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

Supplemental Notice of Proposed Rulemakings for Residential Furnaces

Energy Conservation Standards

October 17, 2016

Department of Energy
Building Technologies Program
EERE–2014–BT–STD–0031
ResFurnaces2014STD0031@ee.doe.gov

Welcome

- Introductions (around the room)
- Role of the facilitator
- Ground rules
  - Speak one person at a time.
  - Say your name for the record – there will be a complete transcript of this meeting.
  - Be concise – share the “air-time.”
  - Keep the focus here – cell phones on silent; limit sidebar conversations.
  - Webinar participants: turn phone on mute; “raise your hand” to be recognized to speak.
- Housekeeping items
- Agenda review
- Opening remarks

Introduction

Listing Via the Webcast

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

Purpose of the Public Meeting

- Present DOE's proposed energy conservation standards for non-weatherized gas furnaces (NWGFs) and mobile home gas furnaces (MHGFs).
- Invite comments, data, and information concerning on the proposed energy conservation standard SNOPR and any additional issues raised by interested parties. Comments are welcome on any part of DOE's analysis.

Opening Remarks

Meeting participants are invited to provide opening remarks or statements at this time.

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Public Meeting Agenda

1	Overview
2	Life Cycle Cost Analysis; Subgroup Analysis
3	Shipments Model; NIA; RIA
4	Manufacturer Impact Analysis
5	Environmental; Indirect Employment; General Analysis
6	Closing Remarks

Overview: Proposal

AFUE Standards

Product Class	Current AFUE Standard	Proposed AFUE Standard
Non-weatherized gas furnaces with a certified input capacity of greater than 55 kBtu/hr	80	92.0
Non-weatherized gas furnaces with a certified input capacity of less than or equal to 55 kBtu/hr		80.0
Mobile home gas furnaces	80	92.0

Standby and Off Mode Standards

Product Class	Maximum standby mode electrical power consumption, ($P_{W,SB}$), watts	Maximum off mode electrical power consumption, ($P_{W,OFF}$), watts
Non-weatherized gas furnaces	8.5	8.5
Mobile home gas furnaces	8.5	8.5

Note: There are no current Standby or Off Mode standards for these product classes

Overview: Summary of NWGF Proposal Results

AFUE Standards Comparison NOPR vs. SNOPR

Product Class	NOPR (TSL 3)	SNOPR (TSL 5)	SNOPR (TSL 6)
Standard	92% AFUE, National	92% AFUE, National	92% AFUE, > 55 kBtu/h
National Energy Savings, Full-Fuel-Cycle (Quads)	2.64	2.68	2.76
Net Present Value (billion $), 3% discount rate*	15.09	22.84	20.70
Net Present Value (billion $), 7% discount rate*	2.77	5.30	5.31
Average LCC Savings ($)*	305**	617	692
Fraction of Shipments Impacted	100%	100%	85%
Fraction of Product Switching	9.3%	11.5%	6.9%
% of Consumers Negatively Impacted	19.7%	17.1%	11.1%
% of Consumers Negatively Impacted, South	19.0%	26.1%	14.9%
% of Consumers Negatively Impacted, Low Income	23.4%	20.4%	10.9%
CO_2 Avoided (million metric tons)	129.7	120.7	137.1
Impacts on Manufacturers (% Change in INPV)	-7.9% to 0.6%	-10.8% to 1.2%	-8.0% to 3.5%
Product Implications	No 80% AFUE furnaces on market	No 80% AFUE furnaces on market	80% AFUE small furnaces on market

* NOPR results are in 2013$, while SNOPR results are in 2015$

** NOPR LCC savings include non impacted consumers.

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Key LCC Analysis Differences: NOPR, NODA, SNOPR

Inputs	NOPR	NODA	SNOPR
Start Year	2021	2021	2022
Dollar Year	2013$	2014$	2015$
LCC Savings Calculation	Included consumers with no impact	Excluded consumers with no impact	Excluded consumers with no impact
Markups Data	2007 Economic Census	2012 Economic Census	2012 Economic Census
Sales Tax Data	2014 Sales Tax	2015 Sales Tax	2016 Sales Tax
Equipment Price Trend	1990-2013 Furnace PPI	1990-2013 Furnace PPI	1990-2015 Furnace PPI
RS Means	RS Means 2013	RS Means 2013	RS Means 2015
NOAA Weather Data	2004-2013	2004-2013	2006-2015
AEO Year Projections	AEO 2013	AEO 2015	AEO 2015
Latest Energy Price Year	2012 EIA Data	2013 EIA Data	2014 EIA Data
Discount Rates	1995-2010 SCF Data	1995-2010 SCF Data	1995-2013 SCF Data
Shipments by Efficiency	AHRI Shipments up to 2009	AHRI Shipments up to 2014	AHRI Shipments up to 2014
Product Prices for Alternative Space Heating Products	CAC/HP: 2011 CAC/HP DFR EF: RS Means 2013 WH: 2010 WH FR	CAC/HP: 2011 CAC/HP DFR EF: RS Means 2013 WH: 2010 WH FR	CAC/HP: 2016 CAC/HP FR EF: Engineering Analysis WH: 2010 WH FR
Capacity Cutoff	Not Included	Included	Included

LCC and PBP Analysis: *Markups*

Topic: Incremental Markup

- Comment: Stakeholders requested DOE use fixed markups instead of incremental markups.

- Response: DOE's use of incremental markups is based on the premise that:
  1. Some costs will scale with the increase in product cost while other costs remain constant after standards.
  2. Firms face a relatively competitive market.
  3. Firms are not likely to sustain higher profits in the medium/long run as a windfall resulting from standards, as would be implied by a fixed markup scenario when product costs increase and demand is relatively inelastic.

LCC and PBP Analysis: *Consumer Price Results*

NWGF Results Comparison

Efficiency Level	AFUE	NOPR (2013$)		NODA (2014$)		SNOPR (2015$)	
		Average	Diff	Average	Diff	Average	Diff
0	80%	$1,163	--	$1,132	--	$1,053	--
1	90%	$1,327	$163	$1,320	$178	$1,260	$208
2	92%	$1,343	$179	$1,326	$194	$1,303	$251
3	95%	$1,477	$313	$1,441	$309	$1,430	$378
4	98%	$1,669	$506	$1,638	$506	$1,574	$522

MHGF Results Comparison

Efficiency Level	AFUE	NOPR (2013$)		NODA (2014$)		SNOPR (2015$)	
		Average	Diff	Average	Diff	Average	Diff
0	80%	$816	--	$805	--	$740	--
1	92%	$975	$158	$990	$185	$891	$150
2	95%	$1,118	$302	$1,128	$323	$1,024	$283
3	96/97%*	$1,233	$417	$1,233	$428	$1,070	$330

* In the NOPR and NODA, EL 3 was at 97% AFUE. In the SNOPR, EL 3 was 96% AFUE.

Note: Considered alternative product price trends in sensitivity analysis (see appendix 8C).

LCC and PBP Analysis: *Installation Costs*

Topic: Installation Costs for Condensing NWGFs

- Comments: Stakeholders stated that DOE underestimated the installation cost of condensing NWGFs compared to the AHRI/ACCA/PHCC contractor survey results.
- Response: DOE's ***incremental*** installation cost for condensing NWGFs is similar to data provided by stakeholders.
  - Installation cost varies widely for different contractors and regions.
  - DOE did not include some installation costs that would be the same regardless of furnace efficiency, including asbestos abatement, emergency installation during the winter, ductwork costs, and premium comfort features.

Topic: New Venting Technologies

- Comments: Stakeholders expect that retrofit installation costs will decrease as the industry provides innovative solutions to address the orphaned water heater issue for some retrofits.
- Response: Although DOE agrees that these installation costs may decrease over time, DOE does not have enough data at this time to project such cost trends.

LCC and PBP Analysis: *Installation Costs*

Topic: High-Cost Installations

- Comments: Stakeholders stated that there are situations where it is impractical or impossible to install a condensing furnace due to physical constraints or extreme costs, such as in row houses.
- Response:
  - DOE investigated the implementation of the condensing furnace standards in Canada and found that the potential problems with retrofitting condensing furnaces were either overstated or the installing contractors found ways to resolve the issues.
  - Regarding row house installations, DOE's current analysis includes costs comparable to the methods that were identified in the Philadelphia weatherization program to address venting difficulties in condensing NWGF installations. (ACEEE, No. 113 at p. 7)
  - DOE's proposed separate standards for small and large NWGFs would significantly reduce the number of installations described as difficult.

LCC and PBP Analysis: *Installation Costs*

Topic: Multi-Family Installations

- Comments: Stakeholders stated that DOE did not fully account for multi-family venting costs for adding a condensing furnace. Specifically, a common vent with multiple gas appliances, will require resizing each time a non-condensing furnace is replaced with a condensing furnace.
- Response: DOE welcomes additional data to estimate the costs associated with modifying the existing vent systems in multi-family buildings. Under the proposed standards, more than half of multi-family NWGF installations would not be impacted because they are sized below the cutoff.

Topic: Mobile Home Gas Furnace Installation

- Comments: Stakeholders stated that cabinet space constraints, common venting issues, and other venting systems issues could make the installation of condensing MHGFs difficult and expensive.
- Response: DOE notes that MHGF models at the proposed standard are similar in size to existing non-condensing MHGFs. Further, HUD standards prohibit common venting installations for all MHGFs, resulting in the similar installation costs regardless of efficiency.

LCC and PBP Analysis: *Installation Cost Results*

Installation Cost Results Comparison (all installations)

Efficiency Level	AFUE	NOPR (2013$)		NODA (2014$)		SNOPR (2015$)	
		Average	Diff	Average	Diff	Average	Diff
NWGF							
0	80%	$1,069	--	$1,100	--	$1,122	--
1-4	90-98%	$1,370	$316	$1,402	$302	$1,375	$253
MHGF							
0	80%	$735	--	$746	--	$774	--
1-3	92-96%	$746	$11	$757	$11	$776	$2

Installation Cost Results Comparison (replacements only)

Efficiency Level	AFUE	NOPR (2013$)		NODA (2014$)		SNOPR (2015$)	
		Average	Diff	Average	Diff	Average	Diff
NWGF							
0	80%	$766	--	$776	--	$811	--
1-4	90-98%	$1,342	$575	$1,340	$564	$1,335	$524
MHGF							
0	80%	$597	--	$606	--	$631	--
1-3	92-96%	$816	$219	$828	$222	$851	$219

Note: DOE considered alternative venting technologies in sensitivity analysis (see appendix 8L).

