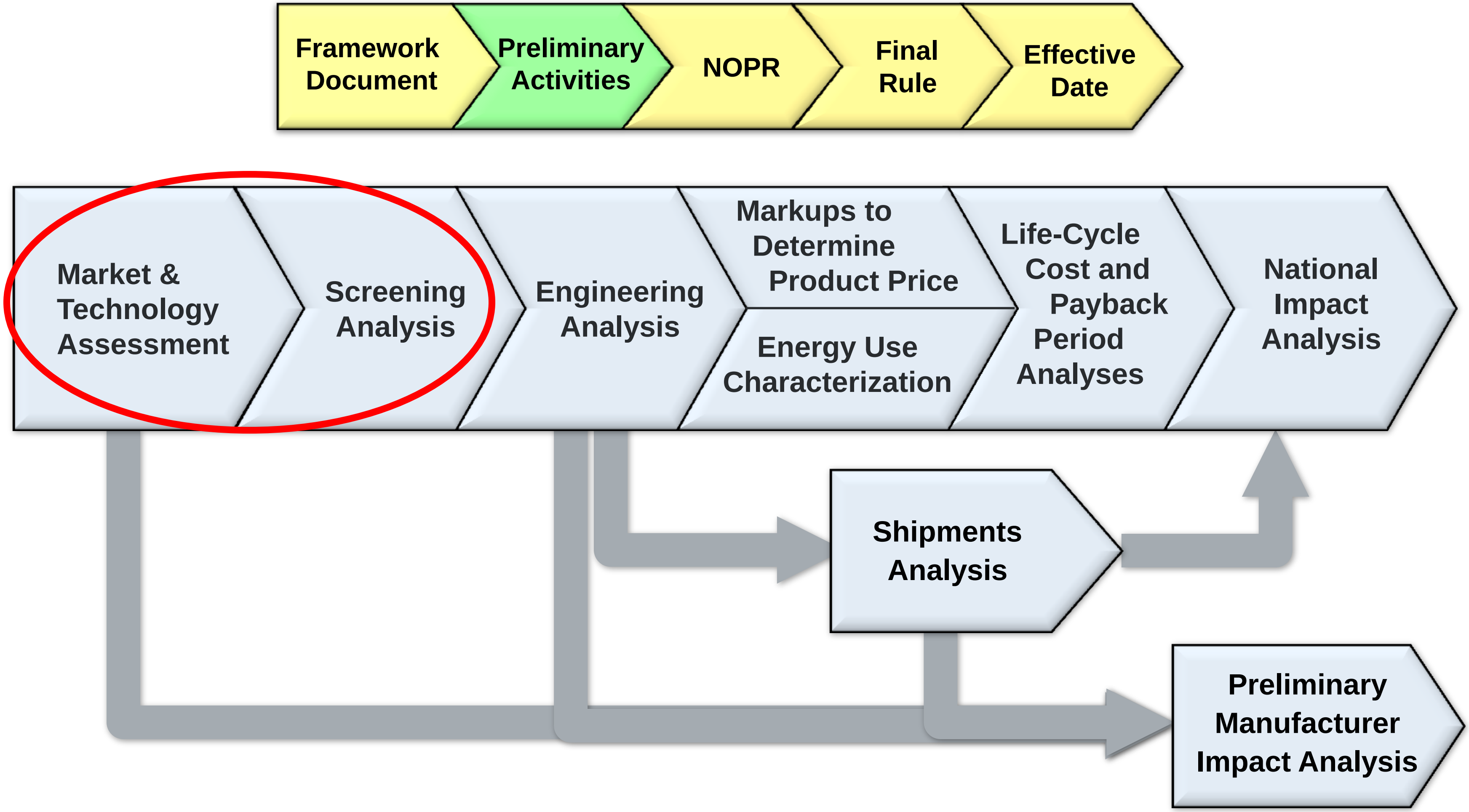
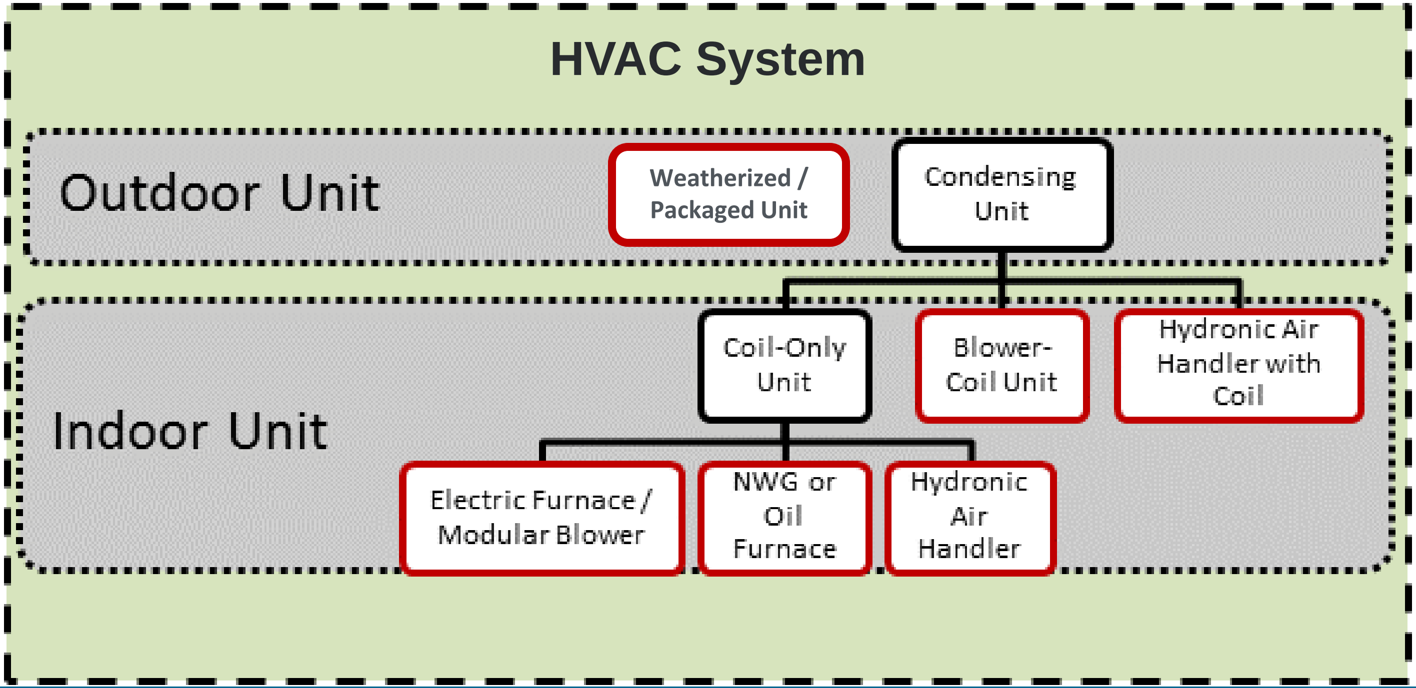
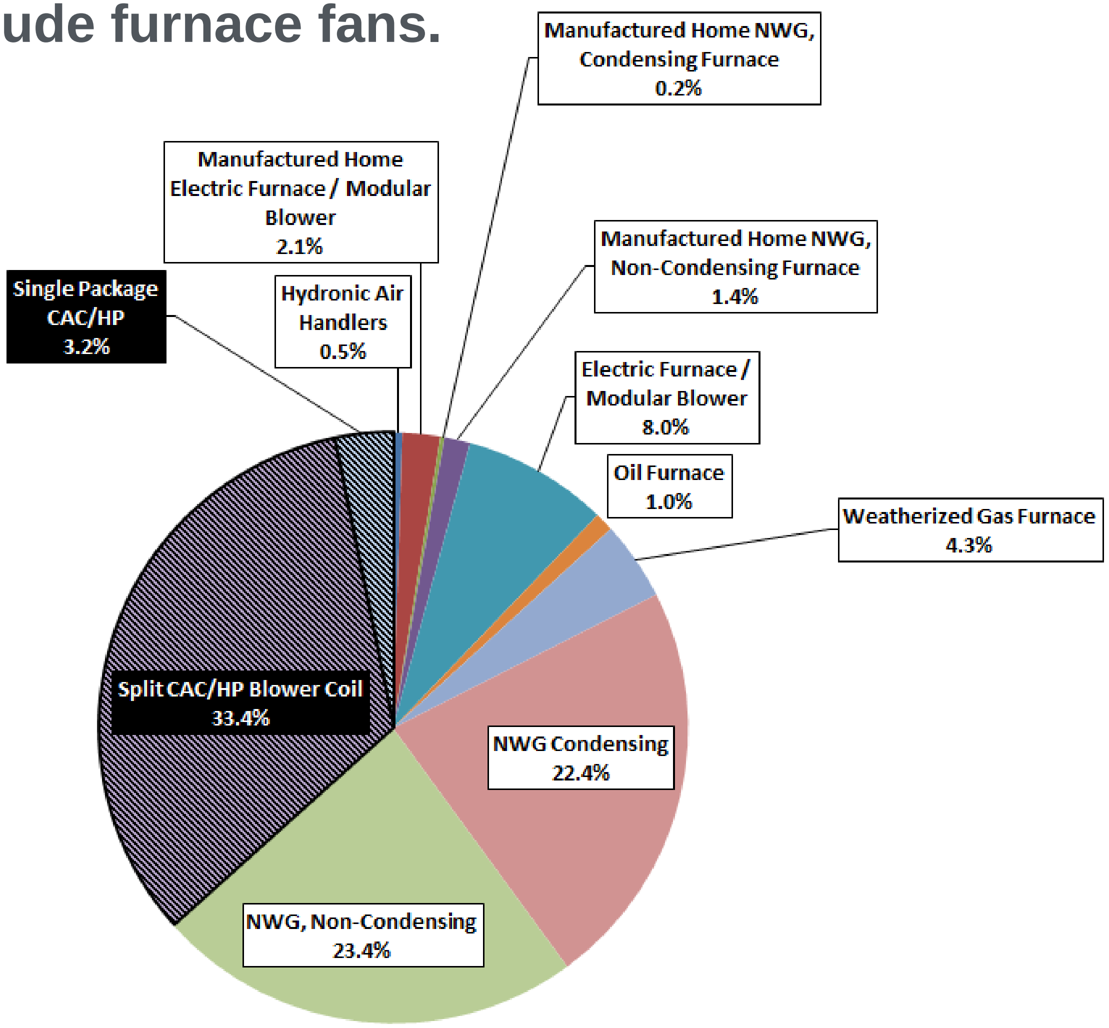


DOE tentatively defines a "furnace fan" as any electrically powered device used in residential HVAC products for the purpose of circulating air through duct work.

- DOE recognizes that a significant number of products may fit its broad interpretation of the statutory language and resulting definition.
- The boxes outlined in red represent key HVAC products that include a furnace fan.



The provisional scope of coverage includes furnace fans that are integrated in 63% of furnaces, air conditioners, and air handling units that include furnace fans.



Key

Considered in this rulemaking.

Not considered in this rulemaking.

DOE identified nine key product classes that represent most of the energy use associated with furnace fans considered in the analysis.

Proposed Key Product Classes (per this Rulemaking)
Non-Weatherized, Non-Condensing Gas Furnace Fan (NWG-NC)
Non-weatherized, Condensing Gas Furnace Fan (NWG-C)
Weatherized Gas Furnace Fan (WG-NC)
Non-weatherized Oil, Non-Condensing Furnace Fan (NWO-NC)
Non-weatherized Electric Furnace / Modular Blower Fan (NWEF/NWMB)
Heat/Cool Hydronic Air Handler Fan (HAH-HC)
Manufactured Home Non-Weatherized Gas, Non-Condensing Furnace Fan (MH-NWG-NC)
Manufactured Home Non-Weatherized Gas, Condensing Furnace Fan (MH-NWG-C)
Manufactured Home Electric Furnace/ Modular Blower Fan (MH-EF/MB)

DOE differentiated product classes by application and internal structure.

DOE identified 12 additional product classes that represent significantly fewer shipments and significantly less energy use.

- For the preliminary analysis, DOE grouped each non-key product class with a key product class to which it is closely related in application and fan performance-related internal structure (i.e. the primary criteria used to differentiate between product classes).

- DOE assigned the baseline FER or IFER and analysis results of each key product class to the non-key product classes with which it is grouped.

- Continuing with this approach in the NOPR would result in a proposed efficiency level for each additional product class that is equivalent to the proposed efficiency level for the key product class with which it is grouped.

DOE grouped each non-key product class with a key product class to which it is closely related in application and internal structure.

Proposed Key Product Classes (per this Rulemaking)	Proposed Additional Product Classes (per this Rulemaking)
Weatherized Gas Furnace Fan (WG-NC)	Weatherized, Non-Condensing Oil Furnace Fan (WO-NC)
	Weatherized Electric Furnace/Modular Blower Fan (WEF/WMB)
	Manufactured Home Weatherized Gas Furnace Fan (MH-WG)
	Manufactured Home Weatherized Oil Furnace Fan (MH-WO)
	Manufactured Home Weatherized Electric Furnace/Modular Blower Fan (MH-WEF/WMB)
Non-weatherized Oil, Non-Condensing Furnace Fan (NWO-NC)	Non-Weatherized, Condensing Oil Furnace Fan (NWO-C)
	Manufactured Home Non-Weatherized Oil Furnace Fan (MH-NWO)
Heat/Cool Hydronic Air Handler Fan (HAH-HC)	Heat-Only Hydronic Air Handler Fan (HAH-H)
	Hydronic Air Handler Fan with Coil (HAH-C)
	Manufactured Home Heat/Cool Hydronic Air Handler Fan (MH-HAH-HC)
	Manufactured Home Heat-Only Hydronic Air Handler Fan (MH-HAH-H)
	Manufactured Home Hydronic Air Handler Fan with Coil (MH-HAH-C)

Request for Comment – Additional Product Classes

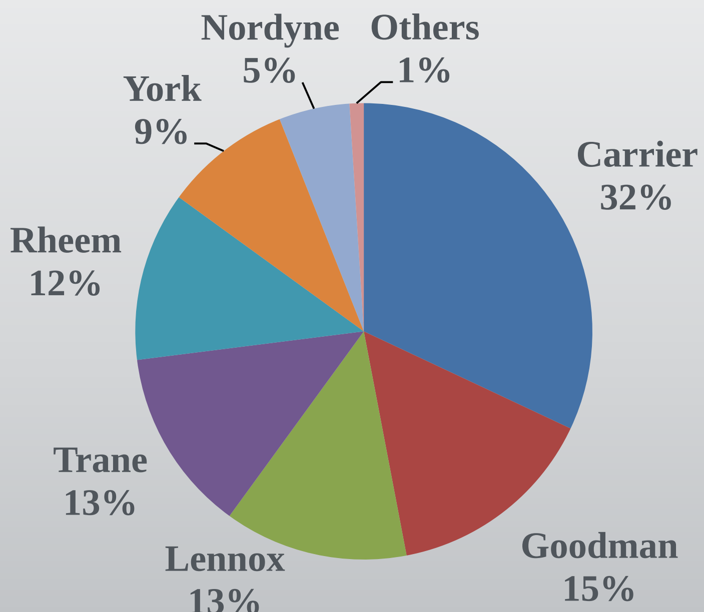
Additional Product Classes: DOE requests comment on the methodology for differentiating product classes and the resulting 9 key product classes.

DOE also seeks comment and data regarding the market for the 12 additional product classes and their expected energy performance. Specifically, DOE requests historical and future shipment data and energy performance data to estimate FER or IFER.

Issue 1

DOE found that the top seven gas furnace manufacturers represent 99% of the market. The top 10 oil furnace manufacturers represent over 90% of the market.

Gas Furnace Market Share 2008



Source: Appliance Magazine.

Oil Furnace Market Share 2008

At Least 10% Market Share	Less than 10% Market Share
• Lennox • Thermo Pride • ECR International	• Adams • Bard • Boyertown • Crown Boiler • EFM • Kerr • Newmac

Source: Public Information and Manufacturer Feedback

The CAC and heat pump market share distribution is comparable to that of the gas furnace market.

As a result of the technology assessment, DOE identified nine technology options.

Technology Options	Brief Description
Inverter technology (PSC motors)	Motor controls used to extend the airflow range and flexibility of PSC motors.
X13 fan motors	Constant-torque, permanent magnet motors, that are more efficient and have a wider airflow range than PSC motors.
ECM fan motors	Constant-airflow, permanent magnet motors, that add to the efficiency and airflow-range benefits of X13 motors.
Backward-inclined impellers	Impellers with backward facing inclined blades that can be more efficient than conventional forward-curved impellers.
Toroidal transformer (standby and off mode product classes)	A toroidal transformer has an annular core made of very tightly-wound, grain-oriented, silicon steel ribbons. Operates more efficiently than conventional laminated core power transformers.
Switching mode power supply (standby and off mode product classes)	A more efficient solid-state power supply alternative to a conventional transformer-based power supply.
Fan housing design modifications	Optimizing the shape of the fan housing to increase efficiency.
Airflow path design	Modifying the HVAC product envelope or elements in the airflow path, such as the heat exchanger, to reduce internal static pressure.
ECM control relay (standby and off mode product classes)	Using a control relay on an ECM to disconnect the motor to further reduce a system's off mode power consumption.

Screening Analysis Methodology

- Technologies were screened using the following criteria:
  - Technological feasibility
  - Practicability to manufacture, install and service
  - Impacts on product utility or product availability
  - Impacts on health or safety.

DOE screened out three technology options.

Technology Option	Need more data	Impacts thermal performance	Impacts product utility
Fan housing design modifications	X		
Airflow path design		X	X
ECM control relay (standby and off modes)			X

- DOE retained six technology options for further engineering analysis.
- Chapter 4, Screening Analysis, of the preliminary TSD provides additional detail on the screening analysis.

DOE considered six technology options.

