RNC Electrification Barriers Study Report (MA21R44)

Final Report

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SUBMITTED TO:
Massachusetts Program Administrators and Energy Efficiency Advisor Council

SUBMITTED BY:
NMR Group, Inc.

NMR Group, Inc.

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Barriers to Electrifying New Homes in Massachusetts

The MA21R44 Residential New Construction (RNC) Electrification Barriers Study was designed to identify behavioral and informational barriers to building new, fully electric single-family homes in Massachusetts and recommend solutions to overcome these barriers.

Methodology

Literature Review

Evaluations and Market Research

Interviews

29 Market Actors

Web Survey

93 Homebuyers

Barriers Findings

Consumer and Contractor Preferences

- Professionals are comfortable with fossil fuel equipment and see no downsides to using it
- Homeowners prefer gas equipment, particularly for cooking, and market actors know it
- Customers have aesthetic concerns with lowest-cost heat pump space heating options
- When natural gas is unavailable, builders default to propane alternatives

Technical Concerns

- Doubts persist about heat pumps' ability to work effectively in extreme cold
- Ductless heat pumps' most cited advantage, room-by-room temperature control, is viewed as a downside by others

Gas Combustion and Indoor Air Quality

- Homebuyers are aware that gas combustion impacts air quality, but it does not yet appear to influence purchasing decisions

Financial Considerations

- Market actors do not see an economic case for choosing electrification measures
- Some all-electric homebuyers would not recommend all-electric to others, often citing utility costs

Capacity of the Electric Grid for Electrification

- Interviewees raised concerns that a high volume of all-electric new homes could stress the grid

Recommendations

- Build robust knowledge-sharing partnerships with key market actors that provide digestible research findings and experiential case studies
- Use the Codes and Standards Compliance Support Initiative and other training resources to promote wider adoption of all-electric new homes, leveraging new energy codes that favor electrification

Considerations and Future Research Options

- Implement or assist with awareness-building campaigns on the health and safety benefits of avoided fossil fuel combustion
- Educate participants on full array of financial assistance available for electrification
- Consider research to understand key details about the HVAC installer population
- Consider research into electrification barriers specific to multifamily and low-to-moderate income sectors

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Glossary

Term	Definition
ACH50	Air Changes per Hour with a 50-Pascal pressure gradient
AERC	Annualized Energy-Related Costs, i.e., utility bills, mortgage, and replacement costs
AFUE	Annual Fuel Utilization Efficiency
ASHP	Air-Source Heat Pump; a ducted fixed refrigerant flow heat pump
BEopt	NREL's Building Energy Optimization modeling tool (more info available here)
BTU	British Thermal Unit; a measure of energy consumption
BTUh	British Thermal Units per Hour
CAC	Central Air Conditioner
CFA	Conditioned Floor Area
CFM25	Cubic Feet per Minute with a 25-pascal pressure gradient
CO_2e	Carbon dioxide equivalent, a measure of greenhouse gas emissions
COP	Coefficient of Performance; a measure of equipment efficiency, usually heating
DHW	Domestic Hot Water
EF	Energy Factor; a measure of equipment efficiency, variations include CEF, IMEF, MEF and UEF
EPS	Expanded Polystyrene; friable foam like a coffee cup
EO	Energy Optimization; an approach to efficiency that maximizes savings benefits relative to costs
ERI	Energy Rating Index; summarizes a home's overall efficiency, lower is better
ERV	Energy Recovery Ventilation; higher performance option to an HRV
FGB	Fiberglass Batt; a pad of loosely felted glass fibers that traps air
Grade	Insulation installation quality; Grade I is best.
GSHP	Ground Source Heat Pump
HERS	Home Energy Rating System; summarizes a home's efficiency, lower is better
HPWH	Heat Pump Water Heater
HRV	Heat Recovery Ventilation
HSPF	Heating Seasonal Performance Factor; a measure of electric heat pump heating efficiency
HVAC	Heating, Ventilation and Air Conditioning
IECC	International Energy Conservation Code
kWh	Kilowatt-Hour; a unit of electricity consumption
MSHP	Mini or Multi-Split Heat Pump, usually ductless
NEI	Non-Energy Impacts; impacts of energy-efficiency measures other than energy savings
NREL	National Renewable Energy Laboratory
NREMDB	NREL's National Residential Efficiency Measures Database, that provides measure costs
PAs	Massachusetts Gas and Electric Program Administrators
R-value	Measure of a material's resistance to the flow of heat, higher is better
RNC	Residential New Construction
SEER	Seasonal Energy Efficiency Ratio; a measure of cooling system efficiency
SHGC	Solar Heat Gain Coefficient; a measure of how much infrared light passes through a window
SIP	Structural Insulated Panel, an alternative to conventional framed construction
TDL	Total Duct Leakage
U-factor	Measure of a material's transfer of the flow of heat, lower is better
UCB	Unconditioned Basement
UDRH	User-Defined Reference Home; the hypothetical baseline home for the RNC program
XPS	Extruded Polystyrene; rigid foam sometimes used as padding in packaging

Executive Summary

Background and Study Goals

The MA21R44 Residential New Construction (RNC) Electrification Barriers Study was designed to identify behavioral and informational barriers to building new, fully electric single-family homes in Massachusetts and recommend potential solutions to overcome these barriers. The study focuses on the RNC market and key electrification measures, including heat pump space conditioning equipment, heat pump water heaters, efficient electric appliances (e.g., induction cooktops), and gas fireplace alternatives. This study complements energy optimization (EO) research being conducted for the Massachusetts Program Administrators (PAs). Together, these studies will provide guidance on electrification strategies that make economic sense to builders and owners, assess why rate payers and market actors may not choose these strategies despite the benefits, and look for opportunities to boost adoption.[1] This multidimensional evaluation of electrification in the RNC market will inform program design and marketing efforts as the PAs continue to support the state's energy efficiency and decarbonization goals via their RNC program.

Methodology

Primary research activities included:

- a review of literature (e.g., evaluations and market research) regarding electrification barriers conducted outside of Massachusetts,
- interviews with 29 professionals involved with new homes in Massachusetts (builders, developers, heating and cooling contractors, HERS raters, and real estate agents),
- and a web survey with 93 recent Massachusetts homebuyers (28 of whom lived in homes heated with heat pumps).

The report focuses on Massachusetts-specific findings derived from the market actor interviews and homebuyer survey. A summary of the literature review, which informed the interview and survey instruments, can be found in Appendix B.

Key Barriers to RNC Electrification

The following table summarizes key barriers to electrification in the RNC market identified in the study, via interviews with market actors, a homebuyer web survey, and a literature review. The table provides the high-level issue identified by the study, along with the market actor type for

[1] Specifically, the MA20R23 RNC Energy Optimization Cost study (2021), https://ma-eeac.org/wp-content/uploads/MA20R23-RNC-EO-Final-Report-10222021-1.pdf, and the ongoing MA21R41 RNC EO Code Compliance and Electrification Modeling study that follows up on MA20R23.

whom that barrier is most pertinent. Each topic area heading in the table includes a link to the detailed findings for that topic.

Table 1: Summary of Findings on Barriers to Electrification

Relevant Market Actors	Cited Barrier to Electrifying New Homes
Consumer and Contractor Preferences	
Builders, developers, HVAC contractors[2]	Professionals are comfortable with fossil fuel equipment, and many do not perceive downsides to this equipment.
Professionals and homebuyers	Homebuyers like gas equipment, particularly for cooking, and market actors know it.
Professionals and homebuyers	The aesthetics of ductless mini-split heat pumps are a major barrier to electrifying space conditioning equipment, and using ducted configurations adds cost and reduces efficiency relative to ductless options (due to duct losses themselves and due to ducted configurations having lower rated efficiencies than ductless variants.
Builders, developers	Builders will typically default to propane equipment when natural gas is not available, and homebuyers seem accepting of that approach.
Financial Considerations	
Builders, developers, HVAC contractors	Market professionals do not see an economic case for choosing electrification measures.
Homebuyers	Concerns about utility costs were frequently expressed by the small subset of all-electric homebuyers who said they would not recommend all-electric homes to others.
Technical Concerns	
Professionals and homebuyers	Concern about the cold weather performance of heat pumps remains a barrier to installations in new homes.
Builders, developers, HVAC contractors, real estate agents	MSHP's most commonly cited benefit in interviews – room-by-room temperature control – was seen by others as a potential downside.
Gas Combustion and Indoor Air Quality	
Professionals and homebuyers	Homebuyers are aware that on-site fossil fuel combustion impacts air quality but there is little evidence this is influencing purchase decisions.

[2] In this study, HVAC includes heating and cooling equipment, whether forced air or hydronic.

