# Incremental Costs: Keeping Current on a Critical Parameter

*Mike Sherman, Nick Beaman, Floyd Keneipp, Navigant Consulting, Burlington, MA; Elizabeth Titus, Northeast Energy Efficiency Partnerships, Lexington, MA*

## ABSTRACT

Energy Efficiency program cost effectiveness determinations rely on several critical parameters. While much attention is paid to realization rates, gross and net savings, discount rates and other factors, relatively little attention is paid to accurately determining baseline and efficient measure costs. In large part this has been so because incremental cost studies are difficult to do and costly. The Regional EM&V Forum, facilitated by Northeast Energy Efficiency Partnerships (NEEP), commissioned Navigant Consulting to determine incremental costs for a group of 12 measures, across a region including New England, New York, Maryland, Delaware and Washington DC comprising six distinct markets. The research team conducted the Incremental Cost Study (ICS) across these varied markets gaining economies of scale in data collection and analysis. The research team developed Non-Regional Specific costs through regression analyses of contractor and secondary data. Using R.S. Means to establish market-specific cost factors, the team developed materials and labor baseline and incremental costs for each market, aiding transparency and cost comparability. Having transparent baseline costs may also help program planners and efficiency baselines progress. The team believes the cost curves are robust enough to be updated with some periodic interviews and online price reviews, a less costly approach than traditional cost studies. The project also has stimulated discussion about policy level cost effectiveness issues, particularly better ways to account for non-energy upgrades in efficient equipment that increase costs without adding further energy savings.

## Introduction

This paper presents the methods and some illustrative results of an incremental cost study conceived and funded by the Regional EM&V Forum, facilitated by the Northeast Energy Efficiency Partnerships (NEEP). The Forum seeks regional consistency and transparency on a variety of EM&V issues in the Northeast and Mid-Atlantic, from basic concepts such as terminology and best practices to research efforts that leverage regional data and economies of scale. The Incremental Cost Study (ICS) is one such effort, in which a unified approach across a band of states ranging from Maine through the District of Columbia will produce incremental cost data on a variety of electric and gas measures chosen by the project Subcommittee of Forum members and researched by the study team.

**Background**

Energy Efficiency program cost effectiveness determinations rely on several critical parameters. While much attention is paid to realization rates, gross and net savings, discount rates and other cost effectiveness considerations, relatively little attention is paid to accurately determining baseline and efficient measure costs. In large part this has been so because incremental cost studies are difficult to do and costly. The EMV Forum, facilitated by NEEP, commissioned the study to determine incremental costs for 12 measures in the Forum region that includes New England, New York, Maryland, Delaware and Washington DC. Navigant conducted the Incremental Cost Study (ICS) customizing the results for six identified markets. The study achieved economies of scale in data collection and analysis, combined with a methodology that will allow cost curves established in 2011 to be relatively easily updated in later years.

There were two unique aspects to the ICS. First, the study focused narrowly on the actual makes and models of efficient equipment for which energy efficiency program administrators are paying rebates. The team reviewed and analyzed program administrators' program databases for contractor and measure information. This focused approach improved the accuracy of cost estimations; for any given measure a small number of makes and models often accounts for a large percentage of all equipment receiving program incentives. Further, being able to contact installers and say, "our records show you've installed X number of 3 ton SEER 15 units manufactured by Y manufacturer in program administrator Z's program" provides researchers with credibility and authority. This approach is not without difficulties, as we will describe.

Second, the ICS did not seek a single, universal result for each measure. Incremental cost studies capture a market snapshot at a point in time. Since it is an expensive and difficult snapshot to take, program administrators are reluctant to update it often. As a result, cost data used in determining cost effectiveness are often old, inaccurate, or are updated using a best estimate approach. However, program designs differ among program administrators across the study region and programs may change from year to year. The ICS' dynamic approach developed cost curves based on comprehensive data collection and analysis. The ICS established overall costs, dubbed Non Regional-Specific Costs, and then tailored them to each of the six markets in the study.

