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# Beverage Vending Machines Standard Evaluation

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# 1 EXECUTIVE SUMMARY

NEEA contracted with TRC to conduct an independent evaluation to qualitatively assess NEEA's influence in the establishment of the Beverage Vending Machine (BVM) standard, and to quantitatively assess the savings from the standard due to the combined efforts of NEEA and energy efficiency organizations participating in the process. An efficiency organization is one whose goal is to seek policies that promote energy efficiency in buildings and appliances.

The BVM standard regulates refrigerated machines that chill and dispense bottled or canned beverages upon payment. The previous BVM standard was adopted in 2009 and included efficiency standards for two equipment classes: Class A (machines that are fully cooled) and Class B (machines that are not fully cooled). DOE published a Framework document in 2013 where they described analyses they planned to conduct during the rulemaking and requested comments from stakeholders. Utilizing comments and other data collected, DOE developed and published a preliminary analysis Technical Support Document (TSD) in 2014. DOE published a Notice of Proposed Rulemaking (NOPR) in 2015 and proposed standards for four equipment classes, which included modified versions of the original Class A and Class B, and new Combination A and Combination B. In early 2016, DOE published a Final Rule, which took effect March 8, 2016. Compliance was required beginning January 8, 2019.

The test procedure rulemaking happened in parallel with the standards rulemaking and was initiated in 2014 after DOE determined that the previous test procedure (published in 2006) should be amended to improve the representativeness of field conditions and incorporate new technology features – including low power modes. DOE published a test procedure NOPR in 2014 which referenced ANSI/ASHRAE Standard 32.1. DOE published a test procedure Final Rule in 2015, codifying these changes. The 2015 test procedure Final Rule took effect August 31. 2015, and compliance was required beginning January 27, 2016.

As part of its codes and standards program, NEEA supported this standard's development and adoption. NEEA and other efficiency organizations provided comments on the 2015 test procedure and 2016 standard that affected the analysis and the ultimate DOE Final Rules.

To conduct its evaluation, TRC reviewed the DOE docket for the 2016 standard and 2015 test procedure, including the Notice of Proposed Rulemakings, Final Rules, Technical Support Documents, and submitted comments. TRC also interviewed eight stakeholders active in the adoption of the process: one NEEA staff member, four staff members from other efficiency organizations, and four manufacturers. All interviewees were involved in the 2016 BVM standards rulemaking and/or the 2015 BVM test procedure rulemaking

For the qualitative assessment, TRC found that NEEA achieved most of the activities identified in NEEA's Codes & Standards logic model of its codes and standards program for this evaluation, particularly through comments submitted in the public review process, including submitting written comments and participation in public meetings. For the quantitative assessment of the standard, TRC found that the efficiency organizations activities led to 10% of the total energy savings from the standard. Almost half of the savings, 4%, came from comments from the efficiency organizations recommending that DOE differentiate equipment classes based on the presence of a glass or opaque front.

# 2 INTRODUCTION

The Beverage Vending Machine (BVM) standard regulates refrigerated machines that chill and dispense bottled or canned beverages upon payment. The previous BVM standard was adopted 2009, and included efficiency standards for two equipment classes: Class A (machines that are fully cooled) and Class B (machines that are not fully cooled). DOE published a Framework document and held a public meeting in 2013 where they described analyses they planned to conduct during the new rulemaking and requested comment from interested parties. DOE used comments from efficiency organizations and others, gathered additional information, and published a preliminary analysis Technical Support Document (TSD) and held a public meeting in 2014. DOE published a Notice of Proposed Rulemaking (NOPR) in 2015 and proposed standards for four equipment classes, which includes modified versions of the original Class A and Class B, and new Combination A and Combination B. In early 2016, DOE published a Final Rule, which adopted equipment class definitions differentiated based on the presence of a glass or opaque front, as recommended by the efficiency organizations. The 2016 Final Rule took effect was March 8, 2016, and compliance was required beginning January 8, 2019.

The test procedure rulemaking happened in parallel with the standards rulemaking and was initiated in 2014 after DOE determined that the previous test procedure (from 2006) should be amended to improve the representativeness of field conditions and account for new technology features – including low power modes. DOE reorganized the test procedure into an Appendix A, which clarified existing provisions of the test procedure and an Appendix B, which incorporated the impact of low power modes. DOE published a test procedure NOPR in 2014 which referenced ANSI/ASHRAE Standard 32.1 (2010) (instead of the previously referenced ANSI/ASHRAE Standard 32.1-2004) in both Appendix A and Appendix B. DOE published a test procedure Final Rule in 2015, codifying these changes. The 2015 test procedure Final Rule took effect August 31. 2015. Compliance was required beginning January 27, 2016 for Appendix A and beginning after the compliance date of the amended energy conservation standards for Appendix B.

As part of its codes and standards program, NEEA supported the development and adoption of the BVM standard, by submitting comments at various stages of the standard development and by participating in public meetings.

## 2.1 Study Purpose

The scope of TRC's evaluation was to investigate the barriers to adoption for the BVM standard, the activities that NEEA conducted, the activities that other energy efficiency organizations conducted, and the effectiveness of these activities. Based on the results, TRC provided two assessments:

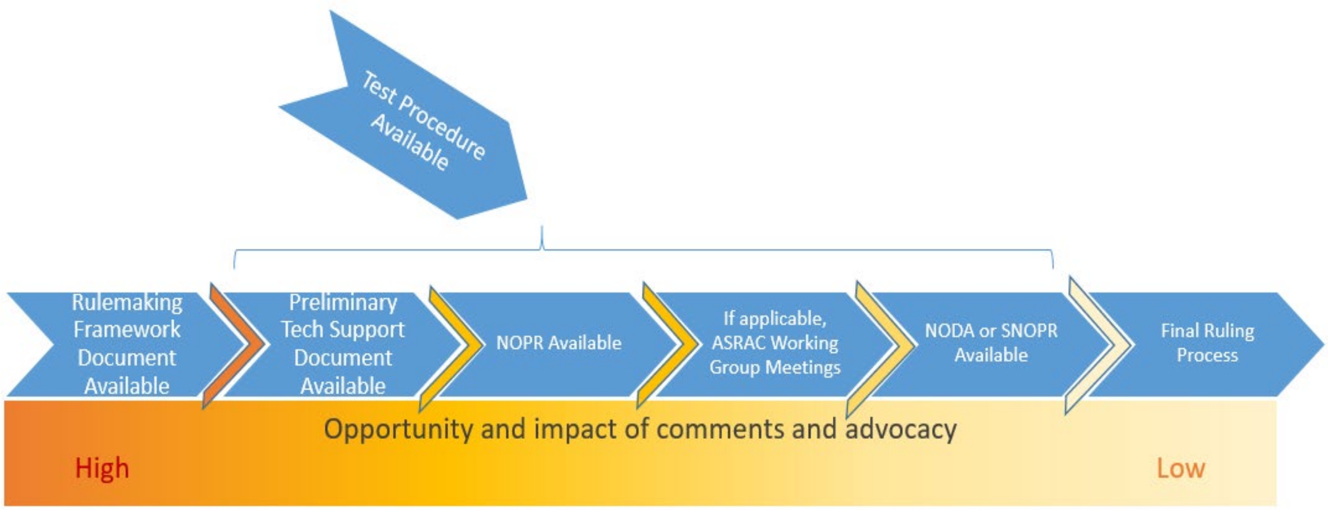
1. A qualitative assessment of NEEA's influence in the establishment of the BVM standards, which TRC developed based on the NEEA Standards Development Logic Model; and

