



U.S. Department of Energy  
**Energy Efficiency  
and Renewable Energy**

Bringing you a prosperous future where energy  
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**Building Technologies Program**

**U.S. Department of Energy**  
*Energy Conservation Program for Consumer Products*

**Energy Conservation Standards Rulemaking for  
Residential Water Heaters, Direct Heating Equipment, and  
Pool Heaters**

**January 16, 2007**

**U.S. Department of Energy  
Washington, DC**



## Welcoming Remarks

- Purpose of Framework Workshop:
  - To discuss how DOE will develop and implement a standards rulemaking for residential water heaters, direct heating equipment, and pool heaters.
  - To solicit information from stakeholders to use as input for conducting DOE's analysis.



# Today's Agenda

**Welcome / Opening Remarks / Introductions / Agenda Review**

**Introduction and Overview of Analytical Methodology**

**Market and Technology Assessment, Screening Analysis, and Engineering Analysis**

**Energy Use, Markups for Equipment Price Determination, and Life-Cycle Cost and Payback Period Analysis**

**Shipments Analysis, National Impact Analysis, and LCC Subgroup Analysis**

**Manufacturer Impact Analysis**

**Utility Impact Analysis, Employment Impact Analysis, Environmental Assessment, and Regulatory Impact Analysis**

**Other Issues and Comments / Closing Remarks**



# Workshop Content

1	<b>Introduction</b>
2	<b>Analytical Methodology</b>
3	<b>Market and Technology Assessment</b>
4	<b>Screening Analysis</b>
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## **Rulemaking Background**

- Three products are bundled together into a single rulemaking
- Residential Water Heaters
  - DOE updated test procedures
    - May 1998 (Appendix E of Subpart B of 10 CFR Part 430)
  - 2001 Final Rule amended standards (66 FR 4474)
- Direct Heating Equipment and Pool Heaters
  - 1987 National Appliance Energy Conservation Act (NAECA) prescribed standards
  - DOE updated test procedures
    - May 1997 for direct heating equipment (Appendix O to Subpart B of 10 CFR Part 430)
    - May 1997 for pool heaters (Appendix P to Subpart B of 10 CFR Part 430)



## **Rulemaking Schedule**

- Workshop Comments Due – January 30, 2007
- Data Collection Complete – June 2007
- ANOPR – September 2008
- NOPR – July 2009
- Final Rule – March 2010



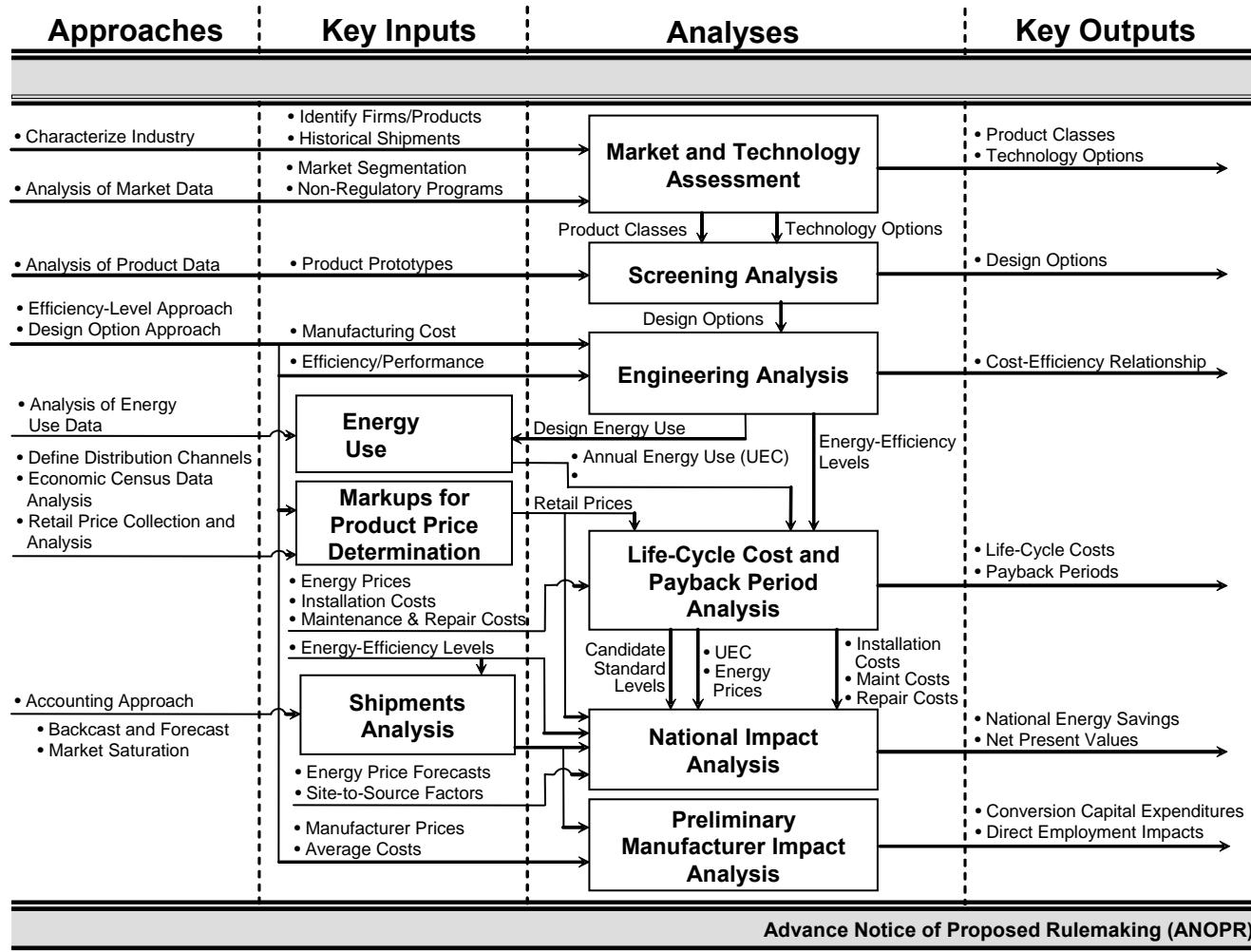
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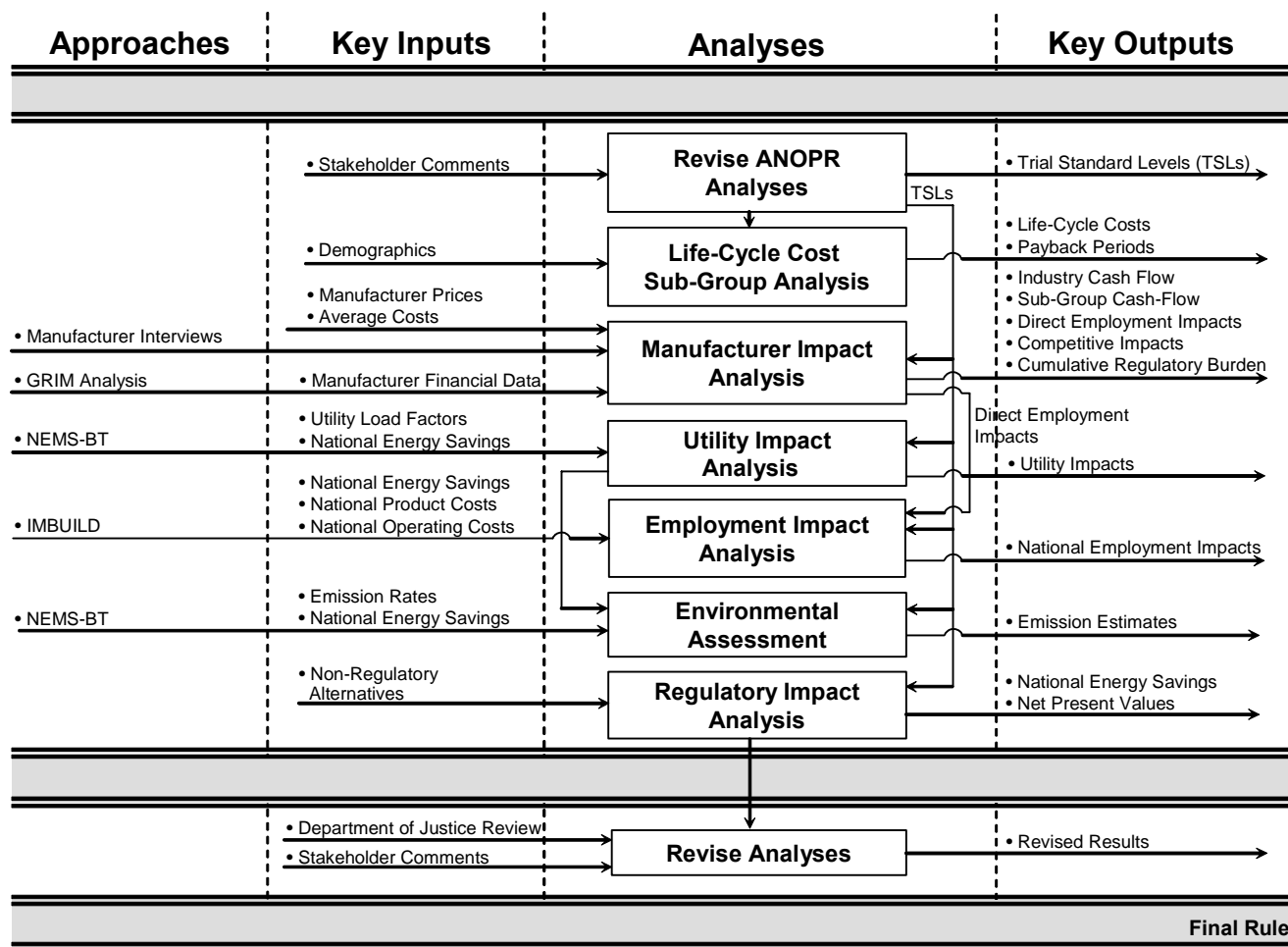