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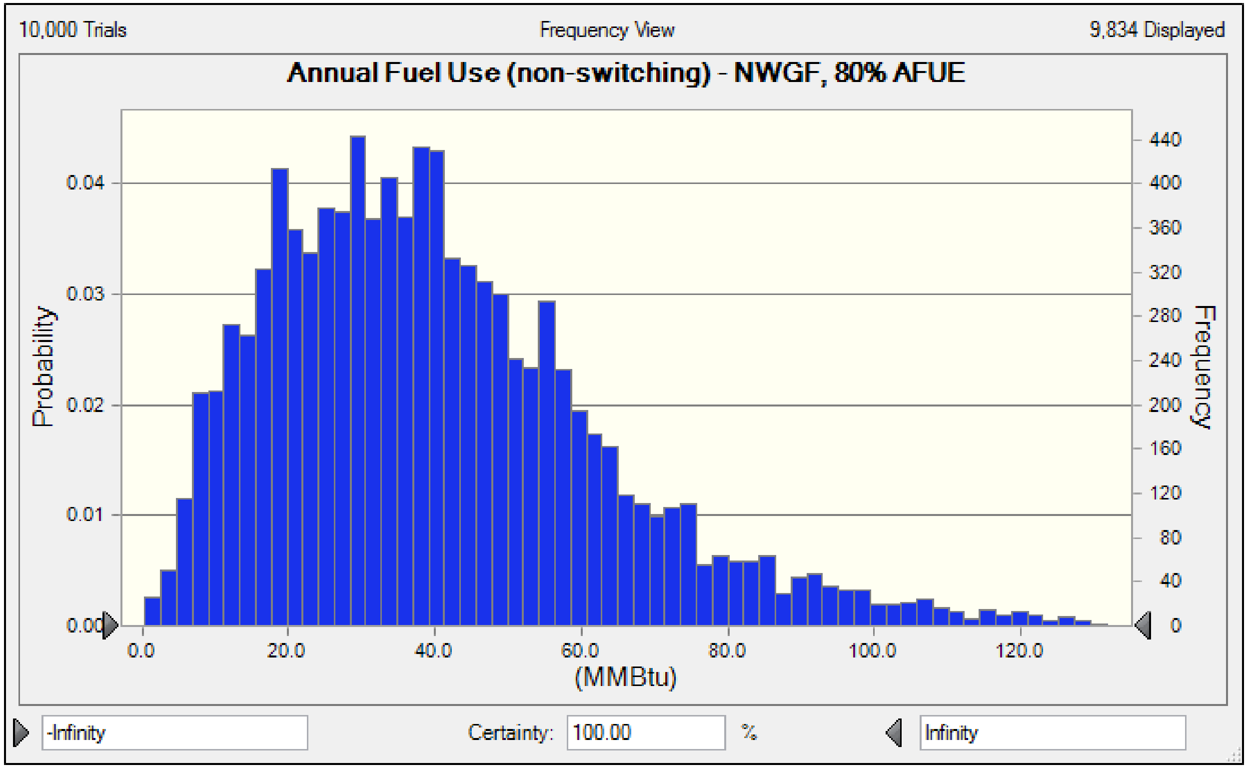
LCC and PBP Analysis: *Energy Use Analysis Results*

Distribution of Fuel Use for Baseline (80% AFUE) NWGF in 2022



Product Class	Average (Median) Heating Energy Use from RECS 2009/CBECS 2003, MMBtu/yr	Average (Median) Estimated Heating Energy Use at Baseline, MMBtu/yr		
		NOPR, 2021	NODA, 2021	SNOPR, 2022
NWGF	50.5 (43.7)	42.7 (37.4)	43.3 (37.7)	43.3 (37.7)
MHGF	39.7 (36.2)	33.3 (31.3)	33.9 (31.3)	33.9 (31.2)

LCC and PBP Analysis: *Energy Prices*

Topic: Marginal Natural Gas Prices

- Comments: Stakeholders stated that DOE overestimated marginal natural gas prices compared to utility tariff data.
- Response: DOE developed seasonal marginal price factors (which relate marginal to average prices) for 23 gas tariffs provided by GTI and compared them to marginal price factors developed from the EIA data. The winter and summer price factors used by DOE are generally comparable to those computed from the tariff data.
  - DOE's use of EIA State-level data effectively averages overall consumer sales in each State, and so incorporates information about all utilities. DOE's approach is, therefore, more representative of a large group of consumers with diverse baseline gas usage levels than an approach that uses only tariffs.
  - A full tariff-based analysis would require data that are generally not available in the public domain and that GTI did not provide.
  - RECS 2009 billing data was also used to validate marginal energy price factors for each RECS 2009 geographical area.

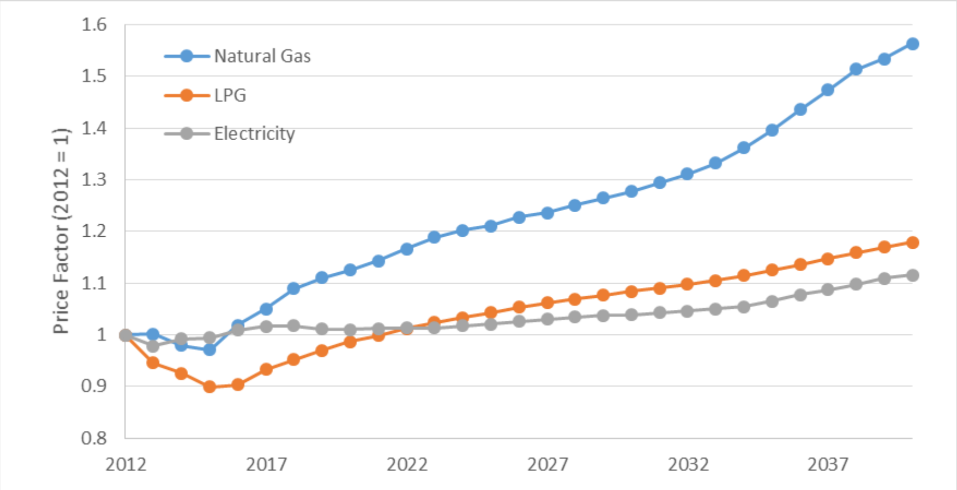
LCC and PBP Analysis: *Energy Price Results*

Summary of Non-Weatherized Gas Furnaces Average and Marginal Prices

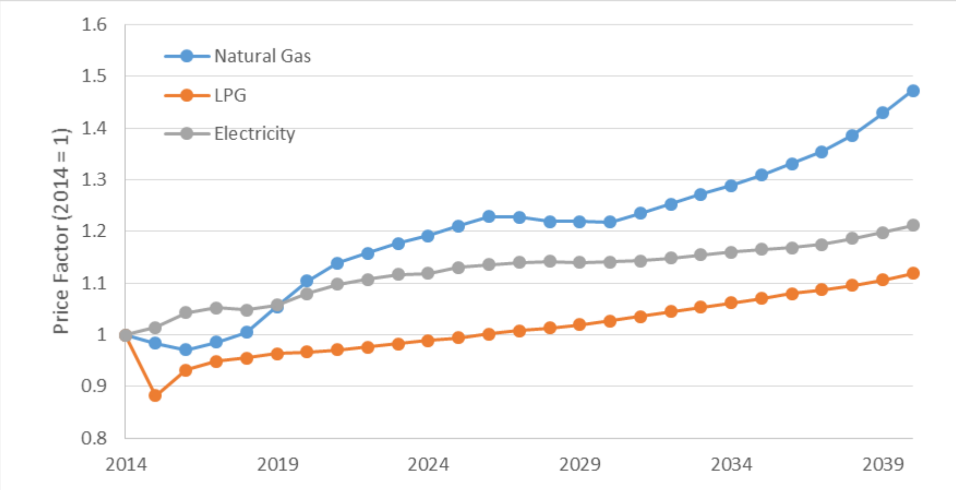
Rulemaking Phase	Natural Gas, $/MMBtu		Electricity, $/kWh		LPG, $/MMBtu
	Average	Marginal	Average	Marginal	Average
NOPR (in 2021, 2013$)	12.78	11.35	0.1281	0.1202	25.94
NODA (in 2021, 2014$)	13.46	11.92	0.1299	0.1223	25.81
SNOPR (in 2022, 2015$)	13.22	11.71	0.1372	0.1292	31.30

National Residential Energy Price Forecasts

NOPR (AEO 2013)



SNOPR (AEO 2015)



Note: Appendix 8K describes sensitivity analysis that considered alternative energy price trends (high and low economic growth scenarios).

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LCC and PBP Analysis: *Lifetime*

Topic: Lifetime Value

- Comments: Stakeholders stated that DOE's furnace lifetime (on average 21.5 years) is too high.
- Response: The furnace lifetime estimates from DOE's literature review range between 15 and 30 years.
  – DOE believes that its method, which is described in a peer-reviewed journal article* and uses a combination of actual shipment and survey data, is well suited to provide a distribution of lifetimes that is appropriate for U.S. furnace installations.
  – DOE found that the Canadian rulemaking analysis and survey data from the American Home Comfort Study (2004-2016) show that the average lifetime is at least 20 years.

Note: Appendix 8L describes sensitivity analysis that considered alternative lifetime distributions.

* Lutz, J., A. Hopkins, V. Letschert, V. Franco, and A. Sturges, Using national survey data to estimate lifetimes of residential appliances, HVAC&R Research (2011) 17(5): pp. 28

LCC and PBP Analysis: *Discount Rates*

Topic: Discount Rate Approach

- Comments: Stakeholders stated that DOE should use **marginal discount rates** (i.e., the rate associated with the **purchase method**, like a credit card).
- Response: The weighted average discount rate approach by income-bin, based on real-world data, used by DOE best reflects the opportunity cost of funds put towards an investment in energy efficiency. The composition of a consumer's debt and asset portfolio reflects a consumer's time value of money.

