Virginia State Corporation Commission
eFiling CASE Document Cover Sheet

2195120042

Case Number (if already assigned)	PUR-2020-00156
Case Name (if known)	Commonwealth of Virginia, ex. rel. State Corporation Commission, Ex Parte: In the matter of baseline determination, methodologies for evaluation, measurement, and verification of existing demand-side management programs
Document Type	RETE
Document Description Summary	Public Version of Virginia Electric and Power Company's Rebuttal Testimony
Total Number of Pages	85
Submission ID	21692
eFiling Date Stamp	5/4/2021 2:07:45PM

McGuireWoods LLP
Gateway Plaza
800 East Canal Street
Richmond, VA 23219-3916
Phone: 804.775.1000
Fax: 804.775.1061
www.mcguirewoods.com

Lisa R. Crabtree
Direct: 804.775.1327

McGUIREWOODS

lcrabtree@mcguirewoods.com

2105108212

May 4, 2021

BY ELECTRONIC FILING

Mr. Bernard Logan, Clerk
c/o Document Control Center
State Corporation Commission
1300 East Main Street
Tyler Building – 1st Floor
Richmond, Virginia 23219

Commonwealth of Virginia, ex. rel. State Corporation Commission, Ex Parte: In the matter of baseline determination, methodologies for evaluation, measurement, and verification of existing demand-side management programs, and the consideration of a standardized presentation of summary data for Virginia Electric and Power Company
Case No. PUR-2020-00156

Dear Mr. Bernard:

Enclosed please find for electronic filing the **Public Version** of Virginia Electric and Power Company's Rebuttal Testimony. An extraordinarily sensitive version is also being filed under seal under separate cover

Please feel free to contact me if you have any questions.

Highest regards,

/s/ Lisa R. Crabtree

Lisa R. Crabtree

Enclosures

cc: Honorable Alexander F. Skirpan, Chief Hearing Examiner
Audrey T. Bauhan, Esq.
Vishwa B. Link, Esq.
April M. Jones, Esq.
Service List

2195190142

WITNESS REBUTTAL TESTIMONY SUMMARY

Witness: Nathan J. Frost

Title: Director, New Technology and Energy Conservation

Summary:

The Rebuttal Testimony of Company Witness Nathan J. Frost responds to the testimony filed by Mark James on behalf of the Virginia Energy Efficiency Council ("VAEEC") and Jim Grevatt on behalf of Appalachian Voices ("Environmental Respondent" or "ER") as it relates to a proposed evaluation, measurement and verification ("EM&V") dashboard format, proposed reporting deadlines for EM&V information, and Respondents' recommendation for EM&V transparency and best practices. He also responds to the testimony filed by David J. Dalton and Georgianne Ferrell on behalf of the Commission Staff ("Staff"), particularly as it relates to the Company's compliance with the Grid Transformation and Security Act ("GTSA") and Virginia Clean Economy Act ("VCEA") and the role that EM&V plays in tracking the Company's progress towards those targets.

Throughout the Respondent and Staff testimony, two key themes or questions were addressed. First, what data should be included in a "dashboard"; and second, how can the energy savings associated with the DSM Programs be reasonably determined in a cost-effective manner.

As to the dashboard, in his Rebuttal Schedule 1, Mr. Frost presents the Company's proposal for an at-a-glance, look-back dashboard that attempts to capture the metrics most of interest to Respondents and Staff, as well as the broader stakeholder group in an easy-to-read one-page format. Mr. Frost notes the list of metrics requested as part of this proceeding and explains that inclusion of all items noted is not possible in a dashboard format; however, the Company—with few exceptions—can include the requested information in a summary format as part of its DSM Annual Report. Mr. Frost further addresses the proposals for more frequent and periodic reporting requirements.

Mr. Frost next addresses specific recommendations made by Staff Witness Dalton regarding directives that Staff asks the Commission to issue to the Company as a result of this proceeding, including measurement initiatives undertaken at PIPP participant households.

Finally, Mr. Frost testifies regarding future stakeholder engagement in refinement of the Company-specific STEP Manual used for EM&V in lieu of joining a regional TRM.

2105190142

REBUTTAL TESTIMONY
OF
NATHAN J. FROST
ON BEHALF OF
VIRGINIA ELECTRIC AND POWER COMPANY
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NO. PUR-2020-00156

Q. Please state your name, position of employment, and business address.

A. My name is Nathan J. Frost and my business address is 600 East Canal Street, Richmond, Virginia 23219. I am Director of New Technology and Energy Conservation for Virginia Electric and Power Company ("Dominion Energy Virginia" or the "Company").

Q. Have you previously submitted testimony in this proceeding?

A. Yes. My pre-filed direct testimony was submitted to the State Corporation Commission ("Commission") on behalf of the Company in this proceeding on November 6, 2020.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to respond to the testimony filed by Mark James on behalf of the Virginia Energy Efficiency Council ("VAEEC") and Jim Grevatt on behalf of Appalachian Voices ("Environmental Respondent" or "ER"), collectively "Respondents," as it relates to a proposed evaluation, measurement, and verification ("EM&V") dashboard format, proposed reporting deadlines for EM&V information, and Respondents' recommendation for EM&V transparency and best practices. Additionally, I will respond to the testimony filed by David J. Dalton and Georgianne Ferrell on behalf of the Commission Staff ("Staff"), particularly as it relates to the Company's compliance with the Grid Transformation and Security Act ("GTSA") and Virginia Clean Economy

Act ("VCEA") and the role that EM&V plays in tracking the Company's progress towards those targets.

Throughout the Respondent and Staff testimony, two key themes or questions were addressed. First, what data should be included in a "dashboard"; and second, how can the energy savings associated with the DSM Programs be reasonably determined in a cost-effective manner. I will address each of these important questions.

Q. Are you sponsoring any exhibits or schedules with your rebuttal testimony?

A. Yes. Company Exhibit __, NJF, consisting of Rebuttal Schedule 1, was prepared under my direction and supervision, and is accurate and complete to the best of my knowledge and belief.

Q. How is your rebuttal testimony organized?

A. My rebuttal testimony is organized as follows:

I. DSM Reporting and Dashboard Recommendations

II. Baselines, EM&V Practices and Improvements

I. DSM REPORTING AND DASHBOARD RECOMMENDATIONS

Q. Before addressing specific recommendations and concerns raised by Respondents and Staff within pre-filed testimony, do you have any general comments?

A. Yes. The Company appreciates the thorough review of our Application in this proceeding by Respondents and Staff.

Important concerns raised by Respondents and Staff highlight the importance of providing transparent, user friendly, efficient, and timely information regarding the

2160514064

Company's DSM Portfolio. The Company is fully committed to working to address concerns and recommendations in each area, in addition to continuing to receive feedback from stakeholders.

The Company's DSM Portfolio has grown exponentially in recent years to the point where we now have almost 40 DSM Programs either approved and operational or pending approval before the Commission. Of note, more than 6,000 customers participated in a Dominion Energy Virginia energy efficiency program in 2020 (as well almost 70,000 participants in demand response programs), and an additional 2.93 million energy efficiency measures were discounted as point-of-sale purchases within our service territory because of our Programs. In addition, the Company has been filing comprehensive and voluminous annual EM&V reports ("EM&V Annual Report") since 2010. One outcome of all this activity—beyond the energy savings, customer bill savings, and beneficial carbon reduction—is the availability of a lot of data in a number of different places. The Company is supportive of Commission and stakeholder interest in seeing the data presented in one place in a more straightforward and meaningful way for all those interested.

The Company believes most, if not all, of the data that Respondents and Staff have requested be included in a "dashboard" as part of this proceeding exists in various formats today. The Company is committed to providing the data in a meaningful way and suggests that the task, now, is to determine the data that should be in a dashboard or executive summary "at a glance" view, and then identify additional data that should be in the EM&V Annual Report. The Company does not believe additional proceedings are needed to review or audit data, and the Company does not believe reporting and analysis

of data more than once per year based on the prior calendar year is efficient or would provide meaningful enhancements to the DSM process. I will discuss these positions in greater detail later in my testimony.

Q. Has the Company given additional thought to what that format might be for a dashboard?

A. Yes, we have. But I would also like to address the term "dashboard" as it has been used in this proceeding. When I hear the word dashboard, I think of a straightforward, high-level presentation of key metrics like an executive summary of data that is able to be read and understood at a glance. This does not appear to be the meaning shared by others, in that the sheer volume of information requested by Respondents and Staff could never be translated into a high-level presentation and in many cases is quite detailed. That is not to say that the Company objects to providing this detailed data; more that it will be important to clearly define what data would show up in the executive summary "at a glance" dashboard and what other information should be presented in a different format, where, when, and how frequently.

Specifically, witnesses to this proceeding have requested the Company dashboard include, by year, the following data:

- Progress towards GTSA proposed spending targets
- Projections towards GTSA proposed spending targets
- Actual spending on a portfolio level
- Actual spending on a program level

2105190842

- The share of total spending on DSM Programs designed to benefit low income, elderly, or disabled individuals, or veterans
- Progress towards VCEA energy savings targets
- Projections towards VCEA energy savings targets
- Actual energy savings on a portfolio level (net and gross)
- Actual energy savings on a program level (net and gross)
- Lifetime energy savings on a program level (net and gross)
- Energy savings from all programs as a share of total sales
- Demand savings on a portfolio level (net and gross)
- Demand savings on a program level (net and gross)
- Program operation years
- Program budgets
- Program spending as a percentage of budget
- Program participation
- Program participation rate as a share of the eligible population
- Program cost per customer
- Program participation by geographic location
- DSM-related emissions reductions
- "other quantifiable benefits of each program"
- Total customer bill savings
- Administrative costs by program
- Avoided costs
- Program cost-effectiveness results

- The above metrics aggregated for residential programs
- The above metrics aggregated for non-residential programs

To a large extent, the Company agrees that the above information is valuable and represents data that the Company or its EM&V vendor already track and, in most instances, provide in either the EM&V Annual Report or the annual DSM filing. Again, however, the Company respectfully notes that an executive summary "at a glance" dashboard cannot convey this data without becoming too long, detailed, and possibly confusing.

Accordingly, the Company's proposal is to present an executive summary "at a glance" dashboard similar in format as my Rebuttal Schedule 1 ("Company Dashboard Proposal"). It appears the consensus request is for a summary of the Company's DSM Programs, savings, and progress towards legislative targets. The Company believes this is best accomplished by developing and publishing a one-page dashboard that presents an annual lookback (i.e., data from the prior calendar year) with the following subset of information from the above list:

- Total Number of Programs (residential and non-residential)
- Total Participants (residential and non-residential)
- Energy saved (kWh and kW) at a portfolio level
- Progress towards GTSA Goal
- Results towards VCEA savings targets
- Total Annual Programs Spend at a portfolio level
- Total Annual Income and Age Qualifying ("IAQ") Programs Spend

- Total customer bill savings for residential and non-residential customers
- DSM-related emission reductions
- Energy saved since inception at a portfolio level

The Company can commit to providing the first Company Dashboard Proposal within 30 days of a Final Order in this proceeding (for the calendar year 2020), and annually thereafter with the EM&V Annual Report (filed on May 15 with data for the prior calendar year). The Company can also continuously have the populated Company Dashboard Proposal available on its website.

The Company proposes to provide the rest of the information, to the extent practicable and with some exceptions addressed later in my rebuttal testimony, in a "DSM Annual Report" submitted with its EM&V Annual Report, similar to the EM&V summary suggested by VAEEC Witness James. Lastly, the Company will continue to evaluate opportunities to streamline the existing EM&V reporting structure to the extent practicable to focus on the metrics that Respondents and Staff have highlighted.

Q. Are there any metrics the Company opposes?

A. VAEEC Witness James, on page 22 of his testimony, testifies regarding the need for specific geographic participation data. Customer data is necessarily confidential, which complicates the issue of displaying program data geographically. For example, a granular display of targeted customers' eligibility and activity by program and location (*e.g.*, by address or even zip code) could inadvertently and unlawfully reveal customer confidential information. The Company and its EM&V vendor can, however, provide summary geographic data by region to the extent this is desirable to stakeholders.

2105160942

The rebuttal testimony of Company Witness Feng addresses the list of requested metrics further in her testimony and offers additional clarifications or limitations on certain of the items.

Q. ER Witness Grevatt states that the Company has not yet proposed a specific format for projecting how its proposed and approved programs will lead to achievement of its Virginia Clean Economy Act ("VCEA") savings requirements or for tracking the evaluated results of its programs. (Grevatt at 4.) Does the Company intend to present such tracking information going forward?

A. Yes, we do, and can commit to VCEA tracking information being included in the Company Dashboard Proposal discussed above. The Company Dashboard Proposal, however, will be limited to historic information in that it is proposed as a look back. Mr. Grevatt indicates a desire for forward looking projections as well.

Indeed, on page 5 of his testimony, ER Witness Grevatt states that the proposed dashboard should not be limited to tracking accomplishments and instead should also be used as a forecasting tool. The Company respectfully disagrees with this recommendation from Mr. Grevatt in light of other initiatives currently underway. Specifically, the Company has hired Cadmus to develop a long-term plan—with input and recommendations from stakeholders—as the roadmap for future DSM initiatives, including the path towards the VCEA savings targets.

Additionally, this recommendation from Mr. Grevatt appears outside the scope of this proceeding based on my layman's reading of the Commission's Order Initiating Proceeding. That Order appears to set the docket's objectives squarely in the context of

"baseline determination, methodologies for evaluation, measurement, and verification of existing demand-side management programs, and the consideration of a standardized presentation of summary data." The Order goes on to plainly specify exactly which Company programs and measures will be considered in this proceeding, restricting the considerations to Phase I through Phase VIII programs. A footnote on page 4 further clarifies this point by stating that this "proceeding is separate from the Company's annual DSM filing and only addresses the Company's currently approved DSM programs." Accordingly, suggestions for use of a dashboard to serve as a forecasting tool are not appropriate in this proceeding.

Notably, the Company does intend to address the topic of projecting energy efficiency savings towards VCEA savings targets and present proposals responsive thereto as part of the Company's DSM Update proceeding, Case No. PUR-2020-00274.

Q. With respect to initial and future timing of dashboard filings, ER Witness Grevatt recommends that the dashboard be populated and filed within thirty days of the Commission's final order in this proceeding and subsequently updated by September 1, 2021. (Grevatt at 5-6, 13.) Subsequently, he recommends the dashboard be updated on a quarterly basis. (Grevatt at 22.) Please respond.

A. As noted above, the Company can agree to populate the Company Dashboard Proposal within 30 days of the Commission's final order in this proceeding. However, should the Commission direct a more detailed dashboard that significantly differs from the Company's proposal, this timeline may be insufficient to complete the required analysis.

On the other hand, the Company respectfully requests the Commission reject the recommendation of Mr. Grevatt to require a September 1, 2021 update and quarterly reporting. Presenting data on a quarterly basis (instead of annually) does not give programs an opportunity to mature and go through seasonal patterns (where common for some measures), and can lead to over-reactions to short-term reported numbers on the programs.

It is also critical to note that the Company and its EM&V vendor are coordinating with an ever-increasing number of implementation vendors and contractor networks supporting the DSM programs. Numerous quality control and assurance checks must occur before Program data is finalized for official reporting. For example, the Company, its program implementation vendors and its EM&V vendor work diligently on a monthly basis to conduct quality control checks and reconcile any program specific differences. Each program measure is tracked through the Company's Business Intelligence system, and that information is submitted to DNV, the Company's EM&V vendor, to assess energy savings. This process ensures that program specific IT data specifications are accurate, and any differences between the three parties are reviewed and resolved. At times, the resolution to a problem may be time-consuming and require additional analysis. The Company would be hesitant to provide quarterly data updates without allowing adequate time to address outstanding issues in order to report the most accurate data. This description of the need for quality control and assurance checks also provides a reason against being able to provide a dashboard that is "fluid" and more frequently updated.

Quarterly reporting can also be costly and burdensome, particularly if the reports are not utilized by the Commission or stakeholders in the interim time periods. These additional

costs become incremental costs to the DSM Programs and to customers, and could impact cost-effectiveness results.