# Analyses for ANOPR





# Analyses for NOPR and Final Rule





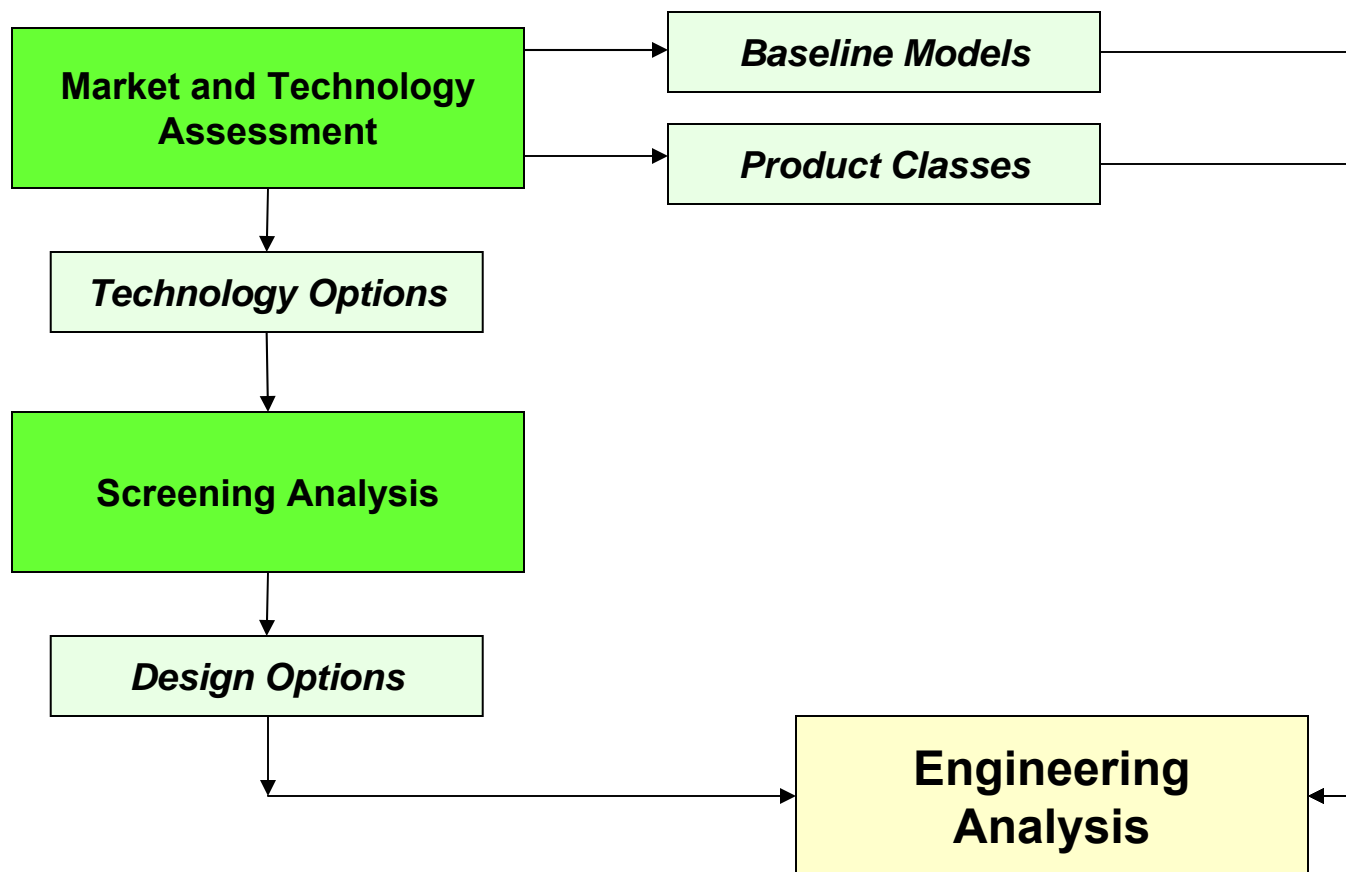
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# Relationship of Analyses





## **Market and Technology Assessment**

- DOE is currently gathering information including:
  - Technology options
  - Market structure data
  - Historical product shipments and prices
  - Current product features and efficiencies
  - Product-feature and efficiency trends
  - Distribution channel information
  - Non-regulatory programs
- ***DOE requests information that would contribute to the market and technology assessment.***



## Product Classes

- DOE separates each product type into product classes based on the criteria established by EPCA, which includes the type of energy used, capacity or other performance-related features.
- DOE establishes energy conservation standards for each product class.



## Baseline Models

- DOE defines baseline model characteristics, for each product class, to serve as the basis for the analysis:
  - Capacity, configuration, efficiency, and features;
  - Based on the product that minimally complies with the existing standard; and
  - Serves as the basis for cost and performance estimates that are intended to represent the “typical” product.



## Technology Options

- DOE identifies technologies that could be used to attain higher energy efficiency levels for each product class.
- Technology options are screened to determine if each should be considered a design option for consideration in the engineering and economic analyses.



## Screening Analysis

- In the screening analysis, DOE will eliminate from further consideration technology options that:
  - are not technologically feasible;
  - are not practicable to manufacture, install and service;
  - have significant adverse impact on the utility of the product to consumers; or
  - adversely affect health or safety.
- Technology options that exist as prototypes are considered technologically feasible.
- Technology options not screened out are referred to as design options and are subjected to the engineering and economic analyses.



# Product Discussions

<b>1</b>	<b>Residential Water Heaters</b>
<b>2</b>	<b>Direct Heating Equipment</b>
<b>3</b>	<b>Pool Heaters</b>



# Residential Water Heater Product Classes

<b>Storage:</b> Heat and store water at a thermostatically controlled temperature	<b>Gas-fired:</b> A nominal input of 75,000 Btu/hour or less and a rated storage volume from 20 to 100 gallons
	<b>Oil-fired:</b> A nominal input of 105,000 Btu/hour or less and a rated storage volume of 50 gallons or less
	<b>Electric:</b> A nominal input of 40,956 Btu/hour or less and a rated storage volume from 20 to 120 gallons
	<b>Heat Pump:</b> A maximum current rating of 24 amperes, voltage no greater than 250 volts, and a transfer of thermal energy from one temperature level to a higher temperature level for the purpose of heating water
	<b>Tabletop:</b> A box enclosure designed to slide into a kitchen countertop space and dimensions of 36 inches high, 25 inches deep and 24 inches wide
<b>Instantaneous:</b> Contain no more than one gallon of water per 4,000 BTU per hour of input	<b>Gas-fired:</b> A nominal input of over 50,000 Btu/hour up to 200,000 Btu/hour and a rated storage volume of 2 gallons or less
	<b>Electric:</b> An input of 12 kilowatts or less



## Residential Water Heater Product Class Exclusions

- DOE is proposing to exclude two product classes from the analyses:
  - Tabletop Water Heaters due to their strict size limitations; and
  - Electric Instantaneous Water Heaters due to their low energy savings potential and low shipments.