Topic: Discount Rate Value

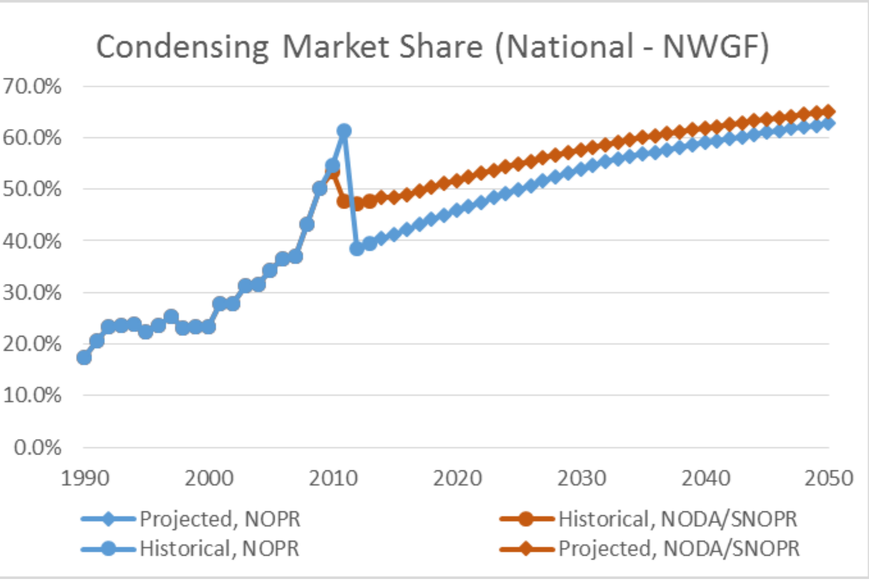
- Comments: Stakeholders stated that DOE's discount rates are too low.
- Response: The discount rates cited by stakeholders are **implicit discount rates**, which are not appropriate for the LCC analysis.
  - *The analysis is not predicting a purchase decision;* many factors that contribute to high implicit discount rates (including transaction costs, option values, imperfect information, credit constraints, cognitive biases) have already occurred from the perspective of the LCC, and are therefore irrelevant to calculating the actual net present value going forward from that point.

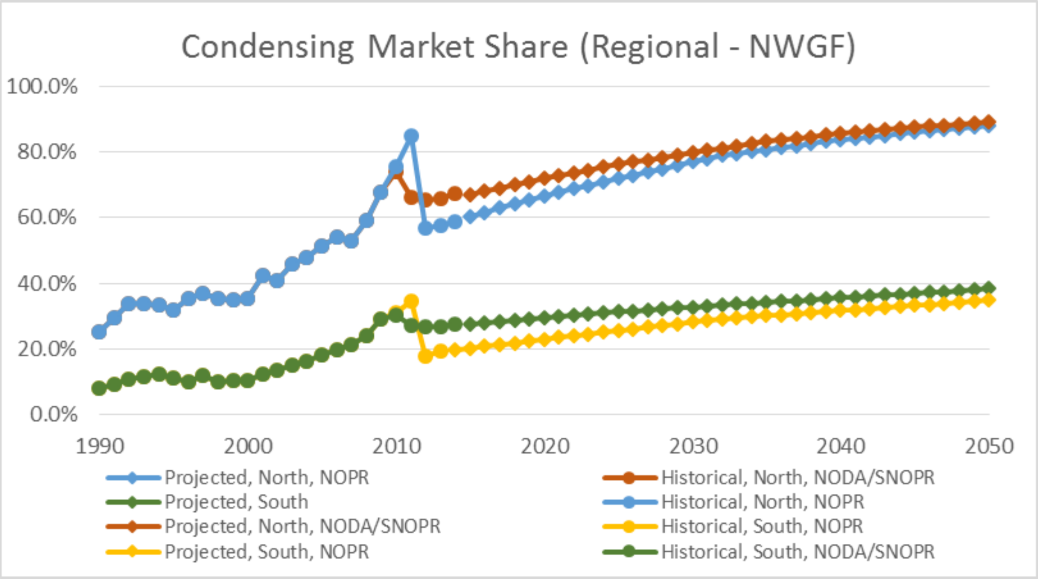
LCC and PBP Analysis: *No-New-Standards Case Efficiency Distribution*

Topic: No-New-Standards Case Efficiency Distribution

- Comments: Stakeholders stated that DOE should not randomly assign furnace efficiencies to households and should instead assign efficiency in the no new standards case based on economic tradeoffs reflected in household-specific energy use. Other stakeholders stated that DOE's approach properly accounts for non-economic consumer preferences and consumer irrationality.
- Response: A consumer that uses more gas for heating does so primarily because the consumer has a higher heating load due to climate and home insulation conditions. This higher heating load is also reflected in the selection of a higher input furnace. The actual number of operating hours is primarily a function of heating degree days in a given climate region. This is already captured in the analysis by using historical shipments data by state. Therefore, the majority of variation in efficiency purchases, at least regionally, is captured.
  - There are a number of factors influencing the furnace efficiency decision, not only economic factors.
    - Systematic cognitive biases: misperception of energy consumption of furnaces
    - Energy prices
    - Pre-existing circumstances (equipment purchased by a previous owner)
    - Environmentally conscious consumers may be willing to pay a premium
    - Efficiency is often correlated with other desirable features for which consumers may have a very high willingness to pay
    - Split incentive/principal-agent problem: e.g., landlord, builder, contractor.
    - Imperfect or asymmetric information

LCC and PBP Analysis: *No-New-Standards Case Efficiency Distribution*





Efficiency, AFUE	SNOPR -- 2022 Market share, NWGFs				
	National	North, Repl	North, New	South, Repl	South, New
80%	46.5%	25.6%	30.2%	70.0%	64.5%
90%	5.9%	5.6%	10.0%	4.6%	6.5%
92%	21.2%	18.4%	33.5%	18.4%	24.4%
95%	25.4%	48.7%	25.7%	6.6%	4.4%
98%	0.9%	1.7%	0.7%	0.4%	0.2%

LCC and PBP Analysis: *Product Switching*

Topic: Product Switching Criteria

- Comments: Stakeholders stated that it is unrealistic to use the same criteria for every consumer to determine product switching.
- Response: The survey data used by DOE to determine the product switching payback period criteria does not provide sufficient information to derive a distribution of required payback periods that is transferable to DOE's methodology.

Topic: Overestimation of Product Switching

- Comments: Some stakeholders stated that DOE overestimated the level of product switching that would occur in response to the proposed standard.
- Response: DOE conducted sensitivity analyses using higher and lower switching PBP criteria. However, DOE prefers to be conservative in its estimates.

LCC and PBP Analysis: *Product Switching Results*

Comparison of Product Switching for Households at Baseline (80% AFUE)

Rulemaking Phase	National Standard at:*							
	90% AFUE		92% AFUE		95% AFUE		98% AFUE	
	North	Rest of Country	North	Rest of Country	North	Rest of Country	North	Rest of Country
Switching to EF*								
NOPR	3.1%	5.8%	2.8%	5.7%	3.1%	5.8%	3.4%	7.2%
NODA	3.9%	6.2%	3.9%	6.2%	4.6%	6.9%	5.3%	8.2%
SNOPR	2.7%	4.1%	2.8%	4.3%	3.1%	4.7%	3.9%	5.6%
Switching to HP*								
NOPR	8.5%	14.3%	8.4%	14.3%	9.9%	19.1%	11.9%	27.4%
NODA	8.2%	14.3%	8.2%	14.7%	9.9%	18.1%	12.3%	26.6%
SNOPR	9.8%	23.5%	10.1%	25.6%	11.2%	30.9%	12.2%	36.8%
Switching GSWH to ESWH								
NOPR	2.7%	2.6%	2.3%	2.7%	2.8%	3.0%	3.3%	3.9%
NODA	3.7%	3.6%	3.8%	3.9%	4.9%	4.0%	6.4%	5.0%
SNOPR	3.5%	3.3%	3.7%	3.4%	4.1%	3.1%	4.8%	3.2%

* Components may not add to 100% due to rounding.
** Includes households that also switch from a gas water heater to an electric water heater.

LCC and PBP Analysis: *Sizing Methodology*

Purpose: Determine the input capacity of the gas furnace.

Method: Assigned an input capacity for the existing furnace of each housing unit:

1. Calculate percentile rank of all RECS 2009 and CBECS 2003 housing units with a furnace in ascending order by heating square foot multiplied by a scaling factor to account for the outdoor design temperature (ODT) using building weights:

$$Adjusted\ SqFt_{heating} = \frac{SqFt_{heating} \text{ x } (65 - ODTdesign_{,\ heating})}{(65 - 42)}$$

2. Construct percentile tables by input capacity based on AHRI historical shipments data and AHRI product directory.

3. Using the adjusted heating square foot percentile from Step 1, match input capacity from the input capacity percentile table in step 2.

LCC and PBP Analysis: *Sizing Methodology*

Input Capacity Shares

<table>
<tr><th>Input Capacity (kBtu/h)</th><th colspan="2">AHRI 2000 Gas Furnace Shipments (%)</th><th>2013 AHRI Directory Fraction of Models (%)</th><th>2022 DOE Fraction of Shipments (%)</th></tr>
<tr><td>40</td><td rowspan="4">9.4</td><td rowspan="2">2.8*</td><td>4.5</td><td>1.4</td></tr>
<tr><td>45</td><td>4.4</td><td>1.4</td></tr>
<tr><td>50</td><td rowspan="2">6.7*</td><td>1.8</td><td>4.2</td></tr>
<tr><td>55</td><td>1.1</td><td>2.5</td></tr>
<tr><td>60</td><td colspan="2" rowspan="2">8.6</td><td>10.9</td><td>8.2</td></tr>
<tr><td>65</td><td>0.5</td><td>0.4</td></tr>
<tr><td>70</td><td colspan="2" rowspan="2">24.8</td><td>5.5</td><td>11.3</td></tr>
<tr><td>75</td><td>6.5</td><td>13.5</td></tr>
<tr><td>80</td><td colspan="2" rowspan="2">13.7</td><td>13.6</td><td>13.7</td></tr>
<tr><td>85</td><td>0.0</td><td>0.0</td></tr>
<tr><td>90</td><td colspan="2" rowspan="4">23.2</td><td>10.2</td><td>8.6</td></tr>
<tr><td>95</td><td>1.1</td><td>0.9</td></tr>
<tr><td>100</td><td>14.9</td><td>12.5</td></tr>
<tr><td>105</td><td>1.4</td><td>1.2</td></tr>
<tr><td>110</td><td colspan="2" rowspan="11">20.4</td><td>6.5</td><td>5.6</td></tr>
<tr><td>115</td><td>0.6</td><td>0.5</td></tr>
<tr><td>120</td><td>9.0</td><td>7.7</td></tr>
<tr><td>125</td><td>1.5</td><td>1.3</td></tr>
<tr><td>130</td><td>1.1</td><td>0.9</td></tr>
<tr><td>135</td><td>2.4</td><td>2.1</td></tr>
<tr><td>140</td><td>1.5</td><td>1.3</td></tr>
<tr><td>145</td><td>0.0</td><td>0.0</td></tr>
<tr><td>150</td><td>0.6</td><td>0.5</td></tr>
<tr><td>155</td><td>0.4</td><td>0.4</td></tr>
<tr><td>160</td><td>0.1</td><td>0.1</td></tr>
</table>

* DOE used 1990 shipments to split the 2022 DOE fraction into “less than 50 kBtu/h” and “50 kBtu/h to less than 60 kBtu/h” bins.