## Project Scope

The EMV Research Subcommittee initially chose 18 measures for the research, dividing them into top and second priority groups. The research team was tasked with first performing a secondary research screening process to establish the availability and usability of existing cost data and then recommending measures that seemed most appropriate for further research. Budgetary considerations limited primary research to 12 measures, six of which were pre-selected by the subcommittee at the outset. Table 1 shows the initial measure list and the team's recommendations.

**Table 1**: Research Team's Recommendations and EMV Subcommittee Decisions

| Measure | Project Application | Research team Recommendation | EMV Decision |
|---|---|---|---|
| **Top Priority Measures** | | | |
| Residential central air conditioners | ROB/NC | Primary | **Primary** |
| Residential air source heat pumps | ROB/NC | Primary | **Primary** |
| Residential furnace fans (e.g. ECM fans) | ROB/NC | Primary | **Primary*** |
| Commercial unitary air conditioners | ROB/NC | Primary | **Primary** |
| Residential insulation upgrades (attic, wall, basement) | RET/NC | Secondary only | **Primary** |
| Residential air sealing | RET/NC | Primary | **Primary** |
| Residential gas furnaces | ROB/NC | Primary Pre-Selected | **Primary** |
| Residential gas boilers | ROB/NC | Primary Pre-Selected | **Primary** |
| Commercial gas boilers | ROB/NC | Primary Pre-Selected | **Primary** |
| Combination Heat Hot water | ROB/NC | Primary Pre-Selected | **Primary** |
| Tankless on demand water heater | ROB/NC | Primary Pre-Selected | **Primary** |
| Indirect water heater | ROB/NC | Primary Pre-Selected | **Primary** |
| **Second Priority Measures** | | | |
| Large commercial HVAC measures (e.g. chillers) | ROB/NC | Secondary only | Secondary |
| Variable frequency drives | RET/NC | Secondary only | Secondary |
| Ductless mini-splits air and heat pumps | ROB/NC | Possible | Secondary |
| Differential dual enthalpy economizers | ROB/NC | Secondary only | Secondary |
| Commercial lighting controls | RET/NC | Primary | **Primary** |
| Energy management systems | RET/ROB/NC | Secondary only | Secondary |

***** The Subcommittee included ECM motors within gas furnaces.

## Secondary Research

Secondary research was conducted primarily in the form of a literature review of more than 30 studies, including Technical Reference Manuals (TRMs) and the California DEER study as well as various other research studies. The DEER study, commissioned by the California Energy Commission, provided much of the relevant secondary data. The team found few timely incremental cost studies from any Forum states. Recent studies often referenced much older studies when carefully examined.

The team scored each measure's data along 6 parameters, assigning a numerical score to each and a total score for each measure. The parameters were:

- Number of Sources Found
- Data Vintage
- Completeness of baseline costs
- Completeness of Efficient measure options
- Completeness o f Labor breakouts and costs provided
- Were full costs (equipment and labor) provided?

As shown in Table 2 below, there was a substantial range among the measures and the scoring categories. Scores ranged from 0 (combination heat and hot water) to 20 (residential insulation); a low score indicates most inadequate quality or lack of secondary data. In general, measures having lower scores were recommended for further primary research but the research team took some additional considerations into account. Additional considerations included: the Subcommittee's initial measure prioritization; the degree of system and site specificity, e.g. Energy Management Systems v Unitary AC; and relative measure contributions to program savings. As shown in Table 1 above, the Subcommittee pre-selected six gas measures and made final decisions on the remaining measures[1].