## Residential Water Heater Baseline Models

- **Energy Efficiency:** DOE is considering using the existing energy conservation standards to characterize the baseline model.
- **Capacity:** DOE proposes to maintain the representative rated storage volumes from the January 2001 final rule.
  - Gas-fired, storage = 40 gallons
  - Oil-fired, storage = 30 gallons
  - Electric, storage = 50 gallons
  - Gas-fired, instantaneous = 0 gallons
  - Because efficiency standards are a function of storage volume, DOE plans to extrapolate the cost data developed for the baseline rated storage volumes to other storage volumes based on the methods developed in the 2001 final rule.



# Technology Options: Residential Storage Water Heaters

## Considered in 2001 Rulemaking (66 FR 4480):

Heat Traps
Plastic Tank
Increased Jacket Insulation
Insulating the Tank Bottom
Improved Flue Baffle
Increased Heat Exchanger Surface Area
Flue Damper (Electromechanical)
Side Arm Heater
Electronic Ignition
Flue Damper (Buoyancy Operated)
Power Venting

## Screened out in 2001 Rulemaking:

Submerged Combustion
Directly Fired
Condensing
Condensing Pulse Combustion
Advanced Forms of Insulation
U-Tube Flue
Thermophotovoltaic and Thermo electronic Generators
Reduced Burner Size (Slow Recovery)
Heat Pump Water Heater
Two-Phase Thermosiphon (TPTS)
Air-Atomized Burner



## Technology Options: Residential Instantaneous Gas-fired Water Heaters

Increased Heat Exchanger Surface Area
Forced Draft (only if baseline is natural draft)
Condensing
Lower Power Electronics
Heat Exchanger Insulation



## Issues on Which DOE Seeks Comment

- ***Should DOE consider changes to the product classes for residential water heaters?***
- ***Are the energy conservation levels and rated storage volumes identified appropriate for characterizing the performance of baseline residential water heaters?***
- ***Are there other technology options that can improve residential water heater energy factor that DOE should consider?***
- ***Of the technology options identified, are there any that DOE should reject from consideration as design options because: they are not technologically feasible; are not practicable to manufacture, install and service; have significant adverse impact on the utility of the product to consumers; or adversely affect health or safety?***



# Direct Heating Equipment Product Classes

Direct Heating Equipment Product Class	Input Capacity (Btu/h)
Gas-fired, Wall, Fan-Type	Up to 42,000
	Over 42,000
Gas-fired, Wall, Gravity-Type	Up to 10,000
	Over 10,000 up to 12,000
	Over 12,000 up to 15,000
	Over 15,000 up to 19,000
	Over 19,000 up to 27,000
	Over 27,000 up to 46,000
Gas-fired, Floor	Over 46,000
	Up to 37,000
Gas-fired, Room	Over 37,000
	Up to 18,000
Gas-fired, Room	Over 18,000 up to 20,000
	Over 20,000 up to 27,000
	Over 27,000 up to 46,000
	Over 46,000



# Direct Heating Equipment Product Class Exclusions

- **DOE is proposing to exclude unvented home heating equipment for this rulemaking.\***
  - Tested using the unvented test procedure in Appendix G to Subpart B of 10 CFR Part 430, which does not specify a method for determining energy efficiency or consumption.

\* It is noted the CFR does not provide a definition for direct heating equipment in section 430.2, but this term appears in the CFR table 430.32(i) which provides the energy conservation standards for vented heaters.



## Direct Heating Equipment Vented Hearth Equipment

- **DOE believes that vented hearth products meet the definition of vented home heating equipment. Therefore, DOE is proposing to include vented hearth products in this rulemaking because:**
  - they are used to provide residential space heating and
  - they are tested using the vented home heating equipment test procedure.
- **DOE believes the energy conservation standards provided in section 430.32(i) of 10 CFR Part 430 and the subject of this rulemaking would be applicable to vented hearth products if:**
  - the appliance has a thermostat; or
  - its manufacturer markets the appliance as a space-heating device; or
  - the manufacturer literature includes a description of the appliance's energy efficiency, energy use, or heating function.



# Direct Heating Equipment Baseline Models

- DOE will analyze representative product classes and extrapolate results to other classes.
- The representative input rating was chosen for each direct heating product class for analysis purposes.

Direct Heating Equipment Product Type	Representative Product Class*	Representative Input Rating**	AFUE†
Wall Fan Furnaces	Over 42,000 Btu/h	55,000 Btu/h	74%
Wall Gravity Furnaces	Over 27,000 Btu/h up to 46,000 Btu/h	35,000 Btu/h	64%
Floor Furnaces	Over 37,000 Btu/h	62,000 Btu/h	57%
Room Heaters	Over 27,000 Btu/h up to 26,000 Btu/h	35,000 Btu/h	64%

\*The representative product class was chosen based on shipment data from the 1993 TSD with the exception of room heaters, which is based on the models in the GAMA Directory.

\*\* The representative input ratings for each product class was determined based on input ratings from the March 30, 2006 GAMA Directory for Heating and Water Heating Equipment.

† The annual fuel utilization efficiency (AFUE) were calculated based on the existing Federal energy conservation standards that became effective on January 1, 1990. (42 U.S.C. 6295(e)(3))



## Direct Water Heating Technology Options

- Increased Heat Exchanger Surface Area
- Input Derating and Controlling Secondary Air
- Electronic Ignition Device
- Vent Damper
- Power Burner or Induced Draft
- Two-stage or Modulating Operation
- Improved Blower Motor Efficiency
- Increased Insulation (Floor Furnaces Only)
- Condensation of Flue Gases
- Combustion Box Damper
- Air Circulation Fan (Room Heaters & Floor Furnaces Only)



## Issues on Which DOE Seeks Comment

- ***Should DOE consider different product classes for direct heating equipment?***
- ***Are the representative product classes, representative input ratings, and energy conservation levels identified appropriate for characterizing the performance of baseline direct heating equipment?***
- ***DOE requests comment on possible methods of extrapolating the standard levels and national impact analysis of the representative direct heating product classes to the other product classes (e.g., maintaining relative incremental energy use specified in Federal energy conservation standards across product classes).***
- ***Are there other technology options that can improve direct heating equipment AFUE that DOE should consider?***
- ***Of the technology options identified, are there any that DOE should reject from consideration as design options because: they are not technologically feasible; are not practicable to manufacture, install and service; have significant adverse impact on the utility of the product to consumers; or adversely affect health or safety?***



## Residential Pool Heater Product Classes

- Gas-fired pool heaters with an input capacity less than 1,000,000 Btu/h.



## Residential Pool Heater Baseline Model

- **Capacity:** DOE proposes using a representative input rating of 250,000 Btu/h.
- **Efficiency:** DOE proposes a baseline efficiency of 78 percent thermal efficiency.\*

\* Thermal efficiency is the Federal measure of energy efficiency defined in 10 CFR 430.23.



# Residential Pool Heater Technology Options

- Electronic Ignition
- Increased Heat Exchanger Surface Area
- Condensing
- Condensing Pulse Combustion
- Condensing with Power Burner
- Induced Draft\*

\* Not Considered in 1994 rulemaking.



## Issues on Which DOE Seeks Comment

- ***Should DOE consider different product classes for pool heaters?***
- ***Is the energy conservation level identified appropriate for characterizing the performance of baseline pool heaters?***
- ***Are there other technology options that can improve pool heater thermal efficiency that DOE should consider?***
- ***Of the technology options identified, are there any that DOE should reject from consideration as design options because: they are not technologically feasible; are not practicable to manufacture, install and service; have significant adverse impact on the utility of the product to consumers; or adversely affect health or safety?***