LCC and PBP Analysis: *Sizing Methodology*

Downsizing

Purpose: Under a separate standard for small NWGFs that does not require condensing technology, DOE expects that some consumers who would otherwise install a typically-oversized furnace would choose to downsize in order to be able to purchase a non-condensing furnace.

Method: Identified households from the NWGF sample that might downsize:

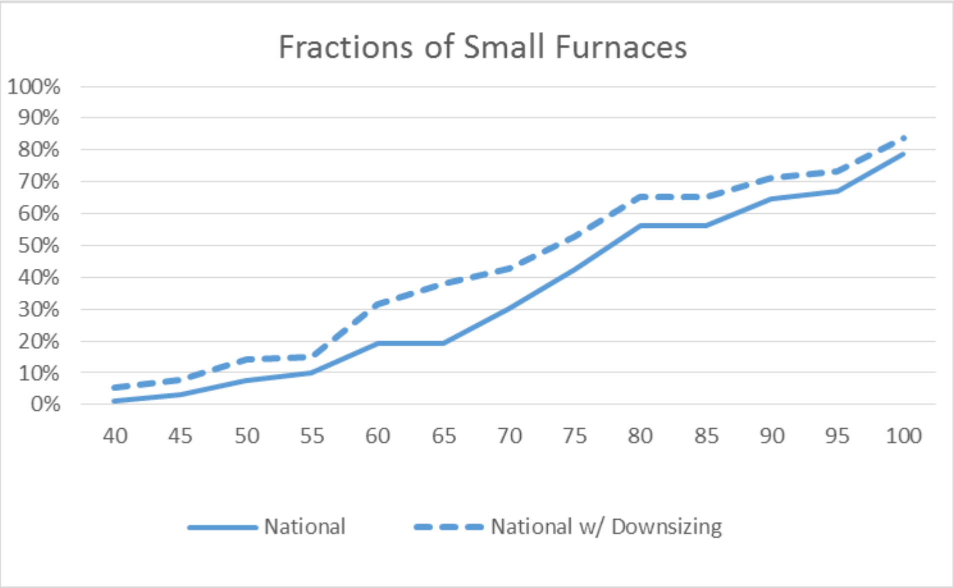
1. Determine if a household would install a non-condensing NWGF with an input capacity greater than the small furnace size limit without amended standards.
2. Determine input capacity of the NWGF using a 35% oversize factor* rather than the standard 70% oversize factor**.
3. If the input capacity of the furnace determined using 35% oversize factor is less than or equal to the input capacity limit for small furnaces, assumed that the consumer would downsize to the small furnace size limit.

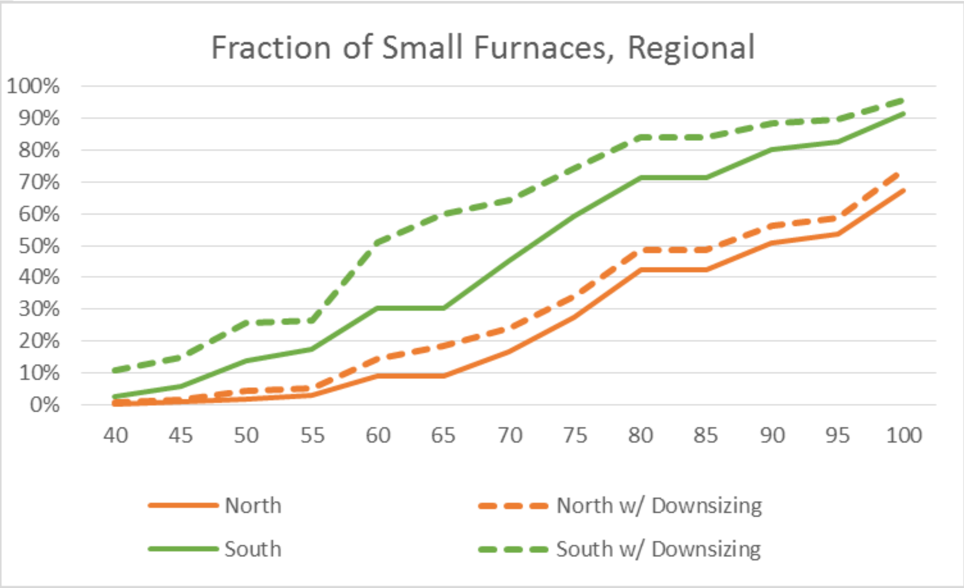
* ACCA recommends a maximum oversize factor of 40 percent.
** Oversize factor from furnace and boiler test procedure.

Note: Appendix 8M describes sensitivity analysis that considered alternative downsizing scenarios.

LCC and PBP Analysis: *Sizing Methodology Results*

Cumulative shipments by Input Capacity Cutoff (with and without downsizing)





ACCA Manual J and Manual S Sizing

- AGA estimated building heating loads and corresponding furnace sizing requirements for townhomes based on Air-Conditioning Contractors of America (ACCA) "Manual J" and "Manual S."
  - AGA's analysis considered Chicago, Oklahoma City, Minneapolis, Atlanta, and Salt Lake City climates.
  - Different building configurations were analyzed based on number of stories (2 or 3), whether the basement is heated or unheated, and the building vintage (1950s era or 2015 code compliant).
- AGA provided Excel and PDF files that show certain inputs to and outputs from the Manual J load calculations and Manual S sizing procedures.
- AGA also provided a slide deck that presents the appropriate furnace input capacities required for various scenarios.
- AGA recommended a small furnace product class threshold of 70 kBTU/h.

ACCA Manual J and Manual S Sizing

- For each climate location, the worst-case scenario for a townhome analyzed by AGA was a three story, 1500 sq. ft. home with unheated basement and 1950s era construction practices.

City	AGA Manual J Building Load (kBtu/h)	AGA Manual S Preferred Output Capacity Range (kBtu/h)*	AGA Manual S Preferred Input Capacity @80% AFUE (kBtu/h)	AGA Input Capacity from Slide Deck (kBtu/h)	AGA Oversize Factor for Slide Deck Results
Minneapolis	35.4	35.4 to 49.6	44.3 to 62.0	87	1.97
Oklahoma City	31.8	31.8 to 44.5	39.8 to 55.6	76	1.91
Chicago	30.9	30.9 to 43.3	38.6 to 54.1	76	1.97
Atlanta	26.5	26.5 to 37.0	33.1 to 46.3	64	1.93
Salt Lake City	24.4	24.4 to 34.1	30.5 to 42.6	67	2.20

*Manual S recommends furnace outputs to range from 1.0-1.4x the calculated building load except under special circumstances, such as for buildings with loads below 25 kBTU/h or when a larger furnace is the only way to obtain the necessary blower power for cooling.

- A 55 kBtu/h or less input furnace would fall within the Manual S preferred range for all of these climates.

LCC and PBP Analysis: *Consumer Subgroup Analysis*

Topic: Low-Income Impact

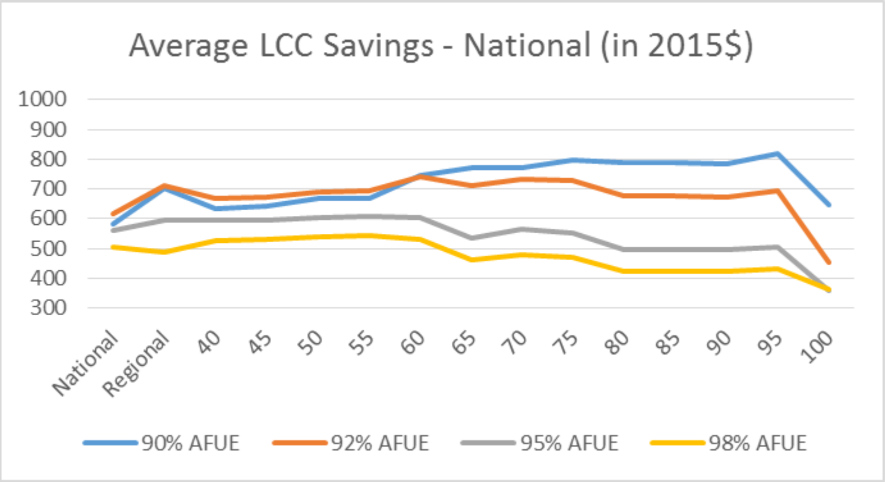
- Comments: Some stakeholders stated a significant fraction of low-income households are renters, so DOE's analysis overestimates consumer costs, since renters have limited and indirect exposure to installed costs.

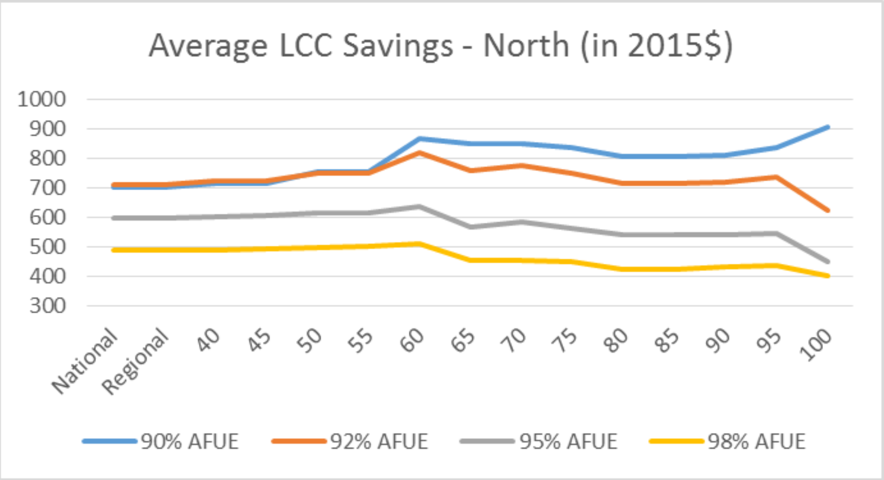
- Response: Low-income people who are renters are likely to benefit significantly from a new standard:
  - Because of split incentive/principal-agent problems, tenants pay higher bills absent the standard because landlords are less likely to invest in efficiency.
  - To the extent that landlords are not able to pass through the entire increased upfront cost from the standard to tenants through rent increases, renters will be better off than in DOE's analysis.