**Table 2**. Scoring Initial Project Measures

| Measure | Number of Sources Found | Data Vintage | Completeness: Baseline costs | Completeness: Efficient Options Covered | Completeness: Labor breakouts provided | Full Costs Provided if needed | Total Score |
|---|---|---|---|---|---|---|---|
| **EMV Subcommitte First Priority Measures** | | | | | | | |
| Residential Central Air Conditioners | 3 | 3 | 3 | 5 | 2 | 1 | **17** |
| Residential Air Source Heat Pumps | 3 | 3 | 3 | 5 | 2 | 1 | **17** |
| Residential Furnace Fans (e.g. ECM fans) | 3 | 1 | 3 | 5 | 2 | 0 | **14** |
| Commercial Unitary Air Conditioners | 3 | 1 | 3 | 5 | 0 | 1 | **13** |
| Residential Insulation Upgrades (attic, wall, basement) | 3 | 3 | 3 | 5 | 5 | 1 | **20** |
| Residential Air Sealing | 3 | 3 | 0 | 2 | 5 | 1 | **14** |
| Residential Gas Furnaces | 3 | 0 | 3 | 1 | 2 | 1 | **10** |
| Residential Gas Boilers | 3 | 3 | 3 | 2 | 5 | 1 | **17** |
| Commercial Gas Boilers | 1 | 3 | 3 | 5 | 2 | 1 | **15** |
| Combination Heat Hot Water | | | | | | | **0** |
| Tankless On Demand | 3 | 3 | 0 | 2 | 2 | 1 | **11** |
| Indirect Water Heater | 1 | 3 | 0 | 2 | 0 | 1 | **7** |
| **EMV Subcommitte Second Priority Measures** | | | | | | | |
| Large commercial HVAC measures (e.g. chillers) | 1 | 3 | 3 | 5 | 2 | 1 | **15** |
| Variable Frequency Drives | 3 | 3 | 3 | 5 | 2 | 1 | **17** |
| Ductless Mini-Splits Air Conditioners and Heat Pump | 3 | 1 | 3 | 2 | 5 | 1 | **15** |
| Differential Dual Enthalpy Economizers | 1 | 1 | 0 | 2 | 2 | 0 | **6** |
| Commercial Lighting Controls | 3 | 3 | NA | 5 | 2 | 1 | **14** |
| Energy Management Systems | 1 | 3 | NA | 1 | 5 | 1 | **11** |

After close examination, the research team did not place much faith in the quality of the cost data contained in the various studies examined for secondary research and chose not to present any of the cost data resulting from its secondary assessments. This was done to avoid the appearance of endorsing the costs for measures receiving only secondary research. With additional resources, the research team would have recommended conducting primary research for every measure of interest to the

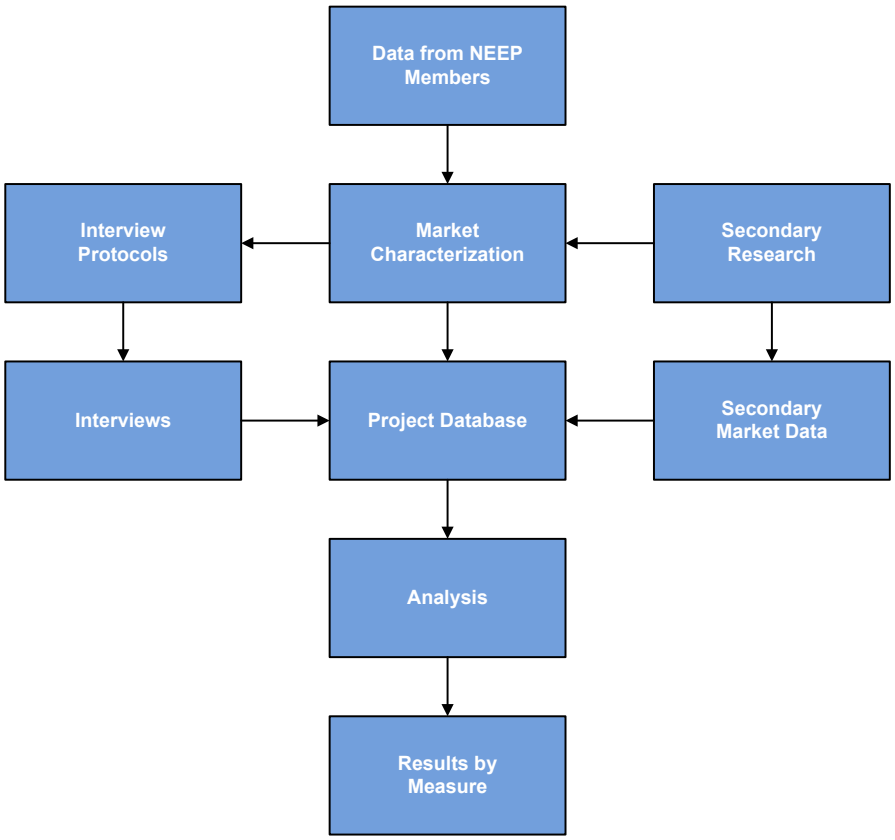
[1] Navigant scored all measures based on the secondary data analysis. As noted above, the Subcommittee had pre-selected six gas measures for primary research And ECM motors were rolled into the residential furnace measure.