# Workshop Content

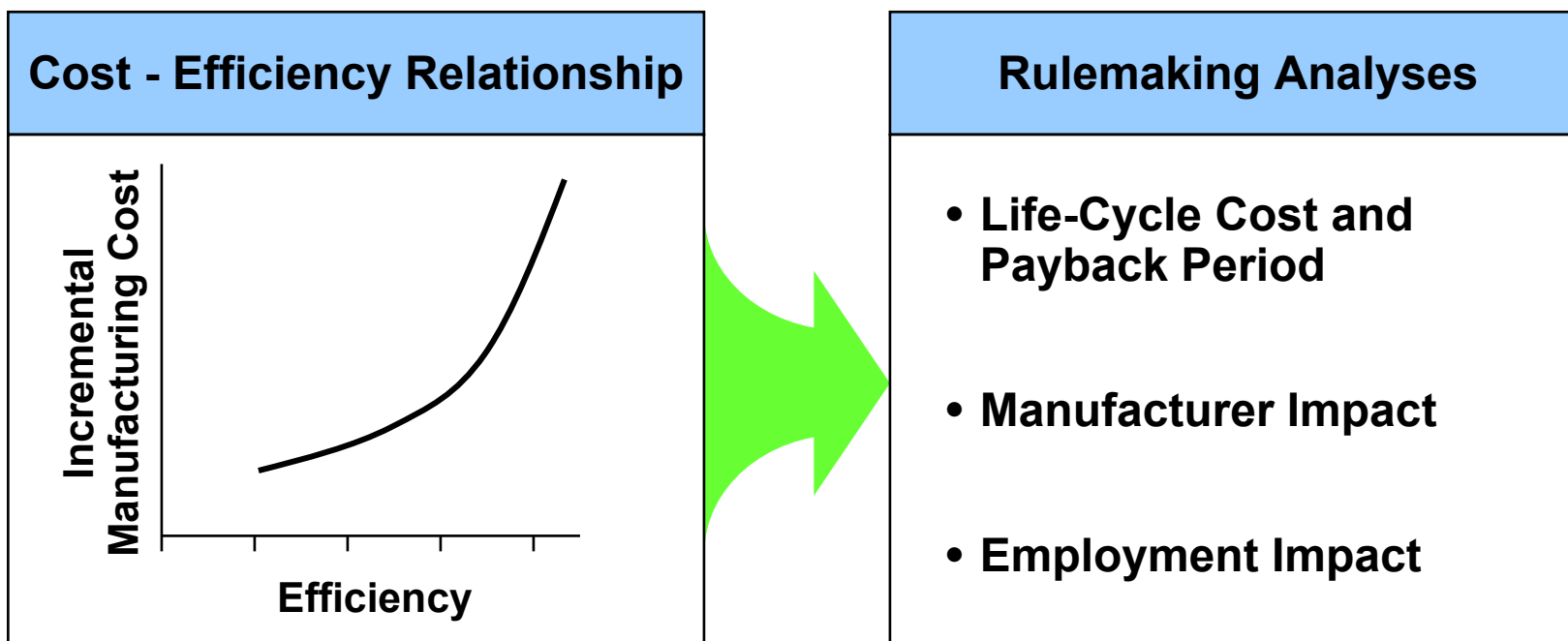
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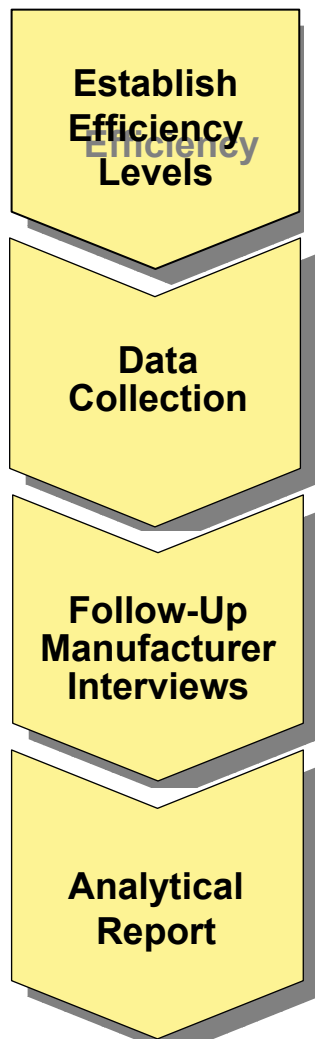
## Purpose

- The engineering analysis characterizes the relationship between manufacturer cost and energy efficiency.





## Methodology



- ↩ Determine efficiency levels for collecting incremental cost data.
- ↩ Collect incremental cost data, broken down by material, labor, and overhead costs.
- ↩ Conduct manufacturer interviews to obtain a deeper understanding of the various combinations of technologies used to increase product efficiency.
- ↩ Document the technologies associated with each efficiency level.



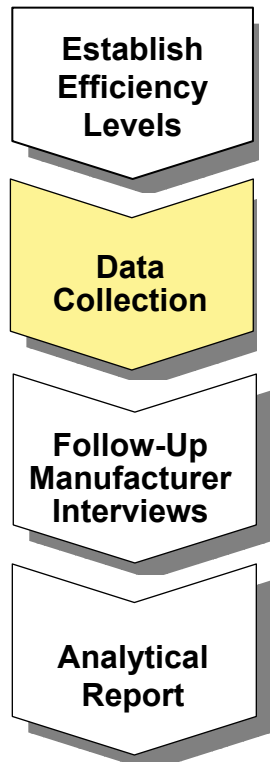
## Establish Efficiency Levels



- Identify the maximum technologically feasible efficiency levels.
- Determine the intermediate efficiency levels, based on available products on the market, existing voluntary initiatives, and consideration of the performance of design options, to be considered in the subsequent analyses.



# Data Collection



- ***DOE requests information to obtain incremental cost data for each product class within the three equipment types.***

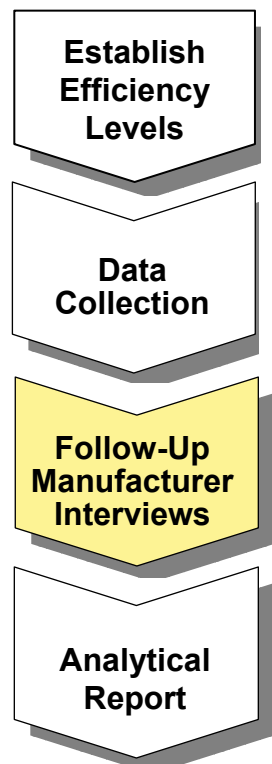
Product Class →	Gas-fired, Storage-type Water Heaters				
Efficiency Level	Baseline	1	2	3	Max Tech
EF	0.59	0.62	0.65	0.68	0.86
<b>Average Incremental Costs (\$ Per Unit)**</b>					
Material					
Labor					
Overhead*					
<b>Minimum Incremental Costs (\$ Per Unit)*</b>					
Material					
Labor					
Overhead*					
<b>Maximum Incremental Costs (\$ Per Unit)*</b>					
Material					
Labor					
Overhead*					
<b>Conversion Capital Expenditures (\$, Thousands)</b>					
Building CAPX					
Tooling/ Equipment CAPX					
<b>One-Time Product Conversion Expenses (\$, Thousands)</b>					
R&D					
Marketing					

\* Depreciation on the conversion capital expenditure should NOT be included in the incremental overhead.

\*\* Incremental costs per unit should be reported relative to the baseline unit's cost.



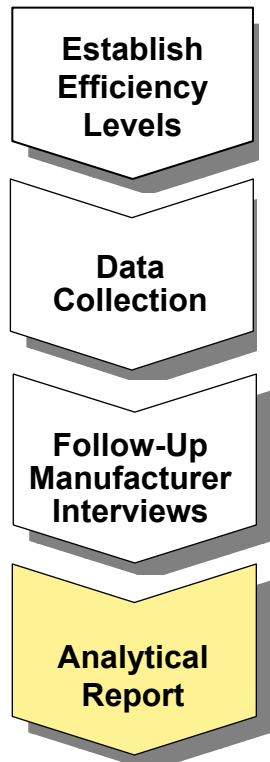
## Follow-Up Manufacturer Interviews



- Interviews will help understand and document the cost of improved efficiency. Example questions include:
  - What are the typical components of the baseline unit?
  - What design features are needed to raise the efficiency of the baseline unit to a specified higher efficiency? What are the costs of these components?
  - What are the fundamental differences between required design changes that make the cost increment much higher for some product class/sizes than others?
  - What capital conversion investments are necessary at each efficiency level? What is the nature of the capital investments?



# Analytical Report



- Document the technologies, and their associated costs, used to achieve each efficiency level.
- Compare new estimates of improved efficiency with market and technology assessment information.
- Document any discrepancies between market and technology assessment information, collected data, and information from manufacturer interviews.



## **Issues on Which DOE Seeks Comment**

- **DOE requests comment on the proposed approach for conducting the engineering analysis.**
- **DOE request comment on the proposed maximum technologically feasible energy efficiency levels identified.**



## Establish Efficiency Levels



⇐ Determine efficiency levels for collecting incremental cost data.



## Residential Water Heaters

- For the purposes of analyzing the cost-efficiency relationship for **gas-fired storage** residential water heaters, DOE is considering the following efficiency levels.

Efficiency Level	Energy Factor	Recovery Efficiency
Baseline – Minimum Federal Energy Conservation Standard	0.59	0.78
Efficiency Level 1	0.62	0.78
Efficiency Level 2	0.65	0.78
Efficiency Level 3	0.68	0.80
Max Available Efficiency Level	0.86	0.95

- DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



## Residential Water Heaters

- For the purposes of analyzing the cost-efficiency relationship for **electric, storage** residential water heaters, DOE is considering the following efficiency levels.