1. Inverter motor controls (for PSC motors)
2. X13 fan motors
3. ECM fan motors (Multi-staging)
4. Backward-inclined impellers
5. Toroidal transformer*
6. Switching mode power supply*

*Standby and off mode technology options

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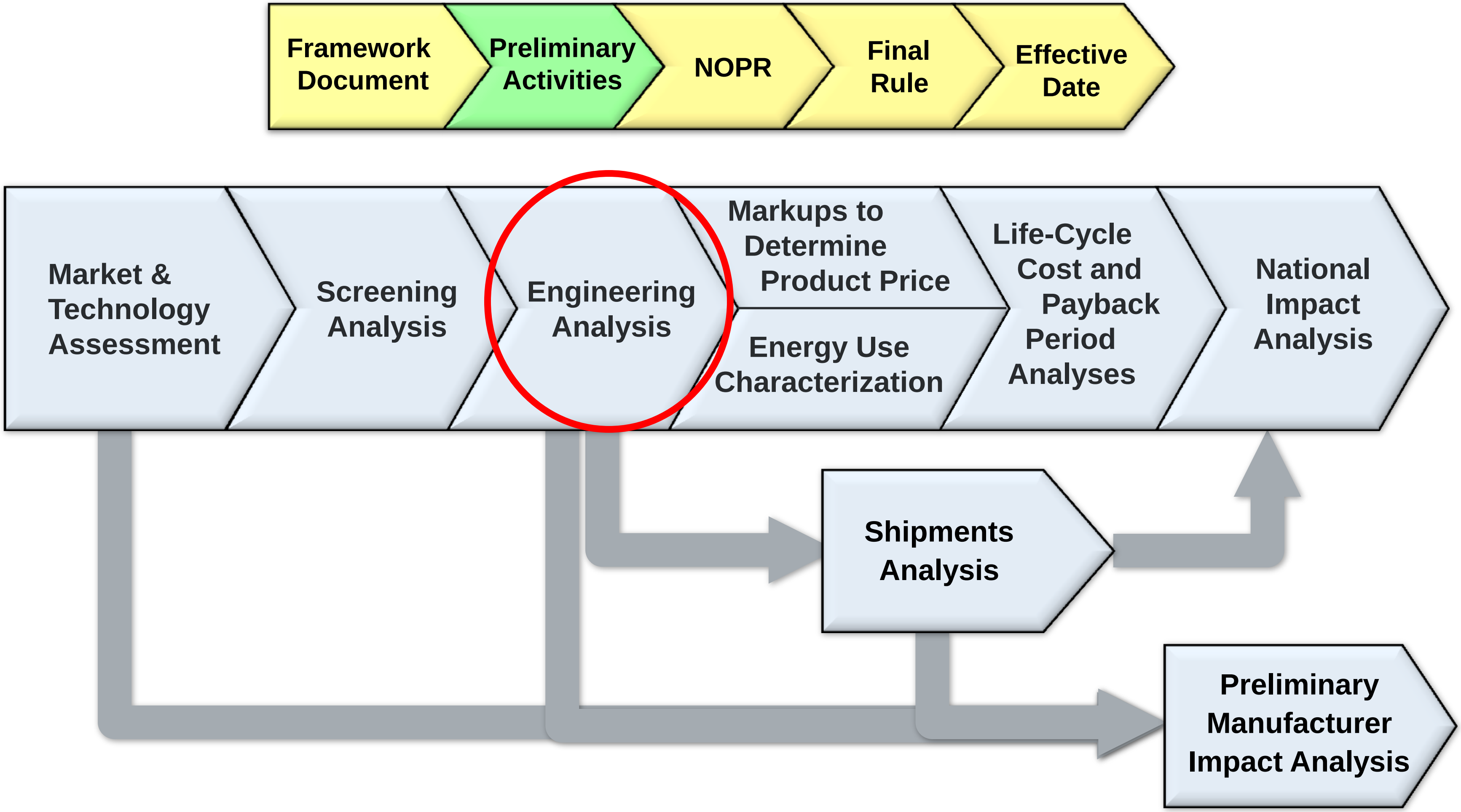
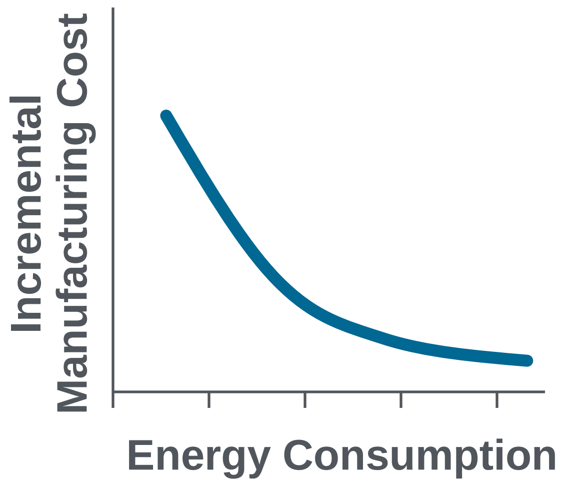


In the Engineering Analysis, DOE evaluated technologies that reduce furnace fan electrical consumption and characterized the relationship between manufacturer cost and energy consumption reduction.

Output: Cost – Efficiency Relationship



Downstream Analyses

- Life-Cycle Cost and Payback Period
- National Impacts
- Shipments Analysis
- Manufacturer Impact Analysis

Engineering Analysis

DOE incorporated information from the following sources in the Engineering Analysis.

Appliance Magazine, AHRI, GAMA
Manufacturer interviews
Product teardowns & manufacturing cost modeling
Product energy testing

DOE acquired units for testing and teardowns to assist in developing FER values and cost models.

Units	• 26 units • 6 manufacturers represented • 800 to 2,200 nominal airflow capacity
Technology Variations	• Motor Type: PSC, constant-torque brushless permanent magnet (X13), constant-volume brushless permanent magnet (ECM) • Airflow Capacity (800-2,200 CFM) • Heat Exchanger Type (Clamshell, Tubular, Drum, Hydronic) • Non-condensing / Condensing • Fan Housing Design (Standard, Proprietary)

Engineering Analysis

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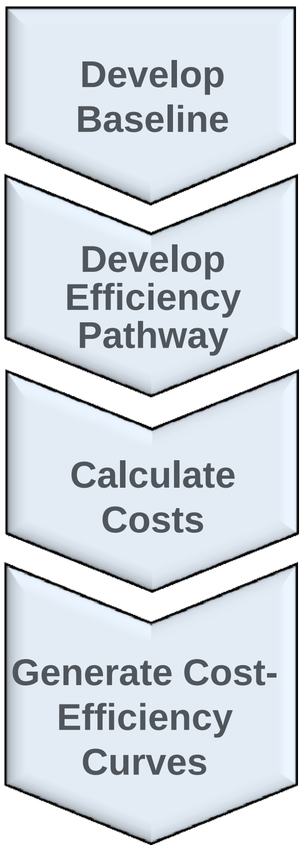
The cost-efficiency curve is developed in four steps.



- Define baseline specifications for each product class;
- Identify design options from the baseline to the max-tech as a pathway for improving energy efficiency;
- Conduct teardown analysis for representative products spanning the range of efficiency levels considered; and
- Generate cost-efficiency curves, which account for full production costs.

DOE selected baseline models typical of the least-efficient furnace fans used in commercially available residential HVAC models.

Across all product classes, a baseline furnace fan includes:

- A PSC motor with 3 or fewer airflow-control settings.
- A forward-curved impeller.
- A standard, sheet-metal fan housing.
- A linear power supply. (Standby and off mode product classes).
- A laminated core power transformer. (Standby and off mode product classes).

Engineering Analysis

DOE reviewed information from publicly-available product literature and FER values calculated from test data to determine baseline FER ratings.

Key Product Class	Baseline FER (W/1000 cfm)	Baseline IFER (W/1000 cfm)	Baseline Standby Watts
Non-weatherized, Non-condensing Gas Furnace Fan	380	-	-
Non-weatherized, Condensing Gas Furnace Fan	393	-	-
Weatherized Gas Furnace Fan	333	-	-
Non-Weatherized Oil Furnace Fan	333	-	-
Electric Furnace / Modular Blower Fan	312	-	-
Manufactured Home Non-weatherized, Non-condensing Gas Furnace Fan	295	-	-
Manufactured Home Non-weatherized, Condensing Gas Furnace Fan	319	-	-
Manufactured Home Electric Furnace / Modular Blower Fan	243	-	-
Hydronic Air Handler Fan (Heat/Cool)	-	107	11

Each efficiency level above the baseline is defined by the specific design option used to achieve it.

- DOE determined average percentage reductions in FER for each efficiency level and applied these reductions to all product classes.
  - DOE found that manufacturers use similar components and design paths to improve efficiency across all product classes that DOE is examining.
  - DOE does not expect the percentage reduction in FER associated with each design option, whether commercially available or prototype, to differ across product classes.

- DOE based the reductions in FER associated with commercialized technologies on measurements or publicly available performance information.

- DOE based the FER reductions associated with prototype technologies on research reports that included performance data.

DOE assigned percentage reductions in FER to each EL to obtain FER values for intermediate ELs. DOE also assigned a reduction in standby watts for the two standby design options (EL6 and EL7).

Efficiency Level	Design Option	Percent Reduction in FER from Baseline	Percent Reduction in FER from Previous EL	Reduction in Standby Power from Baseline (Watts)
1	Improved PSC	2%	-	NA
2	Inverter-Driven PSC	10%	-	NA
3	X13	45%	-	NA
4	ECM and Multi-Staging	59%	-	NA
5 (non-hydronic max-tech)	Premium ECM and Multi-Staging + Backward-Inclined Impeller	-	10%	NA
Hydronic 6	Switching Mode Power Supply	-	-	1
Hydronic 7 (hydronic max-tech)	Toroidal Transformer	-	-	1

A premium ECM motor is narrower and operates at higher RPM, which is characteristic of the motor paired with the backward-inclined prototype.

For all product classes except hydronic air handler fan classes, DOE analyzed four efficiency levels in addition to the baseline and the max-tech.

Efficiency Level	NWG-NC	NWG-C	MH-NWG-NC	MH-NWG-C	NWO-NC	WG	EF/MB	MH-EF/MB
Baseline	380	393	295	319	333	333	312	243
1 – Improved PSC	371	384	288	312	326	326	305	238
2 – PSC + Inv.	344	356	267	289	301	301	282	220
3 – X13	209	216	162	175	183	183	171	133
4 – ECM / MS	158	163	122	132	138	138	129	101
5 – Premium ECM / MS + BI Impeller (max tech)	142	147	110	119	124	124	116	90.8

For furnace fans used in hydronic air handlers, DOE considered two additional efficiency levels (EL6 and EL7) that are associated with design options that reduce standby and off mode energy consumption.

Efficiency Level	IFER (W/1000 cfm)
Baseline	107
1 – Improved PSC	105
2 – PSC + Inverter	97.1
3 – X13	58.9
4 – ECM / Multi-staging	40.2
5 – Premium ECM / Multi-Staging + BI Impeller	36.2
6 – Switching Mode PS	35.5
7 – Toroidal Transformer (Max tech)	34.8

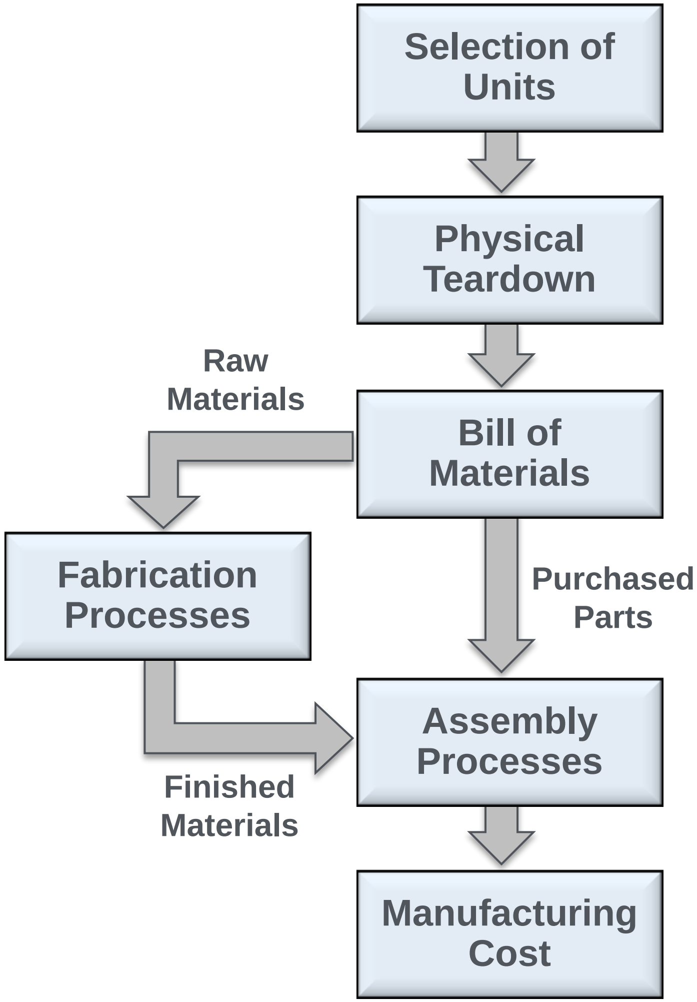
Request for Comment – Rating Metrics and Capacity

Rating Metrics: DOE requests comments on the assumption that the proposed rating metrics, FER and IFER, will not be dependent on capacity because they are normalized by airflow in the maximum airflow-capacity setting, which is dictated by the heating or cooling capacity of the HVAC product.

Issue 2

Manufacturing cost models were developed by DOE as part of the efficiency-level approach.

- Bills of material were generated during product teardown analysis and entered into the cost model.
- Cost model generated manufacturing, material, labor, and overhead costs.
- Physical teardown analysis conducted with representative products.
- Preliminary manufacturer interviews conducted to further refine the analysis inputs and the results generated by the cost model



Structure/Classification of Manufacturing Costs

- **Full Cost of Product**
  - **Full Production Cost ***
    - **Direct Labor**
    - **Direct Material**
    - **Overhead**
      - Indirect labor
      - Indirect material
      - Maintenance
      - Depreciation
      - Taxes
      - Insurance related to assets
  - **Non-Production Cost ****
    - **Selling**
      - Market research
      - Advertising
      - POS promotion
      - Sales person compensation & travel
      - Logistics
        - Warehousing
        - Delivery
        - Record keeping
    - **General & Admin.**
      - Costs of service & staff units
      - General corporate costs – comp., etc.
    - **R & D**
      - Costs associated with efforts to find new or improved products or production processes
    - **Interest**
      - Costs of borrowing funds

* Tax Reform Act of 1986 essentially requires companies to measure cost of goods sold as the full production cost of the goods sold.

** In a company's income statement, many of these costs are reported as a lump sum, under SG&A.

The costs used in the engineering analysis represent the cost of the furnace fan and not the cost of the entire HVAC product.

- The following components are included in the MPC estimates:
  - Fan motor and integrated controls
  - Primary control board
  - Impeller
  - Fan housing
  - Components used to direct or guide airflow
- For reference, furnace fans comprise of approximately 10% of the total HVAC product cost.

Engineering Analysis

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DOE separated furnace fan product classes into high-volume and low-volume product classes to account for factors that impact manufacturers' production costs and purchasing power, such as:

- Some products are produced at volumes significantly larger than others.
- Some manufacturers offer most types of the HVAC products, while others focus on niches.
- High-volume manufacturers operating in lower-volume adjacent markets are expected to have purchased part price efficiencies consistent with their higher overall purchasing volume.
- Low-volume operations were modeled as having lower production volumes and fewer shifts per day.

High Volume	Low Volume
• Non-weatherized Gas Furnaces • Weatherized Gas Furnaces • Electric Furnaces / Modular Blowers	• Oil Furnaces • Hydronic Air Handlers

Engineering Analysis

DOE used a design option approach to estimate the cost of technologies not commercially available in furnace fan applications.

Efficiency Level	Design Option	High Volume MPC	Low Volume MPC	Efficiency Level
2	Inverter Controls for PSC Motor	$12	$16	2
5	Premium ECM / Multi-Staging + Backward-Curved Impeller	$107	$122	5
6	Switching Mode Power Supply	NA*	$7	6
7	Toroidal Transformer	NA*	$11	7

* Standby mode consumption is not covered in this rulemaking for high volume products.

- DOE estimated the cost of an inverter by reverse engineering an inverter that can be used in furnace fan applications. (Varidigm VSM-CA2)
- DOE used a 10% markup on the estimated cost for an ECM as the added cost for a premium ECM motor.
- DOE used photographs and specifications found in research reports to determined cost model inputs to estimate the MPC of the backward-curved impeller to be $12.00 and $12.32 for high volume and low volume products, respectively.
- The MPC estimates for efficiency levels 6 and 7 are the same as those used in the direct final rule engineering analysis for HVAC products. 76 FR 37408

Request for Comment – Inverter-Driven PSC Fan Motors

Inverter-Driven PSC Fan Motors: DOE seeks comment on inverter-driven PSC fan motors and requests data regarding their energy performance and costs.

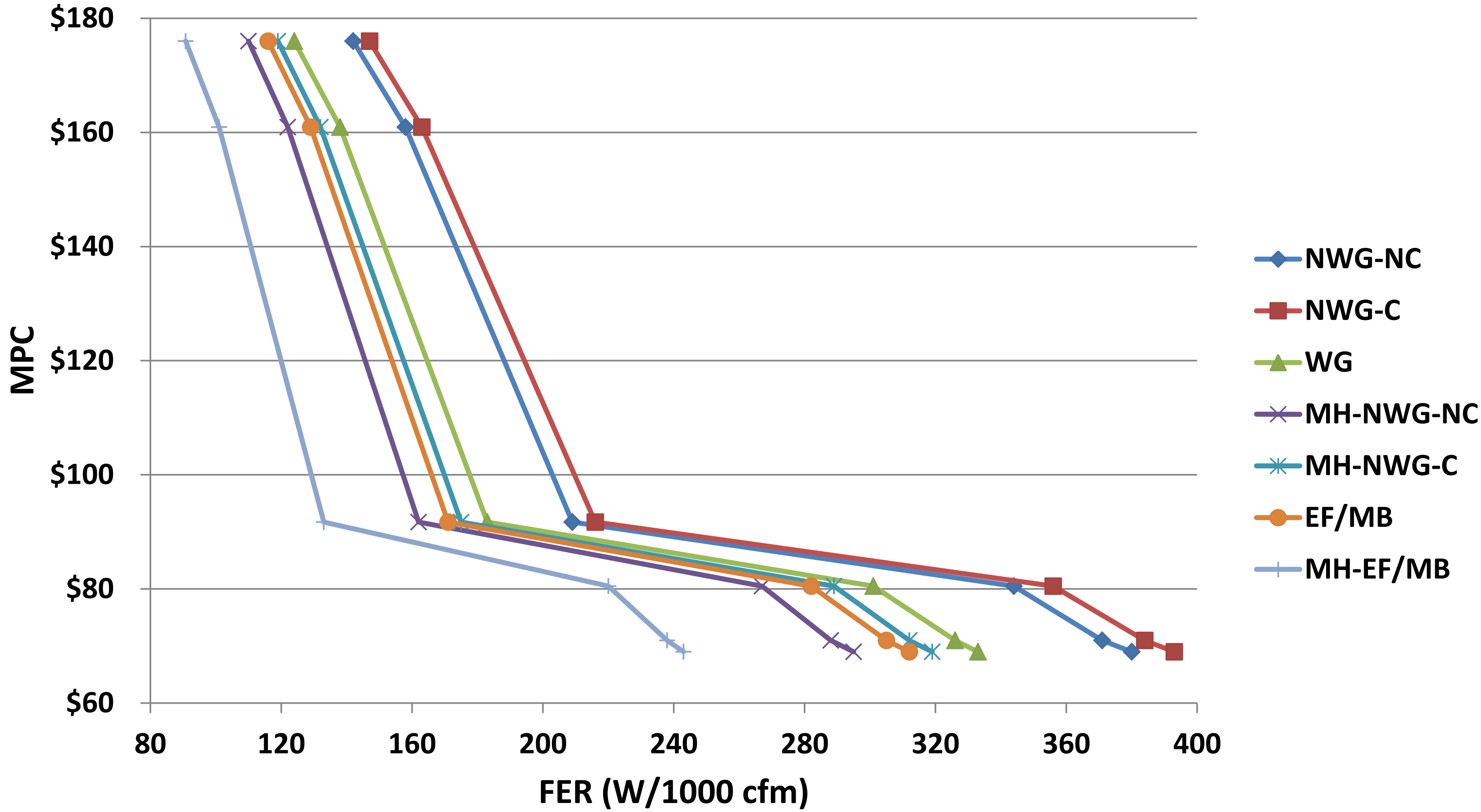
Issue 3

Engineering Analysis Results

Cost-Efficiency Results for High-Volume Key Product Classes

Efficiency Level	Baseline	EL1	EL2	EL3	EL4	EL5
Design Option	-	Improved PSC	PSC + Inverter	X13	ECM +Multi-Stage	Premium ECM + Multi-Stage + BI Impeller
MPC	$69	$71	$81	$92	$161	$176
FER Values						
NWG-NC	380	371	344	209	158	142
NWG-C	393	384	356	216	163	147
MH-NWG-NC	295	288	267	162	122	110
MH-NWG-C	319	312	289	175	132	119
WG	333	326	301	183	138	124
EF/MB	312	305	282	171	129	116
MH-EF/MB	243	238	220	133	101	90.8