Subcommittee. On completing the secondary research, the research team provided its findings and recommendations in a detailed set of Excel workbooks, referencing every study in detail, along 20 characteristics. The team also provided a bibliography of all studies examined.

## Methodology

The ICS used a multifocal approach, as shown in the Figure 1 schematic of the program's operations.

**Figure 1.** Diagram of Elements of Incremental Cost Study Methodology




### Primary Research Data Collection

Detailed program-level data identifying make and model information on energy efficiency measures promoted by energy efficiency program administrators was a key input required in this study. The research team also requested names and contact information for implementation contractors/vendors. The team discovered this relatively straightforward request was in fact difficult for many program administrators to satisfy efficiently, if at all. Most often, implementation contractors and/or consolidated rebate processors store this type of data, rather than program administrators. There is no standardization across organizations or jurisdictions for what implementation contractors collect, store and report. Through no small effort by many participating parties, data sets from multiple sources

and databases were generated for every measure that had been selected for primary research. [2]

The second part of the data collection stage of the primary research consisted of interviews with key informants participating in energy efficiency programs, primarily equipment installers. Some distributors were interviewed as well. Research team members who had detailed knowledge of the relevant equipment, industries and markets conducted the interviews. The team developed interview guides which were reviewed by NEEP and members of the technical advisory group, tested in live interviews and revised as needed.

**Technical Advisors, a Critical Resource**.

Through the efforts of NEEP and the EMV Subcommittee members, the research team developed a Technical Advisory Group (TAG), consisting primarily of program administrator implementers and other 'on the ground' staff who were very familiar with the measures and the programs in which measures were employed. In informal exchanges with ICS team members, the TAG members reviewed and provided valuable input on measure baselines, the interview protocols and later, on individual measure results.

## Residential Gas Furnaces Incremental Cost Methodology

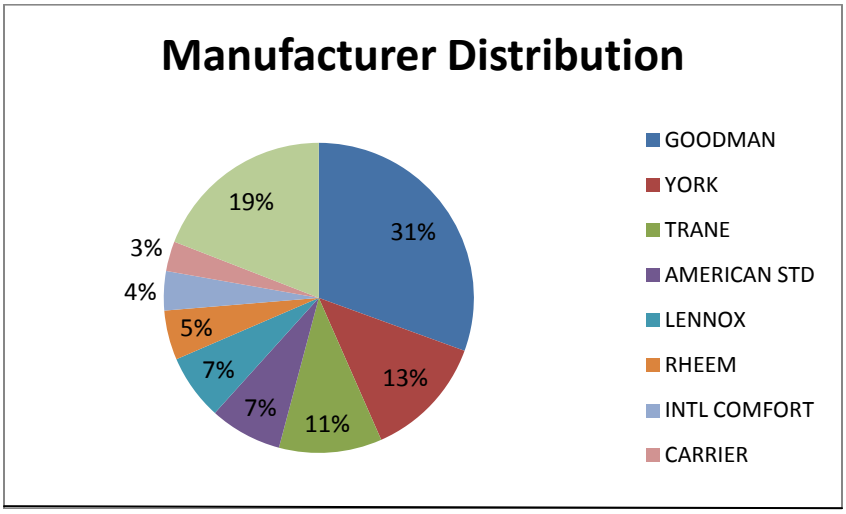
This section describes the primary research as the research team conducted it for one of the study measures. The approach below was applied to every program measure, with minor variations for specific measures as appropriate. The individual measure variations are described in the forthcoming program report. The research team defined a measure as the efficient alternative to the baseline option of installation. In this case, it is defined as a gas furnace with an AFUE of 90, 92 or 94 (corresponding to CEE's Residential Gas Heating Initiative). The baseline condition is defined as the standard equipment that would have been installed without the utility EE activity. The baseline equipment in this instance is a gas furnace with an AFUE of 80%