2. A quantitative assessment of the savings from the standards due to all energy efficiency organizations, including NEEA.

## 2.2 Description of DOE Adoption Process

As background, TRC provides the following description of the DOE federal standard adoption process. The DOE is the government agency responsible for developing and adopting national appliance energy standards. During the standard development process, the DOE seeks input from stakeholders, including comments regarding the feasibility of the proposed standard and its impact on consumers, manufacturers, and other stakeholders. Stakeholders can provide input during public meetings and comment periods, both of which occur after the public release of rulemaking documents. The DOE must address stakeholder comments and demonstrate that the benefit of a new or revised standard will exceed any burden that it may impose – e.g., that the energy savings (in dollars) from the new standard will exceed costs for implementation. TRC developed Figure 1 to illustrate the general DOE standard development process and opportunities for stakeholder input.

*Figure 1. DOE Standard Development Process and Opportunities for Stakeholders' Influence*




There are multiple opportunities for stakeholders to influence the final standard and supporting documents that impact energy savings, including providing comments and data on the:

1. Test procedure, which details how a product must be tested for compliance with the standard
2. Inputs and analysis methodologies used to evaluate each efficiency level considered for the standard, including engineering analysis to determine cost effectiveness, market availability and pricing data, and design options that could affect efficiency
3. Efficiency levels proposed for each equipment class

For some standards, a working group formed by the Appliance Standards and Rulemaking Federal Advisory Committee (ASRAC) provides recommendations to DOE. This often occurs when a standard requires significant negotiations to identify acceptable terms, such as product classes, definitions, or required efficiency level, and the working group typically includes efficiency organizations. In the case of the BVM, there was not an ASRAC working group.

# 3 METHODOLOY

This section provides an overview of the data collection activities and analysis methodology for this evaluation.

## 3.1 Data Collection Approach

To collect data for this evaluation, TRC:

1. Reviewed literature – primarily from the DOE docket for this appliance standard, and
2. Gathered feedback from stakeholders involved in the rulemaking process for this standard, primarily through telephone interviews.

TRC's literature review included:

- DOE docketed comments from stakeholders, including manufacturers, energy efficiency organizations, and other interested parties
- DOE Framework document for the energy conservation standard
- DOE Notice of Proposed Rulemaking (NOPR) for the energy conservation standard
- DOE Final Rule for the energy conservation standard
- DOE NOPR for the test procedure
- DOE Final Rule for the test procedure
- DOE Preliminary, NOPR and Final Technical Support Documents (TSDs) for the energy conservation standard
- Public meeting transcripts

TRC conducted phone interviews with staff at various organizations that were active in the adoption of this standard. This included:

- One NEEA staff member
- Staff members from energy efficiency organizations that played a prominent role in supporting this standard's development. TRC interviewed staff from four of the efficiency organizations, one of which is a representative from a utility that TRC categorizes as an efficiency organization, because they consistently provided comments in support of high efficiency levels;
- Four manufacturers in phone interviews

Figure 2 summarizes the interview dispositions. As shown in this figure, TRC met the total number of target interviews. TRC contacted DOE to request an interview, but DOE staff declined the request, citing the docket instead.

*Figure 2. Number of Targeted and Completed Interviews by Stakeholder Category*

| Stakeholder Category | Target Interviews | Candidates Contacted | Completed Interviews |
|---|---|---|---|
| NEEA C&S Staff | 1 | 1 | 1 |
| Energy Efficiency Organizations and Utility Representative | 3 – 5 | 5 | 4 |
| Manufacturers and Trade Organizations | 3 – 5 | 11 | 4 |
| ***(OPTIONAL - Pending need)*** Other Stakeholders | 1 – 2 | 0 | 0 |
| **Total** | **7 – 11** | **17** | **9** |

## 3.2 Limitations of Data Collection Efforts and Analysis

One overarching limitation was that the DOE began development of the BVM standard years ago, with stakeholder comments submitted as early as June 2013. To help address recall issues, TRC sent interviewees their organization's docketed comments and a summary of the adoption timeline prior to the interview. TRC acknowledges that this may have introduced some bias into interviewees' responses. Several stakeholders interviewed also reported difficulty recalling aspects of the standard development, given the time lag.

Based on TRC's review of the dockets and from information collected through interviews with participants in the process, we believe that our quantitative and qualitative assessments accurately portray the proceedings and that the conclusions regarding efficiency organizations' influence are reasonable.

## 3.3 Methodology to Assess NEEA's Influence

To assess NEEA's influence on the development and adoption of this standard, TRC compared the proposed activities from NEEA Logic Model for Standards Rulemaking Process (provided in Appendix: NEEA Logic Model for Standards Rulemaking Process) with activities that NEEA conducted, based on interviews and the literature review. TRC identified barriers to the adoption of this standard, and then identified influential activities that addressed the barrier in which NEEA participated. Finally, TRC identified NEEA's role and contribution for each activity and output.

## 3.4 Methodology to Estimate Energy Savings from All Efficiency Stakeholders

To estimate savings from all energy efficiency organizations' efforts in support of the standard, TRC first developed a qualitative assessment of the impact of energy efficiency organizations' efforts. Specifically, TRC

1. Used the docketed literature to identify all barriers to the adoption of the standard, including comments raised by all stakeholders
2. Used the docketed literature to identify the outcome of each issue where the efficiency organizations provided comments, and identified those for which DOE made a change based on the comment – such as a revision in product classes, definitions, analysis, or proposed efficiency level.
3. Used the docketed literature and interviews with stakeholders to understand:
    a. The relative significance of the issues where efficiency organizations provided comments compared to all issues raised for the standards
    b. For each issue affected by the efficiency organizations, the relative impact of the efficiency organizations' comments on the final outcome.