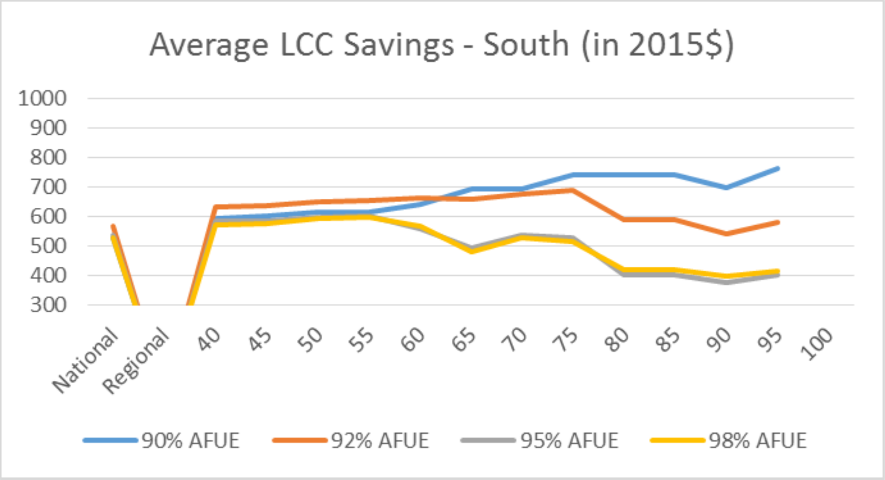
LCC and PBP Analysis: *Results*

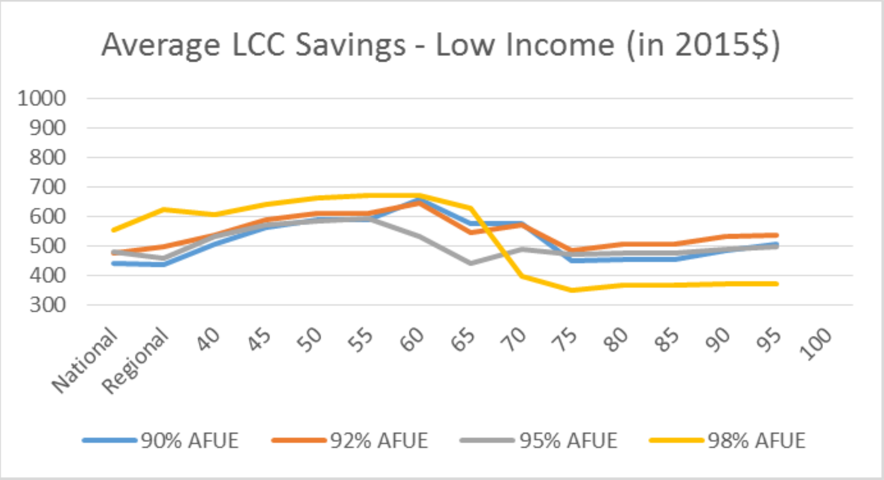
Efficiency, AFUE	Life-Cycle Costs (2015$)				Payback Period (years)		Life-Cycle Cost Savings	
	Installed Cost	1st Year's Operating Cost	Lifetime Operating Cost	Average Life-Cycle Cost	Simple Payback	Average Lifetime	Average Savings* (2015$)	% of Customers Experiencing Net Cost
National								
80%	2,175	684	11,020	13,194	N/A	21.5	N/A	N/A
90%	2,597	623	10,026	12,623	6.8	21.5	582	18.3%
92%	2,635	612	9,859	12,493	6.4	21.5	617	17.1%
95%	2,742	597	9,608	12,350	6.5	21.5	561	22.2%
98%	2,858	586	9,403	12,261	6.9	21.5	506	34.2%
55 kBtu/h Cutoff								
80%	2,175	684	11,020	13,194	N/A	21.5	N/A	N/A
90%	2,542	628	10,127	12,668	6.5	21.5	667	12.1%
92%	2,576	618	9,971	12,547	6.1	21.5	692	11.1%
95%	2,672	604	9,737	12,410	6.2	21.5	609	15.2%
98%	2,775	593	9,540	12,315	6.6	21.5	543	26.0%
60 kBtu/h Cutoff								
80%	2,175	684	11,020	13,194	N/A	21.5	N/A	N/A
90%	2,483	636	10,261	12,744	6.4	21.5	745	7.2%
92%	2,512	628	10,126	12,638	5.9	21.5	741	6.6%
95%	2,592	615	9,927	12,519	6.0	21.5	602	10.0%
98%	2,679	605	9,751	12,430	6.3	21.5	530	19.3%

