(Fuel) Switching It Up: Rethinking Net-to Gross Measurement and Attribution in Non-Residential New Construction Electrification Projects

Matt Woundy & Lisa Wilson-Wright, NMR Group, Somerville, MA

ABSTRACT

In 2022, Massachusetts Program Administrators (PAs) introduced fuel switching incentives within their non-residential new construction (NRNC) program to promote electrification. These incentives encouraged projects to adopt electric heating over fossil fuel systems. The incentives were followed by a regulatory request for a dedicated net-to-gross ratio (NTGR) for avoided fossil fuel consumption generated by fuel switching, which prompted a study to measure program influence on fuel switching decisions.

The evaluators conducted 33 in-depth interviews with customers and design teams (e.g., architects, engineers), targeting one customer and one design team member per project. They successfully completed two interviews in five out of 28 projects. The evaluators adapted an existing self-report NTGR methodology to isolate fuel switching from other energy efficiency decisions. The approach accounted for partial electrification and the influence of municipal policies requiring electrification in public buildings. The study yielded a final NTGR of 34%.

The study revealed that fuel switching decisions are intertwined with energy efficiency considerations, complicating efforts to measure program influence separately. For example, heat pump incentives not only encouraged fuel switching but also influenced the choice to adopt other more energy-efficient systems. Additionally, aggressive state climate policies, energy codes, and municipal decarbonization efforts further impacted decisions, making it challenging to isolate program effects.

The findings suggest that combining efficiency and fuel switching under a unified NTG framework could streamline assessments of program influence. Furthermore, adopting a market transformation framework could prevent penalizing programs for stacking influence alongside other policy tools to enhance fuel switching outcomes.

Introduction

This paper details insights gathered from the design and execution of a two-phase net-to-gross (NTG) study of a non-residential new construction (NRNC) program in Massachusetts that measured net-to-gross ratios (NTGRs) for fossil fuel energy savings derived from fuel switching to electric heat pump systems (NMR and DNV 2024; NMR and DNV 2022). Phase I of the study generated the first evaluated NTGR for fuel switched heat pumps in NRNC projects in response to regulatory requirements applied to the client's energy efficiency plan, which was developed under a resource acquisition framework. Phase II of the study applied lessons learned in Phase I to refine the novel NTG methodology and provided supplemental findings on the challenges of NTG measurements attempting to treat fuel switching in isolation from other building energy efficiency decisions. In addition, primary data collection with key market actors suggested that efforts to attribute the PAs influence on fuel-switching decisions faced an intertwined web of advanced energy codes, local climate policies, federal energy efficiency resources, and competitive real estate markets that also increasingly influence building efficiency decisions. As Phase II of the study concluded, the state was considering policy changes (ultimately adopted in the next statewide energy efficiency plan) that addressed several concerns raised in this research, including placing this program under a market transformation framework that does not require net savings impact accounting and adopting a policy that prevents attribution penalties when complementary initiatives (e.g., tax credits,

grant programs) are stacked with energy efficiency program support to generate desired energy efficiency or decarbonization outcomes.

Program and Regulatory Background

The Massachusetts NRNC program offers financial incentives for energy savings over a baseline, with advanced pathways offering tiered incentives based on how aggressively the design reduces energy consumption. To encourage building electrification, in 2022 the Massachusetts Program Administrators (PAs) updated the program design to introduce additional large incentives for the installation of heat pumps across all participation tiers, provided the heat pumps served as the primary heating source and met certain performance requirements. The launch of these heat pump fuel switching incentives was accompanied by a regulatory requirement that the PAs conduct an evaluation to determine the degree to which the incentivized fuel switch is attributable to the new program support as opposed to other market forces. The Department of Public Utilities provided the following guidance on NTG evaluation for fuel switching:

> "*Apply a NTG value to fuel switching savings in the model to account for those customers who would have installed a heat pump on their own, without program influence. These customers exist and must be accounted for in the savings claimed by PAs. Since there isn't currently an evaluated value for C&I electrification NTG, the parties agree to use a negotiated value for 2022, and conduct a study during that year to arrive at a researched NTG value or values for the remainder of the Plan term (Massachusetts Energy Efficiency Advisory Council 2021, 27-28).*"

Aggressive energy codes and municipal policies push the building sector in Massachusetts towards energy-efficient and low-carbon construction and equipment. Also, the program's client base includes municipalities, universities, and technology firms that favor marketable, advanced buildings signifying a commitment to sustainability and occupant wellbeing. Together, these factors suggest that at least some program participants who adopted heat pump technologies for space heating would have done so without program intervention. The evaluators and the client interpreted the regulatory language to require that the fuel switching decision should be assessed in isolation from other building efficiency decisions that are eligible for existing program incentives, despite the role of fuel switching in generating more efficient outcomes.