TRC then translated this qualitative assessment into a quantitative framework, to approximate the significance of energy efficiency organizations' activities as a percentage of energy savings resulting from activities during the development and rulemaking process. Section 5.1 provides detail on TRC's methodology for the quantitative analysis.

# 4 NEEA EFFECTIVENESS ASSESSMENT RESULTS

Figure 3 summarizes the results of TRC's assessment of NEEA's efforts. TRC developed this figure using the NEEA logic model as an assessment framework. Note that NEEA has one logic model for all codes and standards activities. NEEA adapts its activities to suit the specific needs for each particular standard; therefore, not all barriers or activities are relevant for every standard.

Using the assessment criteria from the NEEA logic model, TRC used information from the analysis to identify whether NEEA met each relevant criterion. TRC identified logic model activities and outputs with a "Y" if NEEA undertook the activity or output and "N" if NEEA did not. The figure provides a rationale for whether NEEA accomplished each objective and describes where some activities may not have been relevant or necessary for this standard.

NEEA's primary influence came from submitting comments to DOE during the standard development process. Comments and recommendations from NEEA and other energy efficiency included the following:

1. Supported DOE's proposed standard level or recommended that DOE select a higher standard.
2. Proposed equipment class differentiation based on the presence of a glass or opaque front and also on the arrangement of products within the BVM. This would replace equipment class definitions that differentiated classes based on whether or not the product was "fully-cooled", which lacked clarity on which products fell into which equipment classes.
3. Proposed that DOE examine possible efficiency improvements from the use of hydrocarbon refrigerants (primarily propane) because they were more efficient than some of the alternatives. Due to a recent U.S. Environmental Protection Agency's (EPA) rule which banned the refrigerant most commonly used in BVM (R-134a), there was debate about which refrigerant would be used in its place given that there is no equivalent.
4. Commented that DOE's shipments projections were too conservative and proposed two reasons why shipments may not decrease so dramatically: shift to healthy beverage options and an increase in the number of BVM replacements ahead of a recent EPA rule which banned certain refrigerants that were commonly used in BVM at the time.
5. Supported DOE's proposal to account for refrigeration low power mode through a calculation-based method, ensuring a repeatable, consistent, fair method to account for refrigeration low power mode.

DOE largely adopted these recommendations and utilized support from the efficiency organizations to adopt their own proposal.

Overall, NEEA engaged in most of activities found in the logic model. There were three activities that NEEA did not conduct for this standard: negotiation with manufacturers, conducting primary research and providing savings, and economic analysis based on Northwest data. In general, TRC found that this standard did not necessitate these activities. There was no direct negotiation because this was not a negotiated rulemaking and did not have an ASRAC working group (described in section 2.2) formed by DOE. There was not a high need for NEEA to provide these data or conduct savings analysis for this standard, since manufacturers or other efficiency organizations (including the CA IOUs) were generally able to provide data.

Figure 3 compares NEEA's activities to the C&S logic model. The white cells show the logic model inputs. The blue cells show TRC's assessment of NEEA's activities for this standard.

*Figure 3. Assessment of NEEA's Activities on the BVM Standard*

| **Barrier (NEEA logic model)** | **Manufacturer opposition** | | | **Lack of data with which to conduct the necessary analyses in a rulemaking** | | **Lack of common interest among certain stakeholders** | **Insufficient funding/staff for US DOE to run standards processes** |
|---|---|---|---|---|---|---|---|
| **Proposed Activity (NEEA logic model)** | Negotiation with manufacturers. | Attend public meetings held by DOE. | Analyze and critique organizations, manufacturers and rulemaking documents. | Conduct primary research to create data for standards and test procedures. | Provide savings and economic analyses based on Northwest data. | Collaboration with other organizations under the umbrella of ASAP. | Encourage utilities to provide data and political support for standards. |
| **Undertaken by NEEA? (TRC)** | N | Y | Y | N | N | Y | Y |
| **Rationale/ explanation (TRC)** | TRC did not find evidence that NEEA negotiated with manufacturers during the RFF standard process. | NEEA attended public meetings at all stages of rulemakings. | NEEA submitted sole comments and joint comments on standard development.<br><br>NEEA attended and actively participated in all public DOE hearings. | NEEA did not collect or provide primary data. | NEEA did not provide savings data for the Northwest. | NEEA submitted joint comments and held on-going communication and meetings. | NEEA worked jointly with CA IOUs, who provided data in the support of the standard. |
| **Outputs (NEEA logic model)** | Consensus-based proposals to submit to DOE or better general understanding of manufacturer positions and concerns | NEEA adds valuable information at each stage of the rulemaking process. | | NEEA adds valuable information at each stage of the rulemaking process. | NEEA information/ analysis referenced in rulemaking proceedings/ documentation | NEEA adds valuable information at each stage of the rulemaking process. NEEA information/ analysis referenced in rulemaking proceedings/ documentation | Utilities are present at hearings/ publicly support new standards. |
| **Accomplished by NEEA? (TRC)** | N/A | Y | | N/A | N/A | Y | Y |
| **Rationale/ explanation (TRC)** | N/A, because NEEA did not complete negotiations with manufacturers. | NEEA provided comments in support of DOE and other efficiency organizations that influence the test procedure and efficiency level adopted. | | N/A, because NEEA did not complete any primary research for this standard. | N/A, because NEEA did not provide any research for the docket. | DOE rulemaking documentation references NEEA joint comments. NEEA was active during public stakeholder hearings. | NEEA collaborated with the California Investor Owned Utilities (IOUs), which submitted comments that generally aligned with NEEA's. |