Finally, I would like to highlight a few additional reasons the Company supports continuing with an annual filing cadence: (i) three or even six months of EM&V data is generally insufficient to analyze trends from one reporting period to the next; (ii) the collection and processing of Dominion Energy Virginia-specific end use data may require up to six to eight months depending on the DSM Program; (iii) the STEP Manual used for EM&V purposes is updated on an annual basis; and (iv) reporting on an annual basis was planned in the EM&V cost projections used for purposes of setting program budgets and caps.

Q. Has the Company considered more frequent EM&V updates in the past?

A. Yes, as has the Commission. For DSM Phases I and II, the Company initially filed EM&V reports on a biannual basis. In the 2011 proceeding, the Company requested that the Commission allow the Company the ability to file EM&V reports on an annual basis, and that has been the practice since then. The annual cadence is even more appropriate in 2021 than it was ten years ago considering the growth in the number of programs offered.

Q. Is there any information the Company can commit to providing more frequently than annually?

A. Yes. Recognizing stakeholders' desire for more timely information, the Company can commit to providing intermittent updates on DSM Program participation. The data we can provide would be unaudited or "raw" participation numbers, and therefore would be subject to changes as part of the EM&V process. However, it should give stakeholders

2195109042

some indication as to how the Portfolio as a whole, as well particular Programs of interest to them, are progressing throughout the year. This information can be disseminated via the existing DSM stakeholder process, or through other means as desired.

Q. In addition to the DSM dashboard, VAEEC Witness James recommends the Company provide an annual EM&V summary, and he highlights a multitude of metrics and data points that would be appropriate to provide at the portfolio and program level. (James at 22-32.) Do you have a response?

A. The Company agrees to provide a DSM Annual Report submitted with its EM&V Annual Report, beginning with the May 2022 filing, which will focus on a summary presentation of the metrics proposed by Respondents and Staff in this proceeding. Company Witness Feng addresses plans for the DSM Annual Report in further detail as part of her rebuttal testimony.

I think it is important to note that even today, the Company tracks and reports on almost all of the data noted by Mr. James. Dominion Energy Virginia is proud of the DSM Programs it offers and the energy efficiency savings customers have achieved as a result of those Programs, and we would like to be able to communicate those successes with stakeholders in a more streamlined manner. I believe that between the Company Dashboard Proposal and the DSM Annual Report, this outcome can and will be achieved.

II. BASELINES, EM&V PRACTICES AND IMPROVEMENTS

Q. In addition to examining presentation of DSM information via a dashboard, the Commission established this proceeding to review baselines used in existing DSM Programs for EM&V purposes. Have you reviewed the direct testimony of Respondents and Staff regarding this area?

A. Yes, I have. Foremost, Respondents' testimony appears to support the Company's approach to the development of baselines and EM&V in general. They recognize the importance of ensuring that EM&V is effective but also performed at a reasonable cost. Staff also acknowledges this balance. In my rebuttal testimony, I will be addressing the specific recommendations made by Staff Witness Dalton regarding directives that Staff asks the Commission to issue to the Company as a result of this proceeding. Company Witnesses Feng and Goldberg will address specific testimony from Staff regarding the determination and use of baselines.

Q. On page 20, Staff Witness Dalton testifies that Staff recommends the Commission direct the Company to document the baseline assumption utilized during program design and all subsequent adjustments or changes to the baselines and provide this documentation, upon request, to Staff and other interested parties. Please respond.

A. The Company does not oppose this recommendation on a going forward basis with respect to proposed and approved DSM Programs. The Company believes this recommendation will best be achieved by requiring entities responding to the annual request for proposals issued for DSM Programs to include a standard form itemizing all baselines used for purposes of their proposal. The Company can then transmit the response received to DNV, which can document the original baselines, make note when

updates to the planning baselines for EM&V purposes are made, as well as track any updates made over subsequent years. This information could then be provided to Staff and other interested parties upon request.

Q. Staff Witness Dalton, on pages 52-56 of his testimony, presents several options for the Commission to consider regarding additional or different EM&V practices the Company and its EM&V vendor could undertake in the future in order to obtain utility- or Virginia-specific data for use as input variables in the Company's EM&V. Staff Witness Ferrell elaborates on one of the options in her testimony as well. Do you have any comments?

A. Company Witnesses Feng and Goldberg will address the Staff options in detail in their rebuttal testimony, but I would like to address one of the options outlined by Mr. Dalton.

On page 55 of his testimony, Staff Witness Dalton testifies that the Company could develop a pilot program that combines several elements of existing programs. He states that the Company could select a sample of new homes constructed in each region of its service territory, install a suitable number of each measure currently offered in each of its residential programs, and install submeters on each incentivized measure within the home, which would provide actual energy consumption and usage patterns. He goes on to state that the Company could expand this measurement strategy to include existing homes that have been retrofitted with energy efficient measures. Mr. Dalton characterizes this option as the "laboratory" approach for EM&V.

As a general concept, the Company is not necessarily opposed to such in-home measurement, with appropriate customer consent. However, also on page 55 at footnote

84, Staff Witness Dalton states, "Staff believes that it may be appropriate to implement this laboratory approach with customers who would qualify for participating in the Company's Percentage of Income Payment Program rate structure. This would, in addition to providing the laboratory environment for data collection described above, provide energy efficiency measures and programs directly to low-income customers."

With all due respect, the Company does not believe this suggestion from Staff is appropriate.

Q. Please elaborate.

A. The Percentage of Income Payment Program, or PIPP, was established by the General Assembly in 2020 as part of the VCEA. The PIPP consists of two parts: a bill subsidy and weatherization. With respect to billing, the PIPP caps the percentage of income that eligible participants spend on their electric bill at 10% of their annual income if they use electricity for heating, or 6% if they use a heating source other than electricity. The PIPP also establishes a goal of reducing the energy usage of PIPP participants via weatherization or energy efficiency.

Importantly, in Case No. PUR-2020-00109, which was the initial proceeding on establishing a universal service fee to fund the PIPP, the Commission found that participation in weatherization or energy efficiency by PIPP participants was *mandatory* under the statute. Thus, a customer who enrolls in PIPP must, pursuant to the Commission's order, participate in state- or utility-sponsored weatherization or energy efficiency program.

Now, as part of this case, Staff is suggesting that these low-income customer homes also be used as "laboratories" to measure energy savings for extrapolation to the Company's larger customer base. While some PIPP customers may voluntarily agree to the type of equipment submetering proposed by Staff, the Company does not support any type of mandatory requirement that PIPP customers must participate in an in-home monitoring of their usage.

I therefore respectfully request the Commission does not adopt or suggest that the Company be or its customers be *required* to perform in-home data collection.

Q. Staff Witness Dalton also suggests EM&V approach for closed DSM programs and measures in order to have a higher level of confidence that these measures remain operational and continue to contribute energy savings towards VCEA savings targets. Specifically, on page 68, he suggests that it "would be appropriate to audit existing installations for expired programs to ensure that the incented measures have remained in service and are continuing to operate as expected." Do you have any comments?

A. Yes. Company Witness Goldberg will address this recommendation from an industry-standard perspective, but I also have some thoughts from a Company perspective.

First, DSM Programs are approved with a defined timeframe (generally 3-5 years) and with cost caps. Once the defined approval period expires, and the ensuing EM&V for last year of participation concludes, the Company no longer seeks cost recovery for the program. The look back audits suggested by Staff would be contrary to this. Furthermore, since program spend is limited by a cost cap—caps that are inclusive of

EM&V—there could be situations where a program exhausted its cost cap and this new EM&V activity would be in excess of the approved caps. Budgets set for the Company's DSM Phase I-IX Programs did not envision unbounded EM&V. Indeed, some measures such as the DSM Phase II Non-residential Duct Sealing Program have a 25-year measure life. Staff's recommendation would be that the Company now has to re-audit measures installed 2012-2016, potentially until 2041.

There are also practical concerns. What if the participating business or resident has relocated? The premise may still have the measures installed, but for privacy concerns, can the Company (i) contact the new account/resident and (ii) seek access to premise to verify install? Even if the Commission were to sanction such action, the Company would be hesitant to intrude on customers as suggested.

For these reasons and for those addressed by DNV, I ask the Commission not direct the verification audits on closed programs suggested by Staff.

Q. Finally, Staff recommends the Commission direct the Company, going forward, to maintain and provide to the Commission the data required for consumption analysis of all program participants as well as a control/comparison group. The required data would include, at a minimum, at least 12 months or pre-treatment kWh billing data and all post-treatment billing data and program tracking data for program participants, as well as sufficient billing data for a comparison group, and weather data. (Ferrell at 20.) Does the Company believe this is a reasonable requirement?

A. No, we do not. To begin, the Commission would need to provide a legal and/or statistical definition of "sufficient billing data for a comparison group" while also defining the specific weather data required for analysis. Individual customer premises would also require an association with a local weather station for each consumption billing period. The Commission must also consider the highly sensitive nature of customer usage data and the voluminous amount of billing data for the 429,607 customers who have participated in the Company's DSM Programs, and address appropriate data management and privacy considerations with the transfer of such data. In sum, the Company does not believe consumption data can be provided as requested without the development of significant additional parameters and safeguards.

Q. Changing topics, on pages 19-20 of VAEEC Witness James's testimony, he recommends the Company join the Mid-Atlantic TRM. Please respond.

A. While Mr. James highlights some definite advantages associated with membership in the Mid-Atlantic TRM, I would note that the Commission has made clear that the preference for DSM source data is for information to be utility-specific or state-specific; and this

2021-00215

preference is also spelled out in the Virginia Administrative Code specific to EM&V of DSM programs. Relying solely on the Mid-Atlantic TRM likely may not be deemed sufficient.

Q. Does the Company believe there is a reasonable alternative to joining a regional TRM?

A. Yes. Respondents appear to make no reference to the STEP Manual that DNV currently develops, publicly provides, and uses for purposes of conducting EM&V on the Company's DSM Programs. As Company Witness Feng elaborates on in her rebuttal testimony, the STEP Manual is a Dominion Energy Virginia (and North Carolina) specific document that includes all measures currently included within the Company's DSM Portfolio. The STEP Manual should be an acceptable alternative to a regional TRM, particularly for cost reasons, as it already exists and is calibrated to the Company's customer segments, end uses, and measures.

The STEP Manual is currently filed as a fully public appendix to the annual EM&V Report, and the latest version (version 10) was included as an Appendix to the Company's initial filing in this proceeding.

Stakeholder objectives of gaining transparency into measure assumption data (baseline, savings algorithms, incremental costs, etc.) are reasonable and can be accommodated through stakeholders reviewing the STEP Manual inputs, suggesting new measures, or suggesting deletions, all of which would be welcomed. Indeed, the Company can arrange to have DNV present the STEP Manual at a future stakeholder meeting to facilitate such discussion.

2165160642

Q. Does this conclude your pre-filed rebuttal testimony?

A. Yes, it does.

DEV DSM Dashboard

2020 at-a-glance

Dominion Energy

TOTAL PROGRAMS

Residential: [total number]

Business: [total number]

TOTAL PARTICIPANTS

Residential: [total number]

Business: [total number]

[LED light bulbs]

[Appliances rebated]

[Appliances recycled]

kWh SAVED - Portfolio

Net: [total number]

Gross: [total number]

kW SAVED - Portfolio

Net: [total number]

Gross: [total number]

PROGRESS TOWARDS $870M GTSA GOAL

[2020 proposed]

RESULTS TOWARDS VCEA SAVINGS TARGETS

As a percentage of 2019 sales

[2020 Net]

[2020 Gross]

ANNUAL SPEND

Portfolio

[total number]

ANNUAL SPEND

IAQ Programs

[total number]

TOTAL CUSTOMER BILL SAVINGS

Residential: [total number]

Business: [total number]

DSM-RELATED EMISSION REDUCTIONS

[total number]

ENERGY SAVED SINCE INCEPTION - Portfolio

Net: [total number]

Gross: [total number]

Company Exhibit No.__
Witness: NJF
Rebuttal Schedule 1
Page 1 of 1

2105130942

2160351606442

WITNESS REBUTTAL TESTIMONY SUMMARY

Witness: Dan Feng

Title: Principal, DNV

Summary:

Company Witness Dan Feng addresses proposals for an evaluation, measurement, and verification ("EM&V") dashboard format, a proposed EM&V annual summary, and topics pertaining to EM&V transparency and best practices.

Ms. Feng first addresses the EM&V dashboard and annual summary. Ms. Feng emphasizes that DNV will support the Company to populate any final dashboard approved as part of this proceeding by providing the necessary data from the most recent EM&V Report. She further notes that DNV will coordinate with the Company to ensure the information responsive to the list of metrics developed as part of this proceeding is provided upfront as an EM&V Annual Summary as part of the annual EM&V Report filings moving forward. The first EM&V Annual summary can be provided with the May 2022 EM&V Report, presuming a final order in this proceeding adopting this approach by year's end.

Company Witness Feng also addresses specific metrics requested by Respondents or Staff, and notes certain metrics DNV does not believe would be appropriate to report on in the EM&V Report. Company Witness Feng, in conjunction with Company Witness Nathan Frost, strongly recommends continuing the existing practice of providing annual EM&V updates, which strike the appropriate balance between providing verified data, transparency, and cost-efficiency. DNV believes providing unaudited, unverified tracking savings data to the Commission and stakeholders would likely introduce confusion because program tracking data currently undergoes quality control and assurance checks from month to month as data is reviewed and audited.

Ms. Feng then addresses the recommendation to develop and maintain Dominion Energy-specific or Virginia-specific TRM. She emphasizes that DNV currently documents the Company's deemed assumptions and approaches in a Dominion-specific TRM, the "Standard Tracking and Engineering Protocol Manual" ("STEP Manual").

Ms. Feng addresses concerns with the use of deemed input variables and the preference for measuring all input variables. DNV notes that both deemed and partially deemed savings are standard evaluation methods, and it is DNV's opinion that their continued use is appropriate.

Lastly, DNV testifies about consumption and/or billing analysis as the primary verification method and the recommendations pertaining to this specific topic.

2105160942

REBUTTAL TESTIMONY
OF
DAN FENG
ON BEHALF OF
VIRGINIA ELECTRIC AND POWER COMPANY
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NO. PUR-2020-00156

Q. Please state your name, position of employment, and business address.

A. My name is Dan Feng. I am a Senior Consultant for DNV. My business address is 1560 Wilson Boulevard, Suite 800, Arlington, VA 22209.

Q. Have you previously submitted testimony in this proceeding?

A. Yes. My pre-filed direct testimony was submitted to the State Corporation Commission ("Commission") on behalf of Virginia Electric and Power Company ("Dominion Energy Virginia" or the "Company") in this proceeding on November 6, 2020.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to respond to the testimony filed by Mark James on behalf of the Virginia Energy Efficiency Council ("VAEEC") and Jim Grevatt on behalf of Appalachian Voices ("Environmental Respondent" or "ER"), collectively "Respondents," as well as the testimony filed by David J. Dalton and Georgianne Ferrell on behalf of the Commission Staff ("Staff"). Specifically, my rebuttal testimony addresses proposals for an evaluation, measurement, and verification ("EM&V") dashboard format, a proposed EM&V annual summary, and topics pertaining to EM&V transparency and best practices.

2160516042

My rebuttal testimony is provided in collaboration with the rebuttal testimony of Miriam Goldberg, also of DNV. Collectively, the two rebuttal pieces of testimony provided by DNV are organized as follows:

I. EM&V Dashboard and Annual Summary
II. Developing and Maintaining Dominion Energy-specific or Virginia-specific TRM
III. Savings Persistence Counted toward VCEA and Other Legislative Goals
Please see Company Witness Goldberg's rebuttal testimony for testimony on this topic.
IV. Baseline
V. Concerns with Use of Deemed Input variables, and Preference for Measuring All Input Variables
VI. Consumption and/or Billing Analysis as the Primary Verification Method

My testimony focuses on topics specific to the Company's existing EM&V practices and Company Witness Goldberg's testimony focuses on topics specific to industry trends, best practices, and deep technical discussions on EM&V issues.

I. EM&V DASHBOARD AND ANNUAL SUMMARY

Q. In the rebuttal testimony of Company Witness Nathan J. Frost, he provides the Company's Dashboard Proposal as an executive summary for certain data points requested by Respondents and Staff in this proceeding. How will DNV be involved in these efforts?

A. DNV will support the Company in populating any final dashboard approved as part of this proceeding by providing the necessary data from the most recent EM&V Report as requested by the Company.