To isolate fuel switching savings that are distinct from more "typical" energy savings derived from upgrading to more efficient systems, the regulatory framework directed the program administrators to calculate the fossil fuel savings associated with heat pump fuel switching incentives using fossil fuel baselines – either natural gas or propane based on the availability of a natural gas connection – and to apply the fuel switch NTGR to those fossil fuel savings. The building energy consumption studies performed for participating projects isolate fuel switching fossil fuel savings in a separate analysis to facilitate application of the fuel switch NTGR. The program also applies a separate, more traditional NTGR to the energy savings derived from system efficiency upgrades that produce energy savings. Participating projects that install heat pumps that qualify for per-ton heat pump incentives were subject to both NTGRs, so it was imperative that evaluators develop a distinct fuel-switch NTGR to avoid double-discounting savings.[1]

Phase I of the study was timed to provide findings in advance of regulatory deadlines for the prospective application of NTGRs for the following program year. However, in meeting those regulatory deadlines, the team discovered that the sample of relevant projects – those that were formally offered the new heat pump fuel switching incentive prior to being included in the study – was limited. This sample

[1] The study also developed an NTGR for application to energy savings derived from system efficiency upgrades, but that work is not the subject of this paper beyond discussion of the challenges of trying to develop two distinct NTGRs.

limitation, plus methodological lessons learned while executing Phase I, spurred the launch of Phase II, conducted roughly one year later after the number of participating projects receiving the fuel switching incentive had increased to support a larger sample size for primary data collection.

Methodology

The evaluators relied on in-depth interviews (IDIs) with project customer representatives and design teams (primarily architects or mechanical, electrical, and plumbing [MEP] engineers) to estimate NTGRs. Interview data was fed into a modified self-report approach (SRA) NTG algorithm used in prior non-residential NTG studies in the same jurisdiction. The SRA structures primary data collection to generate inputs for an algorithm that scores project free-ridership and spillover. Typically, this is done through surveys that utilize close-ended questions to simplify inputs. For this study, the evaluators and clients recognized the need for IDIs instead of surveys to allow deeper insights into a program where annual participation is relatively low; projects are often large, complex, and take years to complete; and large individual projects have noticeable impacts on study results. Additionally, no primary data collection had occurred with participating projects since the program administrators significantly redesigned the program several years prior to the study, and stakeholders desired feedback from participants about how the new program design was impacting the market.[2]

The study team attempted to complete two interviews per project – one with a customer representative and one with an "influential vendor"– to maximize insight into project outcomes and mitigate the impact of poor recall. For this study, the team operationalized the "influential vendor" parameter as architects or MEP engineers on the design team who worked closely with clients and were heavily involved in design decisions. The influential vendor scoring method uses the design team response data to calculate NTGR when both the customer and the design team contact agree that the design team was highly influential on project outcomes. Obtaining two interviews per project is a considerable challenge in the NRNC market where response rates have been in decline. In the end, multiple interviews were secured for only a small number of projects.

Self-Report NTG Algorithm Development

The SRA methodology required modification for deployment in this evaluation. The SRA had typically been used for evaluations of retrofit programs in which interventions in existing buildings were tracked and assessed at the measure level. In contrast, this evaluation assessed the NRNC program that focused on whole building design interventions and building-level performance, often measured in terms of energy use intensity (EUI) reduction. The fuel switch decision represented a new evaluation topic within the NRNC sector and is deeply intertwined with holistic design decisions. The evaluators made the following substantial adjustments to the SRA protocol in Phase I of the research due to the nature of the fuel switch measure:

- Added supplementary contextual questions to better understand the story behind the project, including customer motivations, local policies impacting building designs (including those that favor electrification), and other financial and technical support utilized by the project.
- Developed language asking the respondent to consider the fuel switch decision separately from decisions around equipment performance, as the latter was addressed in separate NTG research.