# 5 INFLUENCE OF EFFICIENCY ORANIZATION S

## 5.1 Description of Calculation of Energy Savings

TRC estimated the energy efficiency organizations' influence using an analysis framework described below. Sections 5.3 and 5.4 provide descriptions of TRC's rationale for our rankings and estimates of percentages. This section includes an example calculation, to demonstrate how we arrived at our estimates in the following sections 5.3 and 5.4. In this example we estimate the impact of removing one barrier (lack of adequate definitions of equipment classes). We do this by first estimating how important the removal of this barrier is compared to all others present in this particular standards process. We then estimate how important and how effective energy efficiency work was in removing the barrier. Below we lay out the steps more explicitly, including the estimated input we used (shown in *italics*)

a. **Identified and estimated the relative significance of the barriers** to adoption of the standard. TRC identified three barriers that were significant for standard development. Within each barrier, TRC identified sub-barriers. Based on the importance of each sub-barrier, TRC assigned a weighting factor to each so that their sum would total 100%:
    i. Manufacturer Opposition to More Stringent Standard: 40%
    ii. Lack of Data Availability and Accuracy: 50% total
        i. *Lack of adequate definitions to differentiate between equipment classes: 20%*
        ii. Lack of consensus on which refrigerant to use in the analysis: 20%
        iii. Lack of accurate accounting of refurbishments on shipments: 10%
    iii. Lack of Representative Test Procedure: 10%

b. **Identified and estimated the significance of each efficiency organization activity to overcome each barrier.** As one example activity the energy efficiency organizations commented that the DOE should define equipment classes based on the presence of a glass or opaque front and the arrangement of products within the machine. TRC found that this activity had a high significance in reducing the barrier, "Lack of Data Availability and Accuracy". TRC estimated the significance as 40% for addressing this barrier, based on the following scale:

    Low = 10%, Medium = 20%, and *High = 40%*

c. **Estimated the effectiveness of each efficiency organization activity relative to all efficiency organization activities to overcome all barriers**. Following our example activity, TRC rated the sub-barrier, "Lack of adequate definitions to differentiate between equipment classes" as 20% of significance across all barriers. Consequently, TRC estimated that the significance of this energy efficiency organizations activity relative to all activities was 20% x 40% = 8%.

d. **Estimated the role of efficiency organizations in each activity relative to all participants to support DOE (i.e. all, primary, major contributor, minor).** TRC estimated efficiency organizations' role to support DOE and address each barrier and applied a weighting to the significance of their activities. Because DOE (including its consultants) did the majority of the work to develop the draft test procedure, NOPR, and draft engineering analysis, TRC assumed that the maximum role played by the energy efficiency organizations for comments affecting these documents and analysis was 50%, as described below:

*Primary Support (50%):* Led efforts to provide comments to DOE.

Major Support (30%): Did not lead efforts but contributed significantly.

Minor Support (10%): Did not contribute significantly.

Using the example activity of comments to regulate BVM at the component level, efficiency organizations provided the Primary Support to the DOE. For this example, activity, the final estimated significance for this energy efficiency activity is 8% (calculated in step c) x 50% = 4%.

e. **Estimated the total impact of efficiency organizations' activities.** For each activity, TRC estimated the significance of each activity to overcome all barriers (step c) and multiplied this by the relative role of the organizations (step d). TRC then summed the significance of all activities.

## 5.2 Efficiency Organizations' Contribution to Energy Savings

TRC estimates the efficiency organizations' influence for this part of the standard development process is 10%. Figure 4 presents the detailed results. TRC provides a supporting rationale for each input in the sections below the figure. Note that this figure only lists barriers for which TRC found that the efficiency organizations impacted the final standard.

*Figure 4. Impact Analysis of Efficiency Organizations' Contributions*

| Barrier, based on NEEA logic model | 1. Manufacturer Opposition to More Stringent Standard | 2. Lack of Data Availability and Accuracy: Lack of adequate definitions to differentiate between equipment classes. | 2. Lack of Data Availability and Accuracy: Question on which refrigerant(s) to assume in the analysis | 2. Lack of Data Availability and Accuracy: Future shipments projections factoring in refurbishments | 3. Lack of Representative Test Procedure | Total |
|---|---|---|---|---|---|---|
| **Sub-barrier specific to standard** | Industry strongly pushed back on DOE's proposed standard, commenting that it was too aggressive and that it was not technologically feasible and not economically justified, especially in light of the new U.S. Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) regulations | Lack of adequate definitions to differentiate equipment classes and therefore ambiguity and lack of clarity on which products fell into which equipment classes. Industry opposed DOE's proposal and did not suggest an alternative. | Due to a recent EPA rule which banned the refrigerant most commonly used in BVM (R-134a), there was debate about which refrigerant would be used in its place given that there is no equivalent. | Debate over what the trend in future BVM shipments would be, particularly accounting for the impact of the EPA SNAP rule and a market shift towards healthy beverages. Industry noted a current and continuing decline in shipments. | Lack of repeatable, consistent, fair method to account for refrigeration low power mode. Some organizations opposed DOE's proposal to include a calculation-based refrigeration low power mode in favor of a physical test. | |
| **Significance for energy savings** | **High** | **Medium** | **Low** | **Low** | **Medium** | |
| **a. Significance of barrier (%)** | **40%** | **20%** | **10%** | **10%** | **20%** | **100%** |
| **Activities Conducted by all EE Organizations** | **Activities to Address Barrier 1** | **Activities to Address Barrier 2** | | | **Activities to Address Barrier 3** | |
| | EE organizations supported DOE's proposed standard level or recommended that DOE select a higher standard. | EE organizations proposed to differentiate equipment classes based on the presence of a glass or opaque front and also on the arrangement of products within the BVM. | EE organizations proposed that DOE examine possible efficiency improvements from the use of hydrocarbon refrigerants (primarily propane) because they were more efficient than some of the alternatives. | EE organizations commented that DOE's projections underestimated BVM shipments and proposed two reasons why shipments may not decrease so dramatically: increase in healthy beverage sales and an increase in the number of BVM replacements ahead of the EPA SNAP compliance date. | EE organizations supported DOE's proposal, due to difficulty of accounting for the wide variety of refrigeration low power modes in a consistent, fair, and reasonable manner. | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Results - i.e., DOE response** | In the Final Rule, DOE lowered the efficiency levels compared to the NOPR. DOE concluded that given that industry experience with SNAP-compliant refrigerants was limited, and that the potential burdens of the more-stringent energy efficiency levels would outweigh the project benefits. While DOE did reduce efficiency levels, they could have reduced them even further in the absence of efficiency comments. | DOE adopted equipment class definitions which differentiated equipment classes on the basis of a opaque/transparent front. | DOE assumed that following the effective date of the EPA rule, 40% of BVM shipments would be propane and 60% would be $CO_2$. DOE accounted for the performance characteristics of both refrigerants, with propane saving more energy than $CO_2$. | DOE revised its analysis to account for both reasons that EE organizations cited. In the Final Rule, total shipments were 15% higher than in NOPR. | DOE adopted a calculation-based method for the refrigeration low power mode in the test procedure Final Rule. | |
| **Effectiveness of activity for addressing barrier** | **Low** | **High** | **Medium** | **High** | **Medium** | |
| **b. Significance for each barrier (%)** | **10%** | **40%** | **20%** | **40%** | **20%** | |
| **c. Significance across <u>all</u> barriers: axb (%)** | **4.0%** | **8.0%** | **2.0%** | **4.0%** | **4.0%** | |
| **EE organizations' role** | **Primary** | **Primary** | **Major** | **Primary** | **Major** | |
| **d. EEs' Relative Role in activity (%)** | **50%** | **50%** | **30%** | **50%** | **30%** | |
| **e. Significance of EE activity relative to total savings, cxd (%)** | **2.0%** | **4.0%** | **0.6%** | **2.0%** | **1.2%** | **9.8%** |