Q. In addition to an at-a-glance dashboard, Company Witness Frost indicates that the Company can, for the most part, provide the data requested by Respondents and Staff as part of an EM&V Annual Summary. Will DNV also support this effort?

A. Yes. DNV will coordinate with the Company to ensure the information responsive to the list of metrics developed as part of this proceeding is provided upfront as an EM&V Annual Summary as part of the annual EM&V Report filings moving forward. Presuming a final order in this proceeding adopting this approach by year's end, the first EM&V Annual Summary can be provided with the May 2022 EM&V Report.

Further, as indicated by Company Witness Frost, DNV will also evaluate opportunities to streamline the voluminous EM&V Reports such that they focus on the metrics parties to this proceeding have indicated are of particular interest.

Q. Are there any metrics requested by Respondents or Staff, which DNV does not believe would be appropriate to report on?

A. Yes. On pages 20–32 of his testimony, Mr. James asks for, among other things, the reporting of "[p]articipation rate (share of eligible population)" as a program-level indicator.

DNV does not currently collect the data needed to determine eligible populations for all DSM programs. For some programs, this type of information may be extracted from the Company's Residential and Commercial Saturation studies. For example, an estimate of the eligible population for the Residential Manufactured Homes program may be the same as the estimated number of customers with manufactured homes. However, in most program areas, the saturation study was not designed explicitly with the intent to collect

2163-E-GEN-22

the data necessary to determine "eligible" populations for existing or future DSM programs. In those cases, participation rate metrics would not be available.

Q. Company Witness Frost indicates that the Company objects to more frequent EM&V reporting requirements for a variety of reasons discussed in his testimony. Do you have any opinion on this matter?

A. Yes, and in conjunction with Company Witness Frost, with regard to the verified EM&V data, we strongly recommend continuing the existing practice of providing an EM&V Report for the prior annual calendar year in May of the following year.

Annual updates strike the appropriate balance between providing verified data, transparency, and cost-efficiency. DNV believes providing unaudited, unverified tracking savings data to the Commission and stakeholders would likely introduce confusion because program tracking data currently undergoes quality control and assurance checks from month to month as data is reviewed and audited. "Closing the books" so to speak on a biannual basis, or more frequently as some suggest, could more than double the reporting costs and might paint a distorted picture of program performance that would also have to be explained.

I note that Company Witness Frost does agree to provide unaudited participation data on a more frequent basis so that stakeholder will have certain performance-related indicators more often than currently available.

II. DEVELOPING AND MAINTAINING DOMINION ENERGY-SPECIFIC OR VIRGINIA-SPECIFIC TRM

Q. Do you have any general comments towards VAEEC Witness James' recommendations, provided on pages 6, 9, and 16-17, for EM&V transparency and best practices, such as focusing on reasonable and unbiased estimates of energy and demand savings and best practices for cost management?

A. Yes. DNV agrees with the general sentiment of Mr. James' recommendations and notes that DNV currently uses these recommended practices in its present EM&V approaches, as we described in the EM&V Background and Information Report and our interrogatory responses in this case.

Q. On page 9 of this testimony, VAEEC Witness James recommends the use of deemed savings for simple, well-defined energy efficiency projects or measures, where uncertainty around average unit savings is low, and where average operating characteristics are well known. Please respond.

A. DNV agrees. This is consistent with our statements in the Background and Information Report section 2.2, which describe DNV's approach for savings estimation of the Company's DSM programs.

2105190242

Q. With respect to cost management of EM&V expenses, Mr. James recommends using agreed-upon deemed values for certain EM&V inputs, often available from accepted technical reference manuals ("TRM"); adapting a TRM to regional or utility-specific conditions, as necessary; and regularly updating TRMs to capture the most current available data (James at 16-17). Do you agree this constitutes best practice?

A. Yes, I agree.

Q. How does this compare with your current practices?

A. This is our current practice. DNV currently documents the Company's deemed assumptions and approaches in a Dominion-specific TRM, the "Standard Tracking and Engineering Protocol Manual" ("STEP Manual"). DNV updates this document annually and files it each May as an attachment to the annual EM&V Report.

Q. VAEEC Witness James testifies that joining the Mid-Atlantic TRM would be especially helpful in establishing baselines and using TRM for common assumptions in evaluating efficiency measures (James at 19-20.) Could you please respond?

A. In researching the feasibility of adopting this recommendation, DNV reached out to the Northeast Energy Efficiency Partnership ("NEEP"), which has annually managed the Mid-Atlantic TRM development and update process. We were informed that the Mid-Atlantic TRM as a regional consortium has been disbanded. Thus, there is no longer an option for the Company to join the Mid-Atlantic TRM. It is our understanding that the program administrators (*e.g.*, utilities, state, and local organizations) who previously participated in the consortium are now developing and maintaining their own individual TRMs.

In the absence of joining the Mid-Atlantic consortium, Mr. James proposes that the Commission "use the Mid-Atlantic TRM for its detailed, common assumptions in evaluating energy efficiency measures." (James, at 20). This is DNV's current practice. DNV relies on the savings estimation methodologies, assumptions, and baselines in the Mid-Atlantic TRM for program measures, where they exist. We then adjust the Mid-Atlantic's assumptions to be utility-specific or Virginia-specific, wherever possible given available data (*e.g.*, adjusting for weather or Virginia-specific local codes and standards).

For measures that the Company offers, but that are not listed in the Mid-Atlantic TRM, DNV reviews publicly available TRMs and research papers to document the savings estimation methods, assumptions, and baselines in the STEP Manual. This process is outlined in Appendix B of DNV's EM&V Background and Information Report.

Q. Mr. James recommends "[c]reating a TRM for Virginia or joining the Mid-Atlantic TRM would provide greater uniformity in evaluation across all Virginia utilities and would further increase transparency and communication." (James at 10.) Do you agree?

A. DNV produces and annually updates the Company's TRM, also called the STEP Manual. We follow best practices for developing a TRM as described by Mr. James on pages 9 and 10 of his testimony. We describe the process for developing the STEP Manual, or deemed savings calculations, in section 2.2.3 of the EM&V Background and Information Report (Dominion Energy tracked savings using "deemed savings calculations"). Since the STEP Manual is developed specifically to measure the Company's programs and measures, and is tailored to the data that are being collected by the Company's implementers, DNV believes that the STEP Manual equations, assumptions, and

parameters produce deemed savings estimates that are highly specific to the Company's programs.

The current STEP Manual is a Dominion Energy Virginia- and Dominion Energy North Carolina-specific TRM. I am unaware of a process currently in place that would broaden its applicability to other utilities in Virginia, and would leave such to a decision to the discretion of the Commission.

DNV would be supportive should the Commission proceed with Mr. James' recommendation to create a TRM across all Virginia utilities. DNV offers the contents of the STEP Manual as a useful starting point.

Q. With respect to transparency and communication, Mr. Frost offers in his testimony that DNV could present the STEP Manual/TRM, at future Dominion Energy Virginia stakeholder meetings and facilitate a discussion regarding its contents. Would DNV support such a discussion?

A. Yes. The STEP Manual, including its source documentation and citations, is a public document and filed annually with the annual EM&V Report. It is available for review any time. As part of our update cycle, we add measures as they are introduced in new programs, and perform a needs review for recommended updates to prior inputs based on new information gained from primary data collection, updates to referenced TRMs, identification of alternative sources, or updated assumptions (new equipment standards, baseline efficiencies, etc.). If stakeholders wish to provide input during the update stage, DNV will coordinate with the independent moderator of the energy efficiency

stakeholder meetings to arrange time to present the Dominion STEP Manual TRM, and to develop a process that engages stakeholders in refinements to this resource.

Q. Does DNV have other responses on this topic?

A. Yes. Please see Company Witness Goldberg's rebuttal for additional comments related to this topic.

III. SAVINGS PERSISTENCE COUNTED TOWARD VCEA AND OTHER LEGISLATIVE GOALS

Please see Company Witness Goldberg's rebuttal testimony for testimony on this topic.

IV. BASELINE

Q. On page 20 of his testimony, Staff Witness Dalton recommends that the Commission direct the Company to document the baseline assumptions utilized during program design and all subsequent adjustments or changes to the baselines and provide this documentation, upon request, to Staff and other interested parties. Is DNV able to comply with this directive?

A. The Company will need to request the planning baseline assumptions used by the DSM Program designers for the first part of Staff's recommendation, and as Company Witness Frost as indicates, the Company is not opposed to this recommendation.

DNV will then support the Company in documenting these initial (Stage 1 per the EM&V Background and Information Report) baselines as requested by the Staff. We will also document any changes to baselines in the STEP Manual or the Dominion Energy TRM,

in the change log located at the end of each measure section, that DNV implemented starting with the STEP Manual version 10 filed with the May 15, 2020 EM&V Report.[1]

Q. Does DNV have other responses on this topic?

A. Yes. Please see Company Witness Goldberg's rebuttal for additional comments related to this topic.

V. CONCERNS WITH USE OF DEEMED INPUT VARIABLES, AND PREFERENCE FOR MEASURING ALL INPUT VARIABLES

Q. Separate from baselines, Staff Witness Dalton indicates that it is unclear to Staff that partially deemed savings, as employed by DNV to estimate the Company's DSM program savings, would be sufficient for meeting a measured and verified standard for complying with the energy reduction targets required by the VCEA. (Dalton at 38.). Please comment.

A. As DNV (EM&V Background and Information Report) and Witness James (James at 16) have both noted, both deemed and partially deemed savings are standard evaluation methods, and it is DNV's opinion that their continued use is appropriate.

As DNV and Respondents James and Grevatt have all indicated, it is important to have the best available information to assess the accuracy of savings estimates. However, the calculated savings will always be estimates because they are calculated relative to the unobservable counterfactual, namely what would have occurred absent the measure or absent the program. It is important to mitigate the uncertainty associated with these

[1] *See* Case No. PUR-2018-00168.

savings to inform the Commission's decision-making. However, DNV does not believe that improved accuracy of savings estimates should be pursued regardless of cost.

Q. Staff Witness Dalton highlights a number of concerns Staff has regarding the use of deemed savings calculations, deemed input variables, and the uncertainty and potential error associated with savings estimates. (Dalton at 37-41.) What has the Company and DNV done to mitigate the uncertainty associated with deemed savings calculations?

A. DNV establishes the deemed savings approaches documented in the STEP Manual (historically) that are updated annually and based on publicly available TRMs. We also independently calculate the savings according to the STEP Manual approaches, and then report on them. This process provides assurance to Staff, the Commission, and stakeholders that the deemed savings have been produced by an independent third party, not determined or influenced by the program implementation and delivery functions. And as DNV described in section 2.3 of the EM&V Background and Information Report (Dominion Energy tracked savings using "deemed savings calculations"), DNV, the Company, and its implementation vendors go to great lengths to define the structure and variables of the customer- and equipment-level input data that is used by DNV to produce the deemed savings estimates, quality check the savings regularly within each year, and report those savings. Moreover, DNV and the Company are committed to conducting more impact evaluations of programs going forward as programs mature. However, DNV maintains that there will be some measures and/or programs that will be appropriate to estimate using only deemed savings estimates without further evaluation. Programs and measures that fall into this category are "simple, well-defined energy

efficiency projects or measures, where uncertainty around average unit savings is low, and where average operating characteristics are well known," as characterized by VAEEC Witness James (James at 9).

Q. Staff Witness Dalton takes issue with using the deemed savings approach to evaluate savings for the DSM programs considered in this instant case (Dalton at 49), and later applying the evaluated savings approach in the longer term. Do you have a response to this?

A. Yes. The Company must report program progress annually in an EM&V Report as required by the VCEA and the EM&V Rule.[2,3] To meet these reporting requirements, there must be methods for tracking the program participation and estimating savings. Many of the DSM programs in this case are in DSM Phase VII and VIII. The majority of the Phase VII programs did not launch until 2020, and the DSM Phase VIII Programs are launching at the beginning of this year (2021). To date, participation levels have not reached the levels necessary to produce sufficient evaluation data such as a representative sample of measures, participant data, and/or comparison group data, and the length of time needed to produce sufficient post-installation consumption data for billing analysis has not passed. These conditions restrict the ability to conduct rigorous evaluations using the evaluated savings approach (Stage 3 as described in the EM&V Background and Information Report).

Restricting EM&V to the evaluated savings approach would also limit the ability to meet reporting requirements and to identify early trends and opportunities for continuous

[2] Va. Code Section 56-596.2 C.
[3] 20 VAC 5-318.

improvement. It also has the potential to produce biased results, or no results in cases where the data requirements cannot be met. To mitigate these limitations and meet mandated reporting requirements, DNV and the Company are using deemed savings methods to report early results until the evaluated savings approach can be applied.

To apply an evaluated savings approach without a sufficient sample of measures or participants may not provide results that are any more valid than those produced by deemed savings estimates.

The earliest that any Phase VII Program could be evaluated would be in late 2020 for early participants in the Residential Efficient Products Program. DNV adopted the timing of the approach described above and evaluated the Residential Efficient Products Program in late 2020. The results of the impact evaluation will be reported in the upcoming May 2021 EM&V Report.

For the remaining active DSM Phase I through VI Programs that were open for customer enrollment when this case was initiated:

- DSM Phase VI's Non-residential Prescriptive Program is currently undergoing an impact evaluation and the results will be reported in the upcoming May 2021 EM&V Report.
- DSM Phase VI's Non-residential Small Business Program was only approved through the end of 2020, and has closed to program enrollment.
- DSM Phase IV's Residential Income and Age Qualifying Home Improvement Program is not required to pass cost-effectiveness screenings.

Q. Does DNV have other responses on this topic?

A. Yes. Please see Company Witness Goldberg's rebuttal for additional comments related to this topic.

VI. CONSUMPTION AND/OR BILLING ANALYSIS AS THE PRIMARY VERIFICATION METHOD

Q. Staff Witness Ferrell notes that DNV conducted a consumption analysis on the Company's previous Low-Income program that showed savings in 2012–2014 ranged from 47–75% of savings estimated from deemed calculations, which illustrates Staff's concerns. (Ferrell at 15-16.) Do you have any comments?

A. DNV agrees that in this situation, the consumption analysis was an appropriate evaluation method based on the guidance summarized in the EM&V Background and Information Report Section 2.2.2 and illustrated in Figure 2-1. We also agree that the results indicate that the deemed savings for this program were overstated. This particular program was open to enrollment in program years 2010 to 2014. Evaluation was conducted via consumption data analysis in successive years, as noted by Witness Farrell. After each year's evaluation, DNV applied the realization rate from that year (*e.g.*, 47% for program year 2012) to the deemed savings estimate for the following year, to produce Stage 2 savings estimates consistent with the empirical results from the consumption data analysis. The billing analysis alone did not provide a basis for adjusting individual deemed savings inputs, since the realization rate or adjustment factor was applied to the combination of installed measures as a whole. Thus, the process of conducting the primary impact evaluation and applying the results to future program years was designed as a whole-house adjustment applied at the program level, rather than a measure-level adjustment implemented in the gross deemed savings calculations.

We further note that, while the primary impact evaluation for this program identified overstated savings overall, other evaluations have found that the deemed savings were understated; *e.g.*, the realization rates for Commercial Lighting Program in DSM Phase I, Home Energy Check-up Program in DSM Phase II were greater than 100% (as indicated in DNV's response to Staff Interrogatory No. 5-57).

Q. **Another Staff recommendation is that, to the extent the Commission allows savings estimates to be based on deemed calculations, the Commission direct the Company to more thoroughly investigate and report the level of uncertainty involved in the savings estimates. Specifically, Staff recommends reporting on input variables that are subject to the most uncertainty with EM&V Reports, and that the Commission direct the Company to conduct sensitivity analyses to identify a potential range of savings. (Ferrell at 20.). Please respond.**

A. We agree that a form of sensitivity analysis is appropriate. This is the essence of the Value of Information framework that we apply. This approach focuses not only on the uncertainty of each individual input, but how that uncertainty contributes to the uncertainty of program or portfolio savings. With this approach, a measure with a lot of individual uncertainty but little current or expected future participation, which contributes minimally to the total estimated portfolio savings, would be a low priority for primary data collection to reduce measure uncertainty. A measure with a similar or an even smaller level of uncertainty in per-unit savings but high current or projected program activity would be a higher priority. Thus, this type of assessment can be done hierarchically, first identifying programs or cross-program measures that have large contributions to savings, then identifying the key measures within the large programs,

and then the key parameters for the key measures. Depending on the evaluation methods used, the uncertainty might be addressed for a program as a whole, a measure as a whole, or an individual input variable.