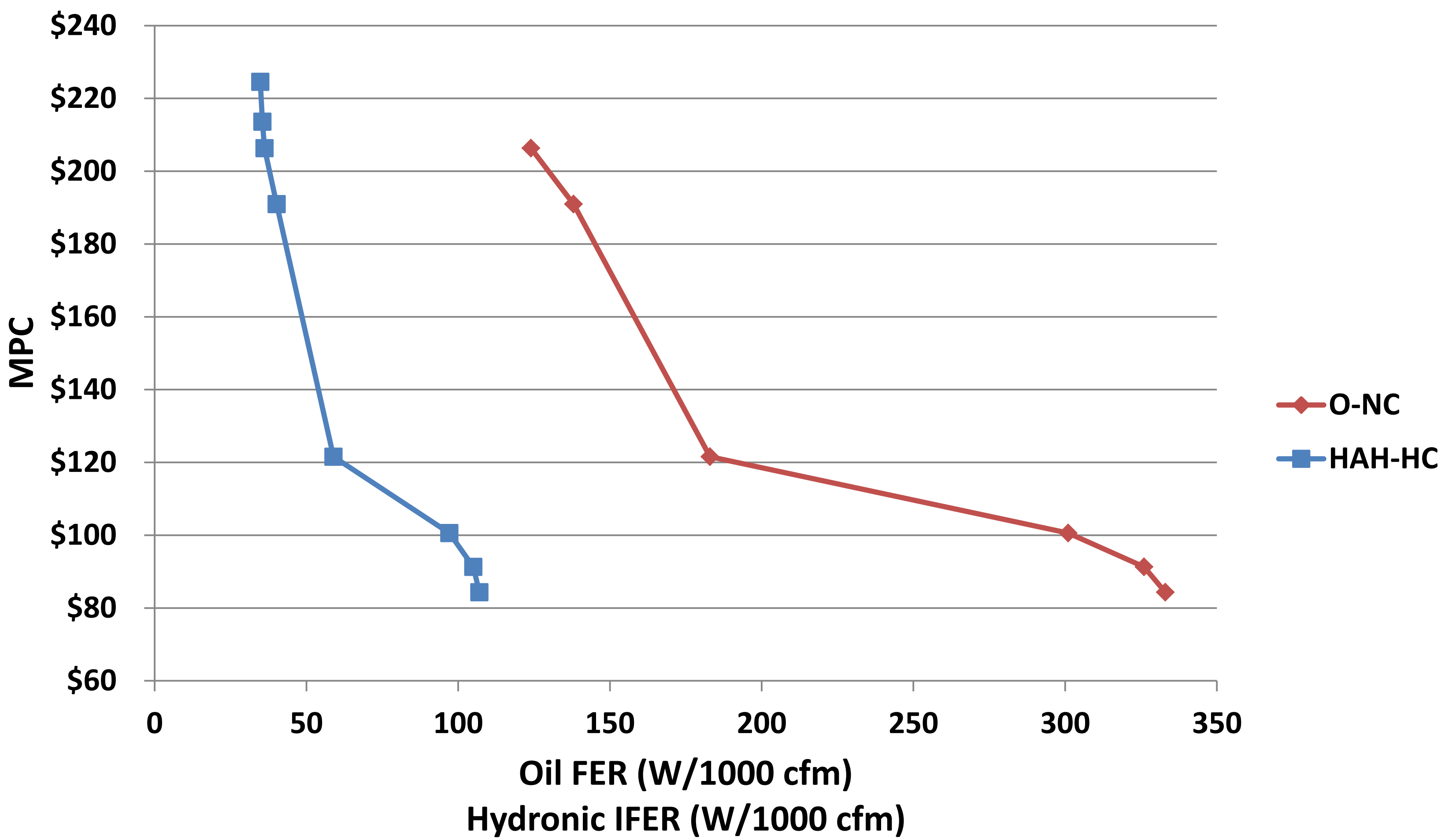
Cost-Efficiency Results for High-Volume Key Product Classes



Cost-Efficiency Results for Low-Volume Key Product Classes

Efficiency Level	Baseline	EL1	EL2	EL3	EL4	EL5	EL6	EL7
Design Option		Improved PSC	PSC + Inverter	X13	ECM +Multi-Stage	Premium ECM + Multi-Stage + BI Impeller	Switch Mode PS	Toroidal XFMR
MPC	$84	$91	$101	$122	$191	$206	$214	$225
FER / IFER Values								
NWO-NC	333	326	301	183	138	124	N/A	N/A
HAH-HC	107	105	97.1	58.9	40.2	36.2	35.5	34.8

Cost-Efficiency Results for Low-Volume Key Product Classes



Request for Comment – Fan Motor Turndown Ratio

- The turndown ratio is the ratio of minimum motor speed to the maximum motor speed.

- DOE has preliminarily found that high-efficiency motors on average have lower turndown ratios (i.e., a wider range of achievable speeds).

Fan Motor Turndown Ratio: DOE seeks comment on the typical turndown ratios that can be achieved technically and in practice by each motor technology (*i.e.*, baseline PSC, improved PSC, inverter-driven PSC, constant-torque ECM, and constant-airflow ECM).

Issue 4

Request for Comment – Proprietary Brushless Permanent Magnet Motor Technology

ECM Technology: DOE seeks comment on the validity of its premise that alternative motor technologies can achieve comparable performance (turndown ratios and efficiency) at comparable cost to the brushless permanent magnet motor technologies offered by Regal Beloit.

DOE also seeks comment on the validity of its assumption that these alternative motor technologies will become increasingly available.

Issue 5

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Request for Comment – High-Efficiency Fan Motor Control Costs

Fan Motor Control Costs: DOE requests comments on whether more costly primary control boards are required to be paired with higher-efficiency motors.

Issue 6

Request for Comment – Backward-Inclined Impellers

Backward-Inclined Impellers: DOE seeks comment on the expected efficiency improvements across the range of operating conditions in residential applications.

DOE seeks comment on which operating conditions result in favorable and unfavorable performance for furnace fans that use backward-inclined impellers.

DOE seeks comment on whether design modifications or specialized components, such as fan motors with unique specifications (*e.g.*, high RPM), are necessary to implement backward-inclined impellers.

DOE seeks comment on whether backward-inclined impellers are incompatible with the designs or components currently used in furnace fans.

DOE seeks comment on whether use of backward-inclined impellers could impact product offerings.

DOE seeks comment on the potential costs associated with implementing backward-inclined impellers.

Issue 7

Request for Comment – Airflow Path Design

Airflow Path Design: DOE seeks comment on airflow path design changes that could result in improved airflow efficiency.

DOE seeks comment on the expected cost and efficiency improvement of airflow path design improvements.

DOE seeks comment or data on the expected tradeoffs between airflow efficiency and thermal efficiency for design changes.

Issue 8

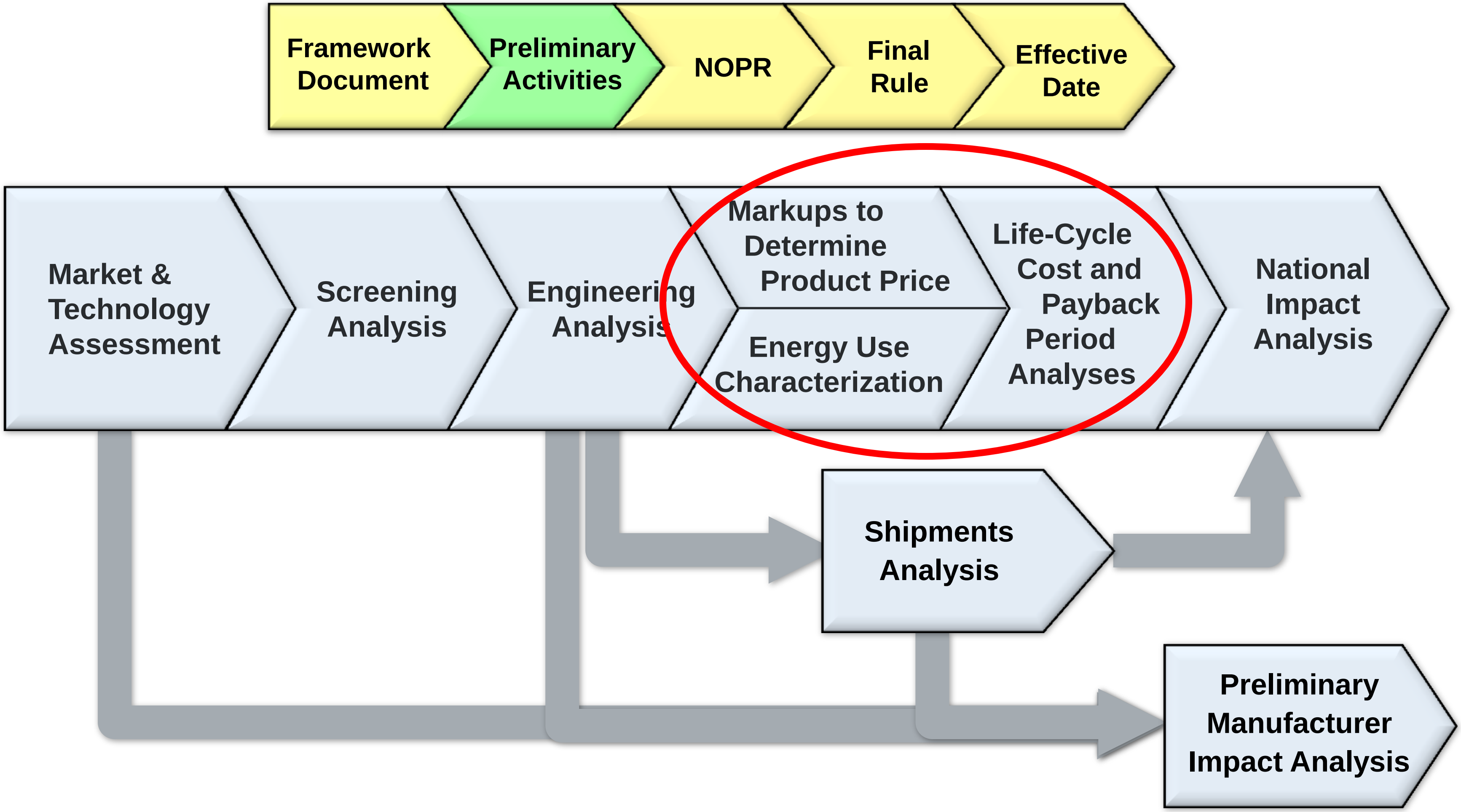
Request for Comment – Other Issues

Other issues: DOE invites comments and recommendations from interested parties on any other aspects relating to the Market and Technology Assessment, the Screening Analysis, and the Engineering Analysis.

Public Meeting Agenda

1. Introduction and Overview
2. Market and Technology Assessment and Screening Analysis
3. Engineering Analysis
4. **Markups, Energy Use Characterization, LCC and Payback Period Analysis**
5. National Impact Analysis
6. Preliminary Manufacturer Impact Analysis
7. Next Steps

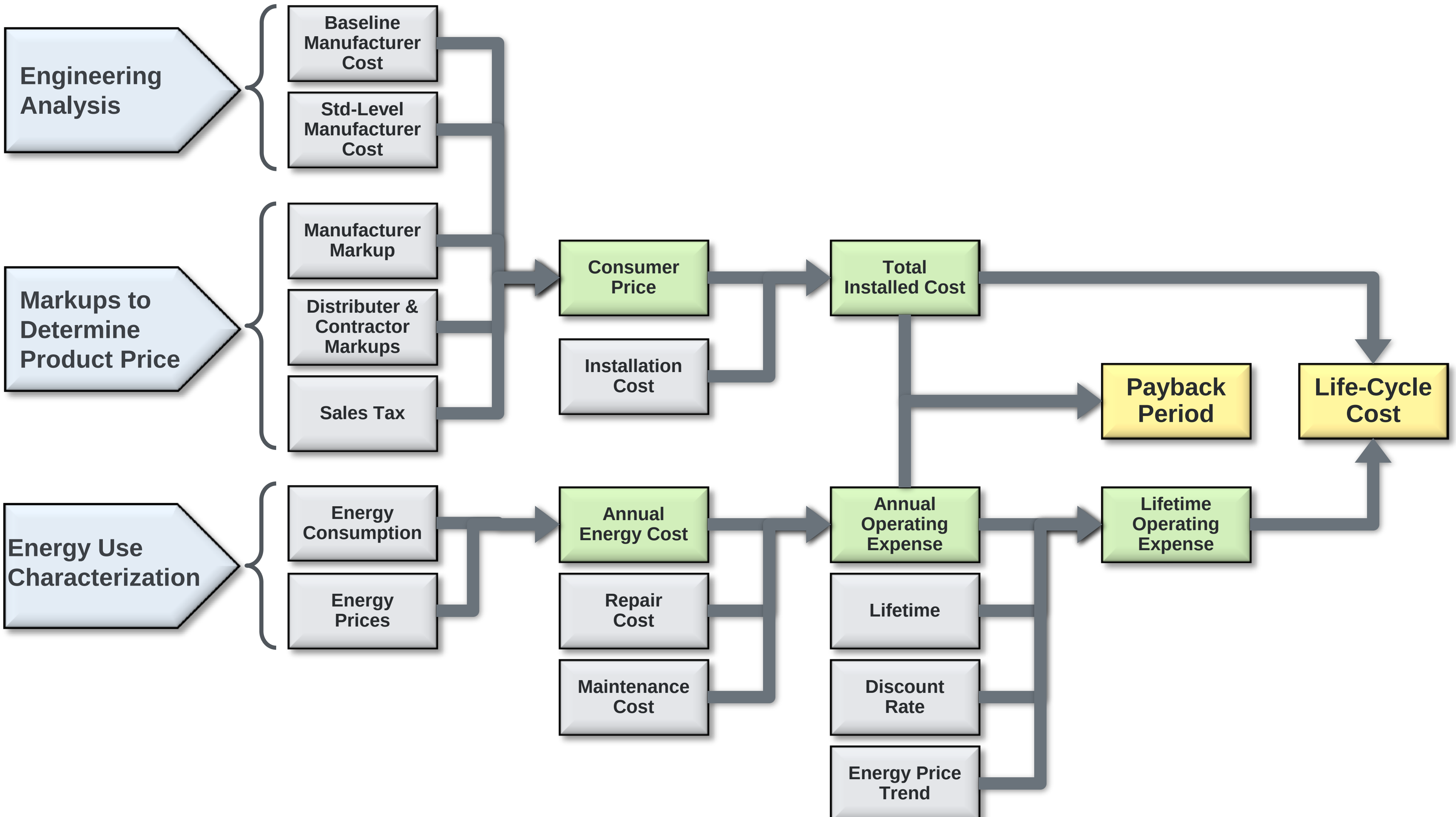
Steps for the Standards Rulemaking: Preliminary Activities and Analyses



Purpose

- **Markups for Product Price Determination:**
  - To characterize the channels for how products are distributed from the manufacturer to the consumer.
  - To determine prices paid by consumers based on manufacturer selling prices for baseline and higher efficiency products.
- **Energy Use Characterization:**
  - To develop energy consumption savings estimates for selected product efficiency levels.
- **Life-Cycle Cost (LCC) and Payback Period (PBP) Analyses:**
  - To develop the consumer life-cycle cost savings and payback period for higher efficiency products.

LCC & Payback Period Analyses Flowchart



Approach

- **Markups** relate consumer price to cost of goods sold (CGS).
- **Baseline and Incremental markups:**
  - *Baseline markups* relate direct business costs of products to baseline efficiency
  - *Incremental markups* relate the incremental change in consumer price to the incremental change in CGS.
- **Regional Markups** developed for each of the geographical areas in the analysis.
- **Sources:**
  - *Manufacturer markups*: See engineering analysis
  - *Wholesaler and mechanical contractor markups*: Firm income statements from the HARDI 2011 Profit Report and from the ACCA 2005 Financial Analysis
  - *General contractor markups*: *Residential Building Construction* sector financial data from the 2007 Economic Census
  - *Manufactured home manufacturer and contractor markups*: *Manufactured Home (Mobile Home) Manufacturing* sector and *All Other Specialty Trade Contractors* sector financial data from the 2007 Economic Census
  - *Sales taxes*: 2011 Sales Tax Clearinghouse Data

Distribution Channels for Residential Furnace Fans Equipment

- **Replacement (Non-Manufactured and Manufactured Homes)**

Manufacturer → Wholesaler → Mechanical Contractor → Consumer

- **New Construction**
  - **Non-Manufactured Homes (Non-MH)**

Manufacturer → Wholesaler → Mechanical Contractor → General Contractor → Consumer

  - **Manufactured Homes (MH)**

Manufacturer → Manufactured Home Manufacturer → Manufactured Home Contractor → Consumer

Request for Comment – Distribution Channel and Market Share of Furnace Fans

In the preliminary analysis, DOE did not consider a distribution channel for replacing furnace fans included in already installed equipment. DOE requests comments whether this channel merits inclusion, and, if so, what would be an appropriate assumption for its market share.

Issue 9

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Average Markups for Market Participants

	Non-MH		MH	
	Baseline	Incr.	Baseline	Incr.
Manufacturer	1.35		1.30	
Wholesaler (replacement for MH)	1.36	1.11	1.36	1.11
Mechanical Contractor (replacement)	1.55	1.23	1.55	1.23
Mechanical Contractor (new construction)	1.44	1.15	-	
General Contractor (new construction)	1.48	1.34	-	
MH Manufacturer (new construction)	-		1.41	1.28
MH Contractor (new construction)	-		1.61	1.31
Sales Tax	1.071			

Average Markups by Product Class

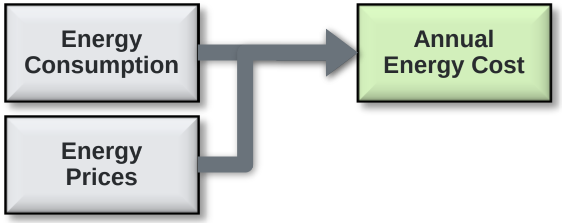
Product Class	Baseline Markup	Incremental Markup
Non-Weatherized, Non-Condensing Gas Furnace Fan (NWG-NC)	2.49	1.59
Non-weatherized, Condensing Gas Furnace Fan (NWG-C)	2.45	1.54
Weatherized Gas Furnace Fan (WG-NC)	2.46	1.57
Non-weatherized Oil, Non-Condensing Furnace Fan (NWO-NC)	2.30	1.46
Non-weatherized Electric Furnace / Modular Blower Fan (NWEF/NWMB)	2.41	1.54
MH Non-Weatherized Gas, Non-Condensing Furnace Fan (MH-NWG-NC)	3.04	2.35
MH Non-Weatherized Gas, Condensing Furnace Fan (MH-NWG-C)	2.96	2.29
Manufactured Home Electric Furnace/ Modular Blower Fan (MH-EF/MB)	2.95	2.28
Heat/Cool Hydronic Air Handler Fan (HAH-HC)	2.62	1.65

Request for Comment – Other Issues

DOE invites comments and recommendations from interested parties on any other aspects related to the Markups Analysis.

Overview

- **Annual energy consumption and energy prices used to calculate annual energy costs**
  - *Annual energy consumption* is the site energy use associated with operating the product.
  - *Energy prices* are the prices consumers pay for energy (electricity, gas or oil).
  - Multiplying annual energy consumption by energy prices yields the annual energy cost.



