

## Questions related to DOE Furnace NOPR LCC model and TSD

### Priority Questions

A) It appears that the assignment of base case efficiency for each individual home is chosen based on a random assignment in the Base Case AFUE sheet D12. This ignores the likelihood that there is an economic motive for consumers in selecting condensing vs. non-condensing furnaces. That is, consumers who have good payback economics for condensing furnaces are actually less likely to be affected by a rule than those with poor payback economics but they are being treated as if both are equally probable. Thus, as it is, payback economics does not appear to drive whether a consumer is affected by the rule or not. If economic decision making were used to determine which households are, or are not, affected by the rule, the projected LCC savings would likely be significantly lower. Why would the approach taken in the LCC model be reasonable?

B) In the discussion of product switching methodology, page 8J-5 of the TSD, it is indicated that in cases where payback is less than 3.5 years, switching will not take place. However, in the LCC model if the payback for the specified efficiency level is less than 3.5 years, switching does take place if switching options with paybacks over 3.5 are present. Please explain this apparent inconsistency?

C) What is the rationale behind including cases where switching options have a first cost advantage relative to the 80% case and operational costs below the specified EL when these clearly are economically viable and would be chosen in the absence of any rulemaking?

D) Following the logic contained in the NWGF Switching, in column AH the term “payback” means the time period after which the consumer begins to lose money. In column AI the term “payback” means the time period after which the consumer begins to save money. Is this intended to be the case? If so, why was the same term used with different meanings?

E) What is the basis of the large differential increase in the installed cost of a baseline 80% NWGF vs. the installed cost increase of condensing NWGFs in the 2014 LCC when compared with the 2011 LCC (present when comparing 2014 LCC in switching and non-switching configuration)?

### Related to the switching logic contained in the NWGF Switching Sheet

1) On page 8J-6, the TSD discloses that proprietary data from the American Home Comfort Study was used to determine payback times. What is the distribution of payback times revealed by the analysis of the American Home Comfort Study?

2) What is the distribution of payback times revealed by the analysis of the American Home Comfort Study as a function of household income, or any other available demographics?

3) What is the rationale for choosing the switching option with the longest payback time rather than the lowest first cost as long as it is over some threshold?

- 4) What is the rationale behind including cases where switching options have a first cost advantage relative to the 80% case and operational costs below the specified EL when these clearly are economically viable and would be chosen in the absence of any rulemaking?
- 5) Following the logic contained in this sheet, in column AH the term “payback” means the time period after which the consumer begins to lose money. In column AI the term “payback” means the time period after which the consumer begins to save money. Is this intended to be the case? If so, why was the same term used with different meanings?
- 6) In the discussion of product switching methodology, page 8J-5 of the TSD, it is indicated that in cases where payback is less than 3.5 years, switching will not take place. However, in the LCC model if the payback for the specified efficiency level is less than 3.5 years, switching does take place if switching options with paybacks over 3.5 are present. Please explain this apparent inconsistency?
- 7) On page 8J-2 of the TSD it states that “the model rejects any option that has a payback period greater than 3.5 years and selects the option with the lowest payback period.” However, the logic contained in the NWGF Switching sheet does not reject options with payback periods greater than 3.5 years; it actually selects options with payback periods greater than 3.5 years. Please explain this apparent inconsistency?
- 8) On page 3-16, DOE states that the industry standard for expected furnace lifetime is around 15 years. However, the LCC model does not seem to use this industry standard and instead uses a much longer lifetime based on many assumptions (including reliance on AHRI historical shipment data and a survival function that is assumed to be independent of product class (within furnaces) and potentially inaccurate survey results. On page 8G-6 DOE states that it has made assumptions “leading to large statistical uncertainty” in this model. Given this uncertainty, why did DOE choose to move away from using the 15 year industry standard lifetime? AHRI shipment data is provided by member companies on a voluntary basis, can DOE break this information out by year (member companies which contributed each year, what data was counted, and companies that did not contribute)?
- 9) DOE plans to monetize the societal cost of CO<sub>2</sub>; will DOE also estimate a societal cost of SO<sub>2</sub>, N<sub>2</sub>O, and Hg emissions?