Further, assessments of uncertainty levels for factors that have not been measured are inherently subjective and qualitative. DNV has no objection to reporting on such uncertainty assessments and corresponding recommendations for primary evaluation activity.

Q. Does DNV have other responses on this topic?

A. Yes. Please see Company Witness Goldberg's rebuttal for additional comments related to this topic.

Q. Does this conclude your pre-filed rebuttal testimony?

A. Yes, it does.

2195196442

WITNESS REBUTTAL TESTIMONY SUMMARY

Witness: Miriam Goldberg
Title: Senior Principal, DNV

Summary:

Company Witness Miriam Goldberg of DNV addresses proposals for an evaluation, measurement, and verification ("EM&V") dashboard format, a proposed EM&V annual summary, and topics pertaining to EM&V transparency and best practices.

Ms. Goldberg first addresses spillover and free-ridership evaluation methodologies. She agrees that some stakeholder concerns about risk and uncertainty may be mitigated by giving stakeholders the opportunity to recommend evaluation methods, while acknowledging that DNV should and will be applying industry best practices.

Ms. Goldberg next addresses the concept of persistence audits as one method to determine the effective useful life ("EUL") of the measures, as suggested by Staff. She notes that DNV has conducted such studies, though the most widely used approach is database or benchmarking. She further testifies that it is not standard industry practice to audit expired DSM programs, and instead standard practice would be to base lifetime savings from prior programs on the final evaluation savings, together with the established measure life or EUL at the time the measures were installed.

Ms. Goldberg testifies regarding the use of "code" baselines in the industry and why, in certain circumstances, it is appropriate and represents a utility-specific data point.

Ms. Goldberg addresses cost estimates for EM&V studies and suggests ways in which costs can be managed. She also addresses the three options that Mr. Dalton recommends the Commission consider for directing the Company to obtain Virginia-specific or utility specific-data for EM&V, including the challenges and/or propriety of each.

Finally, Ms. Goldberg testifies that billing analysis, where applicable, can be a cost-effective method of conducting EM&V. Indeed, as can be seen in the EM&V Plans for the Company's DSM Phase VII–IX Programs, DNV has specified an intent to perform billing analysis at every available opportunity – when it is an appropriate method. However, DNV does not agree that billing analysis should be a comprehensive approach in the sense that it should be applied to all programs and measures if the goal of EM&V is to produce statistically valid and useful estimates of program energy impacts.

2195190042

REBUTTAL TESTIMONY
OF
MIRIAM GOLDBERG
ON BEHALF OF
VIRGINIA ELECTRIC AND POWER COMPANY
BEFORE THE
STATE CORPORATION COMMISSION OF VIRGINIA
CASE NO. PUR-2020-00156

Q. Please state your name, position of employment, and business address.

A. My name is Miriam Goldberg. I am a Senior Principal for DNV. My business address is 122 West Washington Ave, Suite 1000, Madison, WI 53703.

Q. Have you previously submitted testimony in this proceeding?

A. Yes. My pre-filed direct testimony was submitted to the State Corporation Commission ("Commission") on behalf of Virginia Electric and Power Company ("Dominion Energy Virginia" or the "Company") in this proceeding on November 6, 2020.

Q. What is the purpose of your rebuttal testimony?

A. The purpose of my rebuttal testimony is to respond to the testimony filed by Mark James on behalf of the Virginia Energy Efficiency Council ("VAEEC") and Jim Grevatt on behalf of Appalachian Voices ("Environmental Respondent" or "ER"), collectively "Respondents," as well as the testimony filed by David J. Dalton and Georgianne Ferrell on behalf of the Commission Staff ("Staff"). Specifically my rebuttal testimony addresses proposals for an evaluation, measurement, and verification ("EM&V") dashboard format, a proposed EM&V annual summary, and topics pertaining to EM&V transparency and best practices.

My rebuttal testimony is provided in collaboration with the rebuttal testimony of Dan Feng, also of DNV. Collectively, the two rebuttal pieces of testimony provided by DNV

2160540042

are organized as follows:

I. Proposed EM&V Dashboard and Annual Summary
II. Developing and Maintaining Dominion Energy-specific or Virginia-specific TRM
III. Savings Persistence Counted toward VCEA and Other Legislative Goals
IV. Baseline
V. Concerns with Use of Deemed Input variables, and Preference for Measuring All Input Variables
VI. Consumption and/or Billing Analysis as the Primary Verification Method

My testimony focuses on topics specific to industry trends, best practices, and deep technical discussions on EM&V issues, and Company Witness Feng's testimony focuses on topics specific to the Company's existing EM&V practices.

Q. Are you sponsoring an exhibit as part of your rebuttal testimony?

A. Yes. Company Exhibit __, MG, consisting of Rebuttal Schedules 1-3, was prepared under my direction and supervision, and is accurate and complete to the best of my knowledge and belief.

I. PROPOSED EM&V DASHBOARD AND ANNUAL SUMMARY

Please see Company Witness Feng's rebuttal testimony for DNV's response on this topic.

II. DEVELOPING AND MAINTAINING DOMINION ENERGY-SPECIFIC OR VIRGINIA-SPECIFIC TRM

Q. VAEEC Witness James recommends adopting EM&V practices that perform assessments of the certainty and risk in valuing spillover and free ridership when setting baselines for each measure. (James at 15.) Do you agree?

A. I agree that assessing certainty and risk is valuable for EM&V planning in general, not just for spillover and free-ridership. Assessing uncertainty is part of the Value of Information framework DNV has referenced in several proceedings, including this one.

It is not entirely clear to DNV what Mr. James means in his reference to assessing "the certainty and risk in valuing spillover and free ridership" specifically "when setting baselines for each measure." We would agree that if the baseline is assumed to be overly generous (assuming very high energy consumption in the baseline scenario), then the resulting free-ridership assessment will find high free-ridership compared to that baseline—meaning that most customers would do something better than that baseline without program influence. A less generous baseline assumption would mean that a lower free-ridership adjustment is needed. In either case, an appropriate net-to-gross adjustment would result in the correct net savings.

Q. Mr. James further notes that concerns about the risk and uncertainty of energy savings can be addressed by having the stakeholder group evaluate and recommend methods for estimating spillover, and confidence in the accuracy of the savings can be managed by assessing the quality of the data that is available to produce the spillover estimates and by selecting an estimation methodology that reduces uncertainty. (*Id.*) Do you agree?

A. DNV agrees that confidence in the accuracy of the savings can be managed by assessing the quality of the data that is available to produce the estimates, and by applying estimation methods that reduce uncertainty. We further agree that some stakeholder concerns about risk and uncertainty may be mitigated by giving stakeholders the opportunity to recommend evaluation methods.

DNV is deeply familiar with spillover and free-ridership evaluation methodologies and has contributed to the development of many of these methods. We plan to apply these methods following industry best-practice guidance. Thus, while we welcome stakeholder

input and collaboration, the evaluation team should apply best practices.

Q. VAEEC Witness James states, "If the Company is using market codes as the baseline for calculating energy savings, it is likely undercounting program savings [when replacement happens] while the appliance still has effective useful life remaining." He further states, "If the program is encouraging replacement of appliances or equipment before the end of the useful lifespan, then the savings produced by the program should be calculated in two parts. For the first part (the period of what would have been the system's remaining useful life), the savings are the difference between the energy efficiency of the replaced item (the baseline) and the replacement item. For the second part (the time beyond what would have been the system's useful lifetime), a proper baseline would be the existing code or standard for that item at that point in time (i.e., the time when the original equipment is expected to have failed and been replaced)." Do you agree?

A. DNV agrees that use of a market baseline likely understates savings for cases of early replacement before the end of useful life. We also agree that the use of a dual baseline as described by Mr. James can be an appropriate approach to use for such cases. Applying a dual baseline can be complicated in practice. There are various ways that the principles described by Mr. James might be implemented.

Q. Does DNV have other responses on this topic?

A. Yes. Please see Company Witness Feng's rebuttal for additional comments related to this topic.

III. SAVINGS PERSISTENCE COUNTED TOWARD VCEA AND OTHER LEGISLATIVE GOALS

Q. As part of a discussion about tracking VCEA savings, Staff Witness Dalton notes that with respect to counting savings from previous programs, Staff believes it would be appropriate to audit existing installations for expired programs to ensure that the incented measures have remained in service and continue to operate as expected. (Dalton at 68.) Is it standard practice for EM&V conducted across the country to audit existing installations to ensure that the incented measures have remained in service and continue to operate as expected?

A. Audits of existing installations incented by programs to determine continued operation, also known as retention studies or persistence studies, are one of several ways used around the country to determine the effective useful life ("EUL") of the measures. DNV has conducted such studies.

Q. What other methods are used to determine the EUL?

A. The Uniform Methods Project, Chapter 13 describes common methods of determining measure persistence.[1] The most widely used approach is database or benchmarking. This approach can involve review of secondary sources, incorporation of local and regional information, or by applying expert judgment and experience. Expert judgment can be obtained by interviewing suppliers and installers of the measures as well as other kinds of service providers.

[1] D. Violette. National Renewable Energy Laboratory. 2016. Chapter 13: Assessing Persistence and Other Evaluation Issues Cross-Cutting Protocol. The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. https://www.nrel.gov/docs/fy17osti/68569.pdf.

2105100423

Periodic primary data collection via audits or phone calls can be used as part of the process of updating and maintaining the EUL databases. However, such persistence studies are not frequently conducted because they can be challenging and costly.

Q. What are the challenges of conducting audits to determine measure persistence?

A. The goal of persistence studies is typically to estimate the percentage of incentivized equipment still in place and operable as a function of time. Estimating this function accurately requires collecting data at several intervals since installation, and in particular, requires data from a point in time by which more than half the equipment is expected to be no longer operable. Getting access to premises several years after program participation can be difficult. Occupancy turns over and new occupants may not be aware of prior equipment; even original occupants may not remember. Moreover, even with cooperating premises it is not always possible for an auditor to identify program-incentivized equipment even when it is there.

Q. What guidance does the Uniform Methods Project offer on the choice to conduct in-field persistence studies?

A. Section 2.6.1 of the UMP Persistence chapter includes the following recommendations.[2]

1. Before determining whether to undertake a large-scale persistence study of a program or measure (or even to undertake such a study at all), consider whether the results of the study are likely to have a material impact on the economics of the program.
2. Select the methodology that best fits the individual circumstances of the measure/program being evaluated.

[2] D. Violette. Chapter 13: Assessing Persistence and Other Evaluation Issues Cross-Cutting Protocol, p. 17.

3. It is important to be open to the new methods and approaches being developed.
4. Certain types of persistence studies, particularly database/benchmarking approaches, might best be addressed on a regional basis that includes numerous specific programs.

Q. Staff Witness Dalton specifically says that the audits to determine continued operation should be done for expired programs. Would that approach be consistent with standard industry practice?

A. No. Standard practice would be to base lifetime savings from prior programs on the final evaluation savings, together with the established measure life or EUL at the time the measures were installed.

Q. Would that practice still apply when savings goals are set in terms of total cumulative savings?

A. Yes. For example, Illinois' Future Energy Jobs Act set savings goals for each year of a five-year planning horizon in terms of Cumulative Persisting Annual Savings ("CPAS"). This is similar to the VCEA goals based on total annual energy savings. The Illinois Energy Efficiency Policy Manual states that, "For the purpose of determining the amount of CPAS that Measures installed in a given year contribute to CPAS goals in future years, assumptions regarding measure lives and savings degradation factors will be based on the IL-TRM[3] in effect in the year in which they were installed."[4]

[3] Illinois Statewide Technical Reference Manual for Energy Efficiency, https://icc.illinois.gov/programs/illinois-statewide-technical-reference-manual-for-energy-efficiency.

[4] Illinois Energy Efficiency Policy Manual Version 2.0. (Final Version: September 19, 2019, Effective Date: January 1, 2022), p. 48.

Q. Somewhat related, Witness Dalton also suggests that with respect to prior period savings estimates, those estimates should be updated and adjusted based on information gained through the evaluated savings approaches that could result from this proceeding. (Dalton at 70.) Would such adjustment be consistent with standard practice in the industry?

A. No. Ordinarily, primary impact evaluation (stage 3 savings estimation as described in the EM&V Background and Information Report) is applied to savings from the evaluated period. Information from the primary impact evaluation is also used to adjust TRM input parameters going forward, but not to revise previously evaluated savings or savings realized prior to the evaluated period.

Q. Does that mean that an evaluated net-to-gross value would be applied only prospectively and would not be applied to the evaluated program and program period?

A. How evaluated net-to-gross values are applied can vary across jurisdictions, and even within jurisdictions when used for different purposes. When the net-to-gross rate ("NTGR") is included in the technical resource manual ("TRM"), it is not uncommon to apply updated NTGR values on a prospective basis only, as for any other TRM change. This is the approach taken in Illinois, for example.

In the recent ACEEE national survey of energy efficiency EM&V practices that was referenced by VAEEC Witness James, the report authors stated the following:

> We also asked when the results of new net savings analysis results are applied to the calculation of program savings. This is an important issue because many program administrators argue that if they design and deliver a program based on assumptions agreed upon up front regarding a particular net-to-gross

(NTG) ratio, it is unfair to retroactively apply a new assumption of free ridership to the program savings for a program already delivered. Rather, they argue that new assumptions about an NTG ratio should be applied prospectively, to the next program year.

ACEEE's position on this remains the same as it was in 2012. Our recommendations in this area depend on the uses toward which the information is being applied. To judge program administrator performance (and perhaps to determine whether and how much performance incentive has been earned) we tend to support applying such changes prospectively. In general, where program designs and budgets have been constructed based on agreed-upon values for certain key factors like deemed savings per unit and net-to-gross ratios, we believe it is reasonable to not retroactively "change the playing field" and alter the credited accomplishments of the utility/program administrator.

For this survey, a small number of states (14%) do not use net savings, and another 16% apply net savings results both retrospectively and prospectively, depending on the purpose. Of the remaining 26 states that use net savings, nearly two-thirds (61%) said they apply new net savings results only prospectively, while the remainder apply them retrospectively.[5]

As ACEEE indicated, how evaluated results are used are really a matter of policy specific to the purpose set by each individual jurisdiction.

[5] Dan York, Charlotte Cohn, Martin Kushler. 2020. National Survey of State Policies and Practices for Energy Efficiency Program Evaluation. ACEEE Research Report, p. 38. https://www.aceee.org/sites/default/files/pdfs/u2009.pdf

2105190042

IV. BASELINE

Q. With respect to baseline data sources, the Commission directed the Company to indicate whether existing measure baselines were utility-specific, Virginia-specific, or other, which the Company did within Section 3.1.1 of the EM&V Background and Information Report. Staff Witness Dalton disagrees with some of the classifications designated by the Company and DNV (Dalton at 27.) Please comment.

A. Staff Witness Dalton disagrees that "code"-based baselines could be considered to be utility-specific. While code is not a universal baseline for all projects, a common way to set baselines is to use locally applicable code. Code in each jurisdiction is not all set at the same level across the county. Each jurisdiction adopts versions of its own codes at different times. In that way, DNV assesses that code-baselines should be considered local in gross savings calculations.

Q. Staff Witness Dalton uses an example of a heat pump measure, where the baseline is assumed to be the Federal minimum efficiency level, to illustrate his concern that customers or Virginians may generally be choosing baseline equipment above the minimum requirements (Dalton at 28.) Do you have a response?

A. What matters is the net savings. To determine the net program impacts, a net-to-gross study can be conducted. Such a study determines the extent to which customers would have done something different than the baseline.

2105180472

Q. Staff Witness Dalton expresses further concern regarding baselines developed only from codes and standards, and whether those accurately represent customers' actual baselines. He provides a specific example regarding new construction residential homes and how the baseline, in actual practice, for a particular developer or group of developers, could differ from code minimum. (Dalton at 28-31.) Do you have a response?

A. Regarding residential new construction, as described by Company Witness Hubbard in his rebuttal testimony in Case No. PUR-2019-00201, the fact that Ryan Homes offers high-efficiency homes does not mean that the average home purchased from Ryan Homes is at that efficiency level. Further, even if it is determined that the typical practice for the Residential New Construction Program is above code, that does not imply that typical practice for all measures in all programs is likely to be above code.