## 5.3 Rationale for Weighting Significance of Barriers

To identify barriers, TRC began with the barriers in the NEEA Standards Development Logic Model. Because this is the general logic model that applies to all of NEEA's standards development efforts, TRC revised this list of barriers based on the specific challenges of this standard. TRC identified two of the barriers in the NEEA logic model for standards rulemaking as applicable to this standard – Manufacturer Opposition, and Lack of Data – and added a third barrier based on the specifics of this standard: Lack of representative test procedure.

### 5.3.1 Barrier 1: Manufacturer opposition to regulation or more stringent standard

Significance: High

Rationale and Findings: In the NOPR, DOE proposed adopting Trial Standard Level (TSL)[1] 4 for BVM, which was projected to save 0.235 quads. The docket and interviews suggested industry strongly pushed back on the proposed standard, commenting that DOE's proposed standard level was too aggressive and that it was not technologically feasible and not economically justified. Industry commented that this was particularly true considering a recent rule from the U.S. Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) program, which banned certain refrigerants which were commonly used in BVM. Though industry did not identify a particular TSL as an alternative, their comments made it appear that they would have been satisfied with TSL 1 or TSL 2.

TRC ranked this barrier as high because the final efficiency level has a major impact on the energy savings from the standard, and because there was significant industry pushback on the proposed efficiency level.

### 5.3.2 Barrier 2: Lack of data availability and accuracy

DOE makes numerous assumptions in the engineering analysis that ultimately shape the energy savings values. Assumptions are wide-ranging and consist of different factors such as the equipment mark-up by small general contractors, individual component costs, consumer discount rates, and many other factors. In the sections below, TRC describes those engineering analysis assumptions that efficiency organizations commented on that resulted in energy savings. One reason that these engineering assumptions have a significance of Medium and Low is because there were many other assumptions and inputs that stakeholders debated than the issues listed here. (Recall that this analysis only tracks issues that the efficiency organizations impacted.) If DOE revises analysis assumptions that therefore result in lower predicted energy use in the analysis at higher efficiency levels, it may make a higher efficiency level more cost-effective, and therefore enable DOE to adopt the higher level. Figure 5 shows the number of comments that the efficiency organizations and the industry submitted on each topic in the standards Final Rule, illustrating that in the Final Rule alone there were numerous comments from both the efficiency organizations and the industry – including manufacturers and trade organizations, with

[1] The Trial Standard Level (TSL) combines specific efficiency levels for each equipment class.

only a subset of the comments resulting in a change to the final outcome of the rulemaking. A comment is considered to have a "resulting change" if it caused DOE to revise a proposal or if its support of an existing proposal allowed DOE to adopt the proposal when other stakeholders opposed it.

| | Efficiency Organizations | | Industry | |
|---|---|---|---|---|
| **Topic** | **Neutral or No Impact** | **Resulting change** | **Neutral or No Impact** | **Resulting change** |
| Analytical Results and Conclusions | | | | 1 |
| Emissions Analysis | | | 1 | |
| Energy Analysis | 1 | | 2 | |
| Engineering Analysis | 4 | | 6 | 9 |
| Life-Cycle Cost and Payback Period Analysis | | | 4 | 1 |
| Manufacturer Impact Analysis | | | 3 | 2 |
| Market and Technology Assessment | 2 | 1 | 4 | |
| Monetizing Emissions Analysis | | | | |
| National Impact Analysis | | | 1 | |
| Shipments Analysis | | 2 | 2 | 2 |
| Technological Feasibility | | 1 | 1 | |
| Test Procedure | 1 | | 2 | |
| **Total** | **8** | **4** | **26** | **15** |

*Figure 5. Count of Final Rule Comments by Stakeholder and by Topic*

*Sub-barrier: Lack of adequate definitions to differentiate between equipment classes.*

Significance: Medium

Rationale and Findings: In the prior BVM standard (published August 31, 2009), DOE differentiated Equipment Class A and Equipment Class B on the basis of whether or not the product was "fully-cooled". However, DOE did not provide a definition for "fully-cooled". In the framework document of this recent rulemaking, DOE noted that their differentiation of Class A and Class B led to ambiguity and lack of clarity on which products fell into which equipment class. In the standards framework document, DOE proposed a definition for "fully-cooled", and in the test procedure NOPR DOE further expanded on that definition. DOE received significant pushback on its proposal from industry, with particular concerns about the increased test procedure burden due to the proposed definition.

TRC ranked this barrier as Medium because DOE had made multiple proposals regarding the definitions, but many stakeholders opposed their proposals. It is critical that DOE reach consensus on foundational issues like equipment class definitions before discussing issues like standard levels by equipment class.

*Sub-barrier: Question on which refrigerant(s) to assume in the analysis.*

Significance: Low

Rationale and Findings: The U.S. Environmental Protection Agency's (EPA's) Significant New Alternatives Policy (SNAP) program ruled R-134a to be an unacceptable refrigerant in BVM, effective January 1, 2019. At the time of the BVM rulemaking, R-134a was the most common refrigerant used in BVM, and there was debate throughout the BVM rulemaking about what refrigerant would be used in BVM after the SNAP rule took effect. Each potential refrigerant replacement had different performance characteristics, associated safety measures, and costs, with no refrigerant equivalent to R-134a.

TRC ranked this issue as Low because it was clear that DOE had to pick refrigerants to use in their analysis and had to characterize them in the analysis. Industry wanted cost to be a consideration in the refrigerant selection but did not raise the possibility of considering the efficiency benefits.