Relevant Market Actors	Cited Barrier to Electrifying New Homes
Capacity of the Electric Grid for Electrification	
Builders, developers, HVAC contractors, real estate agents	Interview respondents of all types raised concerns about the pressure that a higher volume of electrification measures can place on the grid.

RECOMMENDATIONS AND CONSIDERATIONS

The team provides the following considerations for the PAs to advance the construction of all-electric new homes in Massachusetts based on the barriers and potential solutions identified by the study.

Recommendation 1: Build robust knowledge-sharing partnerships with builders, developers, and HVAC contractors that include access to digestible research findings and experiential case studies of all-electric homes and involve regular interaction with key players. These partnerships should include targeted and evidence-based messaging that focuses on the needs of specific types of market actors, e.g., builders of natural gas vs. propane homes, builders of customer vs. spec homes, or builders of single- vs. multifamily homes. We recommend long-term partnerships with market actors that go beyond simply making trainings or webinars available to them, allowing these market actors to both learn from the PAs and provide real-time feedback to the PAs about the program.

Rationale: Based on interview feedback and survey findings, there appear to be several areas where the PAs can assist in promoting all-electric new homes, in addition to any efforts already underway. Collectively, the approaches below could help market actors understand the extent to which customers are primed to adopt all-electric homes, while also helping ensure that they can confidently build homes that bundle high-efficiency electrification measures with well-sealed and well-insulated thermal envelopes, creating comfortable homes that satisfy their customers. We expect that these efforts will be most successful if tailored to the different market segments and types of builders active in Massachusetts, taking into account their own experiences, preferences, and market focus. We suggest the following as potential options that the PAs and implementers could use to build the partnerships recommended above.

A. ***Experiential case studies that expose market actors to the installation, operation, and performance of all-electric homes.*** Several interviewees suggested that market actors inexperienced with or suspicious of electrification measures will benefit from seeing up close how the equipment is installed, how it operates, and what it feels like in a home using heat pumps and other electrification equipment. The program could potentially use enhanced incentives to recruit homes to serve as case studies and offer stipends to market actors to encourage them to take time away from a day of work.

B. ***Create a direct line to market actors that communicates the Energy Optimization findings from the MA20R23 and MA21R41 studies, specifically, how builders can cost-effectively combine measures to generate code compliant and/or high-***

efficiency all-electric homes. The energy optimization findings are designed to provide concrete examples to professionals on how various construction packages can cost effectively achieve energy efficiency levels that meet or exceed code compliance (including for the recently adopted stretch code and specialized opt-in code that favor all-electric homes), and how builders can generate energy-efficient, all-electric homes with limited additional expense. Putting these examples in front of market actors is meant to build confidence that they can adapt their practices to incorporate new equipment in ways that fit existing capabilities and budgets. The full usefulness of these findings – and other complementary efforts – will not be unlocked until they are put in front of as many market actors as possible. Evaluator reports can generate relevant content, but only PAs and implementers can leverage their market actor relationships and market power to ensure this information gets distributed appropriately.

C. ***Provide research-based strategies to electrify homes using measures with high customer satisfaction, for example through system configurations that may reduce occupant objections*.** The PAs should continue to share relevant research with professionals that can build confidence in their ability to deliver fully electric homes that customers will be attracted to and will like. This study found that customer satisfaction with electrification measures like air-source heat pumps, heat pump water heaters, and induction cooktops was as high or higher than with gas equipment. Builders and developers will consider electrification measures with more data on customer acceptance and satisfaction. The PAs should use the market actor partnerships recommended here to learn more about topics or equipment that could benefit from further research, helping ensure any future research is targeted where it's needed most. As an example of topics where the PAs could help address concerns about customer satisfaction, aesthetic objections to typical wall-mounted MSHP installations were a frequently cited barrier to the wider use of heat pumps. Ducted MSHP installations can address this issue, but duct systems increase installation cost and lower system efficiency due to distribution losses and due to ducted configurations having lower rated efficiencies than ductless variants. The ability to avoid using ducts was cited by interviewees as a key benefit to using MSHPs. The PAs could consider building awareness of less-common MSHP distribution systems, including ductless floor-mounted or ductless ceiling-mounted blowers to address the findings from this report. These systems provide a middle ground where duct systems are avoided and the systems are less visible in the home. Ceiling blowers are mostly hidden from view, apart from distribution registers mounted on the ceiling and floor-mounted units look comparable to steam radiators, and may be less visually prominent than units mounted high on a wall.

Recommendation 2: Use the Codes and Standards Compliance and Support (CSCS) initiative and other PA training resources to promote wider adoption of electrified RNC, in light of the recently updated stretch and specialized opt-in codes that favor all-electric homes.

Rationale: The introduction of new energy codes in Massachusetts that favor all-electric homes provides an opportunity to substantially increase the market share of all-electric homes, moving uptake beyond the early-adopter demographic. These new codes represent a major shift by

disincentivizing fossil-fuel new construction, though they do not fully ban fossil fuels. [3] In addition, ten cities and towns throughout the state will be cleared to ban all fossil fuels in new construction by participating in the pilot program included in the recent Massachusetts climate legislation. Provided that analysis shows the energy savings potential justifies the added implementation costs, the PAs have an opportunity to use the CSCS initiative to expand programmatic support for all-electric construction, even for builders operating outside of the traditional RNC program.[4] The CSCS initiative could help drive all-electric market share by explaining to market actors the benefits of all-electric homes over fossil fuel homes, how they can cost-effectively meet code with all-electric systems, and how to cost-effectively package efficiency thermal envelope measures with high-efficiency electric mechanical systems.

Consideration 1: Consider implementing or assisting with awareness-building campaigns about the health and safety benefits of electric equipment.

Rationale: Research on the health impacts of gas combustion equipment continues to gain media attention. The study saw clear awareness of this issue among industry professionals and homebuyers, including those who bought fossil-fuel homes. In fact, most surveyed homebuyers who bought new homes with fossil fuels rated all-electric homes as providing better indoor air quality. Of course, this perception was not sufficient to drive them to purchase an all-electric home. The high awareness of this issue among owners of fossil-fuel homes, coupled with interview feedback that buyers do not raise this issue in purchasing conversations, suggests that these air quality concerns are not yet acute enough to push all buyers to demand all-electric new homes. Tapping into consumer segments that engage with health and wellness trends by making available defensible findings on such health-related non-energy impacts may help electrification gain traction among consumers.

Consideration 2: Consider educating participants on the full array of financial assistance available and share guidance for accessing incentive and assistance options beyond Mass Save incentives including the Inflation Reduction Act (IRA).

Rationale: Potential participants may not be fully aware of all financial assistance options available to them—including Inflation Reduction Act tax credits worth up to $5,000 that became available at the beginning of 2023—a broader finding supported by the literature review. The program could assist by providing participants with guidance about incentives and support available from the program and other sources. Program resources could aggregate the requirements and guidance needed to access each funding option to facilitate benefit stacking. This financial summary can then be used in consumer outreach materials to present a more convincing case for the financial benefits of pursing electrification measures. This effort could include information about financial incentives for ancillary equipment that may be of particular interest to electrified homebuyers, for example the 30% tax credit for solar photovoltaics (PV) included in the IRA.

[3] Mixed fuel homes under the specialized opt-in code will be required to achieve a lower (more efficient) HERS Index score than all-electric homes. Mixed fuel homes will also be required to pre-wire the home for future electric equipment and install 4kW of solar photovoltaics on the roof if the site supports it with proper unshaded area.
[4] Mass Save | All-Electric Home

FUTURE RESEARCH OPPORTUNITIES

Opportunity 1: Consider conducting or leveraging other PA-funded research on the HVAC installer market involved with new homes to understand population characteristics, experience levels, and training needs.

Rationale: HVAC installers are key to electrification progress, but there is a lack of data with which to conclude if the current RNC-focused contractor pool in Massachusetts has the capacity to meet the electrification goals of the state. If the installer pool in Massachusetts is dealing with a potential wave of retiring contractors,[5] further research may be needed to determine what type of interventions might be necessary in the workforce training and development sector, particularly if a growing number of large-volume builders begin to demand all-electric systems. The PAs will conduct surveys with HVAC installers as part of a study on Heat Pump Market Effects under the Massachusetts cross-cutting contract (study 22X06) to understand more about installer experiences with heat pumps. The PAs can determine if further research is warranted after reviewing the findings from that research. The Mass Save Heat Pump Installer Network can also be a resource for market intelligence,[6] though it will be important to capture input from contractors who are not in the network.

Opportunity 2: Consider conducting additional research focused on barriers to electrification in multifamily new construction, possibly with a focus on low and moderate income (LMI) populations.