While baseline studies can be very informative, they tend to also be very expensive. They are typically required on a targeted basis where there is reason to believe that market practice is above code and the expense makes sense for the portfolio. The cost/value proposition for such a study is also affected by whether the study is determining a single input value to a savings calculation, such as baseline efficiency, or is also cost-effectively gathering additional savings inputs.

In California, for example, decisions to conduct targeted industry standard practice ("ISP") studies are made by the California Public Utilities Commission ("CPUC") and the four investor-owned utilities ("IOUs"), based on feedback from stakeholders. Table 1, copied from Section 3.14 of the CPUC Decision 16-08-019, summarizes the approved

2195-0042

default baseline policy adopted on August 8, 2016.[6] Although ISP study results may be considered to revise baselines, revisions are implemented on a case-by-case basis.

Table 1. Adopted Default Baseline Policy for All Sectors

Alteration Type	Delivery	Savings Determination	Shell and Bldg. System and Add-On Equipment	Behavioral, Retro-commissioning, and Operational	Normal Replacement	Accelerated Replacement and Repair Eligible
New construction, expansions, added load	Any	Any	Code	N/A	Code	N/A
Existing buildings, including major alterations	Upstream and Midstream	Any	Code	N/A	Code	N/A
	Downstream	Calculated[7]	Existing	Existing	Code	Dual
		Deemed	Existing	Existing	Code	Dual
		NMEC[8]	Existing	Existing	Existing, Program Design	Existing
		RCT[9]/ experimental	Existing	Existing	Existing	Existing
Non-building projects, including industrial and agricultural processes	Any	Any	N/A	Existing	Standard Practice	Dual

[6] Order Instituting Rulemaking Concerning Energy Efficiency Rolling Portfolios, Policies, Programs, Evaluation, and Related Issues, Rulemaking 13-11-005, p. 49. https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M359/K000/359000779.PDF

[7] For the CPUC, this term broadly applies to custom measures only.

[8] Normalized Metered Energy Consumption (NMEC) measures are custom measures that use year-over-year metered data—after normalizing for weather—to measure savings either at the site level or at a population level, depending upon program design.

[9] Randomized Control Trial (RCT)

Q. Based on information provided in discovery, Staff Witness Dalton estimates that it would cost approximately [BEGIN EXTRAORDINARILY SENSITIVE] [redacted] [END EXTRAORDINARILY SENSITIVE] to collect utility-specific or Virginia-specific data for use as baseline input variables in estimating energy and demand savings attributable to the Company's energy efficiency programs, though he also notes the range provided by DNV of [BEGIN EXTRAORDINARILY SENSITIVE] [redacted] [END EXTRAORDINARILY SENSITIVE]. (Dalton at 34.) Do you have any comments?

A. The information provided in DNV's response to Staff Interrogatory No. 6-64 and No. 9-117 that was used to develop our cost estimate was based on general assumptions, and assumed that in-field measurements would be required to calculate the input parameters for all measures. In the responses, DNV provided the cost calculations and assumptions to provide transparency into how the estimates were developed. We believe our estimate provides a reasonable range, but as stated in our prior testimony, a budget for a detailed scope of work might vary from the initial gross estimate.

It is unclear how Staff Witness Dalton arrived at his own cost estimate. DNV believes that Staff Witness Dalton's **[BEGIN EXTRAORDINARILY SENSITIVE]** [redacted] **[END EXTRAORDINARILY SENSITIVE]** estimate to measure all baseline input variables in estimating energy and demand savings attributable to the Company's energy efficiency programs is low, even if "some portion of the baselines currently used by the Company are determined to be utility- or Virginia-specific," (Dalton at 34) because it is DNV's understanding that Staff prefers measurement and verification of *all* baseline input variables for *all* measures.

2108531090442

For example, the California 2008–2009 lighting study that DNV referred to at the end of the response to Staff Interrogatory 8-105, cost approximately **[BEGIN EXTRAORDINARILY SENSITIVE]** [redacted] **[END EXTRAORDINARILY SENSITIVE]** alone. The California lighting study was conducted over 10 years ago, for a single measure, and included onsite inventories and metering. The average daily hours of use from that study had a relative precision of ±3% at 90% confidence across all lamps, but for individual lamp types, the relative precision was up to ±36%.

Q. Are there alternative ways to determine Virginia- or utility-specific baselines and other input parameters?

A. Yes, it is possible to use other evaluation approaches including surveys of vendors, distributors, and industry experts, analysis of manufacturer, or distributor shipment volumes if that data is available. This approach would cost less than direct measurement and verification at customer sites. These methods are outlined in Table 3-2 of the DNV's EM&V Background and Information Report. Or, if we are to use onsite data collection, the on-site samples may be reduced to manage costs, with the understanding that a smaller sample size will increase error and uncertainty.

Q. Given the range of methods and costs, do you believe that a reasonable study to determine baselines for all measures and parameters could be conducted for less than the amounts DNV had provided with these initial estimates?

A. Yes, if the Commission directs the Company to conduct a comprehensive baseline study, DNV will work with the Company to propose a study that strikes an appropriate balance between rigor and cost, depending on guidance from the Commission.

Q. Are there ways that the net-to-gross adjustment corrects for possible over-statement of gross savings due to the baseline efficiency assumption being too low?

A. Yes, as noted in the discussion regarding dual baselines above, even if market practice is above code and the gross savings is calculated relative to code, the net-to-gross adjustment should account for the extent to which program participants would have adopted better than code without the program.

Q. Are there advantages to the use of NTGR to address the tendency to adopt better than code without the program, as opposed to a change to the baseline?

A. Yes. The average across the whole market is typically not the same as what participants would do absent the program. As a result, even if EM&V uses a less generous baseline definition, it would still be necessary to estimate the NTGR. Since the NTGR must be determined no matter what, we can get to the same net savings with a code baseline as with a market baseline, potentially at less expense.

When we do the NTGR assessment, it is easier to get responses by asking about likely installation absent the program in terms of commonly understood baselines, such as code, rather than asking if someone would otherwise have installed at a market average that is a blend of equipment types. Further, since participants have benefited from the program, it is generally easier to get information from participating customers than non-participating customers and vendors. As a result, that NTGR can be easier to determine with accuracy than market typical practice, though some study aspects could be similar for both NTGR and baseline studies.

Q. Given what you've just described, are there reasons it would make sense to conduct a baseline study rather than simply addressing baseline in NTGR adjustments?

A. Yes. A value of baseline studies is to assess whether the program is setting efficiency thresholds too low. Programs should generally be providing incentives for practices that are better than what is typical in the market they target.

Q. Does DNV have other responses on this topic?

A. Yes. Please see Company Witness Feng's rebuttal for additional comments related to this topic.

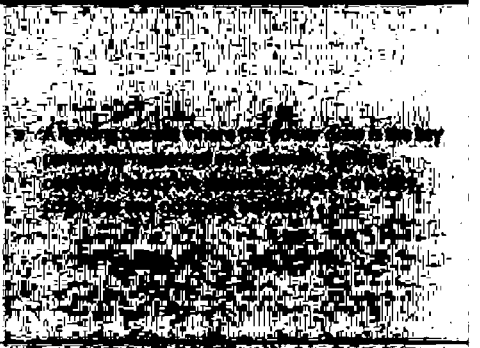
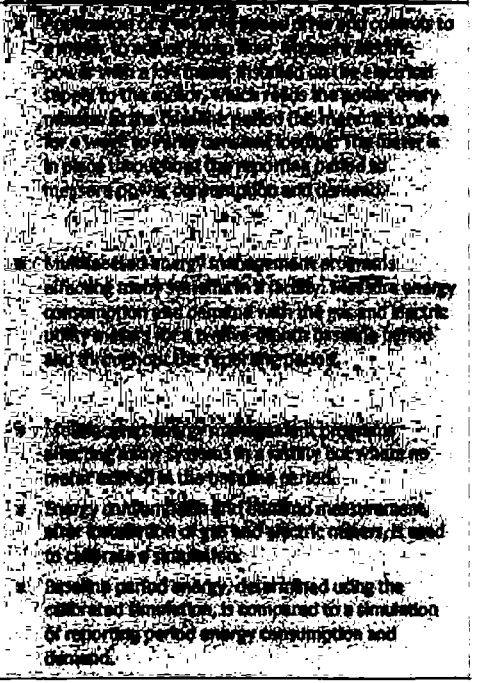
V. CONCERNS WITH USE OF DEEMED INPUT VARIABLES, AND PREFERENCE FOR MEASURING ALL INPUT VARIABLES

Q. Staff Witnesses Dalton notes that for certain programs DNV uses an evaluated savings approach; however, Staff remains concerned that not all input variables will be evaluated and the methodology continues to rely on deemed values. (Dalton at 42-49.) Please respond.

A. The approach of not evaluating all input variables and relying on some deemed input variables is a standard practice that is outlined in the International Performance Measurement and Verification Protocol ("IPMVP") Options A, Retrofit-isolation: Key Parameter Measurement.[10] This is illustrated in Table 2. Overview of IPMVP Options, provided in the IPMVP Generally Accepted M&V Principles document.

[10] Efficiency Valuation Organization. International Performance Measurement and Verification Protocol (IPMVP). https://evo-world.org/en/products-services-mainmenu-en/protocols/ipmvp.

Table 2. Overview of IPMVP Options

IPMVP Option	Definition	How Savings are Calculated	Typical Applications
A. Retrofit-Isolation: Key Parameter Measurement	» Savings are determined by field measurement of the key parameter(s), which define the energy consumption and demand of the ECM's affected system(s) or the success of the project. » Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter and the length of the reporting period. Parameters not selected for field measurements are estimated values. Estimates can be based on historical data, manufacturer specifications or engineering judgment. » Documentation of the source or justification of the estimated value is required. The plausible saving error arising from estimation rather than measurement is evaluated.	» Engineering calculation of baseline period energy and reporting period energy from: short-term or continuous measurements of key parameter(s) and estimated values » Routine and non-routine adjustments as required. Key parameter(s) measured during both baseline and reporting period.	
B. Retrofit-Isolation: All Parameter Measurement	» Savings are determined by field measurement of the energy consumption and demand and/or related independent or proxy variables of the ECM affected system. » Measurement frequency ranges from short-term to continuous, depending on the expected variations in savings and length of the reporting period.	» Short term or continuous measurements of baseline and reporting period energy, or engineering computations using measurements of proxies of energy consumption and demand. » Routines and non-routine adjustments as required.	
C. Whole Facility	» Savings are determined by measuring energy consumption and demand at the whole facility utility meter level. » Continuous measurements of the entire facility's energy consumption and demand are taken throughout the reporting period.	» Analysis of the whole facility baseline and reporting period (e.g., utility) meter data. » Routine adjustments as required, using techniques such as simple comparison or regression analysis. » Non-routine adjustments as required.	
D. Calibrated Simulation	» Savings are determined through simulation of the energy consumption and demand of the whole facility, or of a sub-facility. » Simulation routines are demonstrated to adequately model actual energy performance in the facility. » This option requires considerable skill in calibrated simulation.	» Energy consumption and demand simulation, calibrated with hourly or monthly utility billing data. Energy end-use metering and metered performance data may be used in model refinement.	

2105100042

The IPMVP is an accepted standard and referenced in the current "EM&V Rule" issued by the Commission, in section 20 VAC 5-318-40 Minimum Requirements for Collection of Evaluation, Measurement, and Verification Data, item 3. b. (2). D.[12] This is also an accepted approach in the Uniform Methods Project ("UMP") protocols developed by the U.S. Department of Energy [13] A number of the Protocol chapters describe evaluation of a particular measure type, and many of these measure-specific protocols explicitly describe which IPMVP Options would apply and how. For an example, see the excerpt from Chapter 2: Commercial and Industrial Lighting Evaluation Protocol[14]

6 Measurement and Verification Plan

The M&V plan describes how evaluators determine actual energy savings in a facility where a lighting efficiency project has been installed. Evaluators use M&V to establish energy savings for a random sample of projects. The M&V results are applied to the population of all completed projects to determine program gross savings. The sampling and application processes are described in UMP *Chapter 11: Sample Design Cross-Cutting Protocol*. The sample size should be determined following the recommendations in UMP Chapter 11.

All M&V activities in the protocol are conducted on a representative sample of completed projects, drawn from a closed reporting period (for example, a program year).

6.1 IPMVP Option

The protocol recommends evaluators conduct M&V according to the International Performance Measurement and Verification Protocol (IPMVP) Option A—Retrofit Isolation: Key Parameter Measurement approach.

The key measured parameters are the HOU terms in Equation 1. The fixture quantity parameter is verified through an inspection process. The fixture wattage parameter is verified through a combination of on-site inspections and look-up tables of fixture demand (Watts).

Option A is recommended because the demand (Watts) values are known and published for nearly all fixture types and configurations, and therefore need not be measured, whereas lighting operating hours vary widely from building to building.

[12] 20 VAC 5-318-10.

[13] Uniform Methods Project for Determining Energy Efficiency Program Savings. https://www.energy.gov/eere/about-us/ump-home.

[14] Gowans, D.; Telarico, C. (2017). Chapter 2: Commercial and Industrial Lighting Evaluation Protocol, The Uniform Methods Project: Methods for Determining Energy-Efficiency Savings for Specific Measures. Golden, CO; National Renewable Energy Laboratory. NREL/SR-7A40-68558. http://www.nrel.gov/docs/fy17osti/68558.pdf

2205160042

Q. Mr. Dalton recommends the Commission consider three options for directing the Company to obtain Virginia-specific or utility specific-data for EM&V on pages 52-56 of his testimony. Could you please address these options?

A. Yes, I can. *Option 1:* On page 52 of his testimony, Witness Dalton suggests that the Company "perform suitably random sampling on each currently-deemed input variable utilized in calculating energy and demand savings for each measure." DNV assumes that he means that for each variable of each measure savings calculation, the Company would conduct data collection to obtain the value of that variable for a sample of customers.

DNV does not believe that the approach in Option 1 is a prudent exercise or use of program funds if our interpretation of the option is correct, that Staff suggests conducting a rigorous statistically significant study of all variables.

Option 2: On page 54 of his testimony, Witness Dalton offers the option "to identify the key input variables – those most likely to have the largest impact on the accuracy of savings estimates – that are currently deemed input variables and perform random sampling on only this smaller subset of variables." DNV assumes that he means that for each identified key variable, the Company would conduct data collection to obtain the value of that variable for a sample of customers.

Random sampling on key input variables (Option 2) is in line with the existing process that DNV has proposed for the DSM Phase VII and future programs. However, DNV has stated in the EM&V Background and Information Report (p 15–16):

> DNV believes that it is appropriate to use the original values [from source TRMs] adjusted for local conditions such as weather. We do not plan to recreate these values with data taken entirely within the utility or the state

because conducting such studies with the level of rigor necessary to include metering and sampling a sufficient number of projects can be expensive and span multiple years. The outcome of that investment may be results that are not significantly different from those found in the studies we reference.

Option 3: On page 55 of his testimony, Witness Dalton suggests as a final option that the Company "develop a pilot program that combines several elements of existing programs…select a sample of new homes…install a suitable number of each measure currently offered in each of its residential programs, and install submeters on each incented measure within the home…The Company could further expand this measurement strategy to include a sample of existing homes, retrofitting them with the same items as the newly built homes and submetering them as well."

As Company Witness Frost addresses in his rebuttal testimony, the approach in Option 3 would be highly intrusive to customers. Separately, while the customers who participate in the pilot effort would be Virginia-specific customers, they may not be representative of the customers who participate in the full-scale programs of interest.

Q. **Staff Witness Dalton suggests that the cost of measuring all input variables, which DNV had estimated would be [BEGIN EXTRAORDINARILY SENSITIVE] [redacted] [END EXTRAORDINARILY SENSITIVE] could be reasonable in light of the magnitude of projected DSM-related spending as well as compliance-related considerations he lays out in his testimony on pages 60–63 of his testimony. Do you have any comments?**

A. Staff Witness Dalton cites the IPMVP and states that "it may be appropriate to expend up to ten percent of the value of estimated savings on EM&V" (Dalton, page 62).