[2] The SRA was also chosen in part because it would enable the study to be completed in time for impending regulatory deadlines while other possible methodologies like structured expert judgement (Delphi Panel) were projected to extend the study timeline.

- Adjusted existing SRA question regarding program influence on quantity to focus on changes to heating fuel loads
- Removed questions about the program influence on timing and efficiency, as later adoption is not relevant for new construction and efficiency was addressed in a parallel but separate effort.

The algorithm was structured to generate two FR components: one focused on the decision to use heat pumps to displace fossil fuels (FS FR) and the other focused on the portion of heating load served by heat pumps (Load FR). In Phase I of the study the team averaged these two scores to produce the overall freeridership value. Each respondent received a single spillover score, limited to projects that used heat pumps to displace fossil fuels and that were not enrolled or did not plan to enroll in the program. The final NTG algorithm contained the following key components:

- Determination of whether the customer or design team (or other party) was the most influential in the decision to use heat pumps to displace fossil fuels for heat (assigned an influence score on a 0 to 10 scale)
- Respondent self-report of whether the project would have used heat pumps to displace fossil fuels without program intervention
- Respondent self-report of program-induced changes in planned or actual heat pump heating loads
- Follow-up to identify degree of influence from incentives or technical assistance (TA) on decision to use heat pumps and/or adjust the heat pump heating load (assigned an influence score using a 0 to 10 scale)
- Assessment of fuel switching spillover to other, non-program projects
- Consistency checks to address contradictory responses

Phase II Methodological Refinement

For reasons discussed in more detail below, the Phase I research yielded a very low (poor) NTGR for the program's claimed fuel switching savings. Between phases, the evaluators had several conversations with representatives from the program administrators about the methodology and how it could be refined to more fully capture program influence. These conversions yielded two significant changes to the NTG approach in Phase II: (1) A more in-depth exploration of possible program influences that acknowledged program support beyond incentives and technical assistance, and (2) a revised approach to quantifying how the building heating load served by heat pumps impacted project-level NTGR. Additional context on each factor follows.

Expanded Examination of Program Influence

The evaluators adjusted the NTGR measurement to acknowledge the possibility that it had not adequately captured program influence derived from activities other than incentives and technical assistance. While speculative in nature, the implication was that free-ridership (FR) and spillover (SO) questions used in the SRA may have overlooked the influence of program education and outreach activities, which can increase awareness, understanding, and acceptance of efficient measures and practices. In response to this concern, the evaluators added questions to the Phase II NTGR battery to ask interviewees about whether and how a broader range of program activities and strategies may have impacted the decision to fuel-switch. To implement this change in NTGR measurements, this new dimension of program influence was assigned an influence score using the same 0 to 10 scale as was used for measuring the influence of program incentives and program technical assistance. To determine the project-level FR adjustment, the team chose the highest of the three influence scores and used that to determine a final FR value.

Program Influence on Project Space Heating Load Served by Heat Pumps

In Phase I, fuel switch FR was determined by combining two values: an overall FR score and a load FR score, which measured any influence the program had on increasing the amount of heating load served by heat pumps. Phase I interview respondents had difficulty responding to the load FR questions, so in Phase II the evaluators streamlined and simplified the load FR battery to a single multiple-choice question. For Phase II, the team also adjusted the way in which scoring of overall FS FR based on program influence impacted load FR. The adjustment made it such that any recorded program influence lowered both FS FR and the load FR equally. This updated Phase II approach acknowledged that any shift in load toward heat pumps occurred as part of a broader decision on whether heat pumps would serve as the primary space heating equipment in the project. As a result, any reported program influence is relevant to both FR components.