Rationale: This study scope was limited to single-family new construction. Interview guides touched on multifamily topics, but interviewees worked primarily in the single-family market. Nearly two-thirds of newly permitted housing units in Massachusetts in 2022 were in multifamily buildings, indicating the importance of addressing electrification barriers in the multifamily market. Electrifying multifamily buildings presents different challenges than single family buildings, and there may be multifamily-specific barriers this study did not capture. For example, the MA19R05 Passive House study on high-performance multifamily homes suggested that even skilled proponents of electrification have challenges with electrifying domestic hot water systems in multifamily buildings.[7] Between this study and the PAs' research on barriers to heat pump installations in existing market-rate multifamily homes,[8] many multifamily RNC barriers have likely been identified. A recent California evaluation focused on electrification in low-income multifamily new construction highlighted several of the same barriers identified here, including concerns about grid integrity, high upfront equipment and construction costs, and the utility costs faced by residents.[9] With that said, other factors specific to multifamily construction in Massachusetts likely exist. Additional research on multifamily electrification may also provide useful data on key

[5] See: A 'Gray Tsunami' Is Hitting the HVACR Industry | ACHR News
[6] Mass Save | Heat Pump Installer Network
[7] See Section 6.4 in the report here: MA19R05_PassiveHouse_OverallReport_Final_2020.01.06.pdf (ma-eeac.org)
[8] Microsoft Word - MA21R35 - MF HP Barrier Study_Report_FINAL_25MAR2022 (ma-eeac.org)
[9] The California report also highlights technical concerns with electrifying domestic hot water in multifamily buildings, echoing the concerns raised during interviews conducted for the 19X05 Passive House Market Assessment. Notably though, a majority of stakeholders interviewed in the California study believed that it was practical to build all-electric in their market. See the report here: Report Template v2017.0521 (calmac.org)

barriers relevant to LMI populations in Massachusetts, another important sector that was not the focus of this study scope.

Section 1 Introduction

1.1 Background

The MA21R44 Residential New Construction (RNC) Electrification Barriers Study was designed to identify behavioral and informational barriers to electrifying single-family homes and recommend solutions to overcome these barriers. The study focused on heat pump space conditioning equipment, heat pump water heaters, efficient electric appliances (e.g., induction cooktops), and gas fireplace alternatives, collectively referred to in this report as *electrification measures*.

Heat pump usage in new homes in Massachusetts has grown substantially, but traditional systems have still dominated the heating and water heating market in new homes. The most recent baseline study of new, single-family homes (MA19X02) estimated that 14% of non-program single-family homes used heat pumps as their primary heating system and 17% used heat pump water heaters. In the three previous iterations of that study (2011, 2015, and 2017), heat pumps served as primary heating systems in no more than four percent of homes.[10]

The Program Administrators (PAs) have prioritized electrification as an Energy Optimization (EO) strategy to cost-effectively reduce energy consumption in response to aggressive statewide decarbonization goals. To move the electrification effort forward in the low-rise RNC market, the PAs sponsored the MA20R23 RNC Energy Optimization Cost Study (MA20R23), which provided positive findings about the affordability, reliability, and efficiency of homes using heat pumps. [11] Despite these findings, indicators show heat pump installations lagging the pace needed to meet the Massachusetts 2050 decarbonization goals, though uptake in the RNC market has been relatively strong.[12] Accelerating progress on electrification will likely benefit from a broader understanding of market forces and customer attitudes perpetuating fossil fuel consumption in homes.

The 21R44 study is designed to complement the MA20R23 findings by identifying what equipment choices are preferred by multiple types of market actors and what factors drive decision making. This study will be followed by another Energy Optimization study (MA21R41) that focuses on optimized approaches to complying with the new Massachusetts energy codes and to constructing fully electrified single- and multifamily homes.[13] The two studies are designed to provide complementary findings on what electrification strategies make economic sense, why rate payers and market actors may not choose these strategies despite the benefits, and how to boost adoption most effectively. This multidimensional evaluation of electrification will inform program

[10] MA19X02-B-RNCBL 2019 Residential New Construction Baseline/Compliance Study, 2020. https://ma-eeac.org/wp-content/uploads/MA19X02-B-RNCBL_ResBaselineOverallReport_Final_2020.04.01_v2.pdf
[11] Residential New Construction Energy Optimization Cost Study (20R23) (ma-eeac.org)
[12] See discussion on page 93 about Boston heat pump installs in the Boston Climate Progress Report from the Boston Foundation: https://www.tbf.org/climate2022. Also, the accompanying Boston Globe article: https://www.bostonglobe.com/2022/11/30/opinion/boston-state-must-act-home-heating-changes/?event=event12
[13] Forthcoming.

design and marketing efforts as the PAs continue to support the state's energy efficiency and decarbonization goals.

1.2 Research Objectives

The study explored the following research questions on informational and behavioral barriers to electrification through a literature review, in-depth interviews (IDIs) with professionals in the RNC market, and a web survey with recent RNC homebuyers:

- Are consumers, contractors, and builders aware of electrification measures?
- Do consumers, contractors, and builders believe there are energy, carbon reduction, and other benefits of electrification measures?
- Are consumers, contractors, and builders aware of the economic benefits of electrification?
- To what degree do consumer and contractor preferences for incumbent technology limit installation of electrification measures?
- What are the specific characteristics (perceived or actual) of incumbent technology that consumers and contractors believe electrification measures fall short on?
- What are the behavioral changes that consumers may need to adopt to use electric measures effectively and efficiently?
- What design changes must contractors, architects, and developers make to accommodate electric measures?
    - What programmatic steps can the PAs take to reduce behavioral and informational barriers to electrification to enable greater consumer and contractor adoption of electric measures?

1.3 Report Structure

This report includes the following sections:

- Section 2: Methodology: Overview of the Literature Review, IDIs, and Homebuyer Web Survey.
- Section 3: Barriers to Electrification: Feedback from market professionals and homebuyers on barriers to wider adoption of efficient electric equipment.
- Section 4: Feedback on Solutions to Barriers: Feedback from market professionals and homebuyers on solutions to identified barriers.
- Appendix A: Respondent Details
- Appendix B: Literature Review Summary
- Appendix C: Data Collection Instruments

Section 2 Research Methodology

The following section summarizes the research methods included in the study. The study includes a literature review, IDIs with market actors, and a web survey with homebuyers.

2.1 Literature Review

NMR conducted a literature review of research on barriers to electrification conducted in the Northeast and across the country. The team identified sources before and during study planning from past research and industry publications. These initial sources were supplemented with a review of the E Source DSM Evaluation Library, report repositories of energy efficiency-focused organizations, and reviewing report references. Geographic and organizational coverage included:

States and Regions: New England, New York, California, Colorado, Minnesota, and several publications with national scope.

Organizations: New York State Energy Research and Development Authority (NYSERDA), Northeast Energy Efficiency Partnership (NEEP), American Council for an Energy Efficient Economy (ACEEE), Rocky Mountain Institute, The California Public Utilities Commission, The Colorado Energy Office, and the New Buildings Institute (sponsored by California Utilities).

The literature review was designed to inform the development of interview guides and the web survey instrument. Findings from the literature review reinforced several key themes the team intended to explore in interviews and the web survey, including the impacts of utility costs, availability and capability of installation contractors, perceptions of cold climate reliability, and the role of familiarity when choosing between traditional gas equipment and newer electric alternatives. The team presented the literature review findings to the PAs and EEAC in March of 2022 and integrated feedback from the discussion into the data collection instruments.

2.2 In-depth Interviews

IDIs focused on market professionals in the single-family RNC space. The team completed 29 interviews out of a target of 30 with the following groups:

- Builders, developers, or general contractors (treated as one ‘homebuilder’ group): Target of ten completes.
- Heating and cooling contractors (including both HVAC contractors and plumbers who install heating equipment): target of ten completes, achieved nine. For simplicity, the team uses the term *HVAC contractor* throughout the report for this group.
- HERS raters: target of five completes.
- Real estate agents: target of five completes.

IDI data collection began in May of 2022 with HVAC and plumbing contractors and the bulk of interviews were conducted throughout the summer and early fall of that year.

2.2.1 Sample Development

To recruit HVAC contractors, builders, and general contractors, the team began with an internal database of HVAC contractor and builder contact information developed for past research activities. This database aggregated results from commercial directories previously purchased for PA studies in Massachusetts[14] and the team's general internet research and web scraping.

For each type of market actor, the team performed additional research to supplement the existing contact data throughout the spring and summer of 2022. For developers and builders, the team performed web research and a review of RNC program data, including program tracking data and REM/Rate energy model files. This yielded dozens of new contacts, including many developers, which were not present in the existing sample. For HVAC contractors, the team leveraged a database of heat pump rebate recipients from the past several years from the Massachusetts Clean Energy Center (Mass CEC).