*Sub-barrier: Future shipments projections factoring in refurbishments*

Significance: Low

Rationale and Findings: DOE projects future shipments of BVM in order to calculate the national energy savings of the new standard. During the rulemaking there was debate over what the trend in future shipments would be, particularly accounting for the impact of the EPA SNAP rule and future trends in consumers' consumption of chilled beverages. Industry noted a current and continuing decline in shipments. In the NOPR, DOE assumed a significant (74%) decline in stock of BVM from 2008 through 2026, as seen in Figure 6.

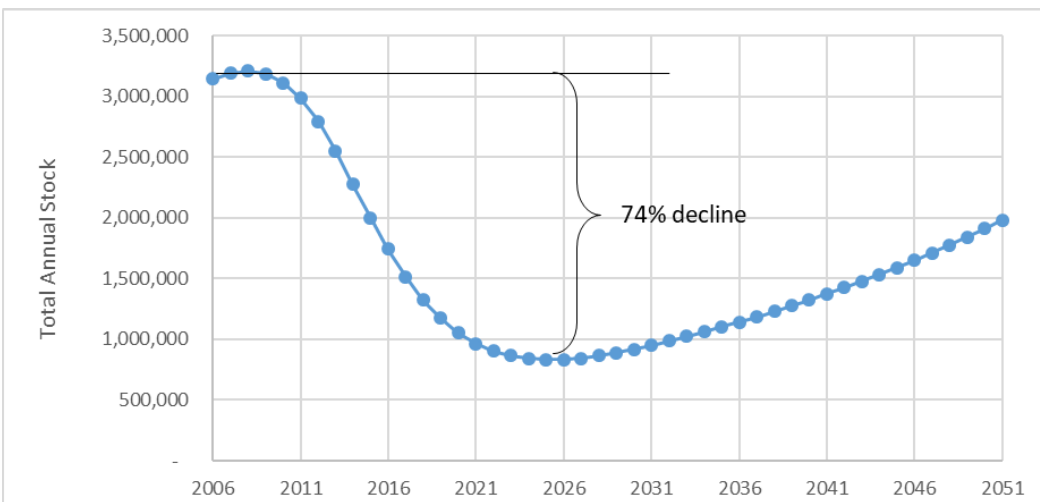



*Figure 6. Total Annual BVM Stock Projected in the DOE NOPR*

TRC ranked this issue as Low, because this assumption has a smaller impact than various other inputs in calculations. The national energy savings calculated by DOE are directly correlated with the shipments projections, so declining shipments would result in lower energy savings projections. However, efficiency levels of standards are typically driven by cost-effectiveness and technical feasibility, so higher national energy savings projections are unlikely to have led to a higher standard efficiency level.

### 5.3.3 Barrier 3: Lack of representative test procedure

Significance: Medium

Rationale and Findings: In the test procedure NOPR, DOE considered several different options for how it would account for refrigeration low power mode, including physical testing as well as calculation-based methods. DOE noted that manufacturers all implement refrigeration low power modes very differently, and therefore had concerns about repeatability of a physical test. DOE ultimately proposed a calculation-based method which gave a fixed percentage credit to all BVMs with refrigeration low-power mode. Some industry groups were in favor of physical testing, stating that it would be the most accurate method and had concerns about the proposed percentage credit.

TRC ranked this barrier as Medium because while there were a number of stakeholders that commented in favor of a physical test and against a calculation method, the efficiency organizations' position was supporting what DOE had already proposed.

## 5.4 Rationale for Weighting Significance of Activities

This section describes TRC's rationale for weighting the significance of each activity that the efficiency organizations conducted.

### 5.4.1 Activities to Address Barrier 1: Manufacturer Opposition to More Stringent Standard

Activity and Significance: In response to the NOPR, the efficiency organizations submitted comments and participated in public meetings expressing support for the proposed TSL and encouraging a higher TSL for some equipment classes. The efficiency organizations justified higher standards on the basis that propane compressors would save energy over existing compressors, suggesting that BVMs currently on the market could likely meet the proposed standard.

While the efficiency organizations' support was useful in providing an upper end of energy savings potential, DOE recognized the lack of industry experience with new/different SNAP-compliant refrigerants and ultimately adopted a lower efficiency level (TSL 3) from that which was proposed in the NOPR. Though industry did not recommend a particular TSL, it is likely that they would have been satisfied with TSL 1 or TSL 2.

Figure 7 gives a summary of the TSLs and associated cumulative national energy savings including full-fuel-cycle over the 30-year analysis period, as determined by DOE in the NOPR.

| Standard Level | National Energy Savings Determined by DOE in NOPR (quads) | Supporters | Relative Savings |
|---|---|---|---|
| TSL 1 | 0.017 | Likely had industry support | - |

| | | | |
|---|---|---|---|
| TSL 2 | 0.063 | Likely had industry support | - |
| TSL 3 | 0.122 | Adopted by DOE in Final Rule | Saves 6x more energy than TSL 1;<br><br>Saves 2x more than TSL 2 |
| TSL 4 | 0.235 | Supported by efficiency organizations | Saves almost 2x more energy than TSL 3 |

*Figure 7. Energy Savings Projections at Each Standard Level and Supporters of Each Standard Level*

Because DOE ultimately adopted TSL 3 – which is a lower TSL than they originally proposed, TRC ranked the efficiency organizations' effectiveness as Low.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being the primary proponent to the DOE for this activity, since manufacturers pushed for lower efficiency levels.

Savings from Activity: 2.0% of savings.[2]

### 5.4.2 Activities to Address Barrier 2: Lack of Data Availability and Accuracy

**Commented on Equipment Class Definitions**

Activity and Significance: The efficiency organizations suggested differentiating equipment classes based on the presence of a transparent or opaque front and/or the arrangement of products within the BVM. Figure 8 shows examples of a machine with a transparent front and a machine with an opaque front. The efficiency organizations suggested that differentiating equipment classes on this basis would be more appropriate and consistent with the differentiation between equipment configurations applied in industry. One manufacturer also commented that equipment classes should be differentiated based on product configuration. In the Final Rule, DOE adopted equipment class definitions based on the presence of a transparent front side.

[2] All savings rates referenced in this section are derived as described in section 5.1 and can be found in Figure 4


*Figure 8. Beverage Vending Machine with a transparent front (left) and an opaque front (right); photo credit: Royal Vendors*

DOE notes that the new definitions in the Final Rule were clarifications on the previously-adopted definitions, and they did not significantly impact how products were classified. However, multiple interviewees (including efficiency organizations and manufacturers) noted that the energy savings due to this issue was high, suggesting that the previous ambiguity in definitions led some products to be classified in an equipment class with a lower efficiency standard level than its intended equipment class in the previous standard.