Average LCC Savings for Different Cutoff for Small NWGFs

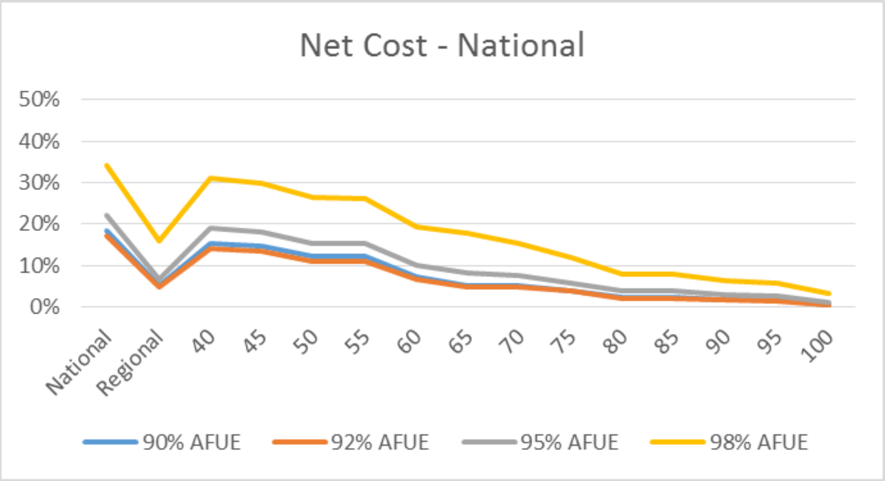


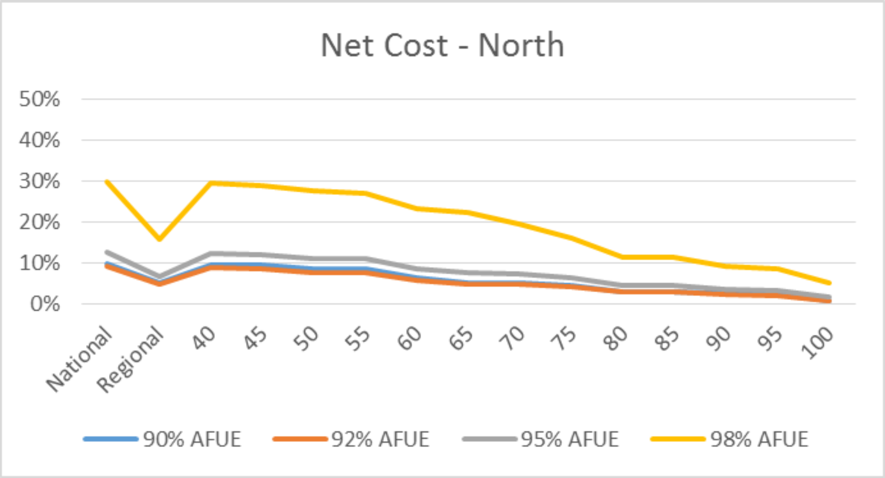


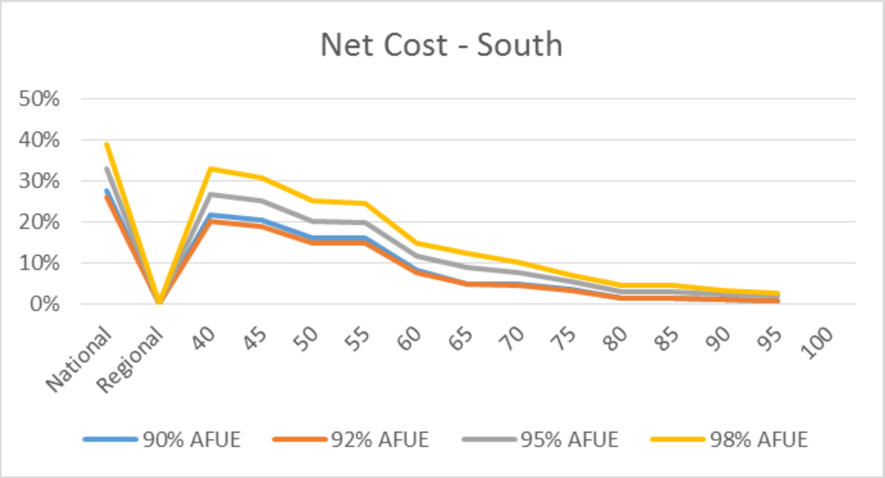


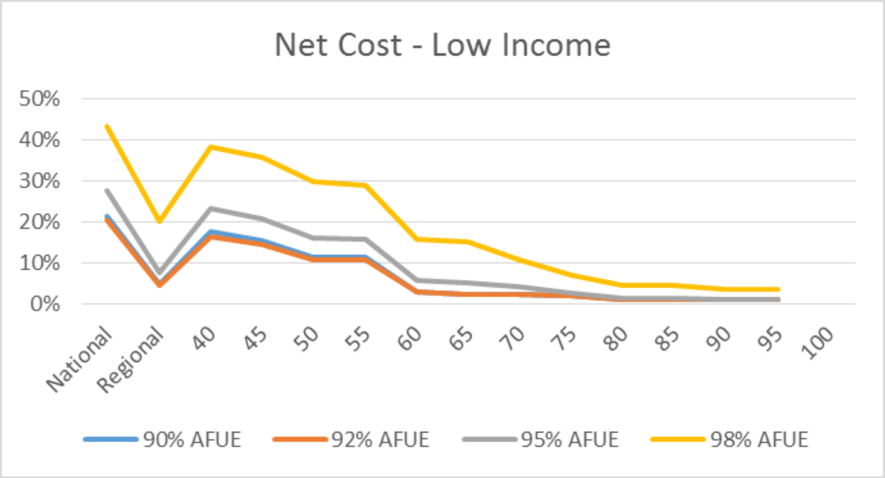


% of Consumers with Net Cost for Different Cutoff for Small NWGFs

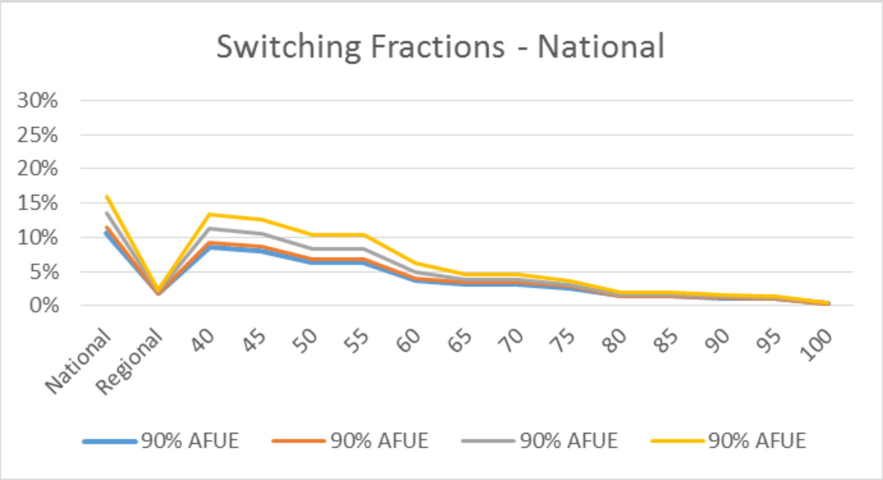


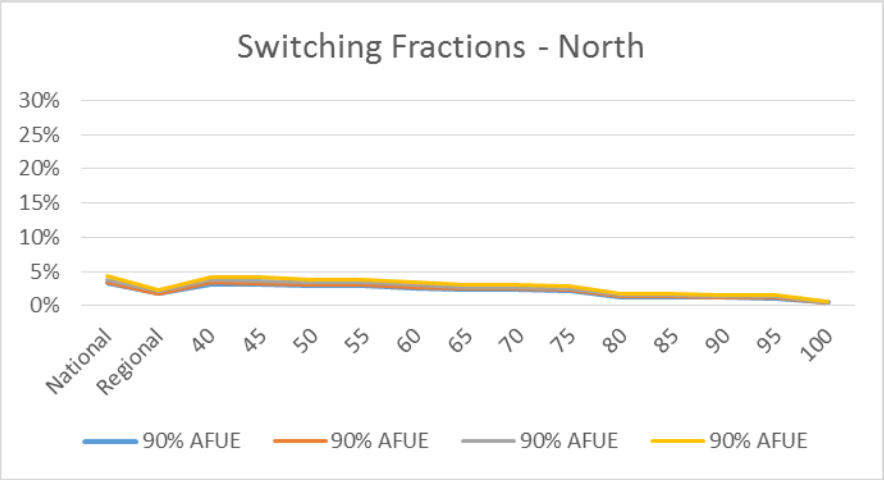


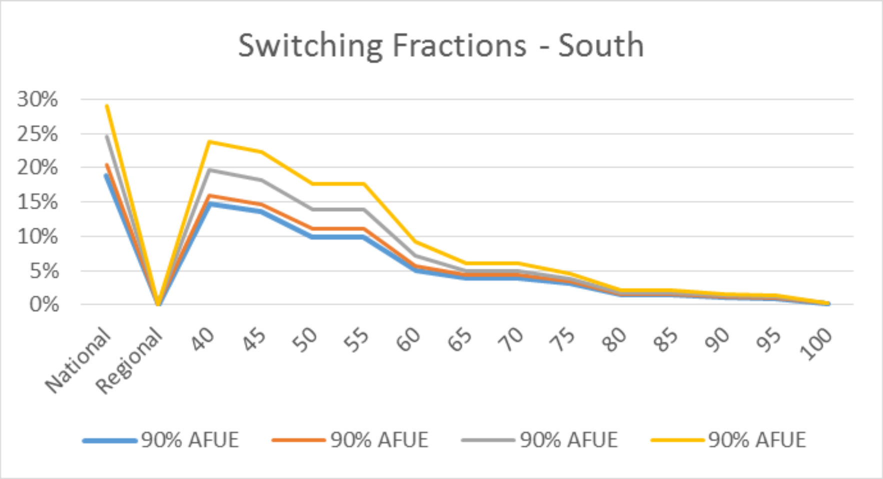


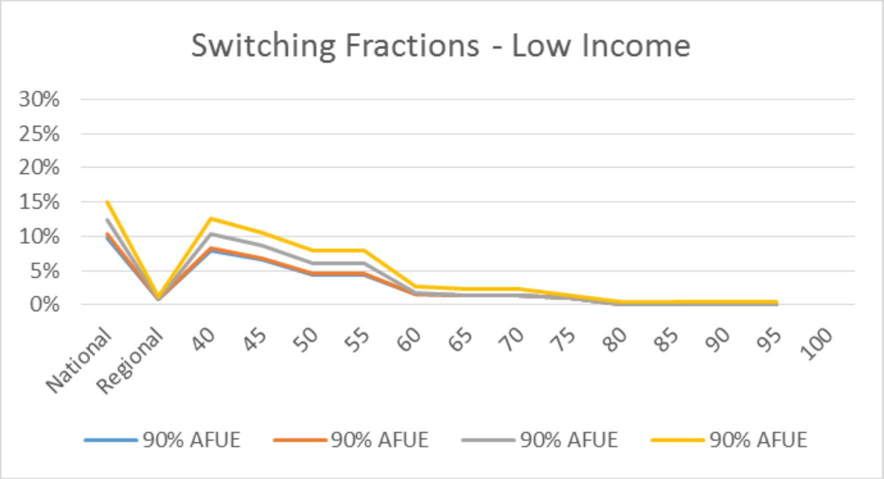


Switching Fractions for Different Cutoff for Small NWGFs









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Public Meeting Agenda

NIA: Key Differences between NOPR, NODA, and SNOPR

Inputs	NOPR	NODA	SNOPR
Compliance Year	2021	2021	2022
Dollar Year	2013$	2014$	2015$
Present Year	2014	2015	2016
Historical Shipments Data	Up to 2013 data	Up to 2014 data	Up to 2015 data (2014 MHGFs estimated shipments data from Mortex)
AEO Year	AEO 2014	AEO 2015	AEO 2015
Product Price Trend	Up to 2013 Data	Up to 2014 data	Up to 2015 data
Shipments by Efficiency	AHRI shipments up to 2009	AHRI shipments up to 2014	AHRI shipments up to 2014
Lifetime	National average distribution	National average distribution	Regional (North and Rest of Country) average distribution
Capacity Cutoff	Not Included	Included	Included

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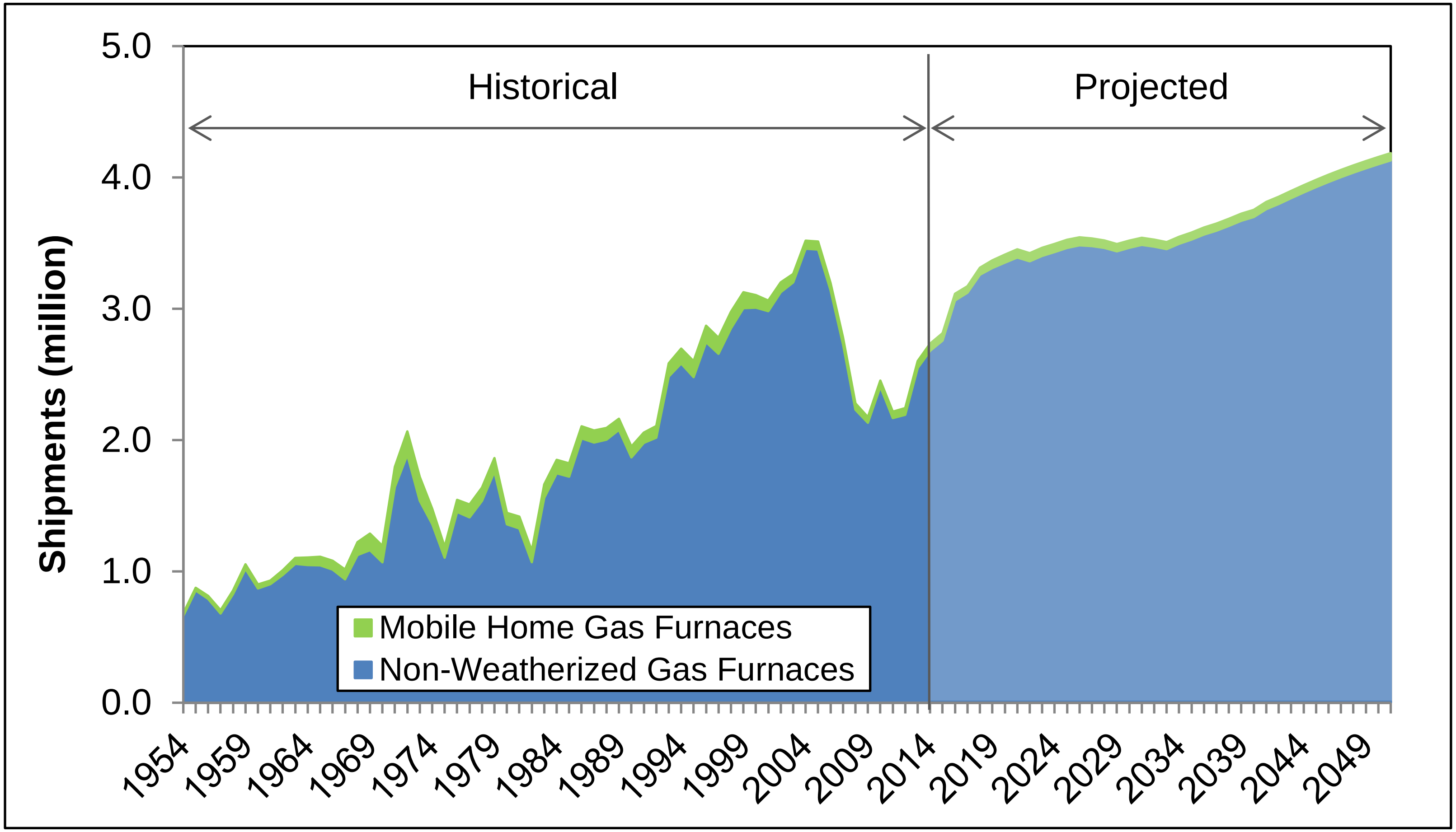
Shipments Analysis: *Historical and Projected Shipments*