#### **Related to the Base Case AFUE efficiency**

- 1) On page 8I-11 of the TSD, it indicates that data from 1994-2004 was used to estimate shipments of condensing furnaces to avoid years 2005 to 2011 due to federal tax incentives. The data displayed on page 8I-12 of the TSD shows the results of this analysis. These figures seem to have significantly lower market shares of condensing furnaces compared to the table “Fraction of Condensing Furnaces” in the AFUE (Existing) sheet in the LCC model. Please explain what is different between these two?
- 2) In Figure 8I.5.1 there appears to be a much faster adoption curve (larger positive slope) in the period leading up to 2005 than there is in the projected period. Why was the growth in adoption of condensing furnaces projected to slow compared to the pre-incentive period which ended in 2005?

3) It appears that the assignment of base case efficiency for each individual home is chosen based on a random assignment in the Base Case AFUE sheet D12. This ignores the likelihood that there is an economic motive for consumers in selecting condensing vs. non-condensing furnaces. That is, consumers who have good payback economics for condensing furnaces are actually less likely to be affected by a rule than those with poor payback economics but they are being treated as if both are equally probable. Thus, as it is, payback economics does not appear to drive whether a consumer is affected by the rule or not. If economic decision making were used to determine which households are, or are not, affected by the rule, the projected LCC savings would likely be significantly lower. Why would the approach taken in the LCC model be reasonable?

4) On page 2-6 of the TSD, Figure 2.3.1, the map of regions for furnace standards indicates that West Virginia is considered to be in the North. However, in the LCC spreadsheet it is grouped with “DE, DC, MD, WV” in the Distributions table in the Base Case AFUE sheet. These other regions are labeled as being included in the South on the map but they all appear to be grouped together in the South. Also, West Virginia is listed separately in the LCC spreadsheet in what appears to be the South. Please clarify which region West Virginia is in and whether it is actually being counted twice in the furnace distributions?

#### **Related to Installation Cost – Forecast Cells sheet**

1) The count of analyzed buildings affected by a specific HVAC installation configuration as well as an average cost of such installation (cells columns N & O rows range 7019 to 7069) remains constant for runs with and without the switching option engaged. Why is there no change in the count and average costs of installations when electric equipment options are used?

#### **Related to Installation Cost – Appendix 8D**

1) Table 8D.2.5 on page 8D-9 showing the breakdown of typical replacement installation cost is missing costs associated with ductwork work estimated to be ~9% of typical replacement installation cost in 2011 version of furnace LCC TSD (Appendix 8B Table 8-B.24 page 8-B-5) . What is the reason for omitting ductwork work costs in the 2014 version?

2) Table 8D.2.15 on page 8D-22 showing the breakdown of typical PVC venting costs of replacement installation is missing materials costs associated with electric work valued at \$35 (\$2009) in the 2011 version of furnace LCC TSD (Appendix 8B Table 8-B.2.16 page 8-B-16) . What is the reason for not including materials costs?

3) How does the DOE model account for things like requirements to install “snorkel” style termination of vents or horizontal terminations where distance to windows and doors, decks, overhangs etc.?

4) How does the model deal with installations where more than one furnace is necessary and where this causes attic and closet installations?

#### **Related to Maintenance Cost**

1) Page 8-22 of the DOE furnace TSD lists the annualized maintenance cost of a non-weatherized gas condensing furnace as \$40.06 in 2013 dollars for all levels (90% to 98% AFUE), only \$1.86 more than for a non-condensing furnace. For mobile home condensing furnaces, the annualized maintenance cost is \$39.62 (or \$1.84 more than for a non-condensing furnace). The source for maintenance costs was estimated from RS Means data. Maintenance frequency data appears to have come from proprietary data. Can this data be made available? Please describe the methodology used to determine maintenance frequency? Also why was only one year of the American Home Comfort Study data used when four years were used for other portions of the analysis?