A HERS rater sample was derived from the same review of REM/Rate energy model files used to identify builders and developers along with the "Find a Rater" function available on the Northeast HERS Alliance (NEHERS) website.[15] The team developed a real estate agent sample through web searches of real estate listings for newly constructed homes on online real estate directories like Zillow.com and Redfin.com. As part of recruitment outreach and again before starting each interview, team members screened respondents from all groups to confirm they had experience with newly constructed single-family homes.

2.2.2 Recruitment

Recruitment for all interviews began with an email using PA-approved recruitment language and Mass Save® branding. In return for their participation, interviewees were offered a $100 incentive delivered as an electronic gift card to a retailer of their choice or in the form of a Visa gift card. After the initial email wave, the team called contacts by phone if a number was available and followed up by email and phone call as needed. HERS raters and real estate agents were responsive to the first wave of outreach and recruitment went quickly. For builders, developers, and general contractors, recruitment was more challenging, but the team was able to hit their target of ten completes after integrating supplemental contact information from web research and program data.

HVAC contractors presented a challenge, with extremely low response rates to emails and phone calls along with frequent cancellations among those agreeing to an interview. Several contacts refused, citing busy schedules. Even with the added contact information available from Mass CEC records, the team was unable to secure all ten interviews. After discussing with the PAs, the NMR team reached out to the RNC program implementer, ICF, for assistance reaching out to their market actor networks, including the Mass Save heat pump installer network. ICF reported that

[14] About Us - Data Axle (data-axle.com). Initial data purchases were from InfoUSA, which was subsequently purchased by Data Axle.
[15] Find a Rater || NEHERS

several contractors refused their recruitment efforts, again citing busy schedules. With this development and continued non-responsiveness from NMR's recruitment sample, the team discussed with the PAs and agreed to end HVAC contractor recruitment with nine interviews completed, one fewer than targeted.

2.3 HOMEBUYER WEB SURVEY

NMR conducted a survey of RNC homebuyers to understand customer preferences for the equipment and fuel used in the home. Homeowners were asked what factors went into their choice of home and for post-occupancy feedback on the systems installed. Data collection occurred between late November 2022 and early January 2023.

2.3.1 Sample Development

To develop a homebuyer sample, the team began with new permanent electric service request data from the PAs covering January 1, 2017, through December 31, 2020. These data have historically been used by NMR to develop sample for RNC baseline and code compliance evaluations, and the team utilized similar data cleaning for this study to filter out multifamily properties and non-dwellings such as garages. This dataset included all available contact information for the account holder(s) associated with the service request. The team then asked the PAs' data management team to append electric and gas billing data for 2020 to the new service records. These data cover electric and utility natural gas consumption, but do not include delivered fuel usage such as propane or data on solar energy usage. This left a sample frame of 35,000 possible new single-family homes, almost evenly split between those with natural gas service and those without (Table 2).

Table 2: Homebuyer Sample Frame and Utility Gas Use Characteristics

PA	Utility Gas Usage		Total
	No	Yes	
Cape Light Compact	2,445	1,735	4,180
Eversource	10,015	13,804	23,819
National Grid	5,175	1,890	7,065
Unitil	55	13	68
Total	**17,690**	**17,442**	**35,132**

2.3.2 Sampling Plan

The team set a target of 100 survey completes with a goal of 34 respondents living in all-electric homes. To do this, the team stratified the recruitment sample by natural gas usage, as indicated by the presence of utility natural gas consumption in the billing data. The team initially allocated one-third of the sample to the sample stratum with natural gas usage and two-thirds of the sample to the sample stratum with no utility gas usage with the aim of getting an equal number of completes for all-electric, propane, and natural gas using homes. The sample stratum with no utility gas usage stratum would provide a mix of propane (soft quota of 33) and all-electric homes.

The initial sample design assumed a 5% response rate, requiring a total of 2,000 contacts for a target of 100 completes. Because the actual response rate after multiple outreach attempts was lower than assumed and the prevalence of all-electric homes was low, the sample was expanded to 4,267. The final sample design is summarized in Table 3.

Table 3: Summary of Survey Sampling Plan and Quotas

	Stratum 1 (Gas Use=No)	Stratum 2 (Gas Use=Yes)	Total
Sampled	**3,277**	**990**	**4,267**
Target completes (Hard Quota)	67	33	100
Soft Quota	No more than 33 homes with propane service*	None	

**To ensure at least 34 all-electric homes among 100 completes, a soft quota for propane was set, which was to be filled only if the prevalence of all-electric homes in Stratum 1 was too low compared to propane homes.*

2.3.2.1 Oversampling of All-Electric Homes

Because recent baseline studies have shown that all-electric new homes are less common than homes using propane,[16] the team proposed a probability proportional to size (PPS) sampling approach for Stratum 1 (the "no utility gas" stratum). By making the "size" variable annual electric consumption, the PPS method would increase the likelihood of sampling homes with higher electricity consumption (and by extension those homes more likely to be all-electric) from among the over 17,000 homes showing no utility gas usage. After discussing the sampling approach with the PAs and EEAC consultants, enhancements to this approach were suggested using monthly consumption data to calculate the following ratios:

- **Ratio of winter electric consumption to shoulder month electric consumption:** By identifying homes where electric consumption increases in the winter relative to shoulder months, the team can better identify homes using electric heat.
- **Ratio of fall electric consumption to spring electric consumption:** This ratio was intended to identify homes with solar, because solar arrays generate more output in the spring than in the fall in New England. A ratio greater than one (i.e., electric use is higher in the fall than the spring) would indicate possible presence of solar, and all-electric homes are more likely to use solar arrays.

This yielded a new size variable for the PPS sampling approach for Stratum 1 calculated with the following formula:

$$\boldsymbol{Size = Annual\ electric\ usage} * \left(\frac{\boldsymbol{Avg.winter\ elec.usage}}{\boldsymbol{Avg.shoulder\ \ elec.usage}}\right) * \left(\frac{\boldsymbol{Avg.fall\ elec.usage}}{\boldsymbol{Avg.spring\ \ elec.usage}}\right)$$

[1616] MA RLPNC 17-2: 2017 MA SF RNC Mini-Baseline/Compliance Study, 2018. https://ma-eeac.org/wp-content/uploads/RLPNC-17-2-Single-Family-New-Construction-Mini-Baseline-Study.pdf
MA19X02-B-RNCBL 2019 Residential New Construction Baseline/Compliance Study, 2020. https://ma-eeac.org/wp-content/uploads/MA19X02-B-RNCBL_ResBaselineOverallReport_Final_2020.04.01_v2.pdf

For Stratum 2, a simple random sampling approach was used as this stratum was uniform in nature for recruitment purposes.

2.3.3 Recruitment and Response Rates

For completing the survey, our team offered homeowners a $50 incentive in the form of an electronic gift card. Email addresses were available for roughly 80% of the homebuyer sample. To address possible bias in email responses, the team used a mixed methods approach that included emails and physical postcards. Sample without email addresses was earmarked for recruitment using physical postcards. The first step in recruitment was a test wave to 100 contacts using email outreach. With no evidence that the test wave had issues completing the survey, the team began full-scale recruitment with emails and postcards. Once emails were sent, the team noted instances where outreach emails went unopened (a metric tracked by the survey platform) and instances where the outreach email bounced (indicating a bad email address). In both cases, these contacts were reassigned to the group receiving physical postcards.

Table 4 provides a summary of survey outreach. The total outreach here differs from the total count of sampled contacts in Table 3 because there were slightly over 150 contacts with undeliverable email addresses.

Table 4: Survey Outreach Summary

Stratum	Emails Sent	Postcards Sent	Total Outreach
1	2033	1180	**3213**
2	778	116	**894**
Total	2811	1296	**4107**

In the end, the team was able to obtain 93 survey completes which would yield a response rate of about 2%. However, many more contacts accessed the survey and were blocked by the quotas set up in the online survey platform to avoid collecting too many responses from any of the main fuel categories. The quotas ended survey attempts for 86 gas and propane homes once the team had hit our targets for those groups. Another 46 people accessed the survey but were ineligible because they indicated they either lived in a multifamily building or had not purchased or built a new home in the last 5 years. If the data includes these groups that showed a willingness to engage with the survey, the response rate increases to nearly 6%. As Table 5 shows, 86% of respondents accessed the survey through email, while the remainder scanned the QR code or typed the URL included on the postcard.