Because of these factors, TRC ranked the efficiency organizations' effectiveness as High.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being the primary proponent to the DOE for this activity.

Savings from Activity: 4.0% of savings.

**Commented on Refrigerants to Assume in Analysis**

Activity and Significance: The efficiency organizations recommended that DOE examine efficiency improvements from the use of hydrocarbon refrigerants and include them in their analysis. While industry did not oppose the use of hydrocarbon refrigerants, they did cite concerns about the associated costs of using such refrigerants, primarily due to the refrigerants' flammability. In the Final Rule analysis, DOE assumed that following the compliance date of the EPA SNAP rule, the market would shift entirely to $CO_2$ and propane refrigerants.

DOE analyzed the performance characteristics and market penetration of each refrigerant separately, accounting for their different energy uses. DOE's analysis showed lower energy use of BVM with propane than with BVM with $CO_2$ for almost all design level options, as seen in Figure 9 for one equipment class. DOE assumed that 40% of shipments would be propane, with the other 60% being $CO_2$. Had the shipments all been $CO_2$, then the national energy savings would be 6% less.

It is likely that DOE would have included both refrigerants in its analysis regardless of the comments from the efficiency organizations because the EPA SNAP program listed propane as an acceptable refrigerant for BVM applications. Additionally, one manufacturer interviewed noted that some component manufacturers were already moving towards alternative refrigerants. However, the efficiency organizations may have had a role in ensuring that DOE accounted for the efficiency improvements associated with propane.

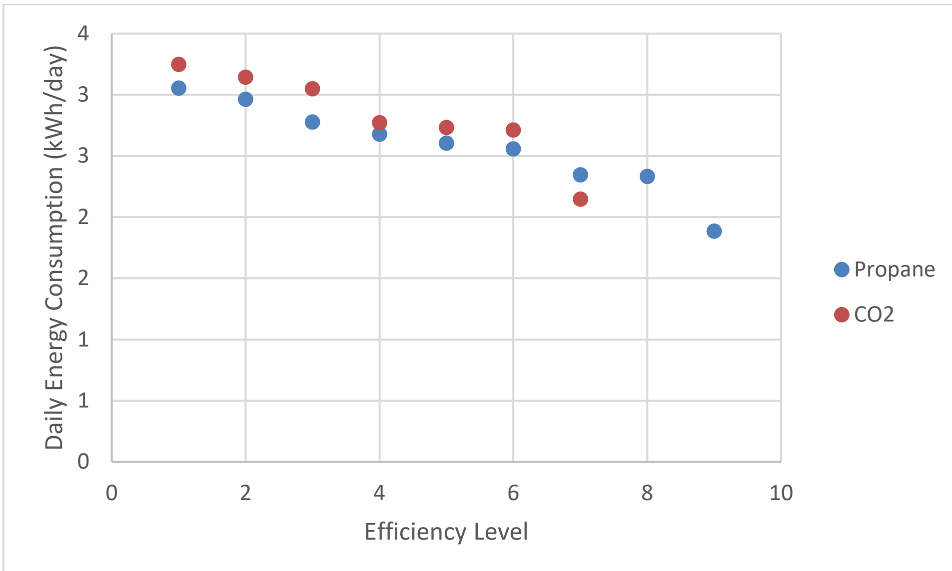



*Figure 9. Daily Energy Consumption of Refrigerants used in Class A, Small (Final Rule TSD)*

Because of these factors, TRC ranked the efficiency organizations' effectiveness as Medium.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being a major role to the DOE for this activity.

Savings from Activity: 0.60% of savings.

**Commented on Shipments Assumptions**

Activity and Significance: In the NOPR, the DOE assumed that BVM shipments would decrease. In response to the NOPR, efficiency organizations commented that DOE's shipments projects may be too conservative, as they resulted in a decline in BVM stock of 20% between 2014 and 2048 at the same time that there would be an increase in the building stock. The efficiency organizations proposed two potential reasons as to why future shipments would actually increase instead of decrease and suggested that DOE account for these.

The efficiency organizations and one industry organization commented that a shift to healthier beverage options would not necessarily mean a decrease in future BVM shipments, since the BVM could sell sports drinks and other non-sugary drinks like water. Efficiency organizations argued that shipments could actually increase over time. Opposing the efficiency organizations, at least one manufacturer noted that they had seen a decline in BVM shipments, and that the decline was likely to continue.

Another significant factor in future shipments projections was the impact that the new EPA SNAP requirements would have. Efficiency organizations commented that the EPA SNAP rule would lead to an increase in shipments as refurbishment may not be practical when switching refrigerants, while three manufacturers and industry organizations commented that the new SNAP rule would decrease new machine purchases in favor of refurbishments.

DOE made a number of adjustments to the shipments model between the NOPR and the Final Rule, accounting for comments from efficiency organizations and manufacturers. To explicitly accounted for refurbishments in the Final Rule, DOE assumed that ahead of the EPA SNAP compliance date, BVM owners would opt to replace aging equipment, therefore leading to an increase in shipments in the near term. This impact is seen in the sharp increase in shipments starting in 2015 in Figure 10, which shows the difference in DOE's assumptions between the NOPR and Final Rule. (TRC created the graph based on data in the NOPR and Final Rule.) Regarding a shift to healthy beverage options, DOE assumed an annual percentage reduction in BVMs by building type in the Final Rule. DOE notes for each building type, the reduction is in part due to increased emphasis on health, but that there was not a complete reduction because DOE also assumed a shift to healthier options. Though this impact was not quantified in the Final Rule, the total shipments projected for the period in which the standard would be effective were 15% higher than those in the NOPR.