Efficiency Level	Energy Factor	Recovery Efficiency
Baseline – Minimum Federal Energy Conservation Standard	0.90	0.98
Efficiency Level 1	0.92	0.98
Efficiency Level 2	0.95	0.98
Max Available Efficiency Level	3.12	-

- DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



## Residential Water Heaters

- For the purposes of analyzing the cost-efficiency relationship for **oil-fired, storage** residential water heaters, DOE is considering the following efficiency levels.

Efficiency Level	Energy Factor	Recovery Efficiency
Baseline – Minimum Federal Energy Conservation Standard	0.53	0.75
Efficiency Level 1	0.58	0.76
Efficiency Level 2	0.62	0.78
Max Available Efficiency Level	0.68	0.82

- ***DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



## Residential Water Heaters

- For the purposes of analyzing the cost-efficiency relationship for **gas-fired, instantaneous** residential water heaters, DOE is considering the following efficiency levels.

Efficiency Level	Energy Factor	Recovery Efficiency
Baseline – Minimum Federal Energy Conservation Standard	0.62	0.78
Efficiency Level 1	0.75	0.80
Efficiency Level 2	0.82	0.85
Efficiency Level 3	0.85	0.85
Max Available Efficiency Level	0.92	0.93

- DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



## Residential Direct Heating Equipment

- For the purposes of analyzing the cost-efficiency relationship for **gas-fired, wall, fan** residential direct heating equipment, DOE is considering the following efficiency levels.

Efficiency Level	Above 42,000 Btu/h AFUE (%)
Baseline – Minimum Federal Energy Conservation Standard	74
Efficiency Level 1	75
Efficiency Level 2	80
Max Available Efficiency Level	91

- DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



## Residential Direct Heating Equipment

- For the purposes of analyzing the cost-efficiency relationship for **gas-fired, wall, gravity** residential direct heating equipment, DOE is considering the following efficiency levels.

Efficiency Level	27,000 to 46,000 Btu/h AFUE (%)
Baseline – Minimum Federal Energy Conservation Standard	64
Efficiency Level 1	66
Efficiency Level 2	68
Efficiency Level 3	71
Max Available Efficiency Level	85

- DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



## Residential Direct Heating Equipment

- For the purposes of analyzing the cost-efficiency relationship for **gas-fired, floor** residential direct heating equipment, DOE is considering the following efficiency levels.

Efficiency Level	Above 37,000 Btu/h AFUE (%)
Baseline – Minimum Federal Energy Conservation Standard	57
Efficiency Level 1	61
Efficiency Level 2	62
Efficiency Level 3	65
Max Available Efficiency Level	91

- DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



## Residential Direct Heating Equipment

- For the purposes of analyzing the cost-efficiency relationship for **gas-fired, room** residential direct heating equipment, DOE is considering the following efficiency levels.

Efficiency Level	27,000 to 46,000 Btu/h AFUE (%)
Baseline – Minimum Federal Energy Conservation Standard	64
Efficiency Level 1	67
Efficiency Level 2	68
Efficiency Level 3	71
Max Available Efficiency Level	91

- DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



## Residential Pool Heaters

- For the purposes of analyzing the cost-efficiency relationship for **gas-fired** residential pool heaters, DOE is considering the following efficiency levels.

Efficiency Level	Thermal Efficiency (%)
Baseline – Minimum Federal Energy Conservation Standard	78
Efficiency Level 1	80
Efficiency Level 2	82
Efficiency Level 3	84
Efficiency Level 4	86
Max Available Efficiency Level	95

- DOE requests comment on the efficiency levels for collecting data and the appropriate maximum technologically feasible efficiency levels.***



# Markups to Estimate Manufacturer Selling Price

**Manufacturer  
Production  
Cost**

+

**Manufacturer  
Markups**  
(Non-Production Costs)

=

**Manufacturer  
Selling Price**

- **Direct material**
- **Direct labor**
- **Factory overhead**
- **Depreciation**
- Sales, general & admin.
- Research & development
- Interest
- Profit
- Examples of publicly available information:
  - SEC 10-K reports
  - Company annual reports
  - Dun and Bradstreet reports
  - Value Line industry statistics
  - Standard and Poor's composite industry statistics
  - Ibbotson Associates reports



# Preliminary Cost Structures and Manufacturer Markups

Division Of Industry Costs	Residential Water Heaters	Direct Heating Equipment	Pool Heaters
Profit Before Financing*	6.0	9.2	7.2
Selling, General and Administrative Expenses (SG&A)	14.0	12.5	16.0
Research and Development (R&D)	2.1	2.0	2.5
Overhead	15.4	16.0	16.0
Labor	10.1	9.4	10.0
Material	52.4	50.9	48.3
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

\*Profit before financing equals to Sales minus the quantity SG&A plus Cost of Product.  
 2000, 2002, 2003 SEC 10-K reports and 2000, 2002, 2003 Statistics for Industry Groups and Industries reports were used for the Preliminary Cost Structures

Heating Product Type	Preliminary Manufacturer Markup
Residential Water Heater	1.28
Direct Heating Equipment	1.31
Pool Heaters	1.35



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## Annual Energy Use

- Storage Water Heaters: Methodology used in the 2001 water heating rulemaking.
- Gas-fired Instantaneous Water Heaters: Appendix E of Subpart B of 10 CFR Part 430.
- Direct Heating Equipment: Appendix O of Subpart B of 10 CFR Part 430.
- Pool Heaters: Appendix P of Subpart B of 10 CFR Part 430.
- DOE also will investigate variability.
  - Storage Water Heaters: Use RECS and apply Monte Carlo sampling to develop a sample of household water heater energy use patterns.
  - Gas-fired Instantaneous Water Heaters: High and low energy use estimates.
  - Direct Heating Equipment and Pool Heaters: Use RECS to define the high and low energy use estimates.



## Annual Energy Use

- ***DOE requests information use for each efficiency level of gas-fired, instantaneous water heaters:***
  - Pilot Input Rate
  - Electricity Use when the Burner is not Operating
- ***DOE requests information use for each efficiency level of direct heating equipment:***
  - Steady-State Efficiency
  - Pilot Input Rate
- ***DOE requests information use for each efficiency level of pool heaters:***
  - Pilot Input Rate
  - Electricity Use when the Burner is not Operating



## Issues on Which DOE Seeks Comment

- ***DOE requests comment on the approaches proposed for specifying the typical annual energy consumption. DOE is interested in sources of data that can assist in characterizing the annual energy consumption of water heaters, direct heating equipment, and pool heaters.***
- ***DOE requests comment on data sources that it can use to characterize the variability in annual energy consumption for each product.***



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## Markups for Equipment Price Determination

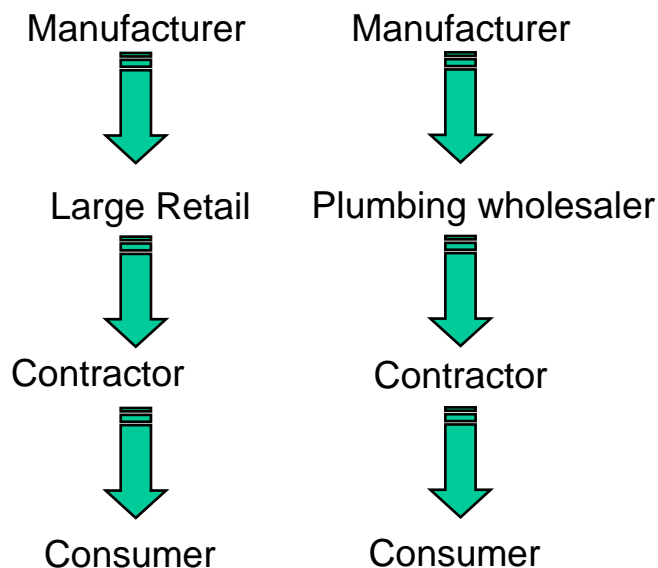
- DOE uses markups to convert manufacturer prices from the engineering analysis into consumer equipment prices.
- DOE needs consumer equipment prices for the life-cycle cost and payback period analysis.
- DOE must characterize distribution channels for each product.
- DOE develops markups for each party involved in product distribution.
- U.S. Census Bureau provides data for calculating markups.
- DOE may collect consumer equipment price data for validation purposes.
- DOE will investigate the variability of consumer equipment prices.