Results

NTG Calculation Process

Table 1 provides an overview of the topics and questions addressed in the refined Phase II NTG scoring process. The interview guides collected background data about the project and program engagement, established which party was most influential on the decision to fuel switch, scored the influence of the program on the fuel switch and any shift in electrified heating load, and assessed whether there had been any spillover from the participating project in question to any following projects. The appendices in NMR and DNV (2024) include the interview guides and the detailed Phase II NTG scoring algorithm. The general scoring process proceeded as follows:

- Assigned an initial FS FR = 1.0 if the project:
    - Used fossil fuels as the primary heating fuel.
    - Reported that they would have used heat pumps for primary heat without the program assistance.
- Identified partial FS FR (between 0 and 1.0) based on an influence score for each type of project assistance experienced by the respondent.
- Assigned a Load FR based on their response to a question about the program influence on the originally scoped vs. final planned fossil fuel vs. electric heat load.
- Calculated the final overall FR as average of the initial FS FR and Load FR minus the maximum program influence across the types of program assistance.

One exception to the general scoring process involved assigning a FR of 1.0 to any public or municipal fuel switching projects in municipalities with binding natural gas or fossil fuel bans. This step was only taken once the evaluators had interviewed a project contact that confirmed the town gas ban was binding and that the project had been requested by the client municipality to be designed and executed without fossil fuels based on the presence of the fossil fuel ban. In these cases, the program could not influence the outcome of heating fuel usage, so the application of a 100% FR was appropriate. The evaluators also applied a FR of 0.5 to any respondents who provided contradictory responses for overall FR and program influence FR that were not cleared up through further questioning.

Spillover can come in many forms: participant “like” (similar project/measure) and “unlike” (different project/measure that saves energy) SO and non-participant SO. The nature of fuel switching required a simplified approach to measuring SO compared to that used in past SRA NTG measurements. The fuel switch is a whole building system change to a heat pump through a fuel usage lens and offers no opportunity for participant SO within the same project. Spillover measurements were thus focused on SO to other projects, which, for discussion purposes here, the evaluators classified as non-participant

spillover (i.e., the project was non-participating). SO was recorded when a respondent indicated that they had begun another project after starting the participating project included in the study, this new project included fuel switching, and this new project **would not** be enrolled in the NRNC program. For such new projects, the evaluators recorded the project's square footage and asked the respondent to rate the influence that the fuel switching incentives had on design decisions in the new project. The general spillover scoring process included the following:

- Assigned spillover = 0 if the respondent had started no additional projects that used heat pumps for primary heating
- Assigned spillover = 0 if the respondent plans to enroll the project in the program
- Assigned spillover = 0 if the prior program experience did not influence the new project using heat pumps for primary heat
- Assigned spillover as the maximum influence score from among the vendor or other program influence on the new project

Table 1. Participant NTG scoring overview

Topic	Question	Response Type
Project Eligibility	Is NG/Propone primary heating	Yes/No
Background	When they engaged PAs and who they engaged	Qualitative
	When heat pump was introduced to the project	Categorical
	What motivated fuel switch	Categorical
Influential Party	Who most influenced the project design and how influential were they	Categorical/ Scale
Program influence on fuel switch	Would project have opted for the heat pump as primary system without program	Yes/No
	How influential was the incentive	Scale
	How influential was the technical assistance	Scale
	Did other program activities influential the decision and how influential were other they	Categorical Scale
Program influence on load	Did the program change the anticipated fossil fuel / electric load and how?	Best fit answer
Program influence on fuel switch spillover	If started new project	Yes/No
	Do they plan to enroll new project in program	Yes/No
	Are they using heat pumps	Yes/No
	Are heat pumps primary heating source	Yes/No
	What is the square footage	Size of project
	Was vendor influential on project? On heat pump?	Yes/No
	Was program influential on project? On heat pump?	Yes/No

Table 2 presents the FR calculation for one respondent. This respondent was a design team member and rated themselves as the most influential party. This respondent – like all other fuel switching respondents – reported zero spillover.