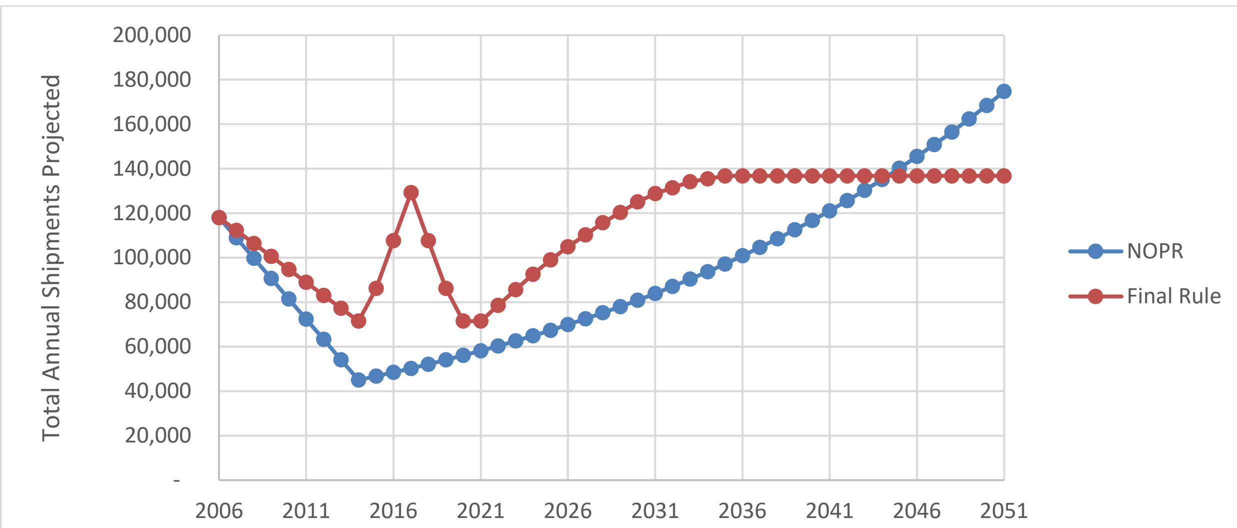



*Figure 10. Total Annual BVM Shipments Projected in DOE NOPR and Final Rule*

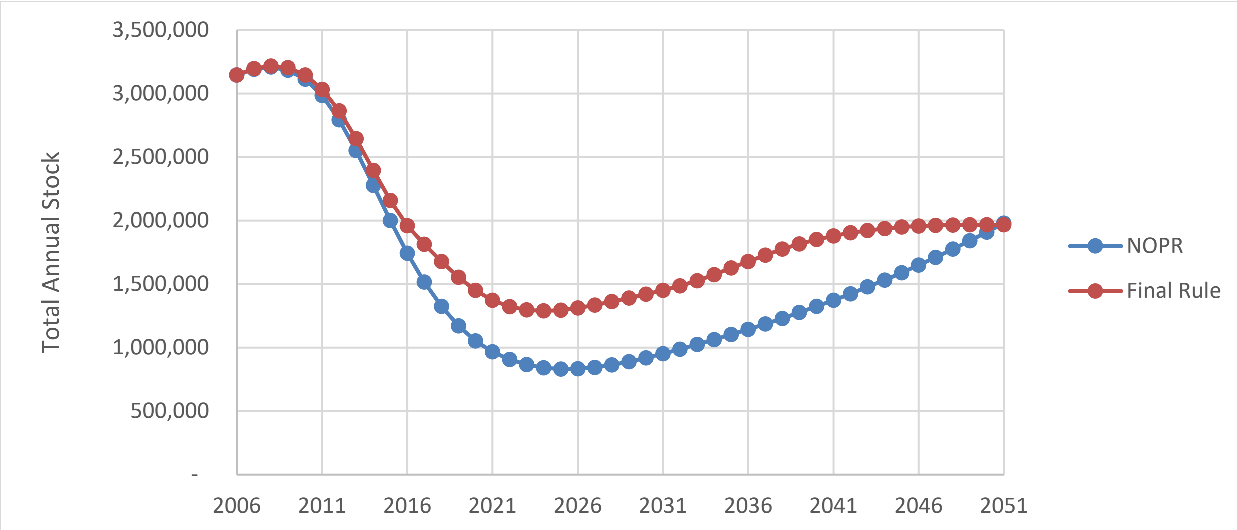



*Figure 11. Total Annual BVM Stock Projected in DOE NOPR and Final Rule*

Because of these factors, TRC ranked the efficiency organizations' effectiveness as High.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being the primary proponent to the DOE for this activity.

Savings from Activity: 2.00% of savings.

### 5.4.3 Activities to Address Barrier 3: Lack of Representative Test Procedure

Activity and its Significance: Some efficiency organizations and one manufacturer supported DOE's proposal for a calculation-based refrigeration low power test, while four different organizations opposed it. DOE noted that the calculation-based approach would be more accurate, consistent, and equitable than a physical-based approach, and ultimately adopted a calculation-based approach in the test procedure Final Rule. Because DOE did receive significant pushback on this proposal, support from the efficiency organizations was key in getting this proposal adopted.

Because of these factors, TRC ranked the efficiency organizations' effectiveness as Medium.

Role of Efficiency Organizations: TRC identified the efficiency organizations as being a major proponent to the DOE for this activity since the efficiency organizations led the commenting on this topic, but one other manufacturer made a similar comment.

Savings from Activity: 1.20% of savings.

# 6 FUTURE ENERY SAVINS AND OTHER FEEDBACK COLLECTED

TRC notes other activities that the efficiency organizations conducted during the BVM standard development that may lead to future energy savings:

- During this BVM rulemaking, efficiency organizations commented that they were in the process of conducting testing comparing the performance of propane to other refrigerants, and would share the data with DOE once completed. They also noted that the safety issues and precautions currently required with propane refrigerant will be addressed by the industry in the future, allowing more widespread use of propane at a lower cost. Given the support from the efficiency organizations for propane refrigerant, TRC believes that in the next BVM rulemaking the efficiency organizations will be successful in pushing the standard even higher.

- During the BVM rulemaking, efficiency organizations proposed including variable speed compressors as a technology option in the engineering analysis, stating that the nature of the operating modes of BVMs make them good candidates for variable speed compressors to reduce energy consumption. In response, DOE had noted the current lack of market availability of such machines. TRC believes that given the insistence of the efficiency organizations and the prevalence of variable speed compressors in other industries, BVM manufacturers will develop products with variable speed compressors, which will likely become the baseline in future rulemaking.

Manufacturers interviewed provided the following comments in addition to those described in Section 5:

- In a particular rulemaking, having any influence on DOE as a manufacturer or as an efficiency organization is difficult.

- The biggest impact that efficiency organizations have is by being the voice of better, more energy efficient standards.

# 7 Conclusions

Based on the data collection, TRC's impact assessment was that efficiency organizations had a low-to-moderate influence on the standard. The influence of the efficiency organizations came from submitting comments related to the engineering analysis, including that DOE define equipment classes based on the presence of a transparent or an opaque front. TRC estimates that the efficiency organizations contributed 10% of total savings from the standard.

## APPENDIX: NEEA LOIC MODEL FOR STANDARDS RULEMAKIN PROCESS