Table 5: Method of Survey Engagement

Access Strategy	Count
Link in Email	80
QR Code (postcard)	8
Anonymous link (Postcard URL)	5
Total	93

2.3.4 Final Survey Disposition

Table 6 provides the breakdown of survey completes by fuel usage. Twenty-one respondents lived in all-electric homes. Another seven respondents lived in homes that used heat pumps for space heating but fossil fuels for other end uses, including cooking or water heating. These homes are designated as gas or delivered fuel (propane/oil) homes in the primary fuel classification, but we developed a secondary classification of homes by heating fuel to capture important nuances in the sample. Some people may be interested in heat pumps for heating but unwilling to give up gas as a cooking fuel, for example. After determining that we would not be able to hit the target of 34 all-electric homes, we opened the survey back up to gas and propane homes to collect some additional barriers feedback. Eight respondents reported using oil for space heating, a surprising finding given the lack of oil homes in the 2019 RNC baseline study.

Table 6: Final Survey Disposition by Fuel Type Classification

Primary Fuel Classification	
All-electric	21
Gas	34
Propane/Oil	38
Grand Total	**93**
Secondary Fuel Classification (Heating)	
All-electric	21
Electric Heat + Fossil Fuel	7
Gas Heating	32
Propane/Oil Heating	33
Grand Total	**93**

Section 3 Barriers to Electrification

The following section provides key findings about barriers to electrification from interviews with market actors and surveys with homebuyers, focusing on issues that were mentioned multiple times and across multiple respondent groups. Interviews showed that respondents and their customers are aware of electrification measures, but beyond this basic awareness opinions and understanding diverged considerably. Where takeaways are relevant to both natural gas and propane equipment we use "gas" as shorthand to describe those systems.

This section includes selected quotations from interviewed market actors. In those cases, we classify respondents as performing a high or low volume of work in the RNC space, based on a self-reported qualitative assessment of their business focus (see Appendix A for respondent details). When discussing survey responses, comparisons are made between buyers of all-electric homes (or electrically heated homes) and homes using fossil fuels for some or all key end uses. Sample sizes did not support testing for statistical significance, a caveat we ask readers to keep in mind as they consider these comparisons.

3.1 Key Barriers to Electrification

3.1.1 Consumer and Contractor Preferences

Interviewed professionals are comfortable with fossil fuel equipment, and many do not perceive downsides to this equipment. When asked to identify downsides or disadvantages to traditional gas equipment, the single most common response among professionals was that there was *none*. Professionals identified downsides to electrification measures much more frequently than with gas equipment (Table 7). Familiarity with the equipment—including with installation, repair, operation, and general capabilities—was the benefit market actors most commonly cited for gas equipment. Interviewees spoke for themselves and their customers. Customer familiarity with gas equipment was important to builders trying to attract buyers to spec homes [17]and to professionals making recommendations they thought would yield the highest satisfaction.

Despite these findings, 14 of the 24 homebuyers who discussed electrification measures with a professional during the homebuying process said the interaction made them more likely to seek out electrification measures (Table 7). Only one respondent reported that interacting with a market actor (an HVAC contractor) caused them to avoid electrification measures. While interviewees highlighted the advantages of gas systems as a known quantity, these survey responses suggest

[17] Spec homes are homes constructed entirely or almost entirely without input from a specific buyer where the builder or developer selects home features during construction.

potential for the same types of market actors to effectively promote consideration of newer, less familiar technology.

Table 7: Homebuyer Interactions with Professionals

Direction of market actor influence	Count
"Caused me to seek out electric equipment or appliances"	***14***
Market actor interactions*	
HVAC contractor	10
Appliance or equipment retailer	6
Builder or developer of the home	6
HERS rater	4
Utility or Mass Save contact	2
Different builder or contractor (Not their builder)	2
Real estate agent	1
Direction of market actor influence	
"Did not impact my choice of equipment or appliances"	***9***
Market actor interactions*	
HVAC contractor	2
Appliance or equipment retailer	4
Builder or developer of the home	4
Utility or Mass Save contact	1
Real Estate agent	1
Direction of market actor influence	
"Caused me to avoid electric equipment or appliances"	***1***
Market actor interactions*	
HVAC contractor	1

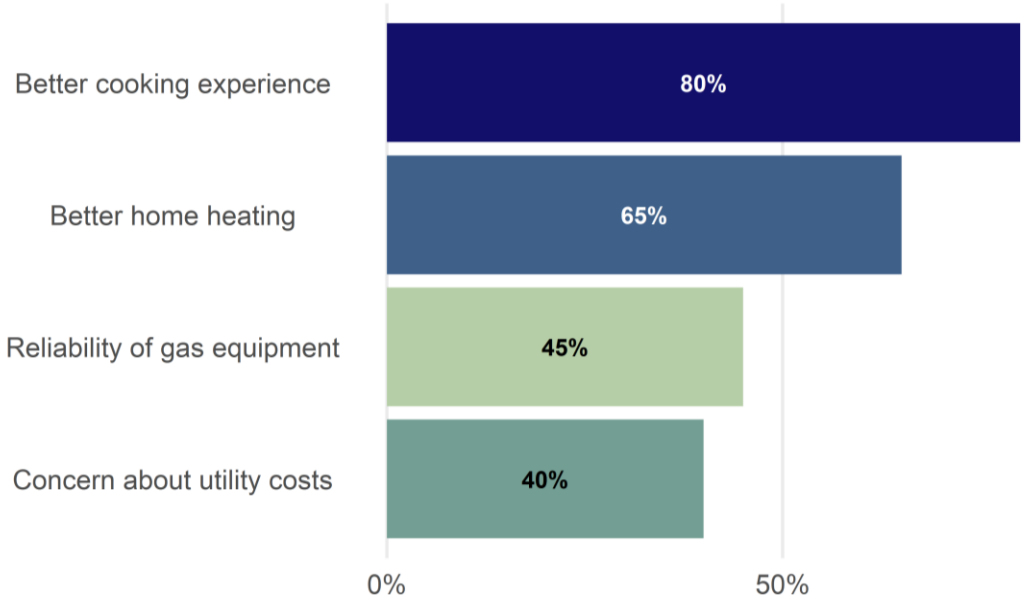
**Respondents could choose multiple market actor types if they interacted with more than one type during the homebuying process.*

Homebuyers like gas equipment, particularly for cooking, and market actors know it. Buyers of gas homes most commonly cited the gas cooking experience as a reason for wanting a home with natural gas service (Figure 1). Builders and real estate agents were nearly unanimous in reporting customer preferences for gas cooktops, and several respondents said that customers have expressed a desire for gas heating due to concerns about cold weather performance, operating costs, and familiarity. All five real estate agents reported customers rejecting homes during the buying process due to lack of natural gas hookups or propane tanks.

Several HERS raters suggested that gas fireplace inserts were a sticking point for customers that lacked appealing electric alternatives.

Figure 1: Homebuyer Rationale for Pursuing Natural Gas Availability

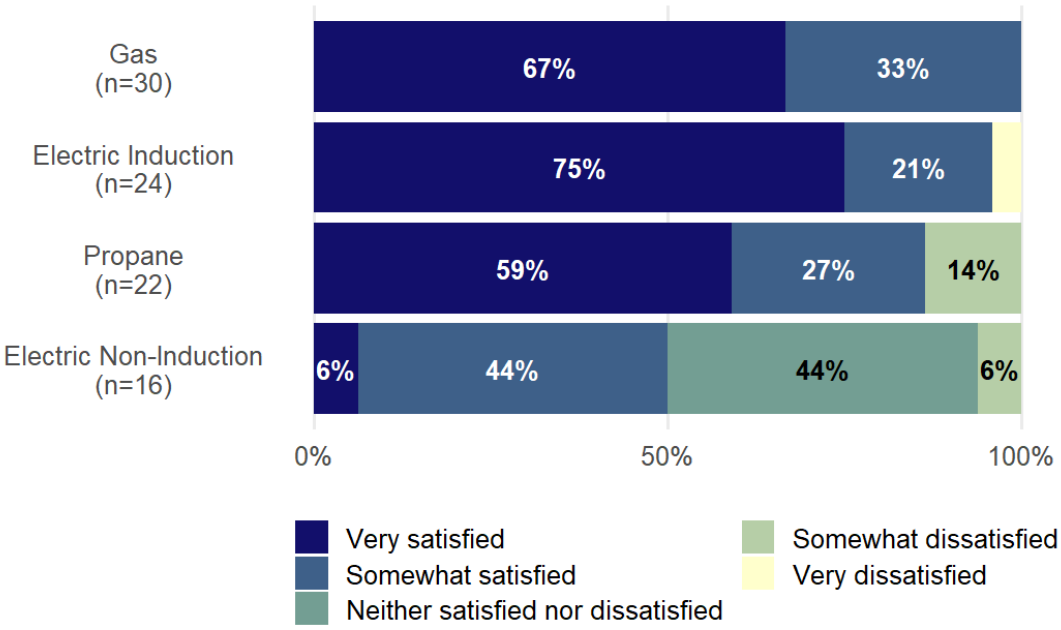
Base: Homebuyers with natural gas preference at time of purchase (n=20, multiple selections allowed)



While gas cooking is popular, the induction stove users we surveyed are highly satisfied. Despite this consensus around customer preference for gas cooking, survey respondents who have used an induction cooktop were almost universally satisfied with their appliance (Figure 2). They were more likely than those with gas cooktops to be very satisfied with their experience. Eighty-three percent of those with an induction cooktop reported that the cooking experience was superior to using a gas cooktop. Satisfaction with gas cooktops is also high in the survey but these

findings show that those who choose induction will not have buyer's remorse and instead can provide momentum-building positive feedback.