Table 2. Example scoring calculations for one respondent

Question	Response / Score
Project would have opted for the heat pump without program	Yes (Initial FS FR = 1)
Incentive influence	4.5 out of 10, scored as 0.45
Technical assistance influence	0 out of 10
Other program influence	0 out of 10
Load influence	None (Load FR = 1.0)
Initial FR Estimate	(Average Initial FR and Load FR) – Max influence = 1 – 0.45 = 0.55
Final individual FR	0.55

To develop the final NTG estimates in Phase I and again in Phase II, the team calculated FR, SO, and a NTGR for every respondent and estimated the overall unweighted NTG ratio across the sample. The unweighted NTG ratio used the following equation:

$$Unweighted\ NTG\ Ratio = \frac{\sum(1 - FR + SO)_i}{n}$$

The unweighted estimate, however, treats all projects equally regardless of their size. Yet, projects ranged from under 10,000 square feet to over 500,000 square feet. Therefore, the NMR team next developed project weights equal to their portion of the total square footage associated with the projects in the analysis. The equation is as follows:

$$Weight_i = \frac{square\ footage_i}{\sum square\ footage}$$

NMR multiplied each unweighted NTG ratio by the project weight and then summed them across all projects to yield the weighted NTG ratio:

$$Weighted\ NTG\ Ratio = \sum(1 - FR + SO)_i\ x\ Weight_i$$

Phase I NTG Results

In Phase I, the team conducted 28 interviews with representatives from participating projects that installed heat pumps. One of the major complications of Phase I was the timing of regulatory deadlines in relation to the timing of the heat pump fuel switching incentives entering the market. To meet the regulatory edict to generate an evaluated heat pump fuel switching NTGR for prospective application *before* the deadline for setting those prospective NTGRs, the team had to collect data from projects that engaged with the program before the official launch of the fuel switching incentives. Projects that engaged with the program before the fuel switching incentives launched could access the incentives if the heat pump equipment in the design met eligibility requirements. However, most of the projects were unaware of the new incentives when they decided to adopt heat pumps as the primary heating system.

Upon further discussion, the evaluators, PAs and EEAC agreed to limit the data used for the Phase I NTGR calculations to 13 projects for which the PAs would claim fuel switch savings, because the PAs expected the project to receive these incentives as they progressed through the program and these

participants discussed fuel switching with program staff. Despite refining the NTGR calculation sample to only those confirmed to be claiming the fuel switching incentive, the 13 projects demonstrated high free ridership and no spillover. The result was an NTGR of 7%. Every respondent claimed that their project would have installed a heat pump in the same configuration and covering the same proportion of heating load without program incentives. The NTGR exceeds zero because some participants exhibited partial FR, explaining that program assistance helped to solidify decisions and secure stakeholder buy-in for the project.

NMR discussed these findings and the issue of timing with the PAs and EEAC and agreed on an approach that applied the 7% NTGR to any fuel switching projects that engaged with the program **before** the fuel switching incentives were officially launched. Projects engaging after the incentives were official and all key details were widely available to the market would receive the same negotiated NTGR of 69% used for fuel switching in 2022, which was based on a prior, more traditional energy efficiency NTGR developed for this NRNC program. With a negotiated value in place, the next evaluation priority was to update the fuel switch NTGR with primary data from more recent projects that engaged with the program with full knowledge and awareness of the fuel switching incentives.

Table 1: Phase I Fuel Switching Net-to-Gross Estimates (*n=13*)

NTG Component	Unweighted Estimate	Weighted Estimate
FR	89%	93%
SO	0.0%	0.0%
NTG	11%	7%

Key Observations from Phase I Data Collection

Interview respondents found it nearly impossible to separate the fuel switching decision from the decision to install high-efficiency heat pump technology and pursue high efficiency building designs. These decisions are closely related and interdependent. For example, the availability of large heat pump incentives may have supported a shift from Variable Refrigerant Flow (VRF) heat pumps to a more expensive ground source heat pump system, which improves the energy performance of the design (and may unlock new incentives based on energy efficiency) but is not applicable to the fuel switch decision under the framework set by regulators.

Second, respondents found it difficult to assign a portion of heating load to specific fuel types even in cases where natural gas, diesel, or propane served as secondary or shared heating fuels. Respondents also had a difficult time thinking about the area served by the heat pump versus other fuels. This suggested the need to rethink how to measure program impacts on the planned heating load provided by heat pumps when using self-report data.