2105160942

While the IPMVP is one of the foundational documents upon which EM&V protocols are defined, it is more typically applied to site-level EM&V (e.g., energy performance contracts, facility-level efforts) where the value of the estimated savings is equivalent to the approved budget. DNV does not believe it is appropriate to use the value of the energy saved as the basis for allocating the EM&V budget, because in practical terms, DSM programs have finite budgets approved by the Commission that are not designed using the value of the energy saved as a stand-alone performance metric. Rather, the Company's EM&V budgets are developed and approved by the Commission following industry best practice; EM&V budgets are measured against total program budgets.

As DNV stated in Rebuttal Testimony of Dan Feng in Case No. PUR-2019-00201, the Company and DNV acknowledged the value of more rigorous EM&V and has already begun to increase to conduct more impact evaluations of more programs, and will continue to do so. This will increase EM&V spending by necessity.

Q. Does DNV have other responses on this topic?

A. Yes. Please see Company Witness Feng's rebuttal for additional comments related to this topic.

VI. CONSUMPTION AND/OR BILLING ANALYSIS AS THE PRIMARY VERIFICATION METHOD

Q. Staff Witnesses Dalton and Ferrell recommend billing or consumption analyses as a comprehensive method for estimating energy savings. (Dalton at 50-52; Ferrell at 13-20.) Do you agree with Staff's assessment?

A. We agree that billing analysis, where applicable, is a preferred method because it accounts for interactive effects of installed measures, takeback, and participant spillover.

In this sense, it is a comprehensive method, where applicable. When appropriate, it is also a cost-effective method.

As can be seen in the EM&V Plans for the Company's DSM Phase VII–IX Programs, DNV has specified an intent to perform billing analysis at every available opportunity – when it is an appropriate method. The applicability and methodology for billing analysis to specific programs, program populations, sample sizes, and measures is consistent across the industry best practice guidance documents (UMP, IPMVP, and ASHRE protocols), and we believe it should be applied accordingly. DNV does not agree that billing analysis should be a comprehensive approach in the sense that it should be applied to all programs and measures if the goal of EM&V is to produce statistically valid and useful estimates of program energy impacts. The Company's response to Staff Interrogatory No. Question 8-107, which is attached as my Rebuttal Schedule 1, explains the situations where billing analysis is commonly used and may be recommended over alternate methods.

Q. On pages 14–15 of her testimony, Staff Witness Ferrell testifies that utilizing a billing analysis approach for an energy efficiency program, instead of relying on deemed calculations for each measure, alleviates a variety of concerns, which she outlines. Staff ultimately recommends the Commission direct the Company to analyze actual consumption data whenever possible. (Ferrell at 20.) Do you agree?

A. If "whenever possible" means whenever the recognized conditions for using billing analysis are present, DNV agrees, as noted above.

DNV's current plans for EM&V of the Company's programs, are to use the Value of

Information framework to identify the programs to evaluate using either consumption or load data analysis or measurement and verification methods. The Value of Information framework is a rubric for decision-making and risk mitigation, not an explicit protocol.

As indicated in Table 2-3 (page 22) from the EM&V Background and Information Report ("Primary impact evaluation methods to measure net energy and demand savings"), DNV is already intending to use consumption data analysis for several programs where it is appropriate.

Q. One of Staff's findings and recommendations as presented by Ms. Ferrell is that the Commission direct the Company to consider EM&V implications in the initial selection and design phases of DSM programs; and, if the Commission determines that consumption data should be used to consider savings as being measured and verified, the Company should design programs that are capable of being evaluated using a consumption data method. (Ferrell at 20.) Are you aware of any other jurisdiction where a regulator has limited DSM programs to those capable of being evaluated using consumption analysis as suggested by Staff?

A. No. I am not aware of other jurisdictions where programs are restricted to those that can be evaluated by one specific method. A requirement to design only programs that can be evaluated via consumption analysis would have eliminated upstream lighting programs (such as the DSM Phase VII Residential Efficient Products Marketplace Program), the most cost-effective and largest contributor to most energy efficiency portfolios for several years.

210510042

Q. Has an explicit sensitivity analysis been used to guide the need for primary impact evaluation in other jurisdictions that you are aware of?

A, Yes, it is common practice to focus studies on reducing the uncertainties that have the most effect on program and portfolio savings. California has used a process to focus on uncertain measures in each year's evaluation plans. The California evaluations never attempt to measure all parameters. Each year a portion of the portfolio is evaluated. Many measures and whole programs have the program-estimated (ex ante) savings passed through without evaluation adjustment because either their uncertainty is not large or they contribute a small proportion to the total portfolio savings. The methods that have been used in California are described further in the Company's response to Staff Interrogatory No. 8-105, which is attached as my Rebuttal Schedule 2.

Q. Staff Witness Ferrell states that if the existing condition is not the appropriate baseline, the consumption analysis results can be adjusted to estimate the savings at the correct baseline. (Ferrell at 18.) Do you agree?

A. This is a possible approach, and one that DNV has developed and applied in past studies. However, it does not necessarily result in greater accuracy compared to the deemed savings approach. Staff Witness Ferrell is concerned about the accuracy of deemed baselines that assume applicable code as the baseline. To adjust a pre-post consumption analysis to an appropriate baseline for new standard efficiency equipment, it would be necessary to know both the new standard efficiency baseline and the efficiency of the existing equipment replaced by the program equipment. As discussed by Agnew and Goldberg (2009), the consumption analysis cannot distinguish between takeback effects

and incorrect assumptions about the existing equipment efficiency.[15] Please see my Rebuttal Schedule 3 for a copy of the referenced paper.

Q. Does DNV have other responses on this topic?

A. Yes. Please see Company Witness Feng's rebuttal for additional comments related to this topic.

Q. Does this conclude your pre-filed rebuttal testimony?

A. Yes, it does.

[15] Ken Agnew and Mimi Goldberg, 2009, "Getting to the Right Delta: Adjustment and Decomposition of Billing Analysis Results," 2009 Energy Program Evaluation Conference, Portland Getting to the Right Delta: Adjustment and Decomposition of Billing Analysis Results," (https://www.iepec.org/wp-content/uploads/2018/02/069-8.pdf)

2021-00042

Virginia Electric and Power Company
Case No. PUR-2020-00156
Virginia State Corporation Commission Staff
Eighth Set

The following response to Question No. 107 of the Eighth Set of Interrogatories and Requests for Production of Documents propounded by the Staff of the State Corporation Commission and received on March 15, 2021, was prepared by or under the supervision of:

Miriam Goldberg
Senior Principal
DNV

Question No. 107

Does the Company or DNV GL view savings estimates resulting from billing analyses or other types of impact evaluations as more accurate than savings estimates derived from deemed savings calculations? Provide a narrative explanation of why or why not.

Response:

As previously stated in the EM&V Background and Information Report, section 2.1.5 (starting on page 11):

> Guidance documents identify deemed savings method as one of three broad categories of evaluation, measurement, and verification methods for calculating EE net savings:
> - Deemed savings – methodology for specific EE measures
> - Direct M&V – applied to individual EE projects or measures [either for each project in the program or for a sample with statistical expansion to the full program]
> - Comparison Group – relying on the analysis of consumption data for an affected group of premises compared to another group[2]
>
> Table 2-1. shows how different savings approaches (to include deemed savings approaches) are commonly used for different types of projects.

---

[2] U.S. Environmental Protection Agency. "Guidebook for Energy Efficiency Evaluation, Measurement, and Verification. A Resource for State, Local, and Tribal Air & Energy Officials." June 2019. https://www.epa.gov/sites/production/files/2019-06/documents/guidebook_for_energy_efficiency_evaluation_measurement_verification.pdf. Page 19

Table 2-1. Common evaluation, measurement, and verification methods for selecting EE and demand response (DR) categories and project types[28]

	EM&V Methods		
	Deemed Savings	Measurement and Verification	Comparison Groups
Program Categories			
Efficiency programs: Direct action (e.g., retail rebates[40]). Typically prescriptive measures, but not always.	Very common	Common	Common
Efficiency programs: Indirect action (e.g., marketing and education[41]). For example, behavior based efficiency programs.	Common	Not common	Common
ESCO energy efficiency projects. Typically a combination of custom and prescriptive measures.	Common	Very common	Not used
Industrial strategic energy management and voluntary efforts.	Common	Common	Not used
Demand response	Can be used	Very common	Can be used
Project Types			
Simple, well-defined individual projects (prescriptive/deemed measures, see definition in Section 2.3)	Very common	Can be used	Not used
Complex, unique individual projects (custom measures, see definition in Section 2.3)	Not used	Very common	Not used
Large number of relatively homogenous projects	Very common	Can be used	Common

Source: Schwartz et al. 2017, modified from Table 7.10.

Applying deemed savings values or calculations, billing analysis with a comparison group, and direct M&V are all valid evaluation methods. Which evaluation method is most accurate depends on the situation and the details of how the method is implemented.

Billing analysis often cannot provide accurate savings estimates because there is not a large enough pool of customers, the savings are too small to be detected above the noise, there is not a valid comparison group available, or the baseline is new standard-efficiency equipment while the billing analysis provides savings relative to existing equipment. In situations where the conditions are suitable for applying billing analysis, the billing analysis avoids biases due to use of deemed values or input variables that differ from the correct values for the participating population. However, billing analysis results often have very wide error bars. The 90 percent confidence interval for savings may be on the order of +/-50 percent of the estimate, or more.

Direct M&V (applying one of the IPMVP Options) can be more accurate given a large enough sample size. However, a small sample direct M&V study may be less accurate than a deemed value based on a more robust prior study. Direct M&V is typically more accurate for an individual site than applying a deemed calculation. For the program as a whole, the accuracy of an M&V study depends on the variability across sites, which is reduced by larger sample sizes, as well as on the magnitude of non-response bias. A burdensome M&V study may have very

high non-response rate. While the non-response bias cannot be measured, the potential for bias in the overall result is greater when the non-response rate is higher.

2195100422

Virginia Electric and Power Company
Case No. PUR-2020-00156
Virginia State Corporation Commission Staff
Eighth Set

The following response to Question No. 105 of the Eighth Set of Interrogatories and Requests for Production of Documents propounded by the Staff of the State Corporation Commission and received on March 15, 2021, was prepared by or under the supervision of:

Miriam Goldberg
Senior Principle
DNV

Question No. 105

Has the Company or DNV GL considered providing savings estimates as intervals, rather than (or in addition to) reporting single value estimates? Please explain why or why not.

Response:

This response contains extraordinarily sensitive information, and is being provided pursuant to the protections set forth in 5 VAC 5-20-170, the Hearing Examiner's Protective Ruling and Additional Protective Treatment dated January 20, 2021, any subsequent protective order or ruling that may be issued for confidential or extraordinarily sensitive information in this proceeding, and the Agreements to Adhere executed pursuant to any such orders or rulings.

No. Providing savings estimates as intervals, rather than (or in addition to) reporting single value estimates has not been considered. It is not typical of deemed savings estimates to be provided as averages with confidence intervals (at least DNV is aware of none), but deemed savings often provide multiple values based on weather or other variables. When reporting the results of impact evaluations, DNV typically reports both net-to-gross ratios and realization rates with confidence intervals, consistent with industry best practice (DOE Uniform Methods, NEEP EM&V Protocols, etc.).

DNV is aware of efforts to quantify the uncertainty of deemed savings only in California. Such an approach may be more appropriate for a targeted subset of measures with high savings where the costs of estimating savings as intervals is somewhat offset by the benefits of estimating the uncertainty around those savings estimates in cases where impact evaluation would be extremely high cost to achieve a precise impact estimate and the analysis would be a substitute or be used to plan a more targeted impact evaluation.

The California Public Utilities Commission ("CPUC") conducted some studies or study elements. In all of these, the uncertainty assessment was based substantially on subjective assessment of the uncertainty of particular inputs. Specifics are as follows:

2151092

Extraordinarily Sensitive Information Redacted

1. The first involved a portfolio-wide parameter uncertainty analysis (a.k.a. P4 analysis) during which industry experts were asked to estimate the uncertainty of each measure group offered by the portfolio. These assessments were then weighted by the annual electric savings they yielded for the portfolio to determine which measure groups contributed the greatest uncertainty to portfolio-level savings. CPUC staff updated this analysis annually from 2013 to 2020, but the process is on hold pending other regulatory reforms.
2. Other studies conducted before and after the P4 analysis existed in California include:
    a. For lighting, as part of 2008–09 EM&V, DNV performed a preliminary analysis before launching a large metering study. The preliminary analysis reviewed the full deemed savings algorithm and uncertainty of each input parameter. The parameter uncertainties were determined subjectively, and vetted by reviewers. The analysis determined that the uncertainty in the lighting hours of use justified the substantial investment in a major metering study to resolve this uncertainty. Based on the overall analysis, each segment of the algorithm was broken down to be addressed over multiple studies:
        i. Metering was conducted in 1,200 homes with over 8,000 meters deployed in 3 waves of several months each, to inform hours of use for all measures. A model of lighting hours of use as a function of home demographics, room type, lamp type, and fixture type was developed, to allow hours of use to be estimated for different subgroups and conditions, and in future years.
        ii. In-store shelf surveys and customer intercept studies were conducted frequently (annual or bi-annually) to determine installation rates, delta watts (given that lighting measure baselines were changing quickly), and net-to-gross rates.
        iii. In-home equipment inventories have been periodically conducted, to provide updated hours of use based on the original model from the metering study.
    b. For HVAC, as part of 2013–15 research, ultimately there was not enough sample across every building type, climate zone, and vintage, in addition to the wide variation in HVAC maintenance measure performance (which correlated to multiple baselines).
3. For high-impact HVAC measures that had not been selected for evaluation, another study was designed to perform Monte Carlo simulations of either the algorithm or the building energy modeling tool used to derive the deemed savings (for a single building type located within one climate zone). The study reported which algorithm or modeling inputs were the greatest contributors to the deemed savings uncertainty. In some instances, it was possible to then estimate the uncertainty around the deemed savings for measures.

The studies do not all have published budgets. For, the HVAC study, 3 items were on the scale of **[BEGIN EXTRAORDINARILY SENSITIVE INFORMATION]** [redacted] **[END EXTRAORDINARILY SENSITIVE INFORMATION]**. The lighting portion of the

2151909422

study was on the scale of **[BEGIN EXTRAORDINARILY SENSITIVE INFORMATION]** [redacted] **[END EXTRAORDINARILY SENSITIVE INFORMATION]**.

Please see the annual executive summaries and reports of the HVAC study (3) available at http://www.calmac.org/results.asp?flag=&searchtext=%22Study+of+Deemed%22&pubsearch=1&dFrom=1%2F18%2F1990&dTo=2%2F23%2F2021&yFrom=1980&yTo=2021&selPubDates=&selToDate=&selProgYear=&selToYear=&pubsort=1&Submit=Search

Please see the following links to papers and presentations related to the P4 analysis:

- Energy Efficiency Portfolio Risk Management: A Systematic, Data-Driven Approach for Timely Interventions to Maximize Results: https://www.iepec.org/conf-docs/papers/2007PapersTOC/papers/123_1129_ab_610.pdf
- ESPI Uncertain List Presentation: https://pda.energydataweb.com/#!/documents/990/view

21051000042

Getting to the Right Delta: Adjustment and Decomposition of Billing Analysis Results

Ken Agnew, KEMA Inc, Madison, WI
Mimi Goldberg, KEMA Inc, Madison, WI

ABSTRACT

Billing analysis provides an empirically based, cost-effective approach to measuring the impact of energy efficient heating and cooling retrofits. Estimates of gross savings, that is, savings with respect to a standard installation baseline, can be derived from billing analysis output using engineering equations. The application of these engineering equations to billing analysis output requires careful attention to what effects are present in the billing analysis output. The presence of take back and quality installation measures affect post-installation consumption and thus affect the application of engineering equations to the billing analysis output.

This paper examines two different approaches for estimating gross program impacts and the potential for bias in both approaches. We quantify the nature of the biases in each approach. We also show that the two approaches produce biases that mirror each other and bracket the unbiased result. We show that, in theory, it is possible to derive a bias-adjusted result by combining the two different approaches. Additional challenges are discussed related to the application of engineering equations to pre-post billing analysis output.

As an application, we show how these methods were used for an impact evaluation of the New Jersey Clean Energy Program CoolAdvantage air conditioner rebate program. The program promoted quality installation and all such programs have the potential for the presence of take back. The methods discussed here were used to confirm the billing analysis impact estimate and assess the presence of take back and the success of quality installation efforts.