Historical and Projected No-New-Standards Case Shipments for NWGFs and MHGF



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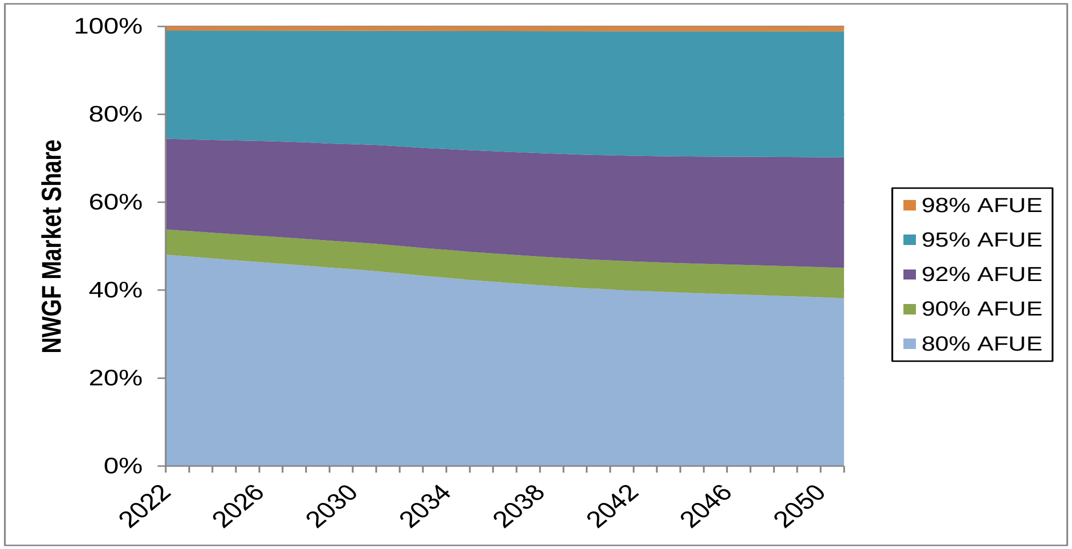
National Impact Analyses

NWGF Efficiency Distributions in 2022 for AFUE Standards, %

EL	No-New-Standards Case	Trial Standard Level (TSL)								
		1*	2*	3**	4*	5†	6*	7†	8*	9†
0	48.1	42.5	33.6	35.6	26.9		13.8		14.0	
1	5.7	2.9	1.5	2.6	0.9		0.5		0.5	
2	20.6	29.0	38.8	10.3	45.8	70.4	58.3		2.0	
3	24.6	24.7	25.1	50.5	25.4	28.5	26.5	98.9	82.5	
4	0.9	0.9	0.9	0.9	1.0	1.1	1.0	1.1	1.0	100.0



Projection of No-New-Standards Case Efficiency Distribution for NWGFs

* The input capacity threshold definitions for small NWGFs are as follows for these TSLs:
TSL 1: 80 kBtu/h
TSL 2: 70 kBtu/h
TSL 4: 60 kBtu/h
TSL 6: 55 kBtu/h
TSL 8: 55 kBtu/h.
** Refers to a regional standard (North).
† Refers to national standards.

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National Impact Analyses

Trial Standard Levels (TSLs) – AFUE Standards

TSL	Product Class			
	Non-Weatherized Gas Furnace		Mobile Home Gas Furnace	
	Efficiency Level	AFUE (Cutoff Criteria)	Efficiency Level	AFUE
1	2	92% (>80 kBtu/h)	1	92%
	0	80% (≤80 kBtu/h)		
2	2	92% (>70 kBtu/h)	1	92%
	1	80% (≤70 kBtu/h)		
3	3	95% (North)	2	95% (North)
	0	80% (Rest of Country)	0	80% (Rest of Country)
4	2	92% (>60 kBtu/h)	1	92%
	0	80% (≤60 kBtu/h)		
5	2	92%	1	92%
6	2	92% (>55kBtu/h)	1	92%
	0	80% (≤55 kBtu/h)		
7	3	95%	2	95%
8	3	95% (>55 kBtu/h)	2	95%
	0	80% (≤55 kBtu/h)		
9	4	98%	3	96%

TSL 6 is Proposed TSL

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National Impact Analyses

Trial Standard Levels (TSLs) – Standby Mode and Off Mode Standards

Product Class	Power (Watts)		
	TSL 1	TSL 2	TSL 3
Non-Weatherized Gas Furnaces	9.5	9.2	8.5
Mobile Home Gas Furnaces	9.5	9.2	8.5

TSL 3 is Proposed TSL

TSL Selection Criteria for each product class:

- **TSL 3:** Switching mode power supply with low-loss transformer
- **TSL 2:** Switching mode power supply
- **TSL 1:** Low-loss transformer

National Impact Analyses: *Results*

National Energy Savings – AFUE Standards (quads)

	Product Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Primary Energy Savings	NWGF	0.68	1.42	1.47	1.86	2.08	2.31	3.28	3.43	4.56
	MHGF	0.09	0.09	0.06	0.09	0.09	0.09	0.10	0.10	0.10
	Total*	0.77	1.51	1.53	1.95	2.17	2.40	3.37	3.52	4.66
FFC Energy Savings	NWGF	0.78	1.65	1.74	2.17	2.68	2.76	4.06	4.04	5.61
	MHGF	0.10	0.10	0.06	0.10	0.10	0.10	0.11	0.11	0.11
	Total*	0.88	1.75	1.81	2.27	2.78	2.86	4.17	4.15	5.72

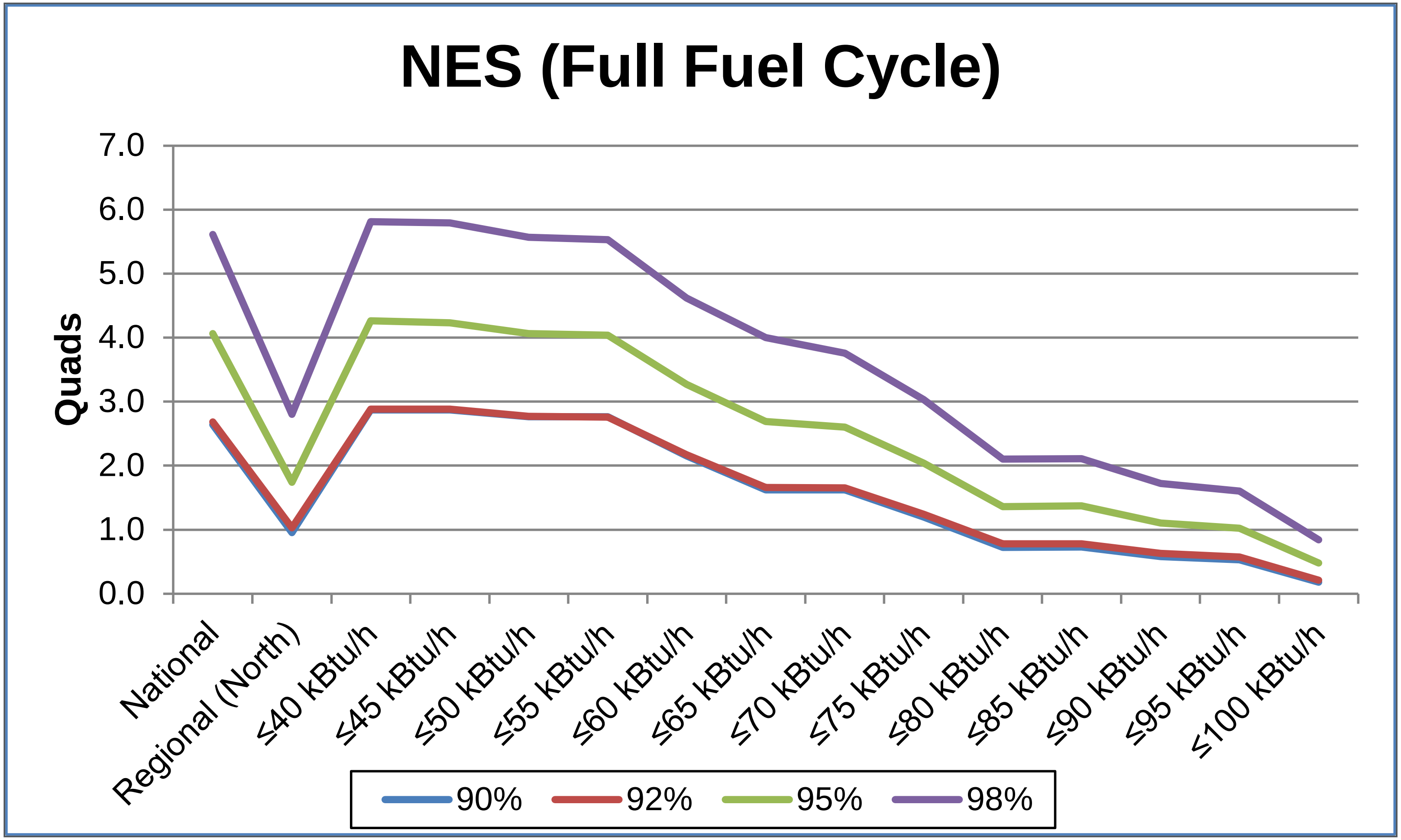
Net Present Value of Consumer Benefit - AFUE Standards (billion 2015$)

Product Class	Discount Rate	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
NWGF	3%	5.4	12.0	15.0	16.1	22.8	20.7	30.7	27.9	38.3
MHGF		1.0	1.0	0.7	1.0	1.0	1.0	1.1	1.1	1.1
Total*		6.3	12.9	15.7	17.0	23.8	21.7	31.8	29.0	39.5
NWGF	7%	1.5	3.3	4.3	4.4	5.3	5.3	7.1	7.0	8.6
MHGF		0.3	0.3	0.2	0.3	0.3	0.3	0.4	0.4	0.4
Total*		1.8	3.7	4.5	4.8	5.6	5.6	7.5	7.4	9.0

* Components may not sum to total due to rounding.