Methodology for Energy Use Determination

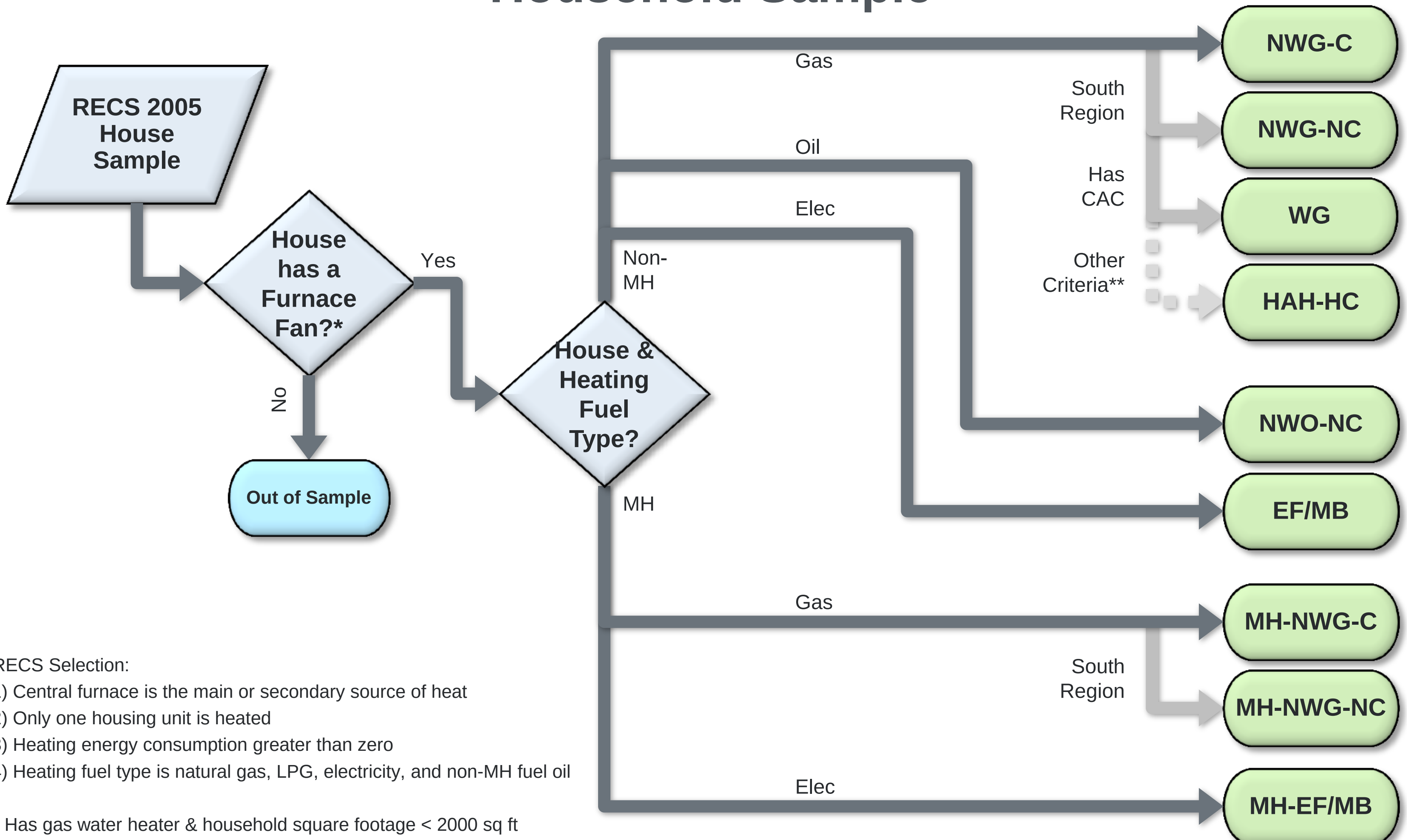
- Furnace Fan (FF) annual energy use equals the sum of the energy used at each operating mode – heating, cooling, and constant circulation:

$$FF\ Energy\ Use = \sum_{i=operating\ modes} FF\ Operating\ Hours_i \times FF\ Power_i$$

  - *Furnace Fan Operating Hours* is determined using RECS 2005 heating and cooling data, furnace fan on-time ratios, and adjustment factors
  - *Furnace Fan Power* is determined using furnace fan performance and the system curve for each household

- Analysis also accounts for the impact of more efficient furnace fans on the overall energy use of the households space conditioning equipment

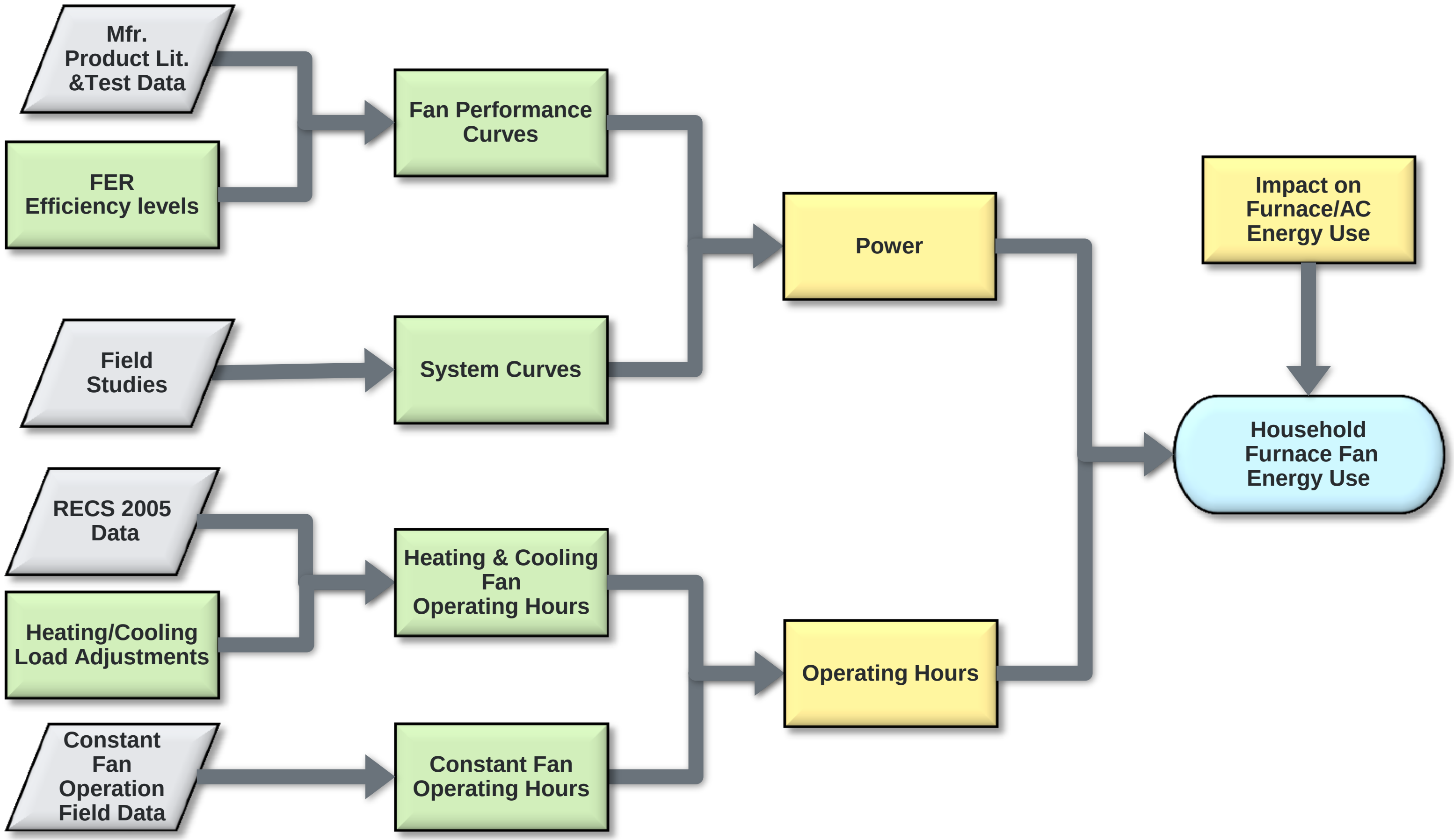
Household Sample



*RECS Selection:
(1) Central furnace is the main or secondary source of heat
(2) Only one housing unit is heated
(3) Heating energy consumption greater than zero
(4) Heating fuel type is natural gas, LPG, electricity, and non-MH fuel oil

** Has gas water heater & household square footage < 2000 sq ft

Energy Use Determination Methodology



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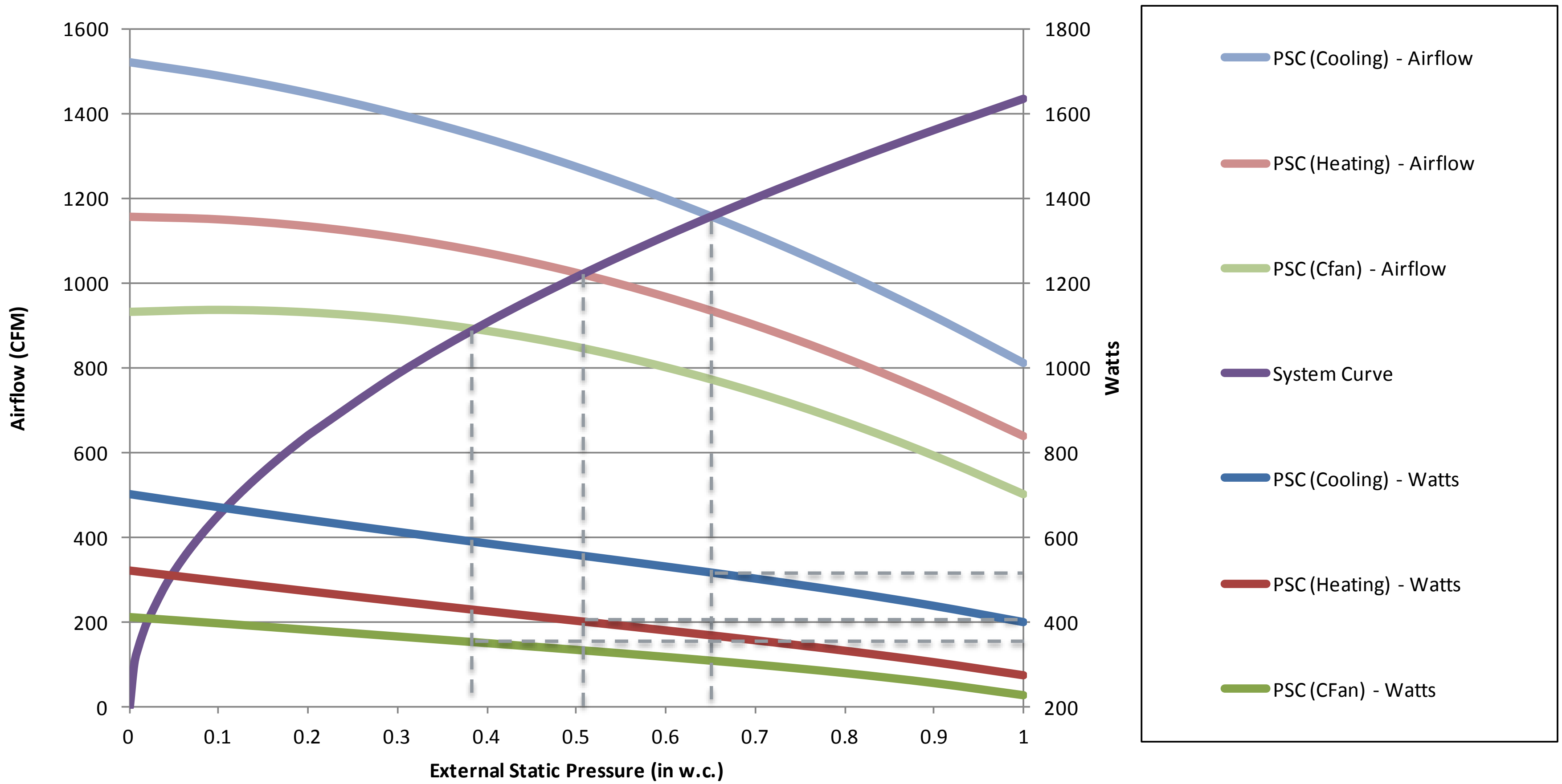
Fan Power Determination



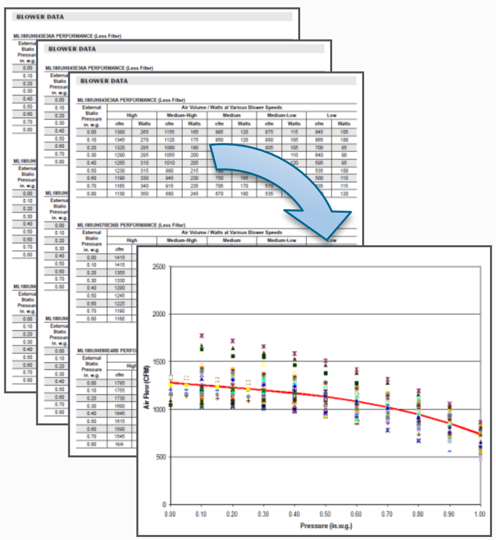
System Curve Derivation

- DOE characterized the system curve by assigning External Static Pressure (ESP) value at the maximum cooling airflow operating mode
- DOE compiled over 1300 field ESP measurements from 27 studies that included furnace fans in single family and manufactured homes in different US regions
- ESP value used for defining the household system curve is determined by assigning a distribution of ESPs depending on the product class and whether the household has a central air conditioner

Product Class	Household has Central AC	Average ESP *(in. w.c.)*
NWG-NC; NWG-C; NWO-NC; EF/MB; HAH-HC	Yes	0.73
	No	0.52
WG	Yes	0.52
MH-NWG-NC; MH-NWG-C; MH-EF/MB	Yes	0.37
	No	0.17

Fan Performance Curves Derivation

Generate Average Fan Performance Curves (Source: mfr literature & test data)



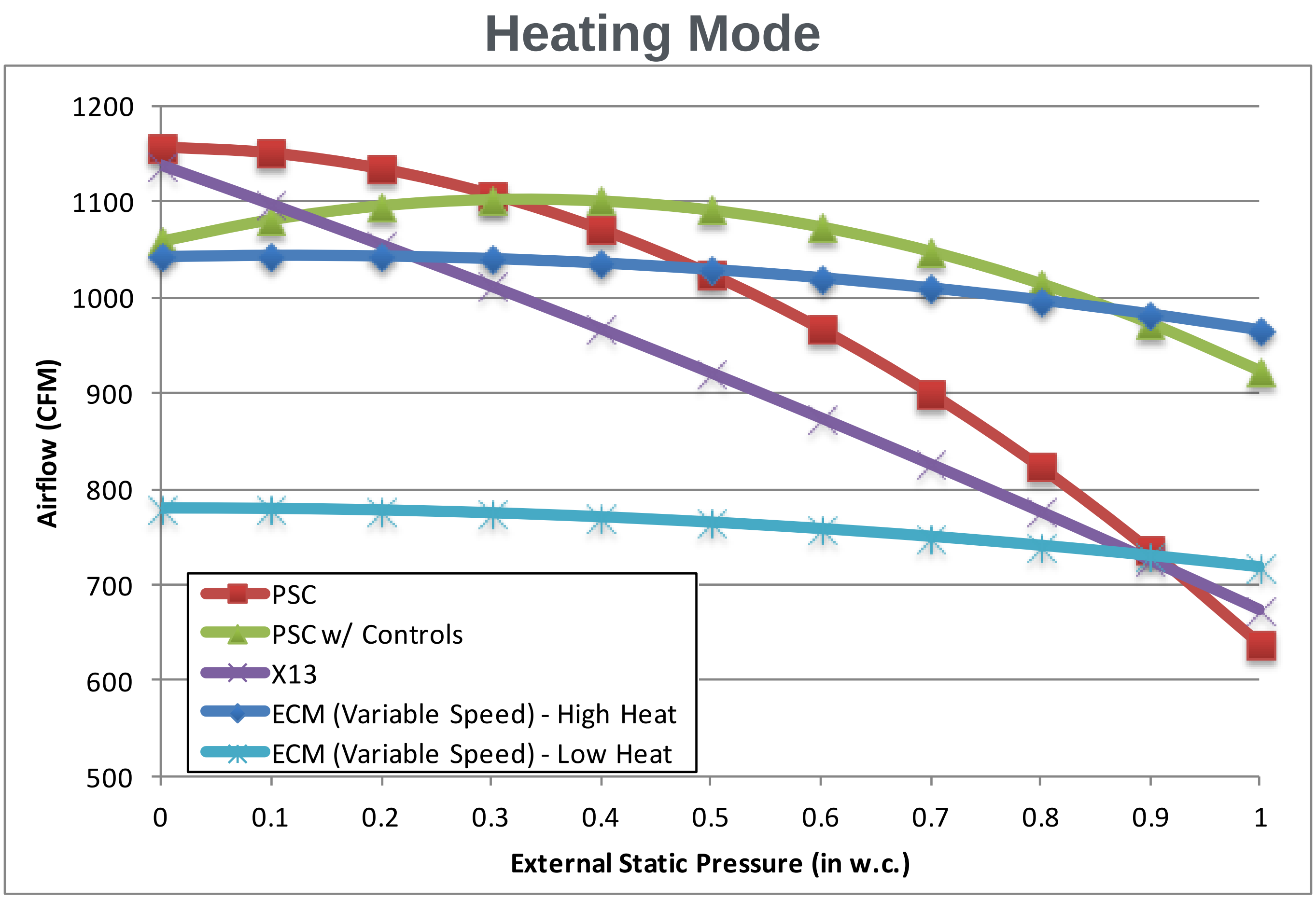
Deriving Adjustment Factors for Fan Performance Curves to match FER values at each efficiency level

Efficiency Level	NWG-NC	NWG-C	MH-NWG-NC	MH-NWG-C	NWO-NC	WG	EF/MB	MH-EF/MB
Baseline	380	393	295	319	333	333	312	243
1	371	384	288	312	326	326	305	238
2	344	356	267	289	301	301	282	220
3	209	216	162	175	183	183	171	133
4	158	163	122	132	138	138	129	101
5	142	147	110	119	124	124	116	90.8

Fan Performance Curves for all product classes and furnace fan sizes

9 product classes
X 7 Fan Sizes (1, 1.5, 2, 2.5, 3, 3.5, 4, 5 AC Ton)
X 6 Furnace Fan Design Options
X 2 Performance Curves (Airflow & Power)
= 756 Furnace Fan Performance Curves