Introduction

This paper examines two different approaches for producing billing analysis estimates of gross program impacts. Both approaches use engineering equations to produce impact estimates relative to the appropriate standard installation baseline. The post-only approach builds an estimate from post-program consumption and an engineering-based estimate of the percentage change in consumption due to the increase in efficiency. The pre-post approach decomposes the change in consumption, the delta, to isolate the program portion of the impacts. While effectively based on the same engineering equations, the two approaches generate impact estimates that incorporate potential biases in opposite directions.

Both approaches have limitations in addressing common features of program participant data. In this paper we seek to identify and quantify the biases inherent in each of the two approaches. We then establish the conditions under which the combined results of these two different approaches allow a bias-adjusted estimate of efficiency related savings assuming a standard installation baseline.

We apply this framework to billing analysis results from an evaluation of the NJ CoolAdvantage program, a central air conditioner rebate program. The framework allows us to confirm the estimate of efficiency related savings and address questions about the effects of Quality installation Verification and take back on the impact estimates.

21051 0842

Background

The primary purpose of the analysis discussed in this paper was to update the New Jersey protocols for the NJ Clean Energy HVAC programs (KEMA 2009). In particular, this paper focuses on the CoolAdvantage program, a central air conditioner rebate program. The program rebated high efficiency central air conditioners with a Seasonal Energy Efficiency Ratio (SEER) of at least 14. The program also had a quality installation verification component (QIV) to ensure optimal charging and airflow. If installers were not certified by North American Technician Excellence (NATE), the rebate application collected documentation related to charging and airflow. QIV measures are justified on theory that new units are not always installed with optimal charging and airflow and thus additional savings can be gained relative to a standard installation.

The NJ CoolAdvantage protocol (NJCEP, 2007) equations are standard engineering equations related to change in unit efficiency. The equations are driven by the annual runtime of the unit or equivalent full load hours (EFLH). The protocols provided an EFLH of 600 hours for the purpose of calculating program savings. The goal of the evaluation was to validate this number based on data from program participants. With an appropriate estimate of EFLH, estimates of efficiency related savings are easily derived.

Methodology

The most direct way of validating EFLH uses an estimate of post-installation consumption and engineering equations to estimate program participant EFLH. This approach has a simple directness to it. It works within the protocol framework while providing empirical validation. This approach also has a potential shortcoming. The estimate of post-installation consumption may include the program-related effects of take back or additional savings related to QIV. This would affect the subsequent estimates of EFLH and impacts.

Take back refers to a reduction in program impacts due to a change in consumption patterns related to the new installation. With a new, efficient CAC, the cost of cooling is decreased. Economic theory tells us that participants will reallocate those savings. One option for the participant is to increase the amount of cooling purchased. The increased consumption "takes back" some of the program's efficiency-related impacts. Conversely, the QIV component included in the CoolAdvantage program design could result in a decrease in post-installation consumption and an increase in program impacts beyond impacts related to efficiency improvements.

The equations used to estimate EFLH and efficiency-related impacts assume a measure of consumption that is not affected by either take back or QIV-related savings. We know, however, that the estimate of post-installation consumption derived from the billing analysis will include the effects of take back and QIV to the extent that they are present. The presence of either of these factors would inject bias into the resulting gross impact estimates.

In the case of the NJ CoolAdvantage program, it was unclear the extent to which either take back or the QIV efforts were a factor. The magnitude of take back for a program like this is difficult to assess. The ultimate efficacy of the QIV activities is also up for question (Titus 2006; Wirtshafter et al. 2007),

To evaluate the potential bias in the post-only estimate of impacts, we also estimated impacts using a pre-post billing analysis on the same data. The pre-post approach derives a gross efficiency impact estimate from the change in consumption associated with the installation. The pre-post approach has the advantage of being based on actual change attributed to the installation of program measures. The approach also has the added challenge of identifying the efficiency level of the existing unit to facilitate breaking out the standard to qualifying efficiency portion of the change in consumption.

21051042

The pre-post analysis was not our primary approach to the evaluation because it was less suitable to the updating of the protocol equations. In addition, there were initial concerns that there would be insufficient pre-installation data points to allow the pre-post approach to work. The pre-post billing analysis did however offer the opportunity to look into the possibility of quantifying the effect issues like QIV savings and take back.

The methods discussed here lay out the two approaches by which gross efficiency savings are derived from billing analysis output. More importantly, we track the potential biases resulting from the presence of take back and QIV savings. We do not discuss the billing analysis process used to estimate both post-installation consumption and pre-post change in consumption. The specifics of that process are not essential to the issues discussed here. The methods discussed below only require that both kinds of billing analysis output represent the average program retrofit participant.

Impacts based on Post-installation Consumption Estimate

The engineering equation at the root of both approaches describes cooling consumption as a function of capacity, efficiency and run time (EFLH). This standard engineering equation provides the relationship between the post-installation estimate of consumption and EFLH. The equation, in this case for a unit qualifying for the program, would be

$$kWh_Q = CAPY_Q * C * \frac{1}{SEER_Q} * EFLH \qquad \textbf{Eqn. 1}$$

where

kWh_Q	=	Annual qualifying unit kWh, post-program
$CAPY_Q$	=	Qualifying unit capacity, in tons
C	=	Conversion factor of 12
$SEER_Q$	=	Qualifying unit SEER
EFLH	=	Equivalent full load hours of cooling

The combination of the capacity and SEER provides the level of hourly load when the unit is running. The EFLH value indicates how many effective hours of this level of usage took place. To update the protocol value for EFLH, we plug in the post-only billing analysis estimate of consumption and nameplate capacity and efficiency data available from program tracking data, and solve the equation for EFLH.

$$EFLH^{*} = \frac{1}{\overline{\overline{CAPY_Q}}} * \frac{1}{C} * \overline{\overline{SEER_Q}} * \hat{kWh}_Q . \qquad \textbf{Eqn. 2}$$

where

$EFLH^{*}$	=	Updated estimate of EFLH using post-only billing analysis consumption
$\overline{\overline{CAPY_Q}}$	=	Median program capacity, in tons
$\overline{\overline{SEER_Q}}$	=	Median program SEER
$\hat{kWh}_Q$	=	Post-only estimate of cooling consumption in a normal weather year

21951 0042

The same basic equation provides the framework for quantifying the change in consumption associated with a change in unit SEER.

$$\Delta kWh_{S-Q} = CAPY_Q * C * \left(\frac{1}{SEER_S} - \frac{1}{SEER_Q} \right) * EFLH \qquad \textbf{Eqn. 3}$$

where

ΔkWh_{S-Q} = Change in kWh consumption standard to qualifying efficiency
$SEER_S$ = Standard install unit SEER of 11

The equation calculates the change in consumption associated with the change in SEER. The combination of capacity and the change in SEER calculates the avoided hourly consumption while EFLH provides the hours of run-time across which those savings are realized.

The estimate of impacts from the post-only approach uses this equation.

$$EstSav_{post} = \overline{\overline{CAPY}}_Q * C * \left(\frac{1}{SEER_S} - \frac{1}{\overline{\overline{SEER}}_Q} \right) * EFLH^* \qquad \textbf{Eqn. 4}$$

where

$EstSav_{post}$ = Estimate of change in annual unit kWh consumption, standard to qualifying efficiency using post-only billing analysis.

By combining the EFLH equation and the efficiency equation, we see that efficiency-related savings are effectively a percentage adder on post-installation consumption.

$$EstSav_{post} = \left(\frac{\overline{\overline{SEER}}_Q}{SEER_S} - 1 \right) * \hat{kWh}_Q = p_{post} * \hat{kWh}_Q \qquad \textbf{Eqn. 5}$$

where

p_{post} = Post-only percentage -- percentage of post-installation consumption that is equal to standard to qualifying efficiency impact.

For this equation to provide an unbiased estimate of program savings, the estimate of post-installation consumption should not include the effects of either take back or QIV savings.

Impacts based on Pre-post Delta Estimate

The pre-post approach also uses the equation that quantifies the change in consumption associated with a change in unit SEER. Equation 3 can also expresses savings given an increase in SEER from existing unit to qualifying unit efficiency.

$$\Delta kWh_{X-Q} = CAPY_Q * \left(\frac{1}{1000} \right) * \left(\frac{1}{SEER_X} - \frac{1}{SEER_Q} \right) * EFLH \qquad \textbf{Eqn. 6}$$

where

ΔkWh_{X-Q} = Change in Annual kWh consumption, existing unit to qualifying efficiency
$SEER_X$ = Existing Unit SEER

210510042

These two equations can be combined to create an equation that defines the standard efficiency to qualifying efficiency increment as a percentage of the pre-post delta which is the existing efficiency to qualifying efficiency increment.

$$\Delta kWh_{S-Q} = \Delta kWh_{X-Q} * \left(\frac{1}{SEER_S} - \frac{1}{SEER_Q}\right) \Big/ \left(\frac{1}{SEER_X} - \frac{1}{SEER_Q}\right) = \Delta kWh_{X-Q} * p_{pre-post} \quad \textbf{Eqn. 7}$$

where

ΔkWh_{X-Q}	=	Change in Annual kWh consumption existing unit to qualifying efficiency
$p_{pre-post}$	=	Pre-post percentage – percentage of full existing to qualifying efficiency delta that is standard to qualifying efficiency.

The pre-post percentage is effectively the mirror to the post-only percentage. Each percentage is applied to its appropriate billing analysis output (post-only consumption and pre-post delta) and produces an estimate of program impacts. The post-only percentage will generally be small as it represents savings as a percentage of annual consumption. The pre-post percentage can be anywhere between zero and one hundred depending on where standard efficiency falls between the existing and qualifying unit efficiencies.

Post-only Approach Bias

Both of these approaches face challenges when applied to real-world data. The post-only estimate of savings is completely dependent on the post only estimate of consumption and the related estimate of EFLH. If the effect of take back is present in the estimate of post-installation consumption then the consumption is too high by the magnitude of the take back effect. The following equations show the estimated consumption as a combination of ideal post-installation consumption and take back.

$$\textit{Observed post-install consumption} = \hat{kWh}_Q = \tilde{kWh}_Q + tb \quad \textbf{Eqn. 8}$$

where

$\tilde{kWh}_Q$	=	Ideal post-installation consumption (no take back),
tb	=	Average annual increase in kWh due to take back.

Applying the post-only percentage to this post-installation consumption that includes take back generates an estimate of impacts that is inflated by take back at the rate of the post-only percentage.

$$p_{post} * (\textit{Observed post-install consumption}) = p_{post} * (\tilde{kWh}_Q + tb) = \tilde{\Delta kWh}_{S-Q} + p_{post} * tb \quad \textbf{Eqn. 9}$$

where

$\tilde{\Delta kWh}_{S-Q}$	=	Standard to Qualifying impact accounting for take back,

QIV impacts would have the same basic effect on consumption and savings estimates but in the opposite direction. QIV measures decrease the post-installation consumption from what it would have been without the QIV. This has the opposite effect as take back on EFLH and impacts. The magnitude of QIV savings would enter the final estimate of gross impacts as a downward bias at the rate of the post-only program proportion, p_{post}.

215190922

Thus the primary issue with the post-only estimate of efficiency-related savings is the two potential biases associated with the presence of take back and QIV in the estimate of post-installation consumption. The two biases enter the savings formula in the same way except for the expected direction of effect. In practice, this means the two biases effectively combine to produce a single net bias. If reduction in consumption due to QIV is greater than the increase due to take back then the net bias in the estimate of gross savings will be down by the post-only percentage times the net reduction in consumption. On the one hand, if both biases are present they will partially cancel each other out. On the other hand, separating the two biases is difficult.

Pre-post Approach Bias

While post-only impact estimates rely only on post-installation consumption, pre-post estimates rely on the relationship between pre- and post-installation consumption. Looking at the post-only impact estimates, we saw that effects that either increased or decreased post-installation consumption caused clear quantifiable biases on the resulting impact estimates. The pre-post scenario faces the same effects increasing or decreasing the post-installation consumption because they affect the delta. In addition, the pre-post approach grapples with the challenge of defining pre-installation consumption with respect to efficiency.

Figure 1 provides a simple schematic that helps illustrate the equation that breaks out the program portion of the pre-post delta. The equation is in terms of SEER, but the general concepts are easier to discuss looking at the different load levels associated with the different SEER levels.

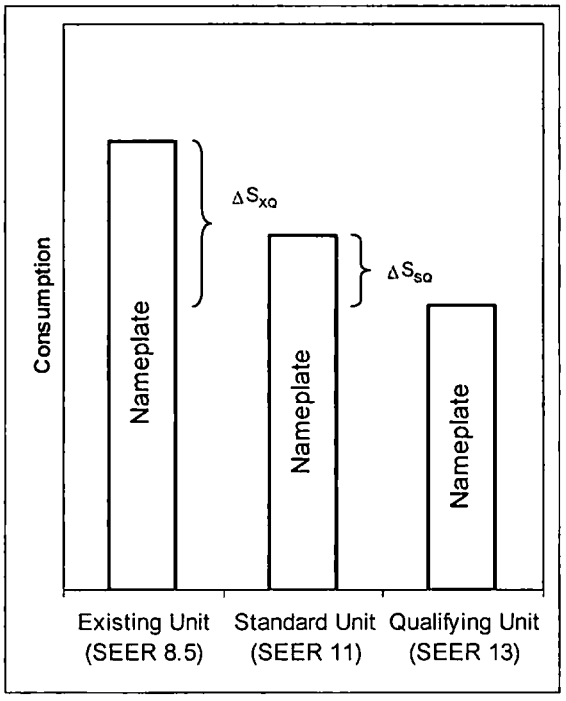


Figure 1 Relationship Between Existing, Standard and Qualifying Units

The overall change in SEER is from existing to qualifying efficiency, represented in consumption terms by ΔS_{XQ}. The part attributed to the program is the standard to qualifying efficiency portion, represented by ΔS_{SQ}. The pre-post percentage calculated above in equation 7 is effectively the ratio, $\Delta S_{SQ}/\Delta S_{XQ}$ but in terms of SEER. It identifies the program portion of the pre-post delta if the only difference between pre- and post-installation consumption is unit efficiency. If pre- and post-installation

21051909 42

consumption reflect the expected consumption given the SEER levels in the equations, then the equation appropriately splits out the program impacts from the existing to the qualifying unit. Unfortunately, as we found with the post-only approach, in the presence of either take back or QIV, post-installation consumption is not simply efficiency-adjusted pre-installation consumption.

The pre-post approach thus faces the same challenges that beset the post-only approach. Both take back and QIV savings change the magnitude of the pre-post delta. The basic framework assumes that the pre-post delta represents a change in usage that is driven entirely by a change in efficiency level. If the qualifying unit consumption in Figure 1 were greater due to take back the observed existing to qualifying delta would be smaller. The following equation shows the relationship.

$$Observed\ pre\text{-}post\ change = \Delta kWh_{X-Q} = \widetilde{\Delta} kWh_{X-Q} - tb \qquad \textbf{Eqn. 10}$$

where

$\widetilde{\Delta} kWh_{X-Q}$ = Ideal pre-post delta (no take back)

If we apply the pre-post program percentage, pre-post estimated savings is

$$p_{pre\text{-}post} * (observed\ pre\text{-}post\ change) = p_{pre-post} * (\widetilde{\Delta} kWh_{X-Q} - tb) = \widetilde{\Delta} kWh_{S-Q} - p_{pre-post} * tb \qquad \textbf{Eqn. 11}$$

where

$\widetilde{\Delta} kWh_{S-Q}$ = Standard to qualifying impact accounting for take back,

Similar to the post-only approach, the bias is in proportion to the applied percentage. However, the direction of the pre-post approach bias is the opposite of the post-only approach bias. Because the delta is smaller, the presence of take back will produce an estimate of impacts that is biased down by the program portion of take back.

The pre-post is, in fact, similar but opposite to the post-only approach in every respect. QIV and take back have mirror effects on the pre-post approach impact estimates. In the pre-post approach, the presence of QIV savings increases the pre-post delta and thus increases the impact estimate. Also, just as with the post-only approach, practically speaking, QIV and take back become a single bias reflecting the net effect of which ever bias is greater. If reduction in consumption due to QIV is greater than the increase due to take back then the combined net bias in the estimate of gross savings will be altered by the net QIV-related reduction in consumption. In the post-only scenario this produces a downward bias. In the pre-post scenario, it produces an upward bias. The combined biases that characterize the pre-post and post-only results will always be in the opposite direction regardless of the mix of take back and QIV.