Figure 2: Survey Respondent Satisfaction with Cooktop



The aesthetics of ductless mini-split heat pumps are a major barrier to electrifying space conditioning equipment, and using ducted configurations adds cost and reduces efficiency relative to ductless options (both due to duct losses themselves and due to ducted configurations having lower rated efficiencies than ductless variants). HVAC installers, builders, and real estate agents have heard negative feedback about the look of indoor MSHP blower units (also called *heads*). This was the most cited downside to heat pump equipment when compared to traditional forced air gas systems. All five real estate agents reported getting complaints about the aesthetics of MSHPs. This issue is especially relevant to spec builders, who are unwilling to risk alienating buyers by installing systems they fear people will not accept. Ducted MSHP systems can address homebuyer concerns about aesthetics, but these installations increase cost and decrease the efficiency of the system. While locating all ducts in conditioned spaces will avoid an efficiency hit from duct losses, the rated efficiency of ducted mini-split configurations is typically lower than ductless configurations. Avoiding the need for duct work was one of the more common benefits given for typical MSHP installations. Ductless, floor-mounted or ceiling-mounted blower units are

"It's a fear structure to me, I build what I believe they know and understand. I use paint colors that they know...everything has to be so that there's no objection to the buyer so that when they see my product, they're comparing it as much apple to an apple as is realistic."
– Low Volume Builder 1

two distribution options that can limit aesthetic objections while avoiding ductwork. Floor-mounted blower units can be hidden behind furniture and present in a similar way to steam radiators that many in New England grew up with.

Builders will typically default to propane equipment when natural gas is not available, and homebuyers seem accepting of that approach. Builders and developers interviewed for this study overwhelmingly favor gas equipment. Those who work in areas without natural gas service default to the same equipment types fueled by propane. Additionally, homebuyers in the delivered fuel group were even more likely (55%) than natural gas homes (42%) to express a belief that fossil fuel homes generated lower utility bills than all-electric homes (**Error! Reference source not found.**), suggesting that the buyers would generally support builders selecting propane equipment over all-electric counterparts. A majority of delivered fuel homebuyers reported a perception that purchase costs of fossil fuel homes were either similar (29%) or lower (29%) than an all-electric home. While affordable natural gas is often mentioned as a confounding factor in the value proposition of electric homes, these findings suggest there is work to be done in educating the delivered fuel market on the economic arguments for going all-electric. Interviews provided little evidence that electric equipment is more heavily considered in areas not served by utility gas networks.

3.1.2 Financial Considerations

Market professionals do not see an economic case for choosing electrification measures. When discussing the advantages of gas equipment over electrification measures, affordability was the most common theme in interviews. Lower operating costs, better overall cost effectiveness, and lower upfront costs for gas equipment were all mentioned with relative frequency.[18] While many respondents understood that electrification measures are more energy efficient than gas systems, they believed the high price of electricity (and price volatility) can undermine these efficiency advantages.[19] Interviewees who brought up the cost of electricity as an issue did not propose solar as a solution, which suggests that there is work to be done in educating the market about the economics of on-site renewables. None of the builders interviewed had experience installing solar on their homes and opinions were split on whether they would consider it, though the new stretch and specialized opt-in codes may affect these decisions. Interview data were limited for the propane market segment but there was little evidence that market actors believe electricity provides operating costs benefits compared to propane.

Concerns about utility costs were expressed by the small subset of all-electric homebuyers who said they would not recommend all-electric homes to others. Five of the 21 all-electric homebuyers were not prepared to recommend all-electric homes to others. Of those five, three were undecided on endorsement and two said they would not recommend all-electric

[18] For overall cost effectiveness, respondents grouped multiple factors such as equipment costs, install costs, and operating costs.

[19] These interviews were conducted during a period of uncertainty in energy prices due to the conflict in Ukraine, but most responses were collected before the Fall 2022 announcements of electricity and gas rate increases by National Grid and Eversource in Massachusetts (Some interviews were performed after the National Grid rate increases were announced in September of 2022).

homes, and four cited issues with utility bills as a reason they would not recommend. Of these four homebuyers, only one was seeking an all-electric home at the time of purchase. The team identified nine survey respondents using solar panels based on open-ended responses (eight used electric heat—seven were all-electric—while one heated with delivered fuels) and only two of this group thought that all-electric homes provided lower utility bills than fossil fuel homes. We are unable to determine if these respondents were answering based on their experience prior to having photovoltaics installed or based on perceptions of utility costs in the absence of photovoltaics that came with the home.

3.1.3 Technical Concerns

Concern about the cold weather performance of heat pumps remains a barrier to installations in new homes. Sixty-five percent of natural gas homebuyers cited better home heating capabilities as a reason for wanting gas service at time of purchase, confirming that these concerns remain present in the marketplace (Figure 1). Some builders and installers remain suspicious of the ability of air source heat pumps (central or MSHP) to maintain temperature set points during the coldest days. Other builders and installers understand that advances in cold climate heat pump technology mean heat pumps can perform as a primary HVAC system but remain hesitant to choose them, knowing that some customers harbor concerns. About half of the surveyed gas and delivered fuel homebuyers thought that gas heated homes offered more comfort than electrically heated homes in extreme cold. Only 30% of gas and delivered fuel respondents thought gas and electric homes heated with equal effectiveness in extreme cold, and only 8% thought that electric homes offered superior heating performance (**Error! Reference source not found.**). After the completion of these surveys, New England experienced an extremely cold spell in early 2023; initial reports indicate that heat pumps performed well in most cases.[20]

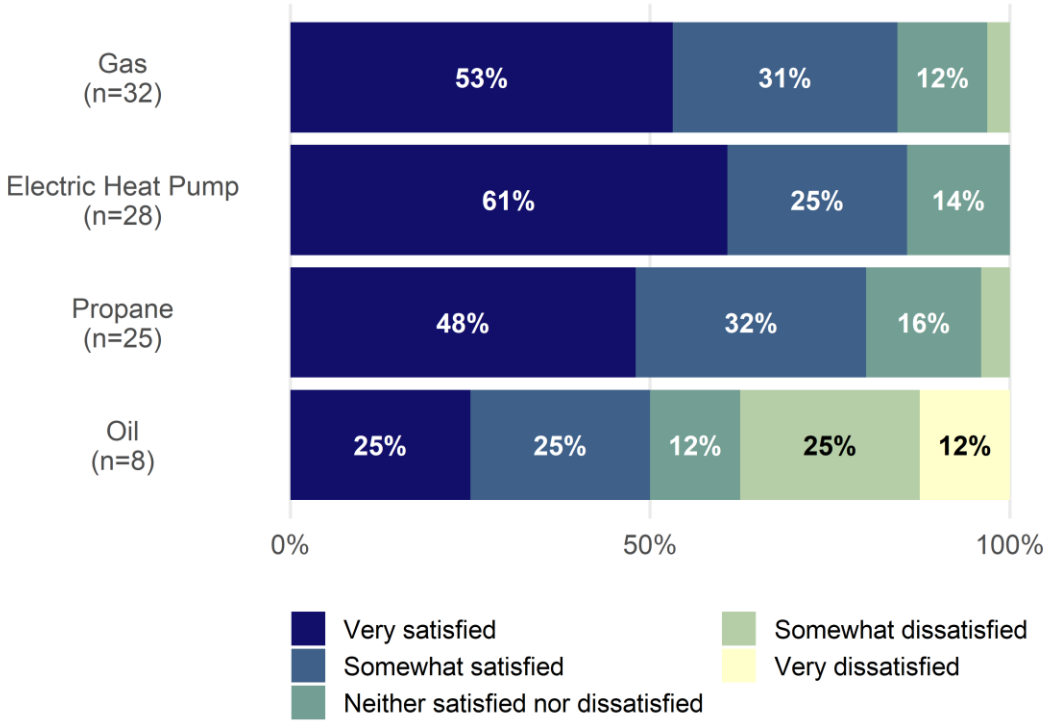
"On a cold day you're looking for the feeling of hot air on you. [Buyers] need to be assured that this will be available to them on the coldest day of the year. And that concern is not easy to change. Here in New England, it's hard to overcome that concern and it takes real effort to convince them that they will be fine." – Low Volume Builder

While some homebuyers and market actors remain concerned about the cold weather performance of heat pumps, survey respondents using heat pumps were more likely to be satisfied with their heating equipment than respondents using gas or propane (Figure 3). As with induction cooktops, this suggests that the actual performance of electrification measures will not serve as a barrier to further adoption. Negative perceptions about older electric equipment can

[20] Boston Globe, "Heat Pumps Had Their First Major Test Last Weekend. Here's How It Went." Feb. 8, 2023. https://www.bostonglobe.com/2023/02/08/science/heat-pumps-had-their-first-major-test-last-weekend-heres-how-it-went/

be a barrier to considering newer, more capable equipment; but advances in equipment performance are changing the conversation.