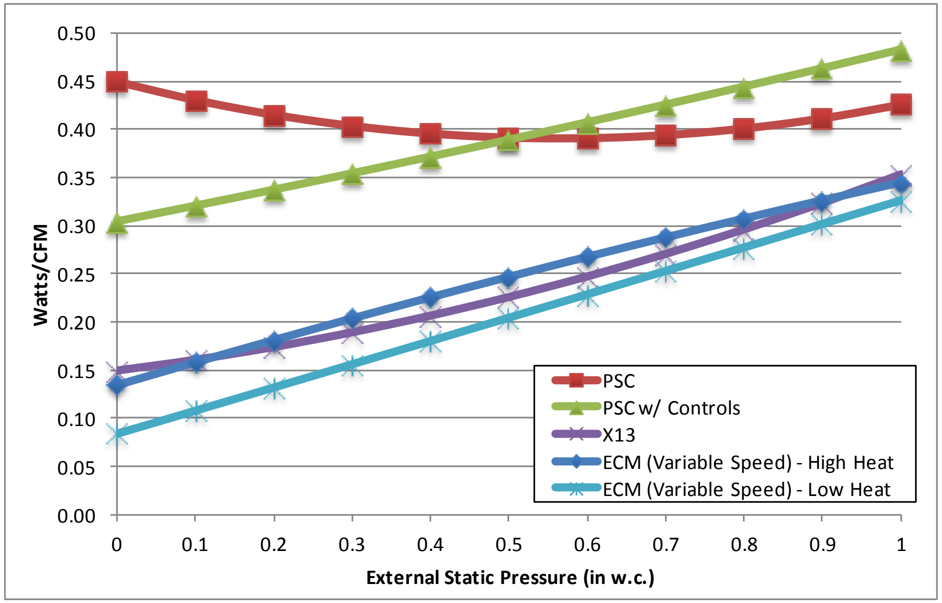
Fan Performance (CFM vs. ESP)

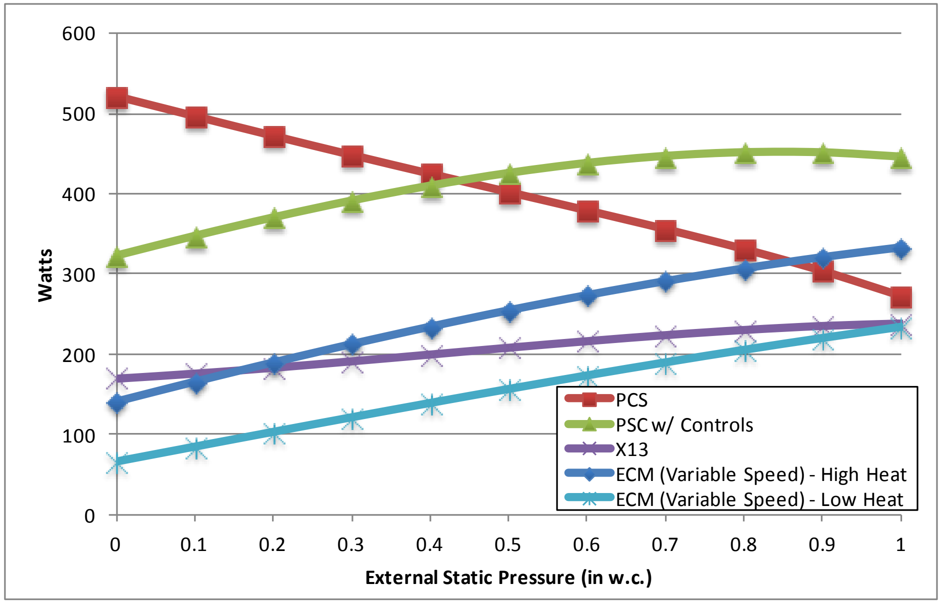


Example: Non-Weatherized (Non-Condensing) Gas Furnace Fan, 3-Ton

Fan Performance (Watts/CFM and Watts vs. ESP)

Heating Mode





Example: Non-Weatherized (Non-Condensing) Gas Furnace Fan, 3-Ton

Operating Hours – Heating and Cooling Mode

$$\text{FF Operating Hours} = \text{Fan On Time Ratio} \times \frac{\text{House Heating or Cooling Load}}{\text{Capacity}} \times \text{AdjFactor}$$

Adjustment Factor (*AdjFactor*) to account for:

- *Building shell efficiency:* Change in heating load based on the difference in physical size and shell attributes for homes in the future (AEO 2012 data)
- *Average climate conditions:* Adjust RECS 2005 energy use data for differences with most recent 10-year NOAA climate data
- *Secondary HVAC energy use:* Subtracted secondary heating or cooling equipment from RECS 2005 heating/cooling energy use data
- *Motor heat:* Accounted for impact of heat produced by the motor on heating/cooling operating hours

Operating Hours – Constant Fan Mode

- Based on fan constant circulation use studies conducted in Wisconsin and Minnesota.
- DOE adjustments for national sample (compared to studies):
  - *South Hot Humid region* - 10 percent of population using constant circulation (i.e. 3.1 percent compared to 31 percent in the studies).
  - *For the rest of the country (North and South Hot Dry regions)* - 50 percent of population using constant circulation (i.e. 15.5 percent compared to 31 percent in the studies).

How Often is Constant Circulation Fan Used?	Combined Data from Studies		Estimated North and South-Hot Dry Region Fractions for LCC Analysis	Estimated South-Hot Humid Region Fractions for LCC Analysis
	# of HHs	Pct. (%)		
No constant fan	69	68%	84%	97%
Year-round	14	14%	7%	1%
During heating season	4	4%	2%	0.4%
During cooling season	4	4%	2%	0.4%
Other (some constant fan)	10	10%	5%	1%
Total	101	100%	100%	100%

Request for Comment – Continuous-Circulation Operation

DOE requests comments on its characterization of use of continuous circulation, and information that would support use of alternative assumptions.

Issue 10

Impact on HVAC with More Efficient Furnace Fans

- Effects on Furnace and Central AC Energy Use during Heating/Cooling Operation
  - *During Heating Operation:* More efficient furnace fans produce less heat which requires more heating operation (Note: additional electricity use by other furnace components is also accounted for).
  - *During Cooling Operation:* More efficient furnace fans produce less heat which requires less cooling operation
- Effects on Furnace Standby Energy Use
  - *For all products other than hydronic air handlers*: Difference in power consumption between the baseline efficiency level (EL 0) and the rest: for EL1 and EL2 = 0 watt; while for EL3 and above = 3 watts.
  - *For hydronic air handlers:* Integrated metric (IFER) includes standby and off mode electrical energy consumption

Summary of Results

(Non-Weatherized Gas Furnace Fan, Non-Condensing & Condensing)

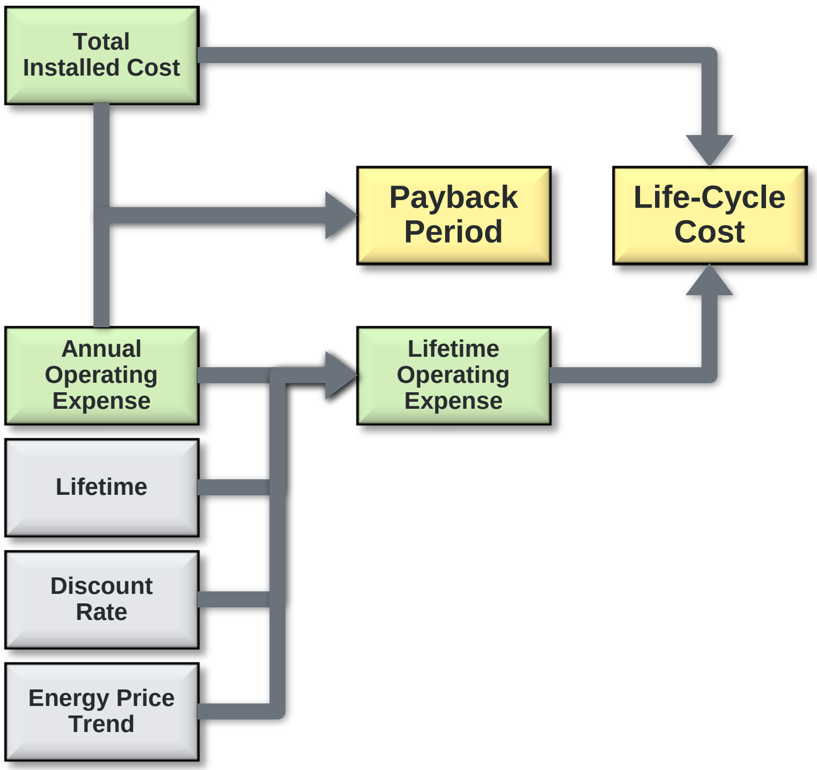
Efficiency Level	NWG-NC			NWG-C		
	Annual Electricity Use (kWh)	Electricity Use Savings (kWh)	Additional Fuel Use (MMBtu)	Annual Electricity Use (kWh)	Electricity Use Savings (kWh)	Additional Fuel Use (MMBtu)
Baseline (PSC)	798	NA	NA	768	NA	NA
Improved PSC	784	13	0.00	736	32	0.00
PSC w/ Controls	779	19	-0.04	643	125	-0.03
X13	508	290	0.28	421	347	0.39
ECM + Multi-Stage	532	265	0.33	410	357	0.44
ECM + BC Impeller	478	319	0.36	372	396	0.48

Request for – Comment Other Issues

DOE invites comments and recommendations on any other aspects related to the Energy Use Characterization.

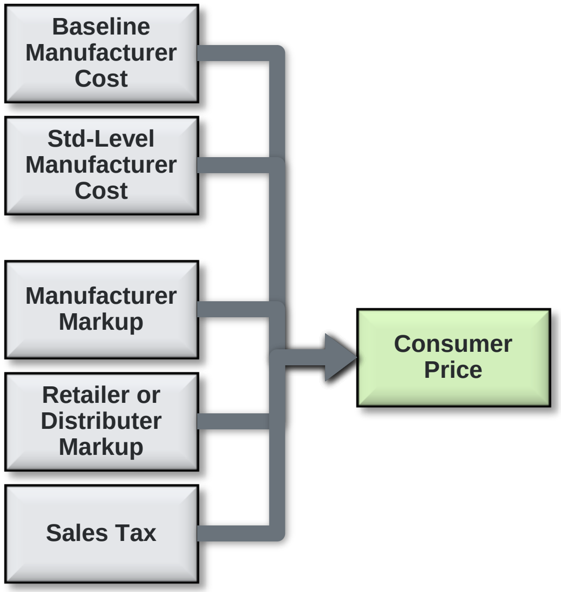
Life Cycle Cost and Payback Period Analysis Method

- LCC equals total installed cost plus the sum of operating expenses discounted to a base year (2018).
- Economic evaluation performed from the consumer perspective.
- Analysis models the uncertainty and variability of inputs using Monte Carlo approach and probability distributions.
- Analysis implemented in an Excel® spreadsheet combined with Crystal Ball.®



Determination of Consumer Price

- **Consumer Price = Manufacturing Cost x Markups x Sales Tax**
  - Manufacturing cost – from Engineering Analysis
  - Markups and Sales Taxes – from Markups Analysis



Installation Costs Approach

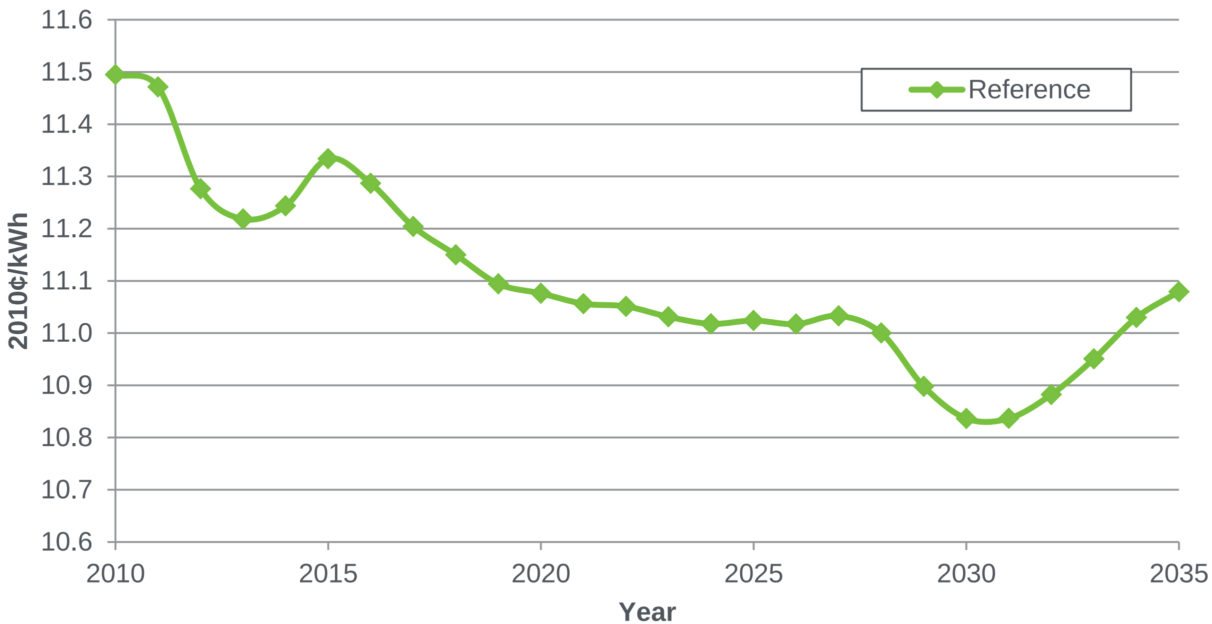
- **Definition:** Installation costs represent the labor and materials necessary to install the appliance
- **Method:** Furnace fan installed in the furnace in the factory require no additional installation cost at the home
  - Exception: A fraction of X13 and ECM furnace fan installations will require up to an hour of extra labor at startup to check and adjust airflow

Energy Prices

- **<u>Purpose:</u>** Develop average marginal monthly prices by geographical area.
- **<u>Methodology:</u>** Multiply most current average annual energy prices by monthly price factors and marginal price factors.
  - <u>2010 average annual energy prices</u> by geographical area based on:
    - *Electricity Prices*: EIA's 2010 Form 826 data
    - *Natural Gas*: EIA's 2010 Natural Gas Navigator monthly
    - *Oil and LPG*: EIA's 2010 State Energy Data System (SEDS)
  - <u>Monthly energy price factors</u> by geographical area based on:
    - *Electricity Prices*: EIA's 1990-2010 Form 826 monthly data
    - *Natural Gas*: EIA's 1989-2010 Natural Gas Navigator monthly data
    - *Oil and LPG*: EIA's 2009 Short Term Energy Outlook 1995-2009 historical data
  - <u>Marginal energy price factors</u> for electricity and natural gas by 9 census divisions and 4 large states based on RECS 2005 billing data.

Energy Price Trends

- **Methodology:** 2010 average monthly marginal energy prices by geographical area multiplied to projected annual energy price trends for the corresponding census division
  - 2018-2035 trends based on EIA's AEO 2012 Early Release by census division
  - After 2035 trends based on Federal Energy Management Program (FEMP) guidelines



Example: National Electricity Price Projection (Reference Case)

Repair and Maintenance

- **Repair Cost:**
  - Definition: Cost of replacing or repairing components in the furnace fan that have failed.
  - Methodology: Repair occurs if fan motor lifetime is less than furnace equipment lifetime.
    - *Failure Year*: Fan motor lifetime (expressed in operating hours) divided by furnace fan annual operating hours.
    - *Labor Hours/Cost*: Based on *2012 RS Means Facility Repair and Maintenance and 2012 RS Means Residential Construction Data.*
    - *Material Cost*: Based on *engineering and markups analysis.*
- **Maintenance Cost:**
  - Definition: Routine cost to the consumer of maintaining components in the furnace fan.
  - Methodology: Assumes blower checking as part of regular equipment maintenance.
    - *Maintenance Frequency*: Based on *Decision Analysts, 2008 American Home Comfort Study* reporting the maintenance frequency for HVAC equipment.
    - *Labor Hours/Cost*: Based on *2012 RS Means Facility Repair and Maintenance and 2012 RS Means Residential Construction Data.*
    - *Material Cost*: None.

Lifetime

- **Definition:** Age when the furnace fan is retired from service.
- **Methodology:** Assumed furnace fan lifetime equals furnace equipment lifetime.
  - For NWG-NC, NWG-C and NWO-NC: Characterized the product lifetime based on an analysis of furnace lifetimes in the field using a combination of shipments data, RECS data on the age of the furnaces in the surveyed homes, and historical AHS data on the total installed furnace stock.
  - For MH-NWG-NC, MH-NWG-C, and EF/MB: Characterized the product lifetime based on a consumer survey (*Decision Analysts, 2004-2008 American Home Comfort Study*), which reports equipment lifetime.
  - For WGF, MH-EF/MB, and HAH-HC: Assumed the same lifetime distribution as EF/MB.

Product Class	Average Lifetime *(years)*
NWG-NC and NWG-C	23.6
NWO-NC	26.5
MH-NWG-NC and MH-NWG-C	18.7
EF/MB (as well as WG, MH-EF/MB, and HAH-HC)	18.0

Discount Rates

- **Definition:** DOE uses the discount rate to determine the present value of lifetime operating expenses when a product is retired from service.
- **Methodology:** DOE derives the discount rates from estimates of the "finance cost" to purchase residential products using the Federal Reserve Board's *Survey of Consumer Finances*. The finance cost can be interpreted as:
  - The financial cost of any debt incurred to purchase products (such as interest charges on debt), or
  - The opportunity cost of any equity used to purchase products (such as interest earnings on household equity).
- **Primary data sources:** Federal Reserve Board's *Survey of Consumer Finances* for the years 1989, 1992, 1995, 1998, 2001, 2004, and 2007.

Housing Type	Finance Cost Based on:	Mean *(%)*
New Construction	Mortgage	3.0
Replacements	Home equity loans, Credit card, Other loans, Checking & savings accounts, Certificates of deposit, Bonds, Stocks	5.0

Product Assignment in the Base Case

- **Definition:** Base case product efficiency assignment reflects the projected market share of products at different efficiency levels.
  - Not all consumers purchase products at current minimum standard.
  - LCC analysis recognizes that consumers already purchasing products at efficiencies greater than or equal to a prospective standard level are not impacted by the standard.
- **Methodology:** Projected furnace fan efficiency market share in 2018 for each product class based on:
  - Historical Data : Sales of furnace fan by efficiency and by product class is not available. Historical data suggest that the market share of ECMs rose from 10 percent to 30 percent within the last five years.
  - Market Share Projection for PSC motors: Assumed market share – 50% baseline; 50% improved PSC furnace motors; and 0% for PSC with controls.
  - Market Share Projection for ECM motors: Calculated for each product class by using the fraction of models with ECMs and assuming it equals 2018 market (45%).
  - Market Share in Replacement/New Construction: Share of ECM fans in furnace fan equipment replacements is 3.7 times higher than the share in new homes (source: Canadian survey, 2003).

Request for Comment – Base-Case Furnace Fan Efficiency Distributions

DOE requests comments on its estimate of the base-case efficiency distribution of furnace fans in 2018 and data that might support use of different assumptions.

Issue 12

LCC and PBP Analysis Results

Example: Non-Weatherized, Condensing Gas Furnace Fan

CSL	Technology Option	Life-Cycle Cost *(2011$)*			Life-Cycle Cost Savings				Median Payback Period *(years)*
						% Households with			
		Average Installed Cost	Average Lifetime Operating Cost	Average LCC	Average Savings *(2011$)*	Net Cost	No Impact	Net Benefit	
0	Baseline (PSC)	241	1,292	1,533	N/A	0	100	0	N/A
1	Improved PSC	246	1,242	1,488	10	20	76	4	0.8
2	PSC w/ Controls	265	1,095	1,361	65	35	53	12	5.3
3	X13	306	840	1,146	169	13	53	33	5.2
4	ECM + Multi-Stage	459	884	1,344	34	54	33	13	22.8
5	ECM + BC Impeller	491	836	1,327	51	71	0	29	17.3

Request for Comment – Other Issues

DOE invites comments and recommendations on any other aspects related to the Life-Cycle Cost Analysis.