2) What is DOE's policy (with references) about relying on proprietary data as the basis for decisions underlying a proposed rule? How is the general public supposed to comment on such decisions and how is a court supposed to review such decisions if challenged?

### **Clarification Comments**

The items in this section appear to be simple errors, but we wanted to bring them up so that they can be clarified.

- 1) 2014 LCC "Building Sample" sheet the cell B60 is labeled "Cooling + Furnace Replaced same time (50%)", while the actual CB distribution is 10%/90%.
- 2) 2014 LCC "Building Sample" sheet the cell B66 labeled "WH + Furnace replaced same time (25%)", while the actual CB distribution is 40%/60%.
- 3) 2014 LCC "Building Sample" sheet the cell B67 WH life labeled "Remaining Years (1-19)", while the actual CB function is 12 years with equal distribution.
- 4) 2014 LCC "Base Case AFUE" the cells D5 and E5 are copies of the cells E35 and F35 in the "Bldg Sample" sheet. In the "Bldg Sample" sheet they are labeled as option 1 being replacement and option 2 being new installation. In the "Base Case AFUE" sheet the labeling is the opposite.

### **Questions asked previously and not answered by DOE**

Please note that our review of the TSD for answers to these questions is not entirely complete. So, in cases where we are saying that these are not answered in the TSD, it is possible that we may have missed an answer, in which case please indicate where the answer may be found.

- 1) The 2011 LCC spreadsheet predicted lower LCC savings, especially for replacements in the south region and for the highest efficiency (98%) condensing furnace cases, compared to the 2014 LCC spreadsheet even though the 2011 LCC spreadsheet did not include the potential of fuel switching.
  - a) What are the major reasons for the significant changes in LCC savings?
  - c) The 2014 LCC spreadsheet predicts first year operations cost savings averaging between \$54 and \$88 depending on the mandated efficiency level while the fuel switching impact analysis model provided by AGA and dated 7/11/2104 predicts a first year cost increase of \$62 even

though both consider fuel switching impacts. What are potential reasons for this significant discrepancy in top level results?

- 2) DOE 2011 Furnace LCC Sheet "Forecast Cells" Installed Price (N58 to N62) converted from 2009\$ to 2013\$ and Installed Price in DOE 2014 Furnace LCC Sheet "Statistics" (L79 to L83) already in 2013\$;

What is the basis of the large differential increase in the installed cost of a baseline 80% NWGF vs. the installed cost increase of condensing NWGFs in the 2014 LCC when compared with the 2011 LCC (present when comparing 2014 LCC in switching and non-switching configuration)?

- 3) Sheet: Forecast Cells. Rows 2397-2406 and 2437-242446

The installation and retail cost of electric water heating equipment predicted by the model is higher than the cost of gas equipment. This is an unexpected result. For example, RSMMeans costs for electric water heaters are lower than for comparable gas water heaters, as expected. What is the rationale for higher electric water heater costs?

- 4) Sheet: Overall Spreadsheet

How are the negatively and positively impacted homes segmented? This includes north/south, and new construction/replacement segments. Included in the segmentation would be replacement costs of different options in different home locations, sizes, and configurations, as well as other factors that would impact consumer classes differently. Averages do not show the marginal affected consumers.

- 5) Using the 2014 LCC spreadsheet and allowing fuel switching improves LCC savings compared to disallowing fuel switching if the 'payback' for switching decisions is long (15 years for sheet NWGF Switching cells D48 and D49). The effect is even larger in the South. Does this mean that fuel switching should be expected to reduce costs to consumers (e.g., in the South) as a result of the new minimum efficiency level?

- 6) Sheet: Prod Price. AC50

What is the source of the factor of 1/3 that is multiplied by the cost differential (EF vs. NWGF)?

- 7) Sheet: Bldg Sample, E67, E61

Why was a uniform distribution chosen for remaining lifetimes for cooling and water heating equipment?

- 8) Sheet: Installation Cost, Columns E and F

The source for the assumptions regarding venting options and conditioned vs. unconditioned space is given as "Consultant Report." Is this report available? If yes, please provide; if not, please explain why not and how the general public is supposed to assess these assumptions.