**Market Characterization**

A market characterization was conducted to gain a better understanding of the market conditions. The research team used this data to review the current activity within the marketplace in order to ensure final results are truly representative of market conditions. For instance, Figure 2 below illustrates that the manufacturers Goodman, York and Trane maintain a relatively dominant presence in this particular market. If the research team were to focus its contractor interviews to include these major brands, it is reasonable to say that the captured costs are representative of the brands of furnaces being installed throughout this particular market.

[2] This accomplishment is particularly noteworthy, given the voluntary nature of participation in the EMV Forum, the multi-jurisdictional scope of the project, and the limited time and resources available to many program administrators.

**Figure 2**. Furnace Manufacturer Distribution in Studied Energy Efficiency Programs




The market characterization also included reviewing specific equipment information (size ranges, efficiency ranges), as well as reviewing geographical and contractor participation data.

**Data Collection**

After completing the market analysis, 15 contractor interviews were completed for the measure analysis. A total of 32 contractor cost points and 23 internet cost points were collected for residential gas furnaces. Interviews for all ICS measures studied included:

- Equipment costs for baseline and efficient equipment in appropriate sizes, efficiencies;
- Determination of installation labor hours,
- Differences between baseline and efficient equipment installation labor hours where appropriate,
- Contractor labor rates.

Primary cost data were collected from energy efficiency program implementation contractors across three states (NY, VT, and MA). Due to the inherent differences in cost from one region to another (i.e. the cost of labor and materials is greater in NY than in VT), analysts adjusted all material and labor cost points to represent non-regional specific (NRS) data using R. S. Means Consumer Cost Indices. Table 3 provides a regional break down of the NEEP territories into markets, showing the cost factors for each. For example, if the cost provided from a contractor in New York Metro for gas furnace was $1000, than the NRS cost would be:

NRS = Original State Cost ($) / Average Adjustment Factor for Original State
NRS = $1000 / 1.26
NRS = $793.65

The same method was used to adjust all labor costs.

**Table 3.** Regional Adjustment Factors

| Market | Market Code | Regions | Average Adjustment Factor |
|---|---|---|---|
| Northern New England | 1 | ME, VT, NH | 0.85 |
| Central/Southern New England | 2 | MA (exc Boston), RI, most CT | 1.05 |
| New England City | 3 | Boston, Providence | 1.12 |
| NY Metro | 4 | NYC, Metro, Suburbs, Southeast CT, | 1.26 |
| NY Upstate | 5 | Buffalo, Rochester etc. | 0.99 |
| Mid-Atlantic | 6 | MD, DE, DC | 0.92 |
| Non-Regional Specific Average | - | - | 1.00 |

For this measure the team augmented contractor data with some costs found on the internet. Internet data were also used to QC the contractor equipment data. Internet costs did not include a contractor markup, and therefore, secondary research was conducted to develop a markup factor; based on a DOE[3] appliance standard rulemaking, a markup of 162% was applied to internet data in order to compare it to the primary contractor data.