Public Meeting Agenda

1. Introduction and Overview
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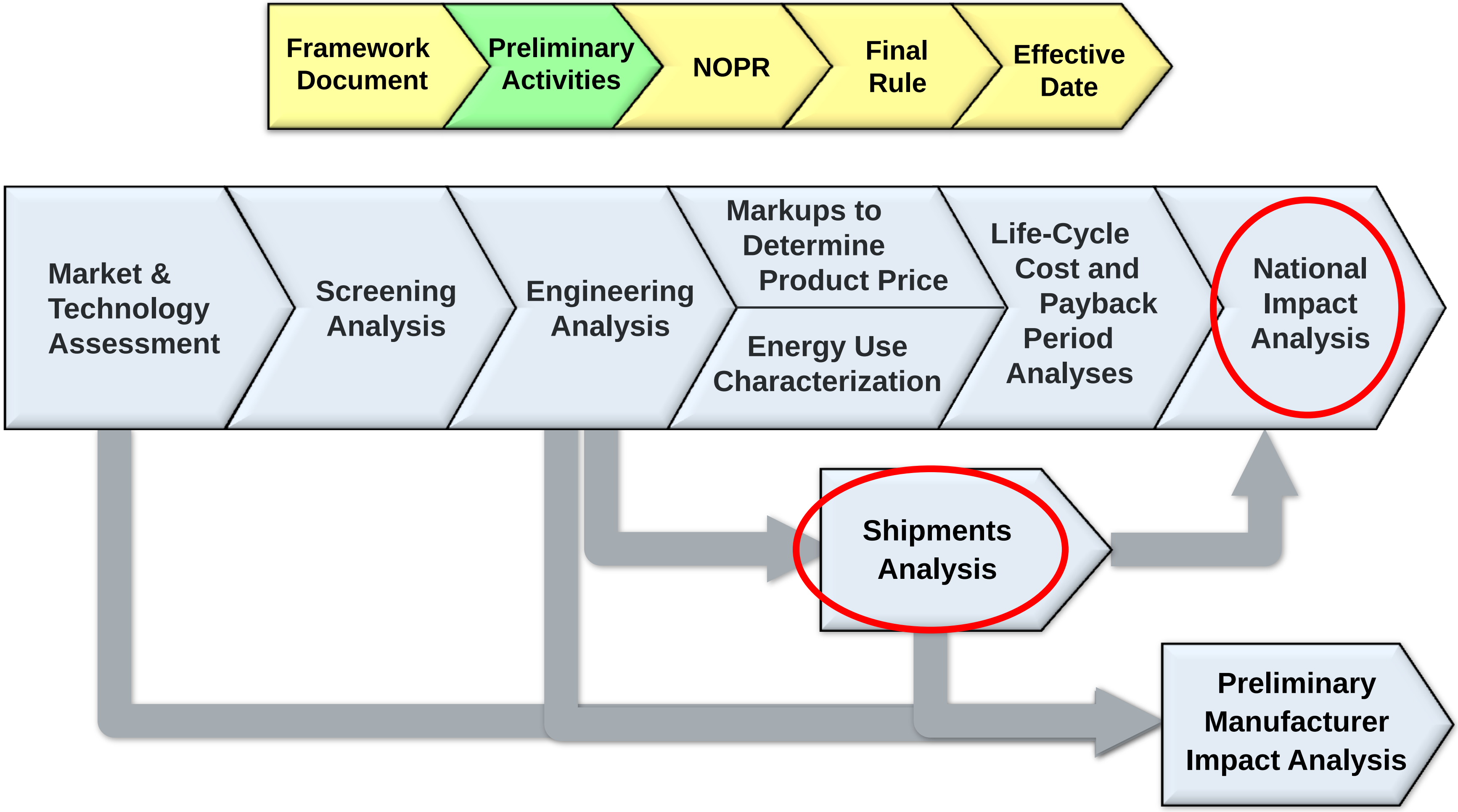
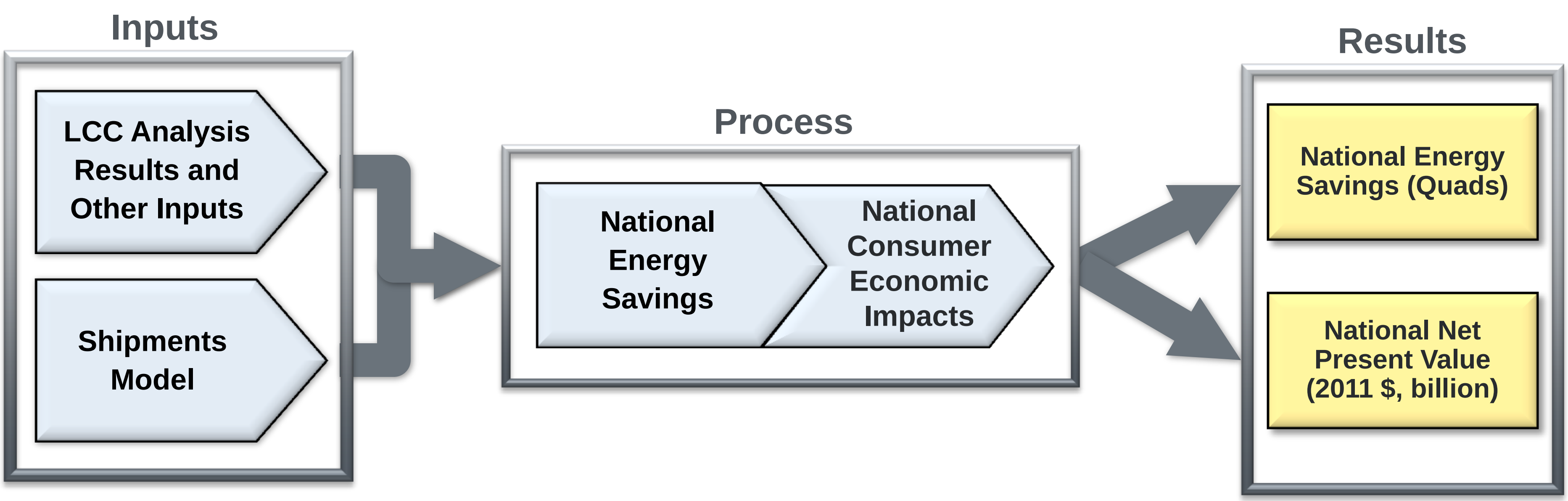
Steps for the Standards Rulemaking: Preliminary Activities and Analyses



Purpose

- **Shipments Analysis:**
  - To estimate residential furnace fan shipments over analysis period.
- **National Impact Analysis:**
  - To estimate the National Energy Savings (NES) from residential furnace fan energy conservation standards at different efficiency levels.
  - To estimate the national economic impact on residential furnace fan consumers (or the Net Present Value (NPV)) from energy conservation standards at different efficiency levels.

National Impact Analysis Process

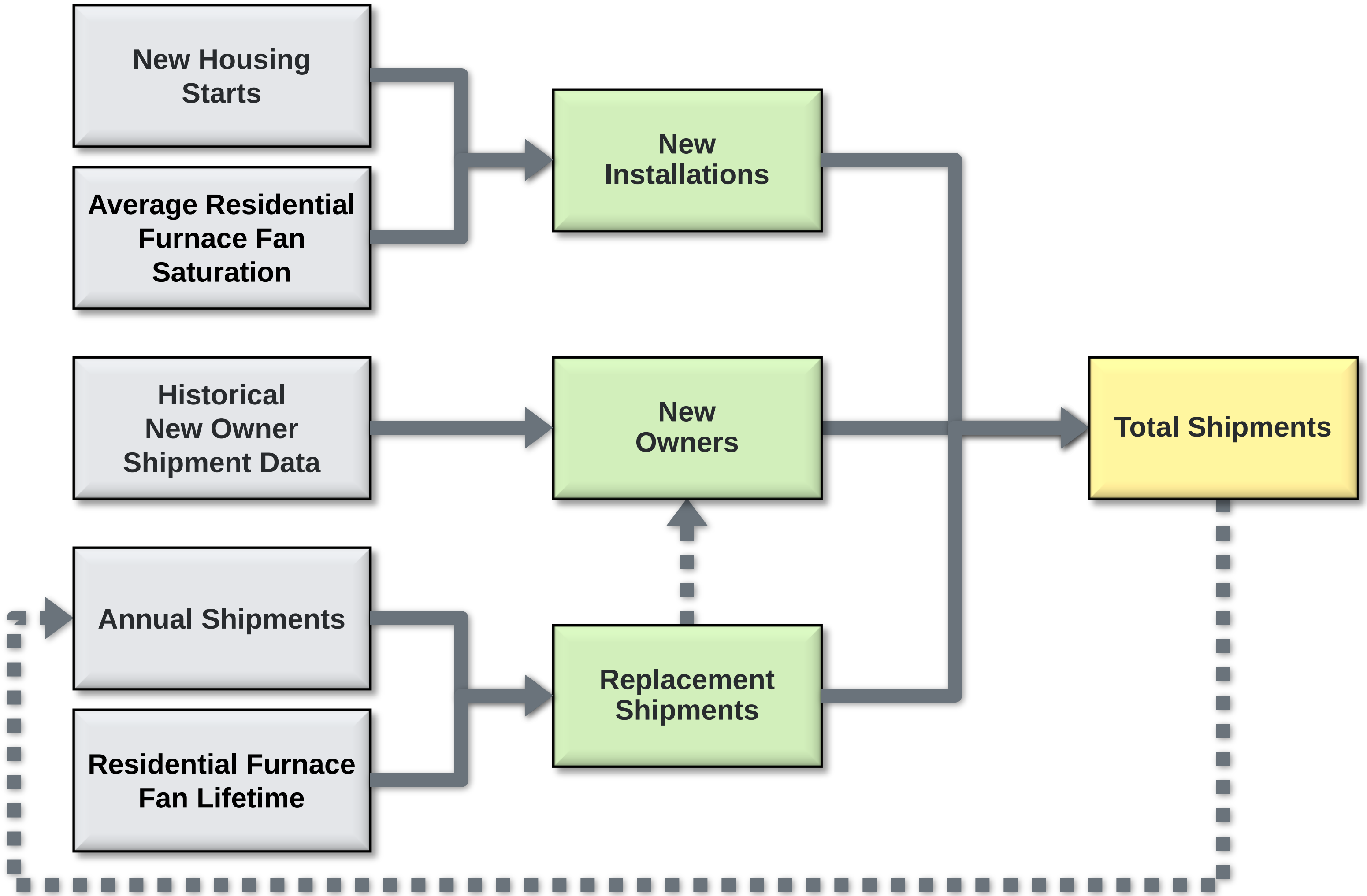


- National energy savings calculated for period from 2018-2047.
- NPV calculated for products shipped over the same period.

Approach

- Assumes furnace fans are shipped pre-installed in furnace fan equipment.
- Shipments Projections by Market:
  - **New construction:** New housing construction projections multiplied by historical market shares.
  - **Replacements:** Product retirement functions (product lifetimes) applied to product stock. Product stock is generated with historical shipments.
  - **New Owners:** Existing buildings that acquire furnaces for the first time. Includes consumers switching between furnace fan product classes.
- Projected shipments done separately by region.
- Accounted for impact of standards on shipments using price elasticities.

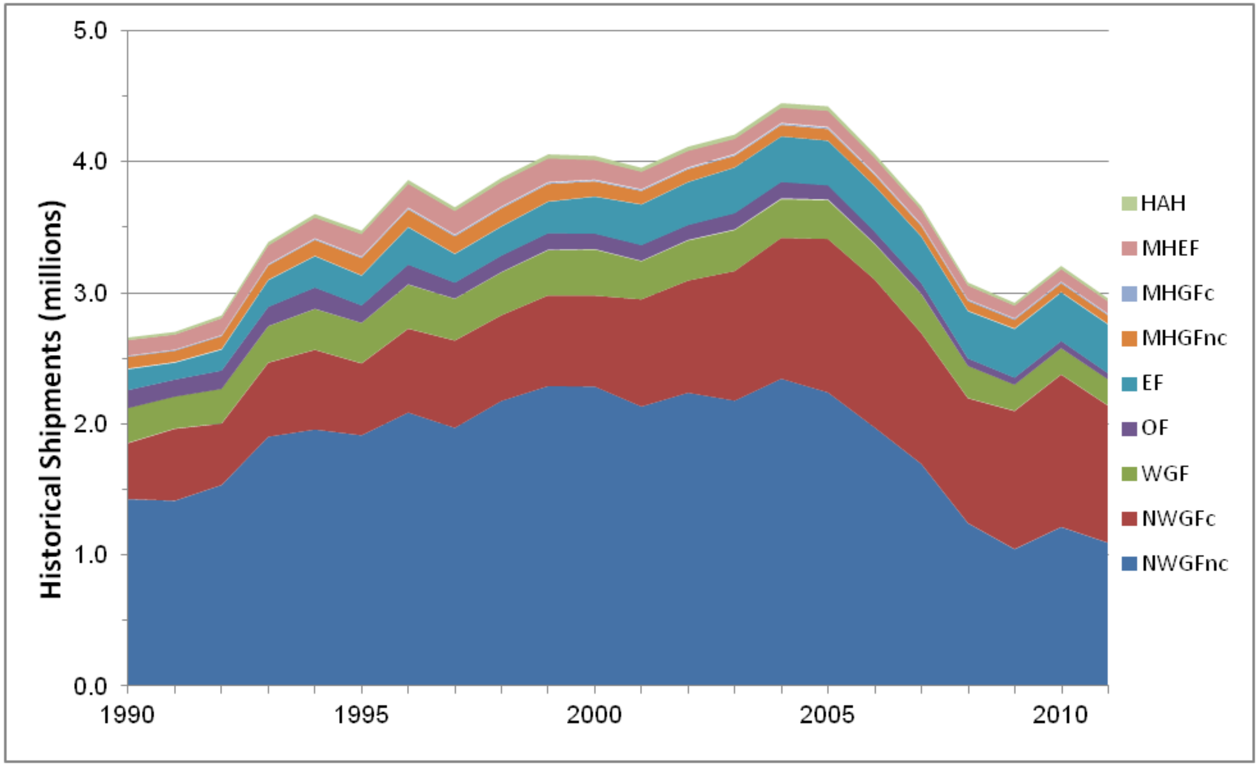
Shipments Analysis Flowchart



Shipments Model Inputs

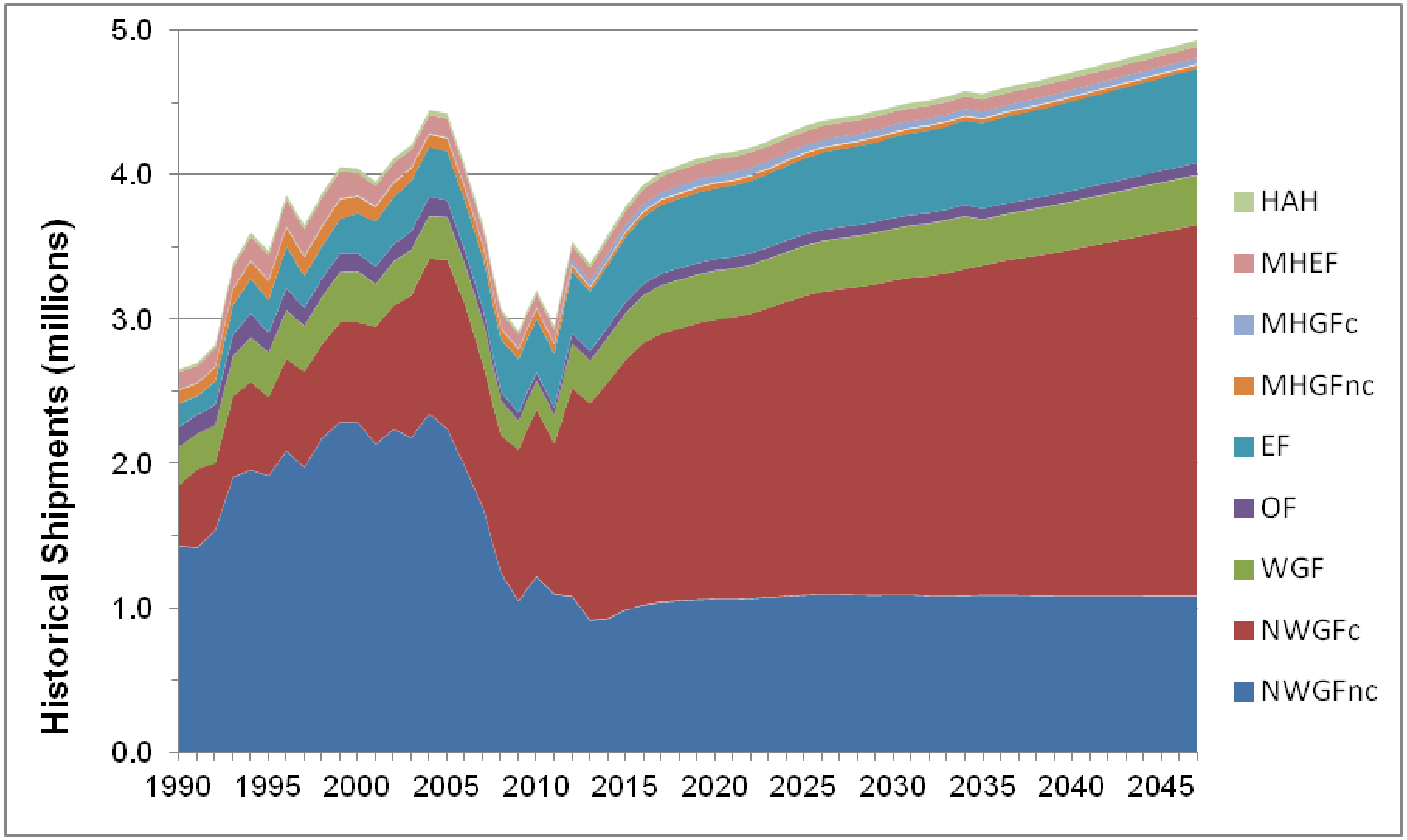
Historical Shipments	Shipments derived from: •AHRI historical shipments, 1972-2009, disaggregated into (1) NWGF and MHGF, (2) OF, and (3) WGF (estimated from AC packaged units) •AHRI 1972-2009 historical shipments by efficiency was used to separate condensing vs. non-condensing NWGF shipments •Census MHGF new construction data, MHGF lifetime, AHS saturation data used to disaggregate NWGF and MHGF historical shipments •For EF, DOE's 2011 furnace standards rulemaking historical shipments •For hydronic air handlers, DOE estimated that they represented less than 1% of the total furnace market.
Replacement Shipments	Furnace fan replaced with same furnace fan product class (also accounts for the housing units demolished).
Shipments to New Housing	New construction market saturations multiplied by projected new housing units based on: •Saturations from Characteristics of New Housing data, U.S. Census Bureau •U.S. Census historical housing starts data and EIA's AEO2011 projections
Shipments to New Owners and Adjustment for Product Switching	New owners of products, plus adjustment for switching between different product classes •Projected shipments developed by estimating the average new owner shipments in the past 3-5 years, and projecting this quantity into the future •Includes households switching between non-condensing and condensing product classes
Projected Condensing and Non-Condensing Market Shares	All NWGF and MHGF furnaces shipments in the north from 2013 onward assumed to be condensing furnaces (in the South region, based on historical information, analysis projects some market increase of condensing furnaces)