Third, the high incidence of municipal projects among program participants may have inadvertently driven down NTG ratios. Many municipalities in Massachusetts have policies that prioritize low-carbon designs for commercial new construction, causing them to be routinely classified as partial or full free riders. Yet, the municipalities in this study explained that they also attempt to take advantage of as many grant and incentive opportunities as possible to reduce taxpayer burden and build support for efficient designs when approval is required. Municipalities represent a unique but common participant group with decision-making processes and priorities that set them apart from the private companies and non-profit organizations that also take part in the program

Phase II Data Collection

Table 3 provides the NTGR results from the Phase II data collection. Phase II data collection yielded a fuel switching NTGR of 34% with an updated sample of projects that formally enrolled[3] with the program after the launch of the heat pump incentives. The team conducted 19 interviews representing 15 participating projects. As discussed above, the measurements taken in Phase II included an expanded examination of program influence that included education and advocacy activities beyond incentives and technical assistance. Interview findings did not show this type of influence to be impactful on NTG outcomes, as it was nearly always rated as lower impact than financial or technical assistance when calculating free ridership. These findings suggest that the absence of these additional influence measurements in Phase I did not contribute to the low NTG results from that phase. However, respondents confirmed that these activities are reaching the market, for example by confirming attendance of trainings and presentations led by the program staff or by learning about program support through engagement with organizations like the Massachusetts School Building Authority (MSBA). As in Phase I, interviews recorded no evidence of spillover as defined for the purposes of fuel switch NTG measurement.

Table 2: Phase II Fuel Switch Net-to-Gross Ratio Estimates (*n=15*)

NTG Component	Unweighted Estimate	Weighted Estimate
FR	65%	66%
SO	0.0%	0.0%
NTG	35%	34%

General Study Observations

Free-Ridership

Interviews with participants and their design team representatives demonstrated how state climate policy, new and more aggressive energy codes, corporate sustainability initiatives, and increased efforts by municipalities to support decarbonization continue to push this NRNC market to higher levels of performance. While not unique to Massachusetts, the stringency and level of uptake associated with energy codes, corporate sustainability initiatives, and local decarbonization policies made them significant factors in the FR measurements derived through the modified SRA used in this evaluation. In addition, primary data collected in this study demonstrated that participants currently receiving program support include market actors already inclined to adopt high efficiency electric equipment. Estimating NTGRs with primary data from these respondents may yield high FR because the participant enters a project with greater knowledge and acceptance of energy efficiency solutions and awareness of what the program can provide. The following attributes were common among both customer and design team respondents:

- They showed a high degree of familiarity with electrification, heat pumps, and high efficiency building practices.
- They worked frequently in (or represented) larger cities and towns with a history of program participation, cities and towns with formalized climate change goals, and/or jurisdictions that had adopted the stretch code or the specialized opt-in stretch code.
- They had past interactions with MassSave® programs and upcoming NRNC projects were likely to participate in the NRNC program, if they were not officially enrolled already.

[3] Formal enrollment was typically established based on the date at which a customer signed a memorandum of understanding with the program agreeing to the eligibility requirements placed on the project.

These findings spurred a consideration by the study team that moving forward, program implementation staff work to target more new customers and practitioners less knowledgeable of high-performance building practices, or smaller customers with fewer resources than large developers who can more readily absorb (or capture financing to offset) higher project costs.

Spillover

As discussed above, zero spillover was recorded in Phase I and II data collection. The data showed that any additional projects begun after the participating project discussed in the interview were either already enrolled in the program or would be enrolled. Often respondents reported that they had worked with the program in the past and that it is standard for them to pursue all available NRNC incentives when designing a new project. The high degree of repeat participation suggests that the program has made progress building relationships with many design firms, municipalities, and developers, but these relationships also limit opportunities for SO as measured through the modified SRA. Spillover measurements may suffer from self-selection bias if repeat participants who are more familiar with and committed to the program are more likely to consent to an interview.