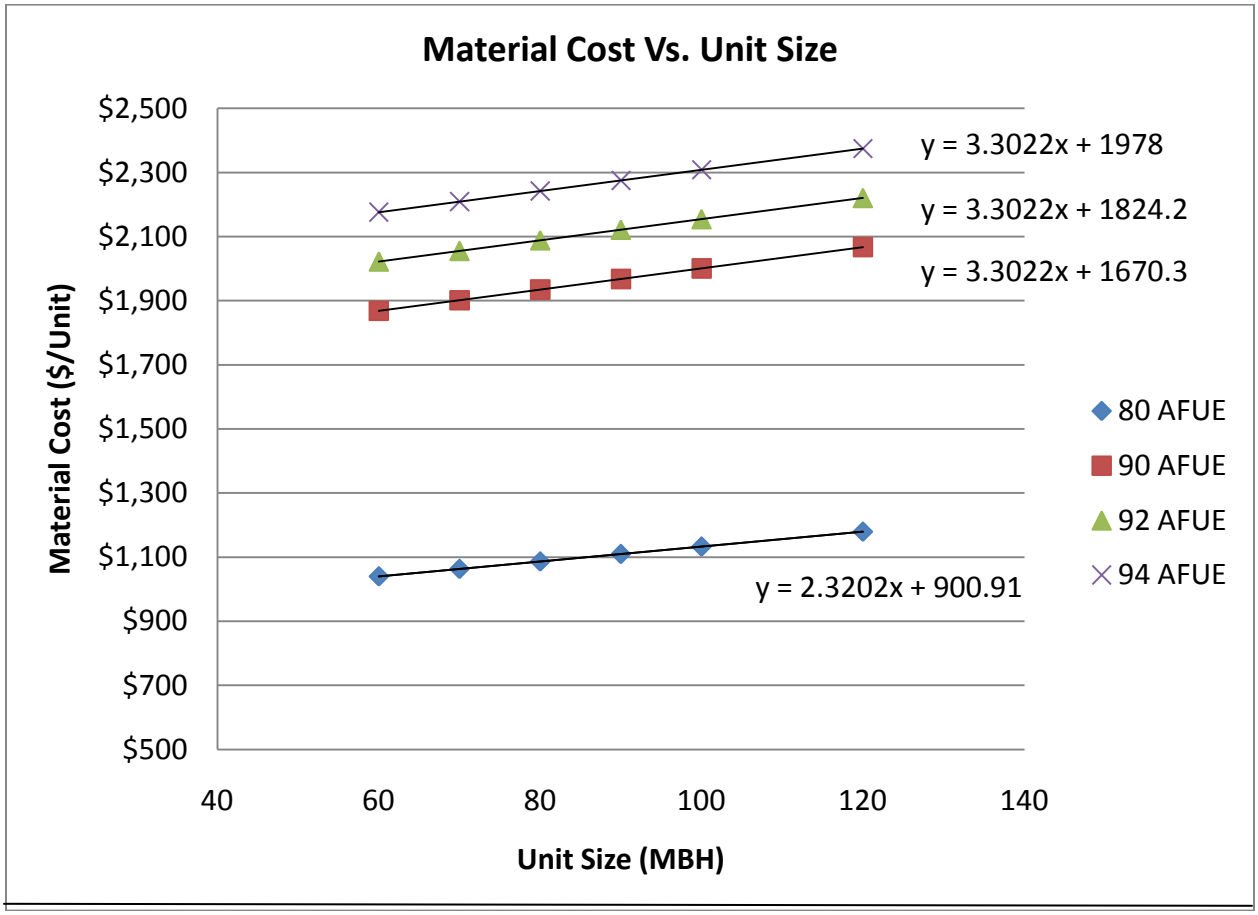
**Material Analysis**

The analysis indentified and removed any potential outlier data points through a review of the data. A linear regression was used to develop the material cost "curve" for the measure. As shown in Figure 3, cost curves were developed based on the results of linear regression for the following efficiency categories:

a) AFUE = 80
b) 80 < AFUE =< 97

[3] http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/fb_fr_tsd/chapter_5.pdf

**Figure 3**. Furnace Material Cost Curves




These cost curves can be used to determine the cost of any equipment size (between 60 and 120 MBH) of the specified efficiency. Therefore, program planners gain flexibility to adopt the curves for programs using other parameters, without requiring further research.