Shipments Model Inputs: Historical Shipments



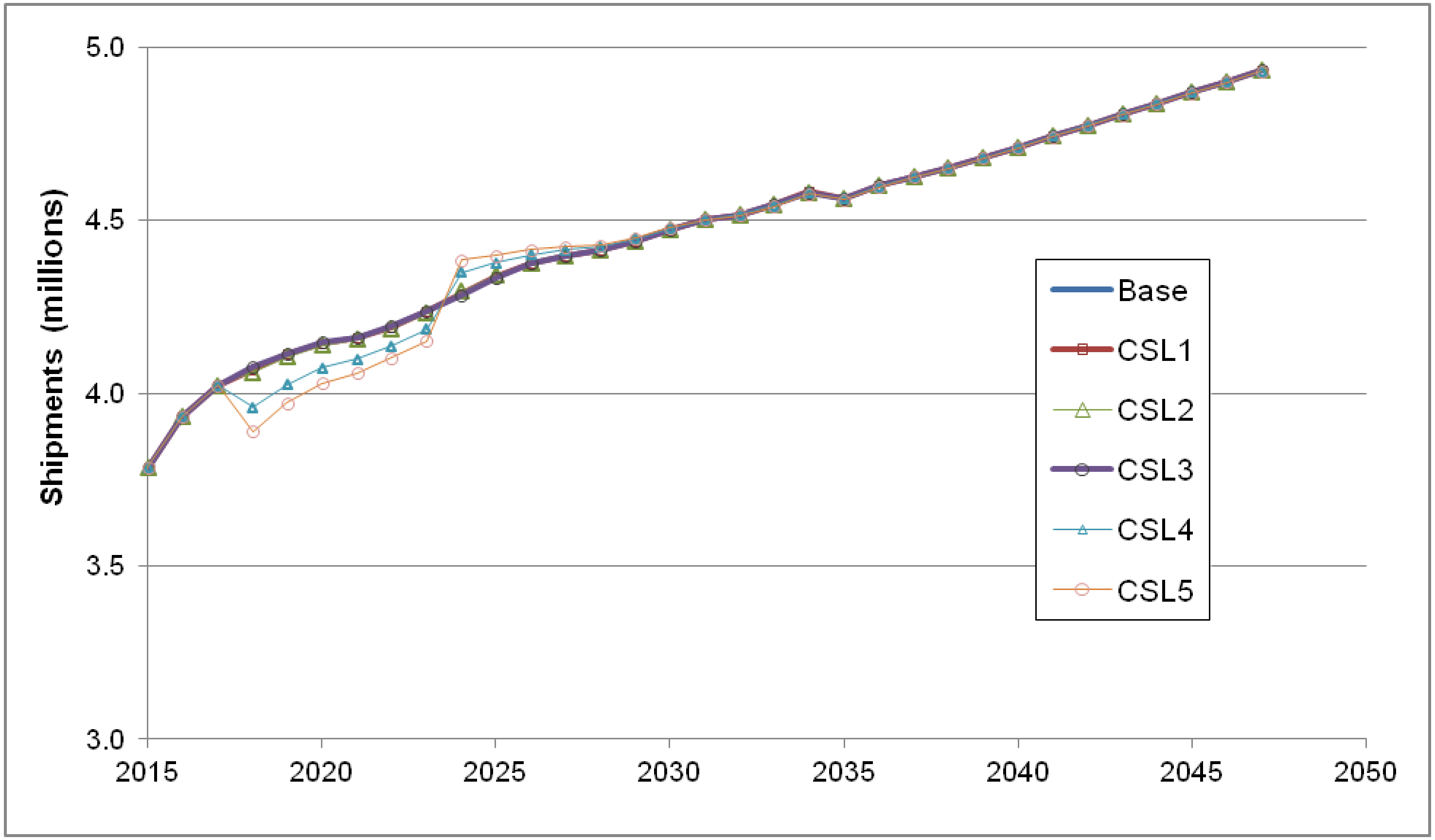
Historical Shipments of HVAC Products with Furnace Fans

Base Case Shipments



Historic & Projected Base Case Shipments of Furnace Fans by Product Class

Base Case and Standard Cases Shipments



Projected Shipments of Furnaces Fans in the Base Case and Standards Cases

National Impact Analysis Inputs

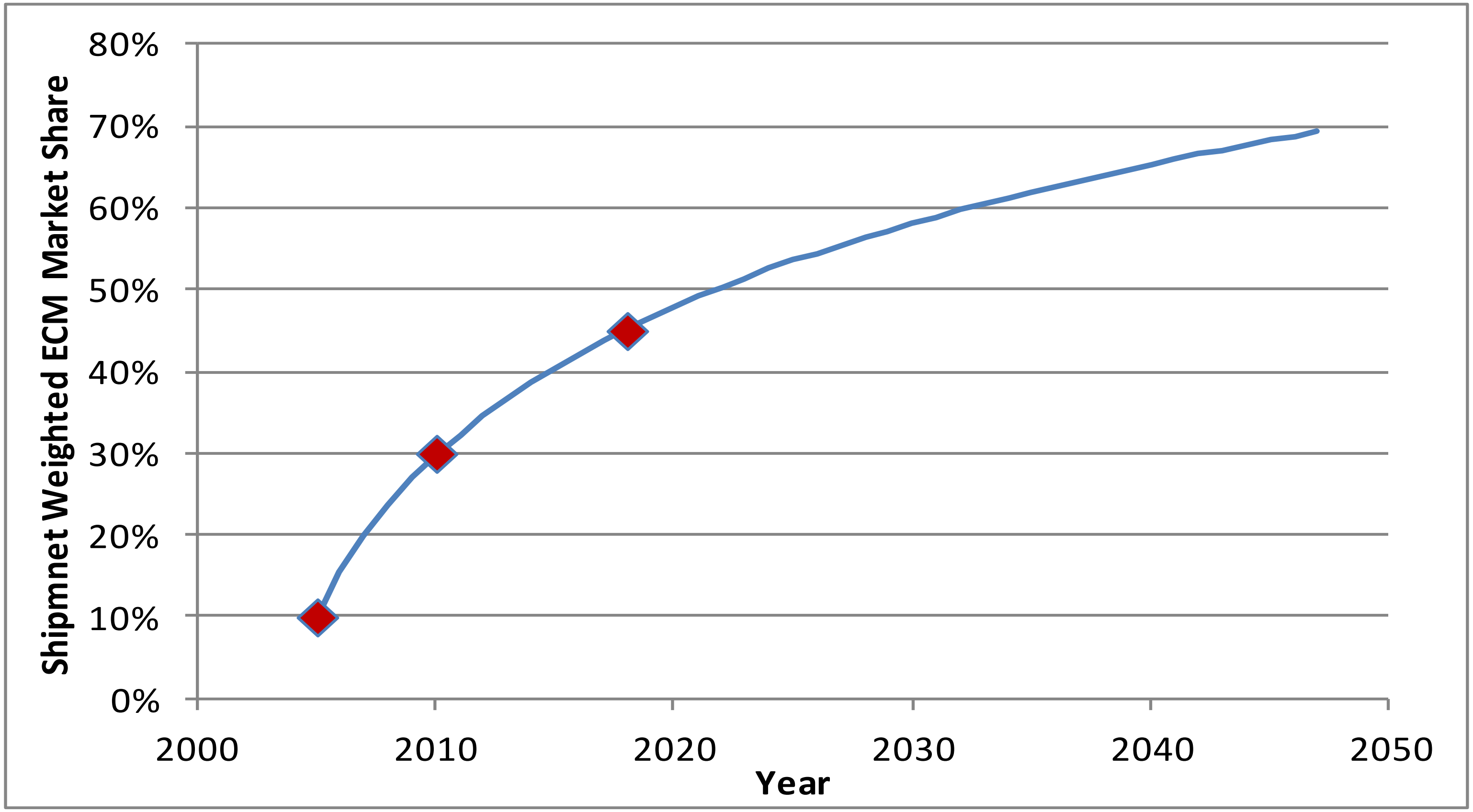
Annual Energy Consumption per Unit (UEC)	For each product class, DOE derived per-unit annual energy consumption as a function of product efficiency.
Shipments	DOE projected shipments for each product class under the base case and all standards cases.
Equipment Stock	DOE determined the yearly stock using annual shipments and the lifetime for each product class
National Annual Energy Consumption	Annual energy consumption is the product of the UEC and the equipment stock.
Rebound Effect	DOE used a 2009 Wisconsin field study to estimate the rebound effect under a standard requiring ECM furnace fans. DOE calculated a separate rebound effect for the north and for the south regions based on the expected increase of constant circulation fan use (20% in the North and 10% in the South).
Site-to-Source Conversion Factor	The site-to-source conversion factor is a factor used for converting site energy consumption into primary or source energy consumption.

Request for Comment – Rebound Effect

DOE requests comments on the reasonableness of the values that it used to characterize this rebound effect.

Issue 11

Projected ECM Market Share after 2018



Based on historical data estimates (10% in 2006 and 30% in 2010) and projected market share for 2018 (45%)

Request for Comment – Furnace Fan Efficiency Trends in the Absence of Standards

DOE requests comments on the reasonableness of its approach and information that would support use of alternative assumptions.

Issue 13

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National Energy Savings Results

(quads)

	Key Product Class	Candidate Standard Level						
		1	2	3	4	5	6	7
		Improved PSC	PSC w/ Controls	X13	ECM	ECM + BC Impeller	Switching Mode Power Supply	Toroidal Transformer
1	NWG-NC	0.022	0.061	0.725	0.624	0.850		
2	NWG-C	0.041	0.265	0.623	0.611	0.911		
3	WG	0.002	0.019	0.122	0.143	0.200		
4	NWO-NC	0.004	0.032	0.042	0.045	0.051		
5	EF/MB	0.003	-0.005	0.102	0.085	0.162		
6	MH-NWG-NC	0.001	0.010	0.018	0.024	0.026		
7	MH-NWG-C	0.001	0.008	0.010	0.017	0.019		
8	MH-EF/MB	0.000	0.007	0.013	0.023	0.031		
9	HAH-HC	0.000	0.000	0.016	0.030	0.034	0.037	0.039

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Net Present Value Results

Discounted at 3 and 7 Percent (billion 2011$)

	Key Product Class	Candidate Standard Level													
		1		2		3		4		5		6		7	
		Improved PSC		PSC w/ Controls		X13		ECM		ECM + BC Impeller		Switching Mode Power Supply		Toroidal Transformer	
		3%	7%	3%	7%	3%	7%	3%	7%	3%	7%	3%	7%	3%	7%
1	NWG-NC	0.110	0.036	0.048	-0.034	4.462	1.553	0.551	-0.278	1.395	-0.077				
2	NWG-C	0.254	0.095	1.559	0.564	4.449	1.618	0.089	-0.505	0.944	-0.392				
3	WG	0.006	0.002	0.083	0.027	0.842	0.340	0.382	0.081	0.581	0.131				
4	NWO-NC	0.023	0.007	0.204	0.070	0.135	0.035	-0.038	-0.049	-0.058	-0.063				
5	EF/MB	0.010	0.003	-0.118	-0.059	0.601	0.229	-0.558	-0.343	-0.406	-0.329				
6	MH-NWG-NC	0.003	0.001	0.021	0.004	0.044	0.011	-0.060	-0.049	-0.066	-0.054				
7	MH-NWG-C	0.005	0.002	0.035	0.013	0.046	0.016	-0.103	-0.067	-0.124	-0.080				
8	MH-EF/MB	-0.001	-0.001	0.009	-0.001	0.038	0.009	-0.093	-0.072	-0.046	-0.055				
9	HAH-HC	0.000	0.000	-0.023	-0.012	0.091	0.031	0.112	0.028	0.132	0.034	0.149	0.040	0.144	0.036

Full Fuel Cycle Analysis

- DOE has published a Notice of Policy (NOP) stating its intention to incorporate full-fuel-cycle (FFC) metrics into the cost-benefit analysis. 76 FR 51282 (Aug. 18, 2011).
- Methodology is based on the calculation of a FFC multiplier, or conversion factor, for each of the primary fuels used by the product.
- For this preliminary analysis, DOE calculated FFC energy savings using a NEMS-based methodology (described in appendix 10-B).
- Primary NES and the FFC energy savings for the considered CSLs can be found in Ch 10, Section 10.5.2.

Request for Comment – Full Fuel-Cycle Energy Savings

DOE welcomes comments on its approach to derive FFC conversion factors.

Issue 14

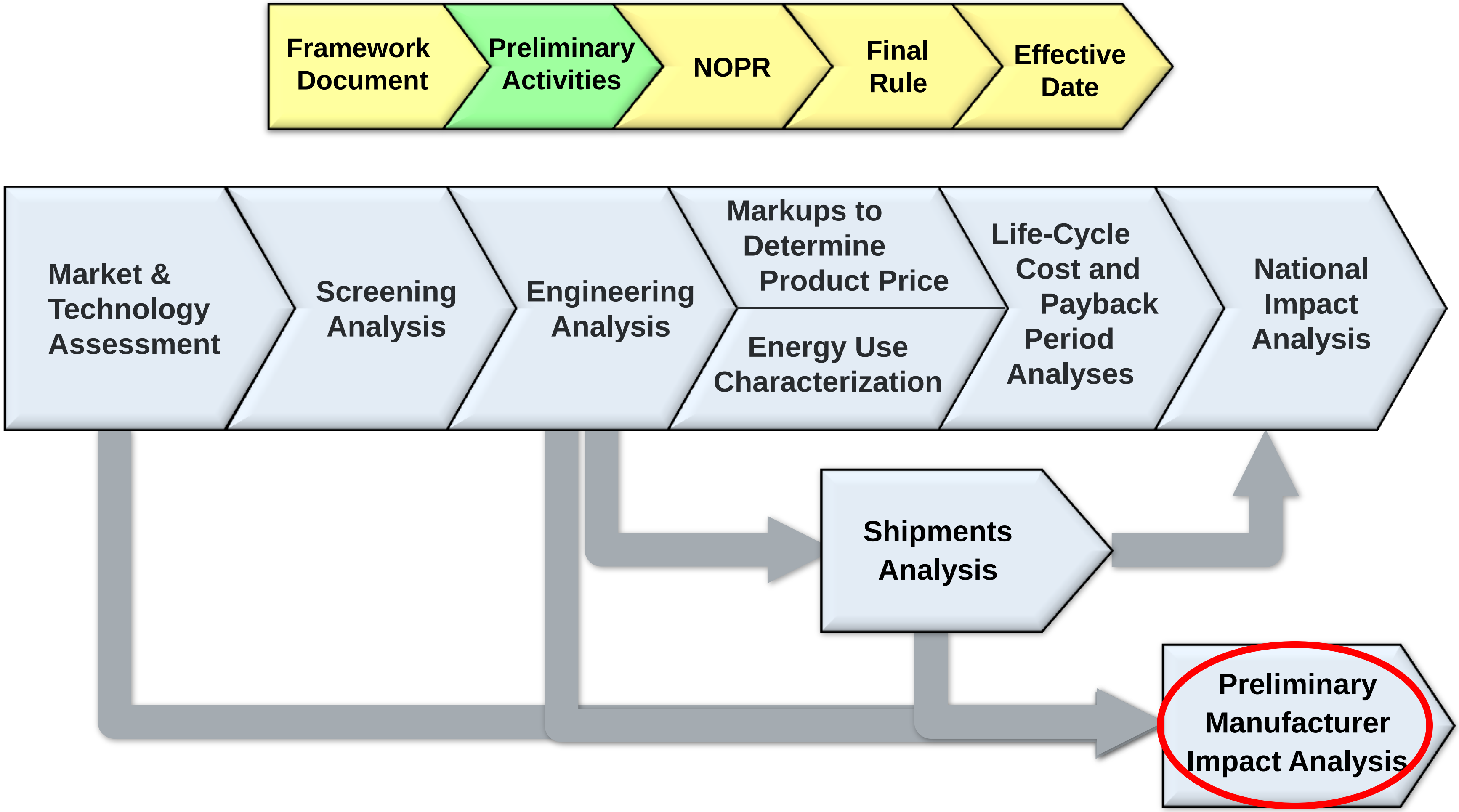
Request for Comment – Other Issues

DOE invites comments and recommendations on any other aspects related to the National Impact Analysis.

Public Meeting Agenda

1. Introduction and Overview
2. Market and Technology Assessment and Screening Analysis
3. Engineering Analysis
4. Markups, Energy Use Characterization, LCC and Payback Period Analysis
5. National Impact Analysis
6. **Preliminary Manufacturer Impact Analysis**
7. Next Steps

Steps for the Standards Rulemaking: Preliminary Activities and Analyses



Preliminary Manufacturer Impact Analysis (MIA) Overview

- DOE is aware of 11 small business manufacturers associated with the products anticipated to be affected by this rulemaking.
- DOE conducted on-site and telephone interviews with manufacturers.
- Interview topics included:
  - Engineering analysis overview, methodology, and results;
  - Key issues (as defined by manufacturer);
  - Current market conditions (shipments, market share, product mix, profitability);
  - Potential impacts of new energy conservation standards (esp. conversion costs); and
  - Cumulative regulatory burdens (state, federal, international).

Key Issues

- Higher upfront costs for consumers
  - Higher initial costs could lead to consumers switching to less efficient products.
  - Higher initial costs may also push consumers to repair rather than replace units.
- Conversion costs
  - Stringent standards may require significant capital conversion costs.
- Reduced innovation
  - A new furnace fan standard would take resources away from the development of new products.
  - A higher standard on furnace fans places new constraints on manufacturers and may limit options for maximizing system efficiency.

Request for Comment:
Other Issues

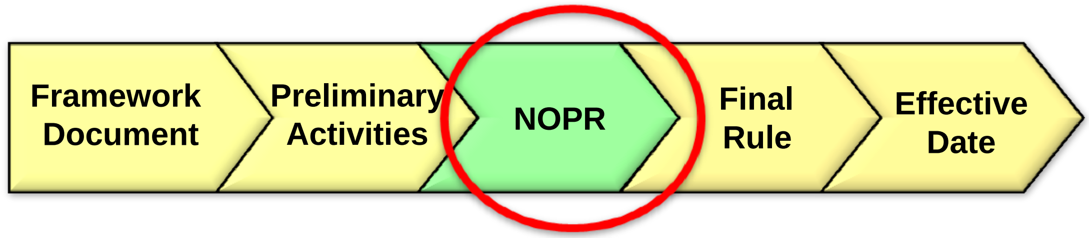
DOE requests comment on its identification of key issues and requests data that can assist in evaluating the potential impact of standards on manufacturers.