Parsing Fuel Switching and Energy Efficiency Decision Making

In addition to recommending prospective NTGRs, this study offered a consideration for future NTG research to develop a unified NTGR for participating projects that install heat pumps which would encompass fuel switching and efficiency savings. Fuel switching is deeply intertwined with the desire to create a more energy efficient project.[4] Interviewees in both phases of the study had a difficult time separating the idea of the fuel switch from the broader goal of creating a more efficient building. The fuel switching heat pump incentives are also significant in scale compared to the traditional EE incentives, meaning the addition of fuel switching incentives may promote additional project changes by changing the cost equations. For example, the per-ton heat pump incentives may induce a fuel switch, but they may also motivate participants to upgrade to a more efficient heat pump system. The nuance of this dependency may be lost to a participant asked to separate energy efficiency from the fuel switch decision and, as a result, the program may not receive proper credit for the system upgrade. It is possible that trying to develop two distinct NTG components, despite careful study design, could muddy the waters when it comes to comprehensively estimating program attribution. Thus, the project team favored a switch to a unified NTG measurement that acknowledged the link between fuel switching and high-performance designs and allowed all relevant program support to be assessed in one set of measurements. It is worth noting that this recommendation was made in the context of a program impact accounting framework that uses site EUI metrics to estimate program savings, which makes such holistic NTG measurements more feasible. The use of EUI metrics derived from parametric building simulation modeling enables program savings calculations to capture the site EUI benefits of fuel switching in conjunction with equipment efficiency upgrades. Other impact accounting frameworks may not be structured to support this approach and, without adjustments, may favor a segmented approach.

Conclusion

This study highlighted challenges in evaluating the decision to fuel switch in isolation from other project energy efficiency interventions and assigning program attribution for the fuel switch under a

[4] For comparison, the more traditional energy efficiency NTGR for program participants that received incentives and technical support to pursue high-performance, low energy use intensity (EUI) designs was 47%. These NTG measurements covered program influence across a range of building design interventions (building envelope, ventilation, etc.) that collectively yield a low EUI design.

traditional resource acquisition framework. Primary data collection with project decision makers showed that many market actors in this jurisdiction sought out program support and factored it into project decision making. The number of repeat participants and the strong presence of municipal projects among participants suggests the program has become a fixture in the market. However, given the many factors influencing project outcomes, including energy codes and municipal policies, and the sheer cost of many NRNC projects, the program did not register as a key intervention under this attribution framework. As such, NTGR results from this study suggested limited program influence on fuel switching. Despite these results, interviews demonstrated that the program was operating as intended, and many participants valued the program support , even if it failed to score as a highly influential intervention under a traditional attribution approach. For example, while some respondents would cite stringent municipal energy codes as the driver for a fuel switch, the program was valued for the ability to educate the market, minimize incremental costs, and drive adoption of more efficient electric systems.

While the study team highlighted some options to adjust future NTG measurements in the event they would be required under the prevailing resource acquisition framework, Massachusetts has since shifted this program to a market transformation framework that no longer requires net savings impact accounting. This shift fit with broader statewide decarbonization goals, providing a more supportive framework for the program to continue offering incentives that worked in concert with other assistance at the federal, state, and local level to decarbonize the NRNC sector. Under this new framework the program can avoid penalties for effectively stacking influence on other complementary market interventions to make decarbonizing the built environment with advanced heat pump systems more feasible and appealing. Through a resource acquisition lens this change in impact accounting, considering the low NTGRs calculated in this research, may be seen to risk overestimation of short-term net impacts. It remains important to understand how the market is reacting to program support and how the program can most effectively impact the market as conditions evolve. But this change in impact accounting supports valuable program contributions that can be difficult to quantify , for example providing educational resources and incentives that, when added on top of a federal ground source heat pump tax credit, successfully tip municipal voting for a new K-12 school to be designed with the best available heat pump system. Moving forward, the program is better situated to serve as an additive force, filling gaps or strengthening arguments for improved design outcomes when the situation calls for it without concern that program evaluation might, if even inadvertently, undervalue and undermine these accomplishments.

References

Massachusetts Energy Efficiency Advisory Council (2021). *Term Sheet to the Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan for 2022-2024*. Final Approved Version, October 25, 2021.

NMR and DNV (2022). *Recommended 2023 NTGRs for Fuel Switching Heat Pumps in Non-residential New Construction*. Delivered to the Massachusetts Program Administrators November 1, 2022.

NMR and DNV (2024). *Non-Residential New Construction Paths 1 and 2 and Fuel Switching Net-to-Gross Report (MA22X02-BNRNCHPNTG)*. Delivered to the Massachusetts Program Administrators June 7, 2024.