### Labor Analysis

Contractor interviews identified an incremental difference in the time to install efficient versus base scenario gas furnaces. In general, efficient equipment took approximately 4 additional hours to install when compared with base equipment. This incremental labor component can be attributed to the additional components that are installed with higher efficiency furnaces, such as a condensate discharge pump and line. The labor rate was calculated with a weighted average of all contractor labor rates ($/HR) collected for residential gas measures. An average installation time was used to determine the time required to install measure and baseline equipment.

## Results

Incremental material, labor, and installed costs were then calculated and are presented in Table 4. Through contractor interviews, the research team defined the most common unit sizes. As such, results

are presented in the table below for each of those size categories at a non-regional specific level.

**Table 4.** Non-Regional Specific Incremental Installed Cost

| Unit Size (MBH) | CEE Tier 1 (90 AFUE) | CEE Tier 2 (92 AFUE) | CEE Tier 3 (94 AFUE) |
|---|---|---|---|
| 60 | $1,131 | $1,284 | $1,438 |
| 70 | $1,140 | $1,294 | $1,448 |
| 80 | $1,150 | $1,304 | $1,458 |
| 90 | $1,160 | $1,314 | $1,468 |
| 100 | $1,170 | $1,324 | $1,478 |
| 120 | $1,190 | $1,343 | $1,497 |

## Conclusions and Recommendations

This project developed cost data for many important gas and electric energy efficiency measures across a number of markets. The research team believes the results, to be published in full in Summer 2011, suggest that the project demonstrates a robust and economical approach to developing cost data that are flexible enough to be more than a snapshot of a single moment in time. Furthermore, the ICS approach provides a pathway for future cost updating that will be neither as onerous nor as expensive as incremental cost studies have typically been. The ICS cost curves can be updated with periodic installer interviews, combined with online reviews for various project measures. In an era of increasing efficiency standards, the cost side of cost-effectiveness determinations is becoming increasingly important as baselines are raised.

In order to succeed in this project, it was necessary to overcome various significant challenges. On the analytical side, defining and developing cost estimates for many geographic market areas was a significant challenge. On the operational side, the project depended heavily on time and information provided by a large group of program implementers and evaluators who were effectively volunteers, given that there was no regulatory requirement for project sponsors to conduct the study and that the studies conducted by the EMV Forum may compete for as well as compliment program administrators' resources.

One of the greatest challenges was that program administrators often do not have ready access to the level of equipment makes and models, as well as data identifying participating installers. These detailed data are often held by third party vendors hired as implementers by program administrators, and the efforts required to provide Navigant with such highly specific data were substantial. Indeed, not every participating program administrator was able to do so, limiting the research possibilities for some measures. Seasonality was also an issue. Study priorities resulted in pursuing heating measure installers toward the end of their busy season and cooling contractors toward the beginning of theirs. Future studies should take seasonality into careful account. That said, program administrator enthusiasm and cooperation was excellent throughout in data development and technical review.

One of the study's great strengths was developing the Technical Advisor Group which drew on expertise from various states and organizations. The TAG provided informal opportunities for feedback and discussion among technically knowledgeable individuals. One result was a tightening and strengthening of the interview protocols. Another result was receiving feedback as measure costs results were completed and provided to TAG members for review. Those discussions were sometimes reminders of the project's starting goals several months on, as well as ensuring that results were carefully checked and triangulated with other sources to ensure their validity.

Finally, this study raised an additional issue that is relevant to evolving baselines that change as a result of standards and other market transformation influences but also raises policy concerns for the EMV members, including its Steering Committee primarily composed of regulators. For at least one study measure, residential central air conditioning, current SEER 15 units are premium products, having some features that increase the equipment's cost without adding additional energy savings. At this writing it is not clear what all of those features are or what costs should be attributed to them. Further investigation of this topic is needed and is particularly critical in a measure in which increased costs can reduce cost-effectiveness below the necessary threshold.

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