Figure 3: Satisfaction with Home Heating Equipment[21]



MSHP's most commonly cited benefit in interviews – room-by-room temperature control – was seen by some as a potential downside. Interviewees did not think the room-level control afforded homeowners by MSHPs would be viewed by everyone as a plus. Some interviewees preferred gas systems for their perceived ability to provide more even space conditioning across larger spaces and/or large numbers of rooms with simple operation. Other respondents noted that

[21] Two of the heat pump systems were geothermal (or ground source) heat pumps (GSHPs). One GSHP respondent was very satisfied with their equipment (this respondent indicated that they had solar panels installed) while the other was neither satisfied nor dissatisfied with the equipment.

rooms can be too small to merit dedicated MSHP heads and switching to a ducted MSHP configuration that can serve all rooms can increase heat pump installation costs.

"I think that that openness is probably something that works against the heat pumps…they're designed for a certain amount of space but with big open floor plans of 1,000 - 1,500 square feet, I think that would probably work against a heat pump design, just because it's harder to control."

"Huge Rooms. Big, large spaces are very difficult to control [with MSHPs]."

–Multiple Builders (Low and high-volume)

3.1.4 Gas Combustion and Indoor Air Quality

Homebuyers are aware that on-site fossil fuel combustion impacts air quality, but there is little evidence this is influencing purchase decisions. Most homebuyers using natural gas and propane believed that all-electric homes provide better indoor air quality than homes using gas or propane (**Error! Reference source not found.**). This suggests that homebuyers likely do not view the air quality impacts of combustion as severe enough to outweigh existing equipment preferences, but it is noteworthy that so many gas homebuyers were sufficiently aware of the issue to assert that all-electric homes fared better on this metric. News outlets are driving more awareness of these issues by covering studies from the Rocky Mountain Institute and others.[22] It is not yet clear if this information will be effective in influencing buyer decision making. No interview respondents mentioned customers voicing concerns about the health effects of using gas in the home (and just two interviewees mentioned it as a downside to gas equipment). Leveraging data on the full impacts of gas combustion on indoor air quality represents one avenue to altering the status of gas equipment as the equipment choice with less downside.

3.1.5 Water Heater Considerations

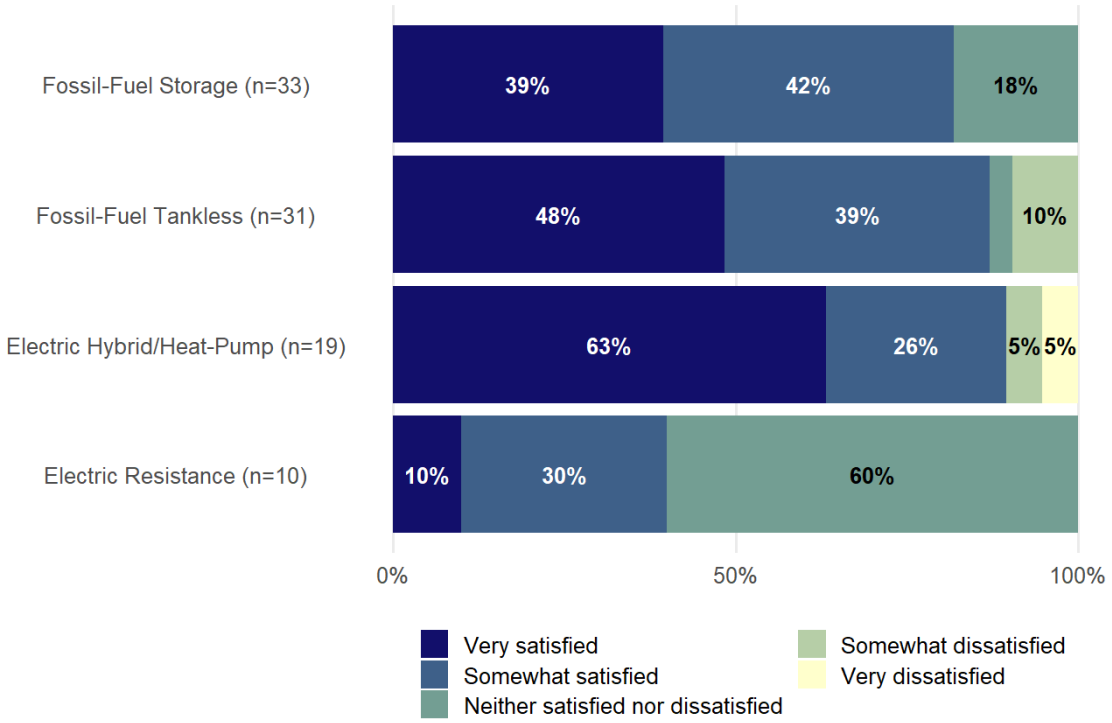
HPWH experiences are limited, and some misconceptions persist, but users are largely satisfied. While a preference for gas cooking may be a common roadblock to electrification, there were several homes that were fully electrified except for their water heaters (domestic hot water or DHW equipment). Interviews indicated that, like with heating and cooking equipment, many professionals prefer to use gas equipment and pivot to propane alternatives where natural gas is unavailable. Interviewees had limited experience with heat pump water heaters. One builder used HPWHs frequently but reported installing a gas supplemental system in larger homes. One HVAC contractor reported that HPWHs rely on their electric resistance heating element so often that they prefer to just purchase a cheaper electric resistance water heater when not using gas.

In contrast, the few survey respondents who used HPWHs were largely satisfied with them, comparing favorably to those using gas or propane equipment (Figure 4). The one homebuyer who was very unsatisfied cited the lag in getting hot water at the tap and the noise the machine makes when refilling the hot water tank. While noisiness is a known attribute of some HPWH equipment, a lag in hot water availability at a faucet far from the water heater does not indicate a

[22] See this article in the Boston Globe and this New York times article from last year as examples.

problem with the water heater; that is likely a plumbing issue that may occur regardless of equipment.

Figure 4: Satisfaction with Water Heating Equipment



3.1.6 Additional Observations

3.1.6.1 HVAC Contractor Training and Capacity

While five respondents mentioned a lack of HVAC installer experience and capacity to take on new work as downsides to choosing heat pumps, these issues were less of a focal point than expected given the discussion of HVAC contractor populations in articles and reports from around the country. [23] One builder reported HVAC installers as the trade partner where they are seeing the biggest increase in costs, which in their view has outpaced labor and material cost increases. Opportunistic installers who understand that there are capacity constraints among their peers can

"We're seeing increases that are what we believe are more sort of 'smash and grab' more than really driven by labor or material cost increases. HVAC is one of the trade partner areas that we have the biggest challenges [with] and most have raised their prices 50% from a year and a half ago. We do know what equipment costs are—we have accounts with the same suppliers that they buy from." – Low Volume Builder

[23] As an example, refer to the barriers discussion in the recent ACEEE Study on barriers and strategies for residential electrification: Ready to Upgrade: Barriers and Strategies for Residential Electrification | ACEEE. Locally, an opinion piece in the Boston Globe chronicled the difficulties in reaching HVAC installers using the Mass Save Heat Pump Installer Network Portal.

charge more for heat pump installations knowing that customers have fewer options and that large rebates are available.

3.1.6.2 Capacity of the Electric Grid for Electrification

Interview respondents of all types raised concerns about the pressure that a higher volume of electrification measures can place on the grid. Some respondents questioned if the grid could support more all-electric homes. One HERS rater thought that doubts about grid capacity could be affecting the degree to which electrification measures are chosen by builders. One builder raised the possibility of increasingly common extreme weather threatening grid integrity, making electrification measures less appealing (though this ignores the need for electric service to operate modern gas equipment).