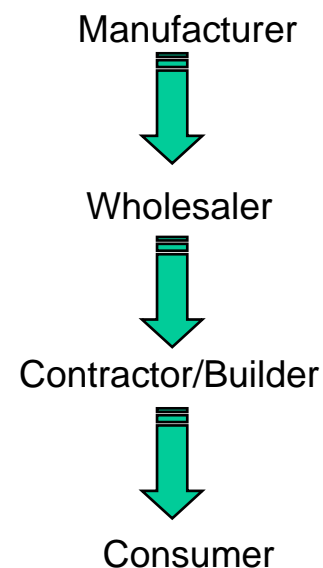
## Distribution Channels

- Water Heaters: Two major distribution paths are being considered, which include large retail outlets and plumbing wholesalers (both sell to contractors).
- Direct Heating Equipment and Pool Heaters: The distribution channels being considered involve wholesalers, contractors, and builders (for new construction only).

### Distribution Channels for Water Heaters



### Distribution Channel for Direct Heating Equipment & Pool Heaters





## Issues on Which DOE Seeks Comment

- ***DOE requests comment concerning its intended approach to develop estimates of consumer equipment prices.***
- ***DOE requests comment about the distribution channels for water heaters, direct heating equipment and pool heaters.***



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## Life-Cycle Cost and Payback Period Analysis

- DOE will estimate the effect of increased energy efficiency standards on lifetime operating expense savings compared to the increase in purchase price.
- Approach
  - Calculate average LCC savings and PBPs from average input values.
  - Analyze variability with sensitivities using high and low input values.
  - Consider the rebound effect. Rebound effect (or take back effect) refers to increased energy consumption that results from actions that increase efficiency and reduce consumer costs.

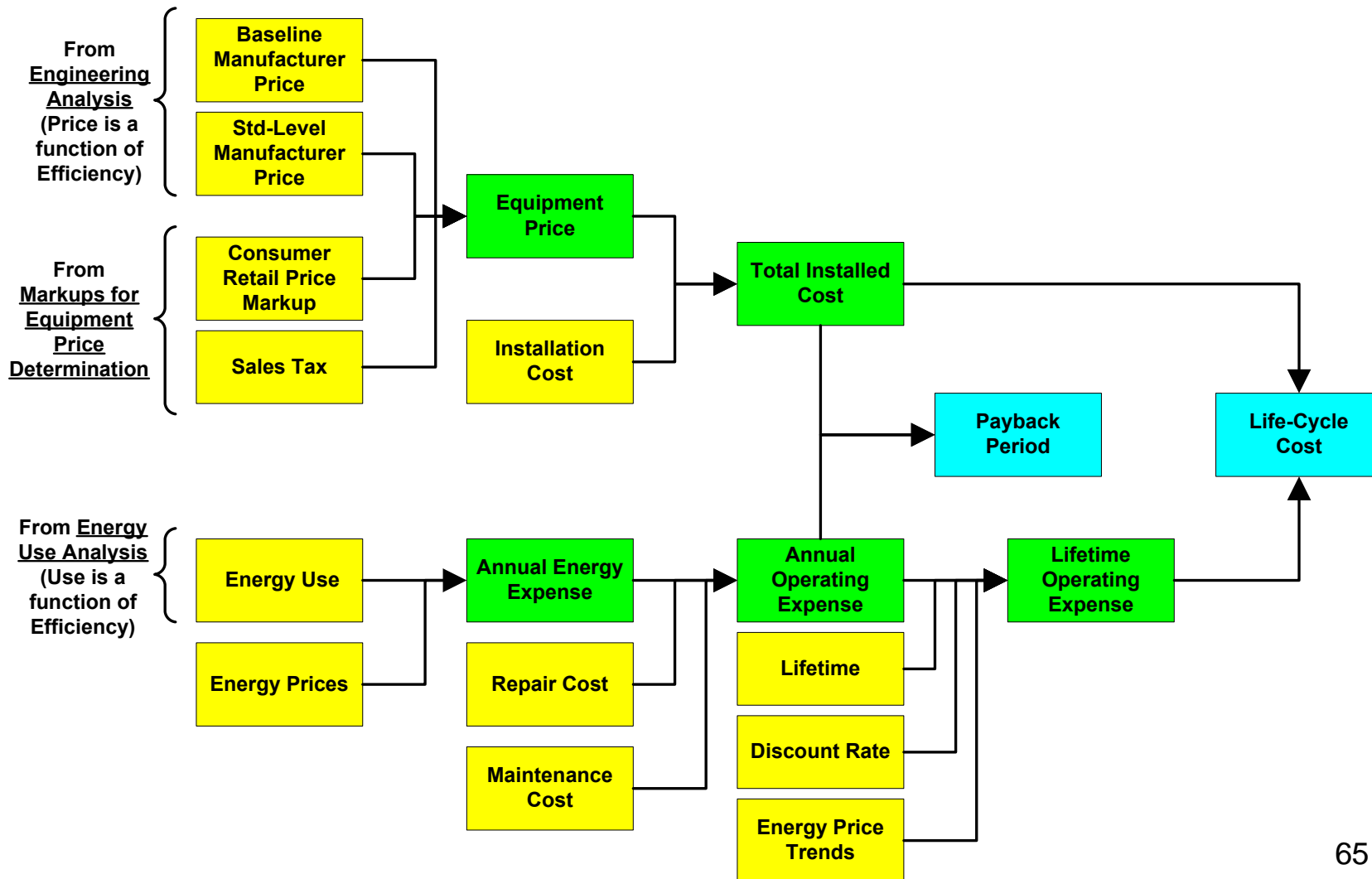


## Issues on Which DOE Seeks Comment

- *DOE requests comment on its proposed treatment of the rebound effect in the LCC analysis.*



# LCC and PBP Flowchart





## Energy Prices

- Determine energy prices from DOE-Energy Information Administration (EIA) data.
- DOE will analyze variability using high and low price estimates.
- DOE will base energy price forecasts on the most recent EIA Annual Energy Outlook (AEO) reference case.



## Discount Rates

- DOE uses discount rates (DR) to discount future operating costs savings.
- DR for residential products – DOE will use similar approach as for other residential product standards rulemakings.
  - The Federal Reserve Board’s Survey of Consumer Finances (SCF) will be used to establish consumer equity and debt holdings.
  - The interest rates associated with equity (e.g., stocks, bonds) and debt (mortgage, home equity line of credit, credit card) will be used to estimate a distribution of “finance costs”.



## Maintenance, Repair, Installation Costs

- DOE assumes that increases in maintenance and repair costs are negligible for more-efficient products, except:
  - Heat pump water heaters would incur higher maintenance and repair costs than the other more-efficient products.
- DOE assumes that increases in installation costs are negligible for more-efficient products, except:
  - Gas-fired water heaters and direct heating equipment could incur installation costs for bringing an electrical outlet to the unit if the more efficient unit requires electricity to operate.
  - Venting system costs associated with more efficient gas-fired equipment are likely to increase.
  - Heat pump water heaters would incur higher installation costs than the other more-efficient products.



## Product Lifetimes

- Past DOE analyses have used the following average lifetimes:
  - Gas-fired and Oil-fired Storage-Type Water Heaters: 9 years
  - Electric Storage-Type Water Heaters: 14 years
  - Gas-fired Instantaneous Water Heaters: 20 years
  - Conventional Direct Heating Equipment: 15 years
  - Hearth Product Direct Heating Equipment: 30 years
  - Gas-Fired Pool Heaters: 15 years



## **Issues on Which DOE Seeks Comment**

- ***DOE requests information on the proposed approaches for estimating current and forecasted energy prices.***
- ***DOE requests comment on the proposed approaches for estimating discount rates for residential consumers of heating products.***
- ***DOE requests comment on its assumption that changes in maintenance and repair will be negligible for more-efficient products.***
- ***DOE requests comment on its assumption that installation costs will be dependent on electrical and venting requirements.***
- ***DOE requests comment on appropriate product lifetimes for the products of interest to this rulemaking.***



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## Shipments Analysis

- Required to calculate national impacts from standards.
- Required to calculate future cashflows of manufacturers.



## Base Case Forecast

- The base case forecast:
  - Depicts the situation (i.e., shipments and energy use for the period of analysis) where new standards are not adopted.
  - Serves as a reference point from which to evaluate the impacts of standards.
  - Forecast accounts for products going to replace failed units, and those going to new construction.
- Data needed to develop base case forecast:
  - Historical shipments data dating back to 1990.
  - Historical shipment-weighted average efficiencies data dating back to 1990.
  - Market share efficiencies data from recent years (i.e., 2002-2005).