Combined, Bias-corrected Savings Estimate

The resulting post-only and pre-post estimates bracket the unknown, unbiased estimate. Because the biases are the same underlying combined effect scaled by two different percentages (p_{post} and $p_{pre\text{-}post}$) we can use the percentages to break out the difference. Table 1 summarizes the conclusions thus far and shows how the difference between the post-only and the pre-post results is split out based on the relative magnitude of the post- and pre-post percentages.

2195100942

Table 1 The Effects of Take Back and QIV on Billing Analysis results

	Billing Analysis Approach		Difference
	Pre-post	Post-only	
Efficiency-related Savings Effect	S	S	0
Take Back Effect	$-TB*p_{pre\text{-}post}$	$+TB*p_{post}$	$-TB*(p_{pre\text{-}post}+p_{post})$
QIV Savings Effect	$+QIV*p_{pre\text{-}post}$	$-QIV*p_{post}$	$QIV*(p_{pre\text{-}post}+p_{post})$
Combined Take Back and Savings Effect	$(-TB+QIV)*p_{pre\text{-}post} = -C*p_{pre\text{-}post}$	$(TB-QIV)*p_{post} = C*p_{post}$	$-C*(p_{pre\text{-}post}+p_{post})$
Theoretical Billing Analysis Estimate	$S-C*p_{pre\text{-}post}$	$S+C*p_{post}$	$-C*(p_{pre\text{-}post}+p_{post})$
Total billing analysis estimate	$\Delta kWh_{S\text{-}Q}=SAV_{pre\text{-}post}$	$\Delta kWh_{S\text{-}Q}=SAV_{post}$	D
Expected Bias-adjusted savings from pre-post Delta	$SAV_{pre\text{-}post} - D*p_{pre\text{-}post}/(p_{pre\text{-}post}+p_{post})$		
Expected Bias-adjusted savings from post-only Consumption	$SAV_{post} + D*p_{post}/(p_{pre\text{-}post}+p_{post})$		

Additional Pre-post Challenges

As we have just seen, post-installation consumption effects produce quantifiable biases in the impact estimates derived from the post-only and pre-post approaches. If we assume the post-installation effects are the only issues to be dealt with then deriving an unbiased estimate of efficiency-related savings is a tractable problem. Unfortunately, the pre-post approach impact estimate faces additional challenges related to the characterization of the pre-installation load. First, there's the problem of the unknown existing unit SEER.

Returning to Figure 1 and equation 7, it's simple to identify the effect of a varying existing unit SEER level. A lower existing unit SEER produces a bigger denominator in equation 7 and, correspondingly, a smaller pre-post percentage, $p_{pre\text{-}post}$. Assuming a greater existing unit SEER value has the opposite effect, decreasing the denominator and increasing the $p_{pre\text{-}post}$. Thus, the estimate of existing unit SEER is essential to the pre-post approach and directly affects magnitude of the impact estimate. This adds an additional moving part to the framework developed above to derive an unbiased estimate of efficiency related savings.

A more comprehensive look at the implications of QIV in the billing analysis framework raises additional questions about the pre-post based impact estimate and the existing unit SEER level. Figure 2 provides a schematic that illustrates the issue.

215519942

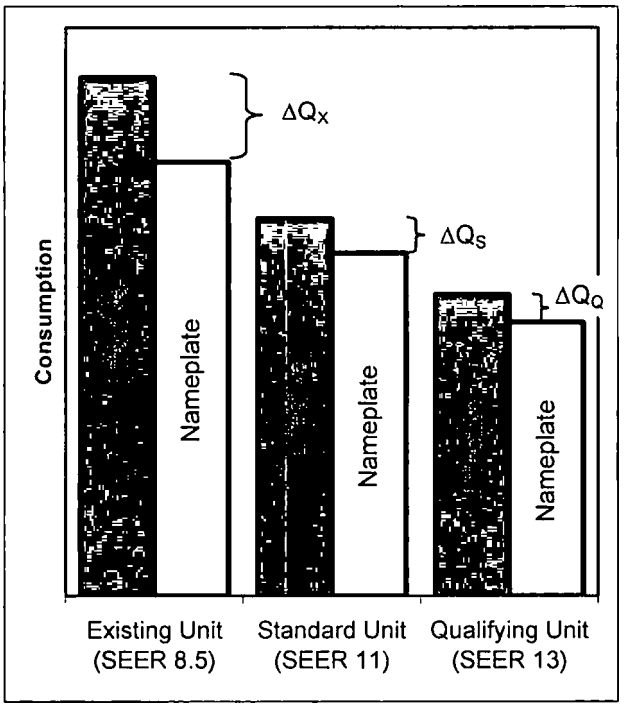


Figure 2 Relationship Between Existing, Standard and Qualifying Units, QIV (Degradation) Included

Figure 2 shows the nameplate consumption as in Figure 1. It also shows the consumption reflecting some increase level of inefficiency due to incorrect installation (charging, airflow etc) for new units or simple degradation for the existing unit (ΔQ). The level of usage associated with this "effective" SEER should always be higher than the nameplate SEER because the nameplate SEER implies optimal conditions. It simplifies the discussion to refer to all of these deltas as degradation. Figure 2 illustrates two other important points. The standard and qualifying units have degradation deltas that represent a similar percentage of usage. Both units are new. Assuming a similar installation process, it is reasonable to assume a similar level of degradation from optimal. The existing unit is portrayed with a greater level of degradation. This reflects the fact that this unit received a standard installation but has had its full life in the field to degrade. The assumption is that the existing unit will always have a greater level of degradation than the two newly installed units.

Recall that the engineering equation that breaks out the standard-to-qualifying portion of the existing-to-qualifying delta describes the relationship between the three units' nameplate SEER. If we consider unit degradation, the observed overall delta from the billing analysis reflects something else altogether. In terms of Figure 2, assuming no QIV took place, the observed delta reflects the relationship between the three units' *effective* SEER. The SEER-based equation will still work, but only under certain restrictive assumptions. If the degradation at each unit is the same on a percentage basis with respect to nameplate SEER, then the important relationships remain the same and the equation decomposes the delta properly.

The degradation of the existing unit, however, should always be greater than the degradation at either the standard or qualifying units. This degradation implies the pre-installation consumption should be identified with lower SEER level reflecting the existing unit effective SEER. This in turn increases the denominator of the pre-post existing to standard ratio and, thus, decreases the program portion of the observed delta. If the adjustment to the lower, effective SEER level is not made, the pre-post approach

21051004

estimate of impacts will be inflated. Assuming standard and qualifying units are set at nameplate levels, the existing unit SEER level should be set at existing unit nameplate SEER level plus the marginal effective SEER decrease due to degradation relative to the standard and qualifying effective SEERs. Ultimately, since none of these values are known, existing unit SEER should be set lower than the expected nameplate SEER for those existing units.

Application

The primary purpose of the evaluation of the CoolAdvantage Program was to update the protocols for the program as it was taken over by the NJ CleanEnergy program, a statewide effort. A retrospective impact evaluation was a second part of the effort, to set a baseline from the existing programs. The evaluation took place after the changeover of the programs to the statewide entity and this was of particular importance with regard to QIV aspect of the program. Getting further information on this effort was a challenge as those personnel who ran the programs were no longer running programs with the utilities. While QIV-related savings are listed in the protocols and the rebate application includes places for data gathered related to the QIV process, there was no information in the tracking data received from the programs. QIV has proven challenging for programs to implement so it should not be taken for granted that this aspect of the program was in fact successful. The retroactive impact evaluation worked within these challenges.

Table 2 provides the results of the post-only CoolAdvantage billing analysis. These results reflect the standard unit baseline but do not include free ridership. The table provides a benchmark estimate based on the 2007 Protocol values. This result is based on an EFLH of 600 hours and a QIV/sizing factor of 23.8 percent of the post-installation consumption estimate. The protocol values produce an estimate of efficiency savings of 409 kWh and QIV/sizing savings of 358 kWh for a total estimated savings of 767 kWh. The efficiency-related savings reflect the difference in consumption from the standard in place at the time, SEER 11, and the program measures of at approximately SEER 14.

Table 2 Gross 2005/2006 CoolAdvantage Ex-Post Per-Unit Impact Estimates Baseline SEER=11

Source for Hour (EFLH) Estimate	Post-Program Cooling Usage (kWh)	Effective Full Load Hours (EFLH)	EFLH Confidence Interval (+/-, 90%)	Impact of Efficiency Improvement (kWh)	Combined QIV/Sizing Savings Percentage	QIV/Sizing Savings as Percentage of Usage	Impact of Proper Sizing and QIV (kWh)	Total CAC or Heat Pump Cooling savings (kWh)
Protocols	1,500	600		409	19.3%	23.8%	358	767
Impact Evaluation	1,252	501	17	341	0.0%	0.0%	0	341
					8.4%	9.2%	115	456
					19.3%	23.8%	298	640

The impact evaluation post-only billing analysis provided an estimate of participant CAC usage in the post-program period of 1,252 kWh. This produced an updated estimate of 501 hours for cooling EFLH with a 90 percent confidence interval of plus or minus 17 hours. This reduced level of EFLH produced an efficiency-related impact of 341 kWh.

To facilitate comparisons of results between post-only and pre-post results, the post-only results used the identical pooled time-series cross-section specification as the pre-post with the exception of the variables necessary to capture the change. Table 3 provides estimates of the program portion of the delta from the pre-post billing analysis. Because the existing unit SEER was unknown we produced estimates across a range of existing unit SEERs. To put these SEER values in context, the EIA Residential Energy Consumption Surveys from 1987 and 1990 put average new unit SEER at 9 and 9.3 (EIA 2000), respectively. These values provide a rough guideline of nameplate SEER assuming an

215100042

estimated useful life of 15 to 18. If we take degradation into account the effective SEER would be lower.

Table 3 Pre-Post Billing Analysis Total Cooling Savings Assuming Replaced Unit SEER

Assumed SEER of Replaced Unit	Total CAC or Heat Pump Cooling savings from Pre-Post Billing Analysis (kWh)
6.5	235
7.0	272
7.5	313
8.0	362
8.5	420
9.0	489
9.5	574
10.0	679
10.5	815
11.0	996

Setting existing unit SEER at 8 provided a pre-post impact estimate of 362 kWh. The post-only impact estimate was 341 kWh. Within the framework developed in this paper we can conclude:

- The bias-adjusted, gross impact estimate lies between these two values -- approximately 350 kWh given the post-only and pre-post percentages used to derive the impact estimates. This is not statistically different than the original post-only estimate.
- The combined take back and QIV effect was approximately 2.7 percent of post-installation consumption in the direction of QIV. That is, whatever take back consumption was present, when combined with QIV, the 2.7 percent QIV effect remained. Survey data revealed little evidence of take back among participants. This indicates there was minimal take back in the post-installation period and smaller than expected QIV savings.

These results are based on an assumed existing unit SEER of 8. Setting existing unit SEER at 7.8 would indicate a balance between the take back and QIV effects. Below 7.8 the effect of take back would be greater than the QIV effect. An existing unit SEER above 8 would produce QIV savings greater than 2.7 percent, net of take back.

Though it is impossible to establish a single estimate of effective existing unit SEER, comparing the post-only and pre-post impact estimates still provides a comprehensive indication of the level of potential bias in the post-only impact estimate. Within the range of realistic effective exiting unit SEERs, there is limited evidence of bias in the post-only estimate of gross impact for the CoolAdvantage program.

Conclusions regarding the separate effects of take back and QIV are more difficult given their combined expression in impact estimates. Separate evidence, in this case the survey data related to take back, can help solidify conclusions. As long as AC programs include a quality installation component, estimates of cooling impacts will in most cases have the potential for these conflicting effects. Other applications of billing analysis with the potential for take back but without potential savings due to quality installation will allow for more confident statement with regards to the presence of bias.

21951962

Conclusion

This paper focuses on getting to the right delta when doing billing analysis. There's more to billing analysis than weather normalizing and reporting the pre-post delta. Attention must be paid to what the delta represents. In this paper we discuss two billing analysis approach that produce impact estimates that reflect a standard installation baseline. We explore the biases that enter into impact estimates due to the presence of the effects of take back and QIV in the post-installation consumption. We quantify these effects in both a post-only billing analysis approach and a pre-post billing analysis approach. We further discuss the implications of unit degradation on estimates developed in the pre-post framework. Finally, we establish the conditions under which the results of these two different approaches allow an unbiased estimate of gross savings.

For an application of these ideas we look at results from an evaluation of the New Jersey CoolAdvantage HVAC program. The final result for this program was based on post-installation usage and engineering equations to support, and remain consistent with, Protocol guidelines. The pre-post results were primarily developed as a check of the post-only results. The combination of the post-only and the pre-post results support the gross impact results produced with the post-only approach. We also checked for evidence of take back and quality installation savings for the cooling program. The combination of the post-only and pre-post results along with additional information indicate that there was little take back in the post installation consumption and that QIV savings were not realized at expected program levels.

References

[EIA] Energy Information Administration. 2000. *Trends in Residential Air-Conditioning Usage from 1978 to 1997.* http://www.eia.doe.gov/emeu/consumptionbriefs/recs/actrends/recs_ac_trends.html. Washington, DC: Department of Energy.

New Jersey Clean Energy Program Protocols to Measure Resource Savings, Revisions to September 2004 Protocols. 2007. Prepared for New Jersey's Clean Energy Program.

KEMA, Inc. (Draft). 2009. New Jersey's Clean Energy Program Residential HVAC Impact Evaluation and Protocol Review WarmAdvantage™ and CoolAdvantage™ Programs Prepared for the New Jersey Board of Public Utilities, Trenton NJ.

Titus, E. 2006. Strategies to Increase Residential HVAC Efficiency in the Northeast Final Report. Prepared for National Association of State Energy Offices (NASEO), Contract #03-STAC-01.

Wirtshafter, R., T. Thomas, G. Azulay,W. Blake, and R. Prahl. 2007. "Do Quality Installation Verification Programs for Residential Air Conditioners Make Sense in New England?" *In Proceedings of the 2007 International Energy Program Evaluation Conference, 962-973.* Chicago, Illinois: International Energy Program Evaluation Conference,

210510042

CERTIFICATE OF SERVICE

I hereby certify that on this 4th day of May 2021, a true and accurate copy of the foregoing filed in Case No. PUR-2020-00156 was hand delivered, electronically mailed, and/or mailed first class postage pre-paid to the following:

Andrea B. Macgill, Esq. (ES)
Kiva Bland Pierce, Esq. (ES)
Office of General Counsel
State Corporation Commission
1300 E. Main Street, Tyler Bldg., 10th Fl.
Richmond, VA 23219

C. Meade Browder, Jr., Esq. (ES)
C. Mitch Burton, Jr., Esq. (ES)
John E. Farmer, Jr., Esq. (ES)
Office of the Attorney General
Division of Consumer Counsel
202 N 9th Street, 8th Floor
Richmond, VA 23219

Nate Benforado, Esq. (ES)
William Cleveland, Esq. (ES)
Southern Environmental Law Center
201 West Main Street, Suite 14
Charlottesville, VA 22902

Bobbi Jo Alexis, Esq. (Public)
Culpeper County Attorney
306 N. Main Street
Culpeper, VA 22701

Noelle J. Coates, Esq. (Public)
American Electric Power Service Corp.
1051 East Cary Street
3 James Center, Suite 1100
Richmond, VA 23219

James R. Bacha, Esq. (Public)
American Electric Power Service Corp.
1 Riverside Plaza, 29th Floor
Columbus, OH 43215

Meera Ahamed, Esq. (Public)
John C. Dodge, Esq. (Public)
Karen M. Hardwick, Esq. (Public)
Office of General Counsel
1000 Maine Avenue, SW
Washington, DC 20024

T. Borden Ellis, Esq. (Public)
Assistant General Counsel
NiSource Corporate Services Company
1890 Coyote Drive
Chester, VA 23836

Cale A. Jaffe, Esq. (ES)
University of Virginia School of Law
580 Massie Rd.
Charlottesville, VA 22903

/s/ Lisa R. Crabtree