National Impact Analyses: *Results*

FFC NES for NWGFs by Input Capacity



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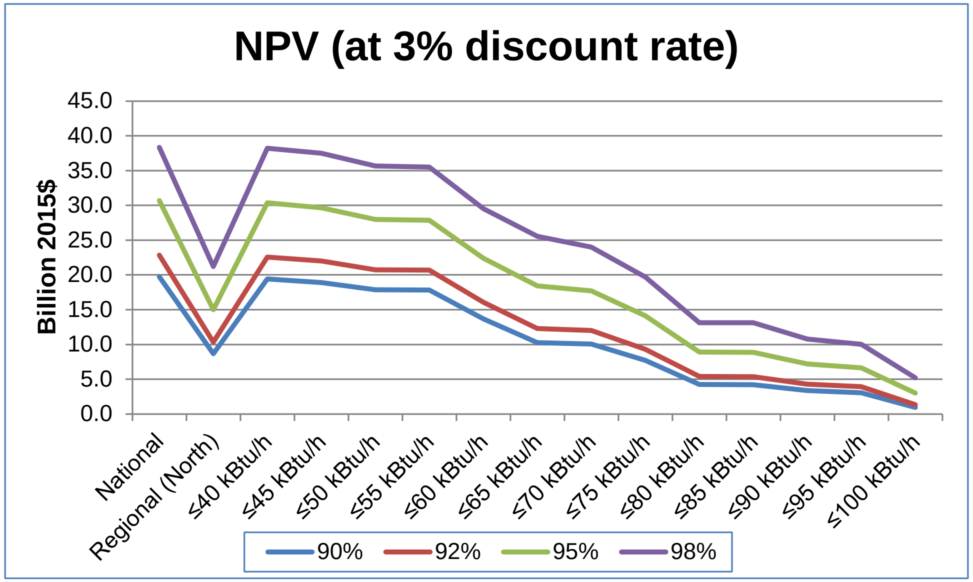
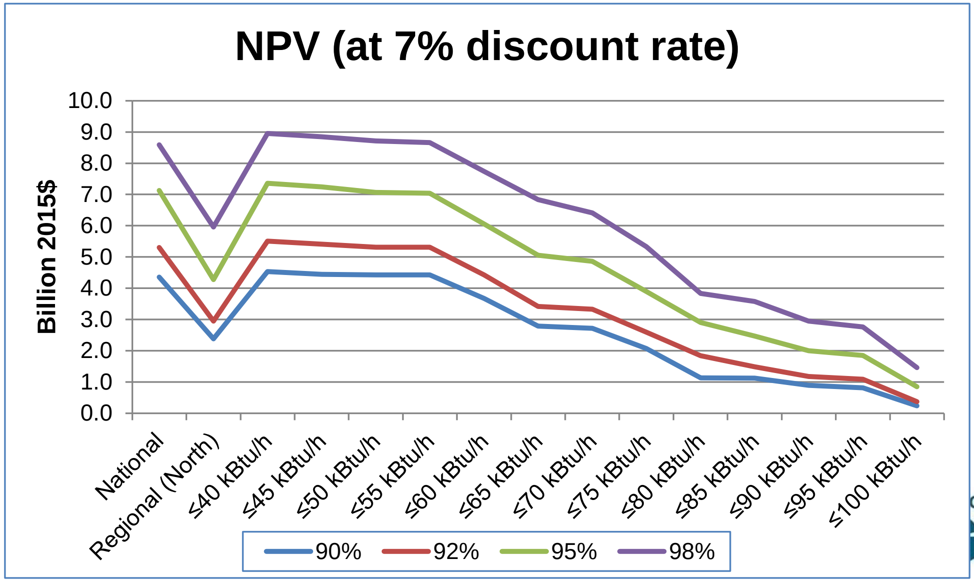
National Impact Analyses: *Results*

NPV for NWGFs by Input Capacity





Energy Efficiency & Renewable Energy

National Impact Analyses

National Energy Savings – Standby Mode and Off Mode Standards (quads)

	Product Class	TSL 1	TSL 2	TSL 3
Primary Energy Savings	Non-Weatherized Gas Furnaces	0.15	0.18	0.27
	Mobile Home Gas Furnaces	0.00	0.00	0.00
	Total*	0.15	0.18	0.27
Full-Fuel Cycle Energy Savings	Non-Weatherized Gas Furnaces	0.16	0.19	0.28
	Mobile Home Gas Furnaces	0.00	0.00	0.00
	Total*	0.16	0.19	0.28

Net Present Value of Consumer Benefit - Standby Mode and Off Mode Standards (billion 2015$)

Product Class	Discount Rate	TSL 1	TSL 2	TSL 3
Non-Weatherized Gas Furnaces	3%	2.52	2.47	3.96
Mobile Home Gas Furnaces		0.00	0.00	0.00
Total*		2.52	2.47	3.96
Non-Weatherized Gas Furnaces	7%	0.89	0.78	1.30
Mobile Home Gas Furnaces		0.00	0.00	0.00
Total*		0.89	0.78	1.31

* Components may not sum to total due to rounding.

Public Meeting Agenda

MIA Analytical Updates

Topic: Cumulative Regulatory Burden

- Comments: Stakeholders requested that DOE incorporate all cash-flow impacts from the July 2014 furnace fan final rule into the GRIM.
- Changes: DOE updated the GRIM to include all cash-flow impacts from the furnace fan rule, including product cost and conversion cost impacts.

Topic: Regulatory Flexibility Analysis

- Comments: Stakeholders asked for more granularity in the impacts to small manufacturers in DOE's regulatory flexibility analysis.
- Changes: DOE provided a company-by-company product availability and conversion cost impact analysis for the small manufacturers in the SNOPR regulatory flexibility analysis.

MIA Results - AFUE Standards

The SNOPR GRIM incorporates updated MPCs, updated shipments, updated conversion costs, impacts from the 2014 Furnace Fan rule, and updates TSL structure.

	Units	No-New-Standards Case	Trial Standard Level*								
			1	2	3	4	5	6	7	8	9
INPV	2015$M	1,104.3	1,031.6 – 1,097.0	1,005.8 – 1,101.7	846.8 – 1,104.6	1,007.0 – 1,119.2	985.2 – 1,118.0	1,016.4 – 1,142.8	729.2 – 1,126.8	771.6 – 1,147.1	526.5 – 1,100.0
Change in INPV	2015$M	-	(72.8) – (7.3)	(98.5) – (2.7)	(257.6) – 0.3	(97.4) – 14.8	(119.2) – 13.7	(88.0) – 38.5	(375.2) – 22.5	(332.8) – 42.8	(577.9) – (4.3)
	%	-	(6.6) – (0.7)	(8.9) – (0.2)	(23.3) – 0.0	(8.8) – 1.3	(10.8) – 1.2	(8.0) – 3.5	(34.0) – 2.0	(30.1) – 3.9	(52.3) – (0.4)
Total Conversion Costs	2015$M	-	34.1	43.0	67.0	47.8	61.9	54.7	107.6	94.2	327.9

*Parenthesis indicate negative values

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Public Meeting Agenda

1	Overview
2	Life Cycle Cost Analysis; Subgroup Analysis
3	Shipments Model; NIA; RIA
4	Manufacturer Impact Analysis
5	Environmental; Indirect Employment; General Analysis
6	Closing Remarks

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

Emissions Analysis

Topic: Accounting for Future Legislation

- Comment: Stakeholders stated that AEO 2015 does not account for the EPA MATS rule and the Clean Power Plan, which are estimated to significantly reduce coal-based electricity generation, thus reducing emissions from the power sector after 2020.
- Response: DOE notes that AEO 2015 incorporates the MATS rule. DOE will use AEO 2016 for the final rule.

Topic: Low-NO_X Furnaces

- Comments: Stakeholder commented that low-NO_X furnace designs should be taken into account in the emissions analysis.
- Response: DOE used a lower, technology-specific NO_X emission factor for the fraction of the market projected to install NWGFs with low-NO_X burners.

FFC Emission Results: AFUE and Standby and Off-Mode Standards

Rulemaking Stage	CO_2 (million metric tons)	NO_X (tons)	SO_2 (tons)	Hg (tons)
NOPR	153	840	-189.6*	-0.59*
SNOPR	159	717	-67.6*	-0.26*

* Negative values indicate an increase in emissions.

Monetization of Emission Reductions

Topic: SCC

- Comments: Stakeholders questioned the use of the SCC for various reasons. Other stakeholders supported DOE's use of the SCC.
- Response: The current estimates of the SCC have been developed by an interagency process over many years, using the best science available, and with input from the public. The three models used to estimate the SCC are frequently cited in the peer-reviewed literature. DOE notes that not using SCC estimates because of uncertainty would be tantamount to assuming that the benefits of reduced carbon emissions are zero, which is inappropriate. Lastly, the 7th U.S. Circuit Court of Appeals recently upheld the use of the SCC values in DOE's analyses.

Results: FFC Emission Reductions Benefits, *million 2015$*

Standard	CO_2	Low NO_X value at 3% discount rate	Low NO_X value at 7% discount rate
AFUE Standard (TSL 6)	839 to 12,551	495	165
Standby Standard (TSL 3)	98.4 to 1,454	46.8	15.8

General Analysis Topics: *Peer Review*

Topic: Peer Review

- Comment: Stakeholder stated that key elements of the current analysis have not been subjected to an unbiased and current peer review as required by OMB's Final Information Quality Bulletin for Peer Review, and that the peer review conducted many years ago was insufficiently robust and independent.
- Response:
  - In 2007, DOE prepared a Peer Review Report, which involved a rigorous, formal, and documented evaluation by qualified and independent reviewers objectively judging the technical/scientific/business merit, and actual or anticipated results, of programs and/or projects.
  - DOE has determined that the peer-reviewed analytical process continues to reflect current practice in the present rulemaking.
  - In addition, there have been extensive interactions with stakeholder experts and detailed review by these parties of DOE's analytical models and data in the subject furnace standards rulemaking. DOE incorporated a number of inputs from these reviewers into its analyses in this rulemaking in order to be consistent with OMB's Information Quality Guidelines.

General Analysis Topics: *Peer Review*

Interactions with Stakeholders in Residential Furnaces Rulemaking

Document Name	Date	Notes
Ex Parte Meeting Record	09/12/14	Meeting between AGA and DOE to discuss fuel switching impact model
Preliminary Analysis Spreadsheets	09/22/14	Various preliminary spreadsheets DOE put out for stakeholders prior to issuance of the NOPR
AGA Workshop on Condensing v. Noncondensing Appliances	10/9/14	AGA workshop held for stakeholders to discuss DOE's furnace rule
AGA Marginal Cost & Fuel Switching Analysis	10/21/14	Posted after AGA workshop; independent AGA analysis
GTI Fuel Switching Analysis	10/21/14	Independent GTI analysis
Ex Parte Meeting Record	10/23/14	Meeting between AGA, APGA, GTI, and DOE to discuss fuel switching
Notice of Public Meeting	10/30/14	Notice for meeting to discuss DOE's analytical tools
Public Meeting	11/07/14	Public meeting where DOE discussed analytical tools
Correspondence between APGA and DOE Counsel	11/14/14	DOE answers to APGA follow-up questions from the Nov. 7, 2014 public meeting
NOPR Spreadsheets	02/05/15, 02/11/15	DOE spreadsheets revised for NOPR; put out ahead of NOPR issuance
Summary of Changes to Analytical Tools	02/12/15 & 02/24/15	Summarizes changes DOE made to analytical tools in light of meetings
NOPR Public Meeting	03/27/15 & 4/13/2015	Public meeting to discuss March 2015 NOPR
Correspondence between DOE and APGA/AGA	04/23/15	DOE answers to questions from APGA/AGA on shipments data presented at the NOPR public meeting

Public Meeting Agenda

1	Overview
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5	Environmental; Employment; General Analysis
6	Closing Remarks

Closing Remarks

Meeting participants are invited to provide any closing remarks or statements at this time.

How to Submit Written Comments

- In all correspondence, please refer to the furnace rulemaking by:
  - Energy Conservation Standards for Furnaces
  - Docket Number: EERE–2014–BT–STD–0031
  - Regulatory Identification Number (RIN): 1904-AD20
- Email: ResFurnaces2014STD0031@ee.doe.gov

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- **Comment period closed on November 22, 2016 at 11:59 PM EDT**