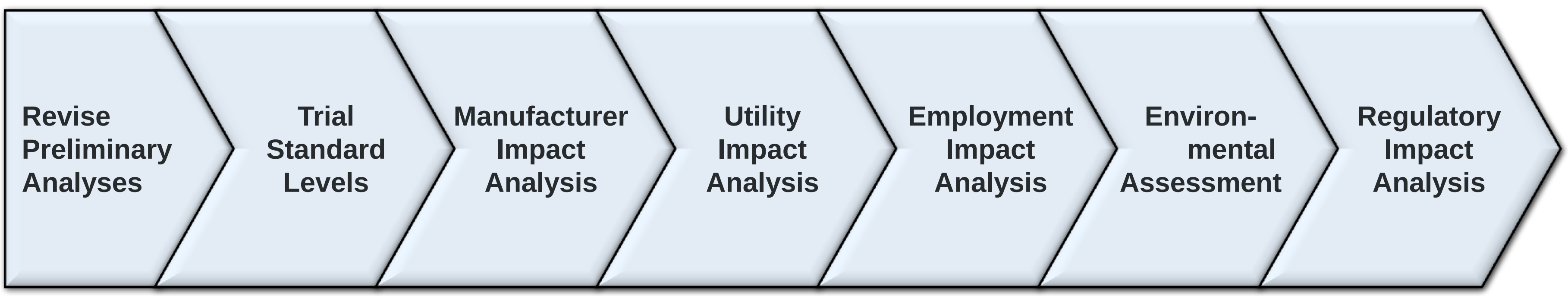
Public Meeting Agenda

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

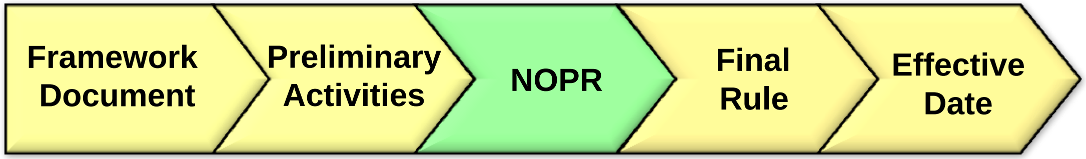
1	Introduction and Overview
2	Market and Technology Assessment and Screening Analysis
3	Engineering Analysis
4	Markups, Energy Use Characterization, LCC and Payback Period Analysis
5	National Impact Analysis
6	Preliminary Manufacturer Impact Analysis
7	**Next Steps**

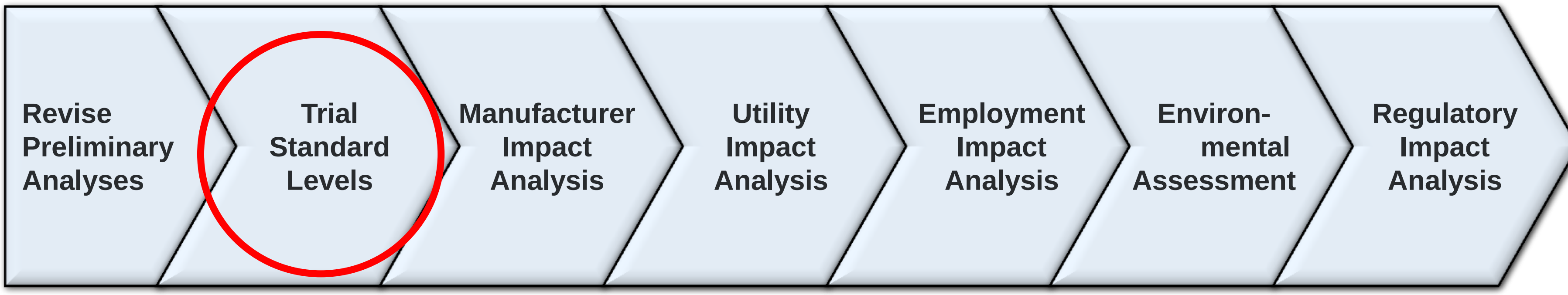
Next Steps in the Standards Rulemaking: NOPR





Next Steps in the Standards Rulemaking: NOPR





Selection of Trial Standard Levels

- **Purpose:**
  - To develop a list of potential amended standard levels from which impacts are weighed and a proposed standard level is selected.
    - Each trial standard level consists of a set of efficiency levels covering all product classes, and may vary between product classes.
    - NOPR analyses assess impacts for trial standard levels (not efficiency levels for each product class).
- **Method:**
  - Trial standard levels are assembled from the product classes and efficiency levels identified in the preliminary analyses.
    - Trial standard levels cover a range of efficiencies and can include:
      - Most energy efficient level (max-tech);
      - Efficiency level with the lowest life-cycle cost;
      - Efficiency level with a payback period of three years or less;
      - Efficiency levels with noteworthy technologies; and
      - Efficiency levels that fill in large gaps.

Request for Comment:

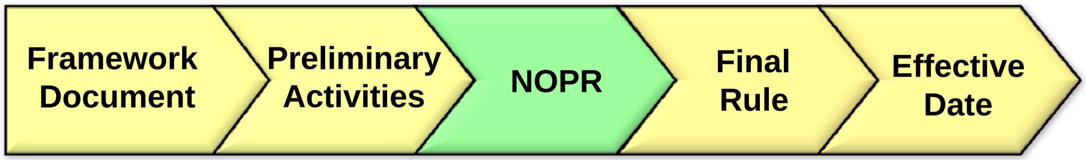
Criteria for the Selection of Trial Standard Levels

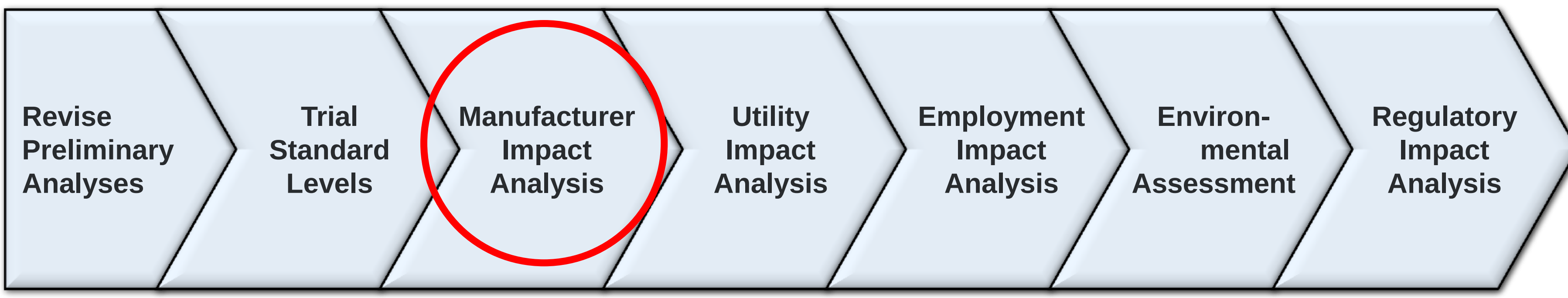
- A critical part of the NOPR analysis on which DOE is seeking early guidance is the criteria used in selecting trial standard levels.

- Trial standard levels are created from combinations of efficiency levels at the product class level.

DOE requests feedback on the criteria it should use for basing the selection of **Trial Standard Levels.**

Next Steps in the Standards Rulemaking: NOPR



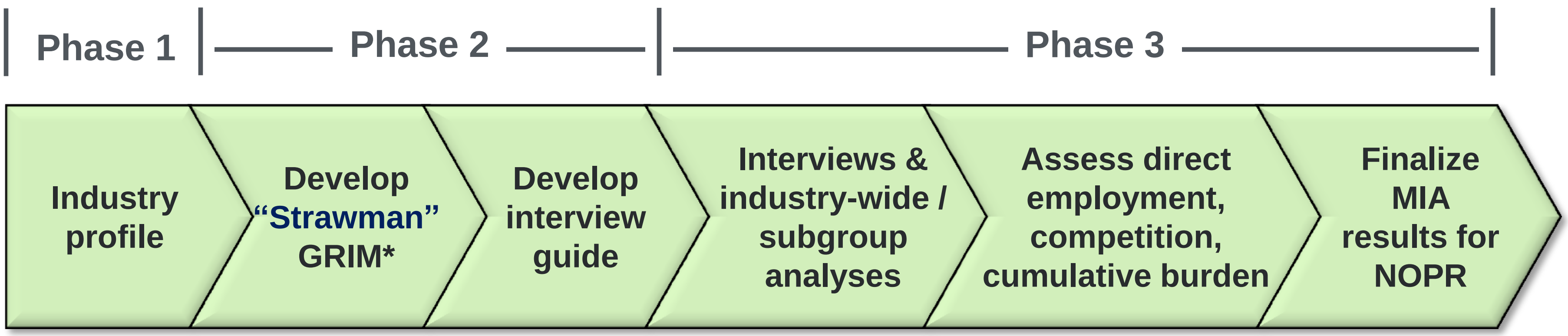


Manufacturer Impact Analysis

- **Purpose:**
  - To assess the impacts of standards on residential furnace fan manufacturers.
  - To identify and estimate impacts on manufacturer sub-groups that may be more severely impacted than the industry as a whole.
- **Method:**
  - Analyze industry cash flow and net present value through use of the Government Regulatory Impact Model (GRIM).
  - Interview manufacturers to refine inputs to the GRIM, develop sub-group analyses, and address qualitative issues.
- **Output:**
  - Industry Net Present Value impacts;
  - Sub-group Net Present Value impacts; and
  - Other impacts

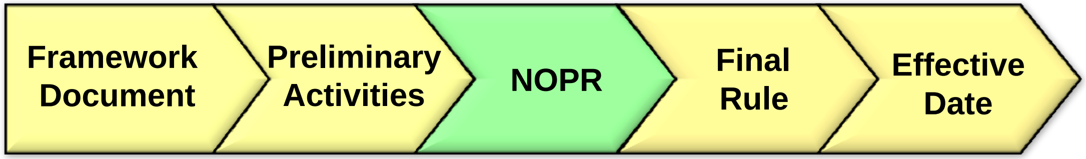
Manufacturer Impact Analysis Process

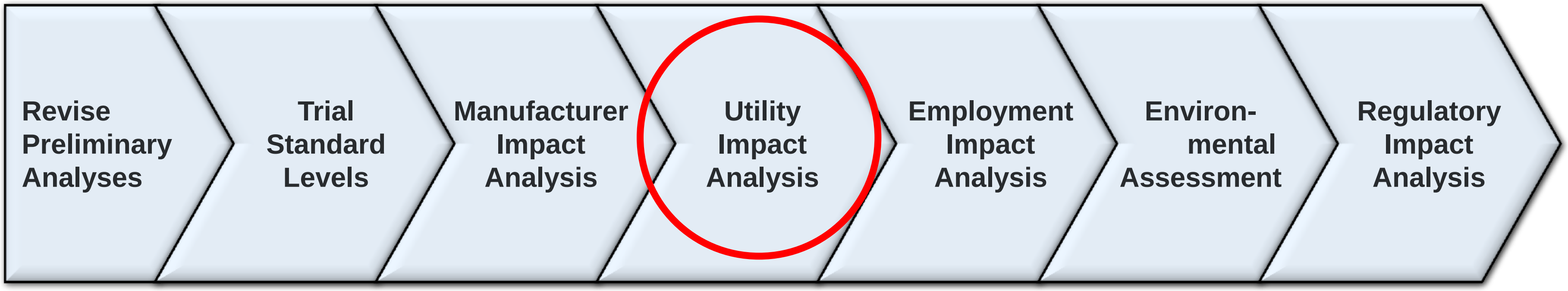
- The MIA consists of three phases:



** Government Regulatory Impact Model (GRIM)*

Next Steps in the Standards Rulemaking: NOPR





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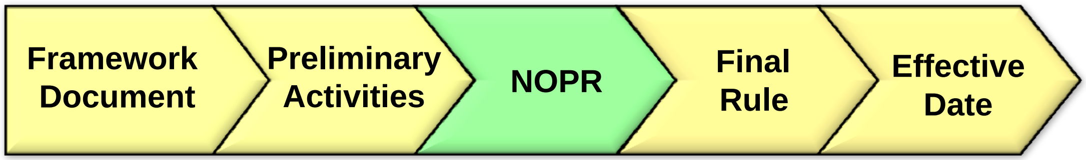
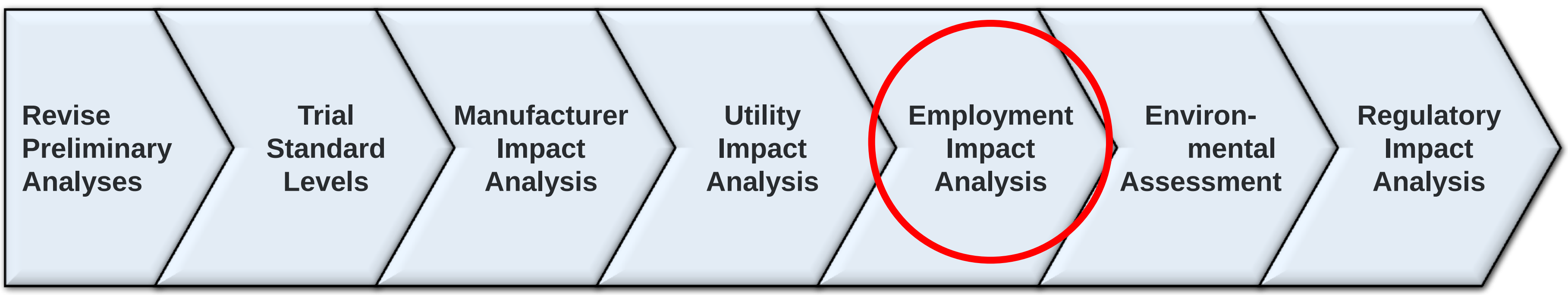
Utility Impact Analysis

- **Purpose:**
  - To investigate the effects on utilities from reduced energy sales and peak load demand due to potential standards.
- **Method:**
  - Uses national energy savings results.
  - Uses the Energy Information Administration's National Energy Modeling System (NEMS) tailored for DOE's Building Technologies Program (NEMS-BT).
- **Output:**
  - Change in energy sales and price by region.
  - Change in the mix of electricity generation.
  - Change in new capacity construction.

Next Steps in the Standards Rulemaking: NOPR

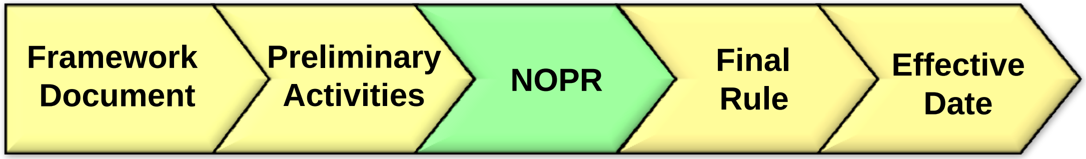


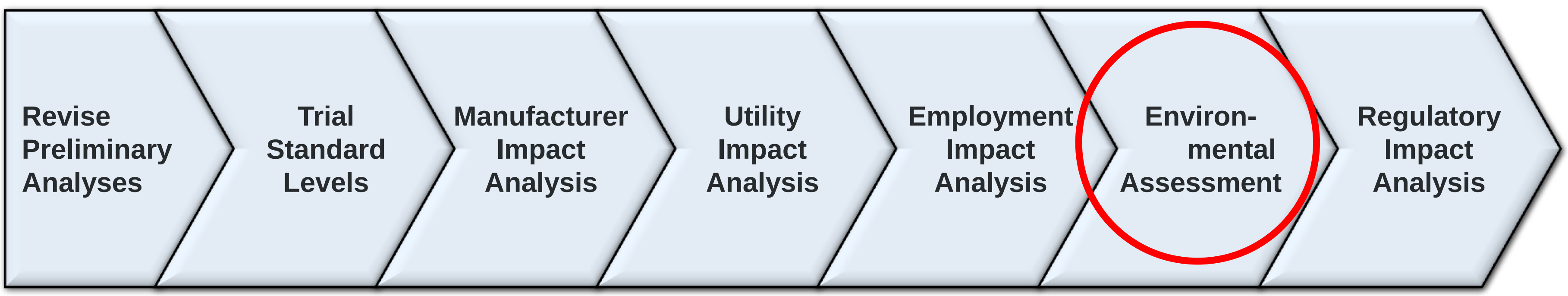


Employment Impact Analysis

- **Purpose:**
  - To report net jobs created or eliminated nationally as a consequence of new energy conservation standards.
- **Method:**
  - Uses the ImSET tool, a spreadsheet model of the U.S. economy that focuses on 188 sectors most relevant to industrial, commercial, and residential building energy use.
  - Changes in product and energy expenditures taken from the National Impact Analysis.
  - Estimates the national employment and income effects of energy saving appliances.
  - Direct employment impacts taken from the Manufacturer Impact Analysis.
- **Output:**
  - Change in employment by sector as a consequence of new standards.

Next Steps in the Standards Rulemaking: NOPR

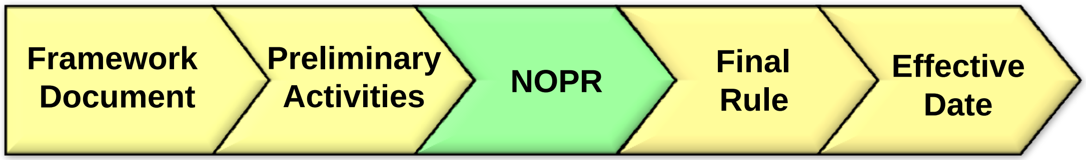


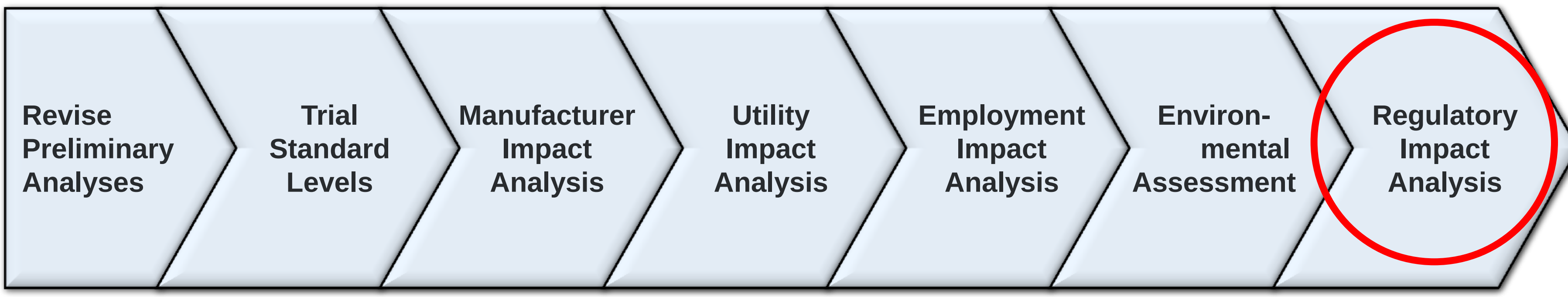


Environmental Assessment

- **Purpose:**
  - To report environmental impacts as a consequence of new energy conservation standards, including changes in power plant emissions as well as emissions in households due to the use of gas appliances.
- **Method:**
  - Energy savings results taken from the National Impact Analysis.
  - Energy Information Administration's National Energy Modeling System (NEMS) provides power-plant emissions.
  - 'In-Building' emissions due to fossil-fuel fired appliances to be determined using emission factors.
  - Economic benefits resulting from emissions reductions based on a range of monetary values.
- **Output:**
  - Estimate of national emission reductions of SO2, NOx, mercury and CO2.
  - Power plant SO2, NOx, and mercury are effectively capped through Congressional legislation resulting in little to no emission reductions due to standards.
  - In-building CO2, SO2 and NOx still emitted by fossil-fuel fired appliances.

Next Steps in the Standards Rulemaking: NOPR





Regulatory Impact Analysis

- **Purpose:**
  - To investigate the national impacts due to non-regulatory alternatives compared with mandatory energy conservation standards.
  - The non-regulatory alternatives that may be considered:
  - No new regulatory action; early replacement; prescriptive standards; consumer tax credits; manufacturer tax credits; consumer rebates; voluntary efficiency targets; bulk government procurement.
- **Method:**
  - Modify NES spreadsheet model to consider non-regulatory scenarios.
  - Non-regulatory scenarios increase overall appliance efficiency and are modeled by modifying the base case efficiency trend.
  - NPV calculated for non-regulatory alternatives in the same way as for the adopted standard.
  - Each non-regulatory scenario will decrease national appliance operating costs and increase appliance equipment prices.
- **Output:**
  - National Energy Savings and Net Present Value of the non-regulatory alternatives.

Final Comments and Questions

DOE requests comments and invites questions from interested parties regarding the Department of Energy's Residential Furnace Fans Energy Conservation Standards Rulemaking.