# Electric Storage Water Heaters

- *DOE requests historical shipments and shipment-weighted efficiency data.*

Year	Shipments, Domestic + Imports (Thousands of Units)	Shipment-Weighted Average Efficiency (EF)
		(EF)
1990		
1991		
↓	↓	↓
2005		

- *DOE requests market share efficiency data for 50-gallon Electric, Storage Water Heaters.*

Efficiency Bins (EF)	Market Share (percent)			
	2002	2003	2004	2005
<b>0.90:</b> Baseline = 0.90				
<b>0.91-0.93:</b> Efficiency Level 1 = 0.92				
<b>0.94-0.95:</b> Efficiency Level 2 = 0.95				
<b>&gt;2.5:</b> Max Available = 3.12				



# Gas-fired Storage Water Heaters

- *DOE requests historical shipments and shipment-weighted efficiency data.*

Year	Shipments, Domestic + Imports (Thousands of Units)	Shipment-Weighted Average Efficiency (EF)
		(EF)
1990		
1991		
↓	↓	↓
2005		

- *DOE requests market share efficiency data for 40-gallon Gas-fired, Storage Water Heaters.*

Efficiency Bins (EF)	Market Share (percent)			
	2002	2003	2004	2005
<b>0.59-0.60:</b> Baseline = 0.59				
<b>0.61-0.63:</b> Efficiency Level 1 = 0.62				
<b>0.64-0.66:</b> Efficiency Level 2 = 0.65				
<b>0.67-0.72:</b> Efficiency Level 3 = 0.68				
<b>&gt;0.83:</b> Max Available = 0.86				



# Oil-fired Storage Water Heaters

- *DOE requests historical shipments and shipment-weighted efficiency data.*

Year	Shipments, Domestic + Imports (Thousands of Units)	Shipment-Weighted Average Efficiency
		(EF)
1990		
1991		
↓	↓	↓
2005		

- *DOE requests market share efficiency data for 30-gallon Oil-fired, Storage Water Heaters.*

Efficiency Bins (EF)	Market Share (percent)			
	2002	2003	2004	2005
<b>0.53:</b> Baseline = 0.53				
<b>0.54-0.60:</b> Efficiency Level 1 = 0.58				
<b>0.61-0.67:</b> Efficiency Level 2 = 0.62				
<b>&gt;0.67:</b> Max Available = 0.68				



# Gas-Fired Instantaneous Water Heaters

- *DOE requests historical shipments and shipment-weighted efficiency data.*

Year	Shipments, Domestic + Imports (Thousands of Units)	Shipment-Weighted Average Efficiency
		(EF)
1990		
1991		
↓	↓	↓
2005		

- *DOE requests market share efficiency data for Gas-Fired, Instantaneous Water Heaters.*

Efficiency Bins (EF)	Market Share (percent)			
	2002	2003	2004	2005
<b>0.62-0.63:</b> Baseline = 0.62				
<b>0.70-0.77:</b> Efficiency Level 1 = .75				
<b>0.82:</b> Efficiency Level 2 = .82				
<b>0.85:</b> Efficiency Level 3 = .85				
<b>&gt;0.86:</b> Max Available = 0.92				



# Fan Wall Furnaces

- DOE requests historical shipments and shipment-weighted efficiency data.**

Year	Shipments, Domestic + Imports (Thousands of Units)		Shipment-Weighted Average Efficiency (AFUE)	
	Up to 42 kBtu/h	Over 42 kBtu/h	Up to 42 kBtu/h	Over 42 kBtu/h
1990				
1991				
↓	↓	↓	↓	↓
2004				

- DOE requests market share efficiency data for only fan wall furnaces over 42 kBtu/h.**

Efficiency Bins (AFUE)	Market Share (percent)			
	2002	2003	2004	2005
<b>Over 42 kBtu/h</b>				
74%: Baseline = 74%				
75%: Efficiency Level 1 = 75%				
76-82%: Efficiency Level 2 = 80%				
>82%: Max Available = 91%				



# Gravity Wall Furnaces

- DOE requests historical shipments and shipment-weighted efficiency data.*

Year	Shipments, Domestic+Imports (Thousands of Units)							Shipment-Weighted Average Efficiency (AFUE)						
	≤10 kBtu/h	10-12 kBtu/h	12-15 kBtu/h	15-19 kBtu/h	19-27 kBtu/h	27-46 kBtu/h	≥46 kBtu/h	≤10 kBtu/h	10-12 kBtu/h	12-15 kBtu/h	15-19 kBtu/h	19-27 kBtu/h	27-46 kBtu/h	≥46 kBtu/h
1990														
1991														
	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2004														

- DOE requests market share efficiency data for only gravity wall furnaces over 27 and up to 46 kBtu/h.*

Efficiency Bins (AFUE)	Market Share (percent)			
	2002	2003	2004	2005
<b>Over 27 up to 46 kBtu/h</b>				
<b>64%:</b> Baseline = 64%				
<b>65-66%:</b> Efficiency Level 1 = 66%				
<b>67-68%:</b> Efficiency Level 2 = 68%				
<b>69-80%:</b> Efficiency Level 3 = 71%				
<b>&gt;80%:</b> Max Available = 85%				



# Floor Furnaces

- *DOE requests historical shipments and shipment-weighted efficiency data.*

Year	Shipments, Domestic + Imports (Thousands of Units)		Shipment-Weighted Average Efficiency (AFUE)	
	Up to 37 kBtu/h	Over 37 kBtu/h	Up to 37 kBtu/h	Over 37 kBtu/h
1990				
1991				
↓	↓	↓	↓	↓
2004				

- *DOE requests market share efficiency data for only floor furnaces over 37 kBtu/h.*

Efficiency Bins (AFUE)	Market Share (percent)			
	2002	2003	2004	2005
<b>Over 37 kBtu/h</b>				
57-58%: Baseline = 57%				
59-61%: Efficiency Level 1 = 61%				
62-63%: Efficiency Level 2 = 62%				
64-65%: Efficiency Level 3 = 65%				
>65%: Max Available = 91%				



# Room Heaters

- **DOE requests historical shipments and shipment-weighted efficiency data.**

Year	Shipments, Domestic+Imports (Thousands of Units)					Shipment-Weighted Average Efficiency (AFUE)				
	≤18 kBtu/h	18-20 kBtu/h	20-27 kBtu/h	27-46 kBtu/h	≥46 kBtu/h	≤18 kBtu/h	18-20 kBtu/h	20-27 kBtu/h	27-46 kBtu/h	≥46 kBtu/h
1990										
1991										
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
2004										

- **DOE requests market share efficiency data for only room heaters over 27 and up to 46 kBtu/h.**

Efficiency Bins (AFUE)	Market Share (percent)			
Over 27 up to 46 kBtu/h	2002	2003	2004	2005
64-65%: Baseline = 64%				
66-67%: Efficiency Level 1 = 67%				
68-70%: Efficiency Level 2 = 68%				
71-75%: Efficiency Level 3 = 71%				
>75%: Max Available = 91%				



# Pool Heaters

- DOE requests historical shipments and shipment-weighted efficiency data.**

Year	Shipments, Domestic + Imports	Shipment-Weighted Average Efficiency
	(Thousands of Units)	(Thermal Efficiency %)
1990		
1991		
↓	↓	↓
2004		

- DOE requests market share efficiency data for 250,000 Btu/hour Gas-fired Pool Heaters**

Efficiency Bins (Thermal Efficiency)	Market Share (percent)			
	2002	2003	2004	2005
<b>78%:</b> Baseline = 78%				
<b>79-80%:</b> Efficiency Level 1 = 80%				
<b>81-82%:</b> Efficiency Level 2 = 82%				
<b>83-84%:</b> Efficiency Level 3 = 84%				
<b>85-87%:</b> Efficiency Level 4 = 86%				
<b>&gt;90%:</b> Max Available = 95%				



## **Approach for Forecasting Shipments – Accounting Methodology**

- This approach accounts for products going to replace failed units and those going to new construction.
- EIA's Annual Energy Outlook provides forecasts of new construction.
- Product lifetimes are used to estimate replacements.
- DOE needs historical saturation rates to properly account for existing stock of products.
  - Data provided by industry and government publications for residential products.



## **Standards Impacts on Product Shipments**

- DOE develops Standards Case Forecasts from the same data it used to develop the Base Case Forecast.
- Standards Case Forecasts also use purchase price increases and operating cost savings to estimate shipments impacts.
- It is difficult to obtain data showing sensitivity of shipments to purchase price and operating costs.
  - DOE may forecast Standards Case shipments forecasts with scenarios (i.e., specific percentage drops in annual shipments for particular efficiency levels).
- DOE will consider impacts from market-pull programs.



## Issues on Which DOE Seeks Comment

- ***DOE requests comment in order to obtain historical shipments data, shipment-weighted average efficiency data, and market-share efficiency data.***
- ***DOE requests data on representative saturation rates for each of the three products under consideration for this rulemaking to determine the shipments forecast.***
- ***As part of its preliminary manufacturer impact analysis, DOE requests comment from manufacturers on the potential impact of new energy conservation standards on product shipments. DOE requests comment on any market-pull programs that currently exist to promote the adoption of more-efficient products.***



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## **National Impact Analysis**

- Determines Standards Case national energy savings (NES) and national consumer economic impacts relative to Base Case.
- Approach – Take individual consumer impacts due to standards and aggregate them to the national level.
- Analysis relies on inputs from prior analyses:
  - shipments; consumer prices; energy use; energy prices; repair & maintenance costs; product lifetimes.
- DOE calculates consumer economic impacts as net present value (NPV).
  - Difference between national operating cost savings and increased equipment expenditures.



## Issues on Which DOE Seeks Comment

- ***DOE requests information on its plan to develop NES spreadsheet models for estimating national impacts of amended energy conservation standards.***



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## **Life-Cycle Cost Subgroup Analysis**

- Determine LCC impacts from standards on any consumer subgroups that may be disproportionately impacted by new standards.
- Possible subgroups DOE may consider include low-income households and senior citizens.
- DOE will evaluate variations in regional energy prices, variation in energy use, and variations in installation costs that might affect the impacts of a standards on the consumer subgroups.
- DOE will not apply the rebound effect in the LCC subgroup analysis.



## Issues on Which DOE Seeks Comment

- ***DOE requests comment as to what consumer subgroups are appropriate for residential water heater, direct heating equipment, and pool heater products.***



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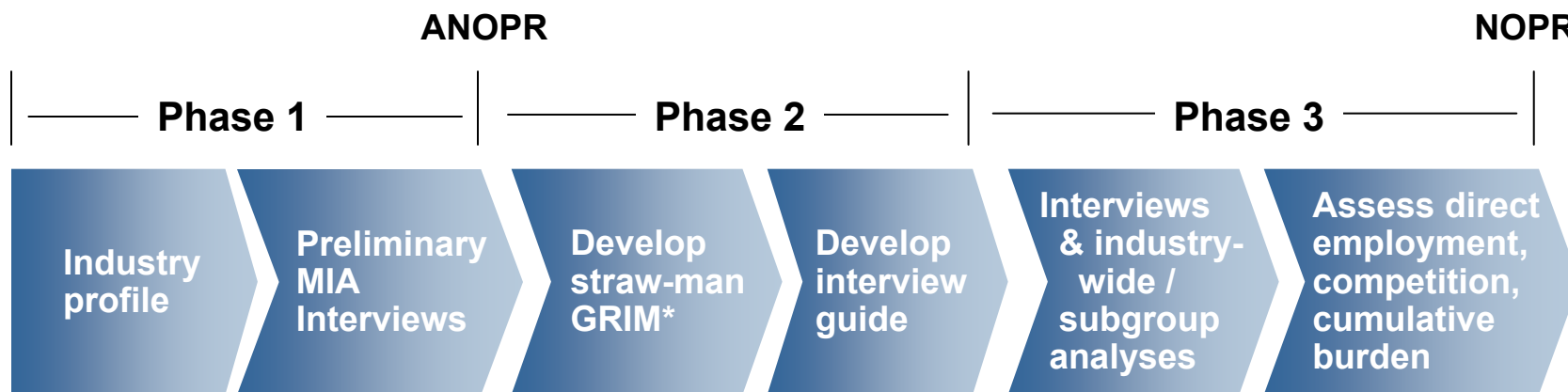
# Manufacturer Impact Analysis

- Purpose
  - To assess the impacts of standards on manufacturers.
  - To identify and estimate impacts on manufacturer subgroups that may be more severely impacted than the industry as a whole.
  - To examine the impact of cumulative regulatory burden on the industry.
- 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 subgroup analyses, and address qualitative issues.
- Output
  - Industry Net Present Value impacts
  - Subgroup Net Present Value impacts
  - Other impacts



# Methodology

- The MIA consists of three main phases



\*Government Regulatory Impact Model (GRIM)



## Phase 1

- Phase 1 consists of the industry profile and preliminary manufacturer impact analysis interviews.

### Industry Profile

- » Evaluation of current and past industry structure and market characteristics
- » Produce an industry profile report with aggregated findings and characteristics
- » Identify critical issues that require special consideration in the MIA, for example:
  - » Types or groups of manufacturers
  - » Access to technology
  - » Potential regulatory scenarios

### Preliminary MIA Interviews

- » Occurs during the engineering analysis
- » Topics include:
  - » Shipment projections
  - » Conversion costs
  - » Product mix and profitability
  - » Market shares and industry consolidation
  - » Cumulative regulatory burden



## Phase 2

- Phase 2 consists of the straw-man GRIM and interview guide preparation.

### Straw-man GRIM

- »@ Starting point for discussion of impacts
- »@ Inputs include:
  - »@ Manufacturer prices
  - »@ Shipment forecasts
  - »@ Manufacturing cost estimates
  - »@ Financial information

### Interview Guide Preparation

- »@ Interview topics include:
  - »@ Engineering analysis
  - »@ Shipments model
  - »@ Cost structure and financial parameters
  - »@ Conversion costs
  - »@ Cumulative burden
  - »@ Direct employment impacts
  - »@ Import / Export issues
  - »@ Consolidation / competitive impacts
  - »@ Replacement parts or refurbishments
  - »@ Impact of the standard's effective date



## Phase 3

- Phase 3 consists of the manufacturer interviews, subgroup analyses, and assessment of industry impacts.

### Manufacturer Interviews

- » Confidential discussion of potential impacts resulting from standards, including:
  - » Obsolescence of existing manufacturing assets
  - » Tooling
  - » Investment

### Assessment of Impacts

- » Assess competitive impacts on smaller, significant manufacturers
- » Assess cumulative regulatory burden on manufacturers from amended DOE standards and other regulatory actions
- » Assess impacts on industry employment levels
- » Assess impacts on manufacturer subgroups



## Issues on Which DOE Seeks Comment

- ***What procedures should DOE follow when scheduling interviews and requesting information?***
- ***What are appropriate manufacturer subgroups for each of the four products?***
- ***What regulations or pending regulations should DOE consider in the manufacturer impact analysis?***



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## **Utility Impact Analysis**

- This analysis will estimate effects on electricity and gas utility industries of reduced energy sales due to new energy efficiency standards.
- DOE will use a variant of EIA's National Energy Modeling System (NEMS) called NEMS-BT to estimate impacts.



## Issues on Which DOE Seeks Comment

- ***DOE requests comment on the proposed use of NEMS-BT to conduct the utility impact analysis.***



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## **Employment Impact Analysis**

- Estimate indirect employment impacts that occur from standards.
  - DOE estimates direct employment impacts in the manufacturer impact analysis.
- DOE will use Pacific Northwest National Laboratory's 'Impact of Sector Energy Technologies' (ImSET) model.
  - Estimates the employment and income effects of energy-saving technologies in buildings, industry, and transportation.



## Issues on Which DOE Seeks Comment

- ***DOE requests comment on the proposed approach to assessing employment impacts?***



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## **Environmental Assessment**

- This assessment estimates the impact of standards on three types of energy-related emissions: carbon dioxide (CO<sub>2</sub>), oxides of nitrogen (NO<sub>x</sub>), and sulfur dioxide (SO<sub>2</sub>).
- DOE will use NEMS-BT to estimate emissions impacts from power plants.
- DOE will carry out a separate analysis to estimate in-building emissions from gas-fired appliances.



## Issues on Which DOE Seeks Comment

- ***Are there any other environmental factors DOE should consider in this rulemaking?***



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## Regulatory Impact Analysis

- This analysis estimates the energy savings and net present value of non-regulatory alternatives.
- ***Are there any programs that should be examined as optional, non-regulatory alternatives? Are there other approaches to the regulatory impact analysis that DOE should consider?***



## How to Submit Written Comments

- **In all correspondence, please refer to the Heating Products Rulemaking**
  - Docket Number **EE-2006-STD-0129**, or
  - Regulatory Identification Number (RIN) 1904-AA90
- **Email:**
- **Postal Mail:** Ms. Brenda Edwards-Jones  
U.S. Department of Energy  
Building Technologies Program, Mail Stop EE-2J  
Residential Water Heaters, Direct Heating Equipment, and Pool Heaters  
RIN 1904-AA92  
1000 Independence Avenue, SW  
Washington, DC 20585-0121
- **Courier:** Same as above, except “Room 1J-018”  
in place of “Mail Stop EE-2J”  
202-586-2945
- **Comment period closes January 30, 2007**