3.1.7 Summary of Market Actor Feedback on Gas and Electric Equipment

Table 8 quantifies interviewee feedback on the benefits and drawbacks of traditional gas equipment and Table 9 provides the same information for electrification measures. For these questions, interviewees were provided examples of what we considered "traditional" gas equipment (e.g., furnace and central air conditioner combinations, natural gas or propane cooktops, and gas water heaters) and electrification measures (e.g., MSHPs, HPWHs, induction cooktops). Typically, respondents answered for equipment they had experience with or were more aware of; some of these responses are specific to MSHPs or ducted fossil fuel systems while others may be more general observations. In the tables, the counts show the number of respondents in each market actor category who mentioned a given benefit or downside. We highlight numbers in bolded, green text when a benefit or drawback was mentioned by at least a third of the respondents in a group.

Table 8: Benefits and Drawbacks of Traditional Gas Equipment

Source: (Interviews)

Benefits of Traditional Gas Equipment					
Benefit	Builder (n=10)	HVAC Contractor (n=9)	HERS Rater (n=5)	Real Estate Agent (n=5)	Total (n=29)
Familiarity	3	3	**4**	0	**10**
Overall cost effectiveness	1	2	1	4	**8**
Low/stable operating cost	**5**	1	1	1	**8**
Lower upfront costs	1	**4**	1	1	**7**
Cold weather reliability	2	2	1	1	**6**
System reliability (general)	0	1	1	3	**5**
Low install costs/ease of installation	2	1	1	0	**4**
Even heat in large spaces/lots of rooms	2	2	0	0	**4**
No benefits	1	1	0	0	**2**
Parts availability	0	1	0	1	**2**
Resilience of gas in storms/outages	1	0	0	0	**1**

Aesthetics (hidden ducts)	1	0	0	0	**1**
Downsides of Traditional Gas Equipment					
Downside	**Builder (n=10)**	**HVAC Contractor (n=9)**	**HERS Rater (n=5)**	**Real Estate Agent (n=5)**	**Total (n=29)**
No downsides	3	**3**	1	1	**8**
Cost of adding a duct system	3	0	0	0	**3**
Large equipment and ductwork	3	0	0	0	**3**
Less granular control with central unit	1	2	0	0	**3**
Less efficient than heat pumps	0	1	**2**	0	**3**
Higher operating costs	0	2	0	0	**2**
Air quality/safety	0	0	1	1	**2**
Placement issues (attics and ice dams)	1	0	0	0	**1**
HE versions less reliable than older versions	0	1	0	0	**1**
Sizing issues (oversized)	0	0	1	0	**1**
Safety (combustion danger)	0	0	0	1	**1**

Table 9: Benefits and Drawbacks of Electrification Measures

Source: (Interviews))

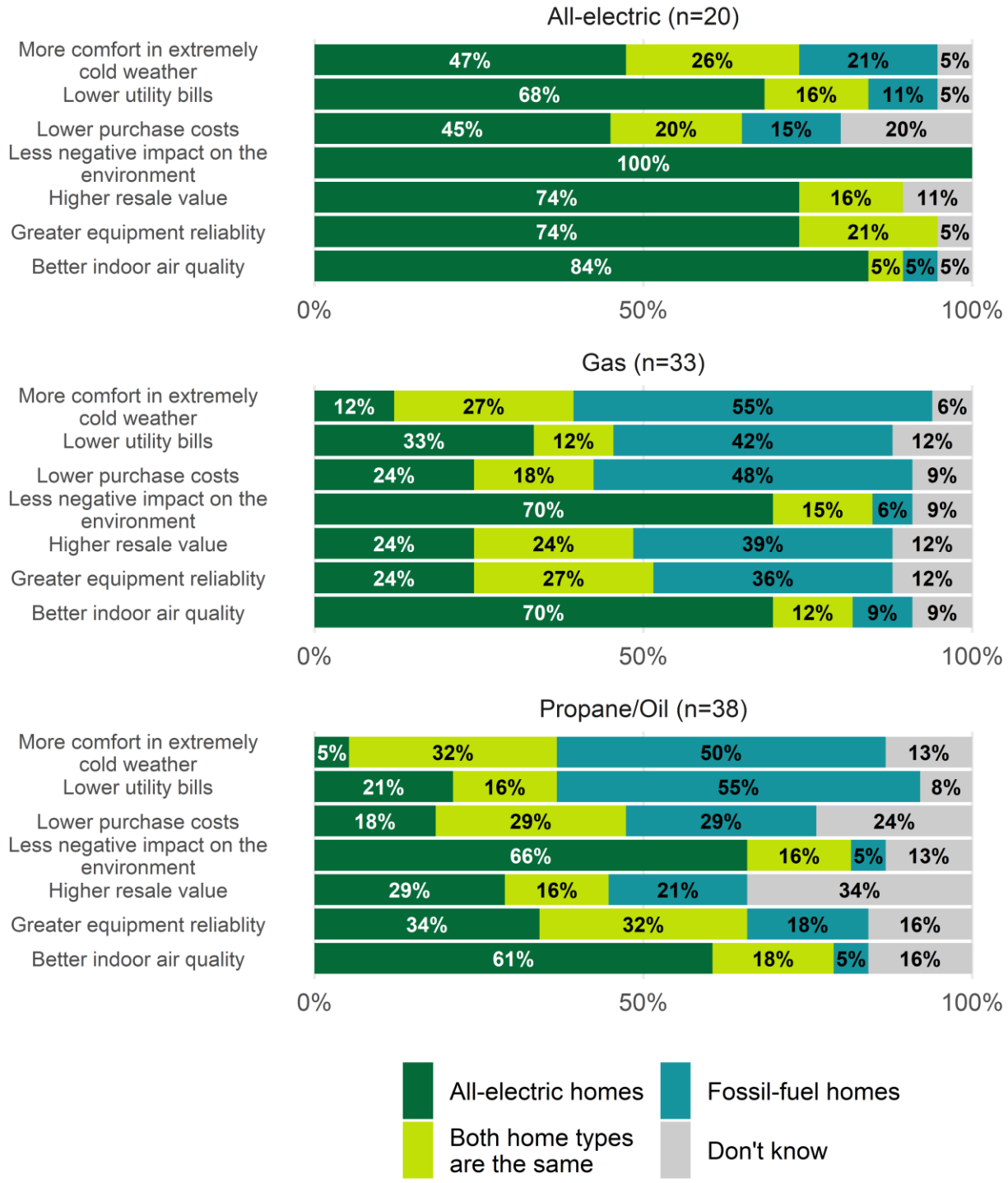
Benefits of Electrification Measures					
Benefit	Builder (n=10)	HVAC Contractor (n=9)	HERS Rater (n=5)	Real Estate Agent (n=5)	Total (n=29)
Granular, room-by-room control	3	**6**	1	**2**	**12**
More efficient than gas equipment	3	**5**	1	1	**10**
Simple install (no ducts or gas lines)	2	**4**	1	0	**7**
Safety (no combustion)	2	0	1	1	**4**
Access to high rebates	1	0	**2**	0	**3**
Potential for lower operating cost	1	0	1	1	**3**
No benefits	2	0	1	0	**3**
Good for smaller spaces	2	0	0	0	**2**
Heating and cooling in one	0	1	0	0	**1**
Solar can offset costs	0	0	0	1	**1**
Simple (less to break)	0	0	0	1	**1**

Downsides of Electrification Measures					
Downsides	**Builder (n=10)**	**HVAC Contractor (n=9)**	**HERS Rater (n=5)**	**Real Estate Agent (n=5)**	**Total (n=29)**
Aesthetics (indoor MSHP heads)	3	2	0	**4**	**9**
Doubts about cold weather performance	**4**	2	1	**2**	**9**
Utility costs (total and volatility)	**4**	1	**2**	1	**8**
No downsides	0	2	**2**	1	**5**
Lack of expertise/capacity among installers	3	2	0	0	**5**
Equipment costs	3	1	0	0	**4**
Lack of market demand	1	0	0	1	**2**
Supply chain issues	0	2	0	0	**2**
Lack of familiarity in the market	0	0	1	1	**2**
Uneven heat in large spaces/more rooms	2	0	0	0	**2**
Warranty issues	1	0	0	0	**1**
Trained installers can charge more	1	0	0	0	**1**

All-electric homeowners favor their home type, but particularly for air quality and environmental impact, many gas homebuyers still provide positive opinions of all-electric homes. Figure 5 presents surveyed homebuyers' opinions on the advantages of all-electric and gas homes, organized by their primary fuel grouping (all-electric, natural gas, and propane/oil). Respondents were asked to choose if all-electric or gas homes performed better on certain attributes, including cold weather comfort, purchase costs, resale value, and environmental impacts, or if there was no difference in the two home types. For a given home attribute, a larger dark blue portion on the left of the chart shows more homebuyers favor all-electric homes while a larger light green portion on the right represents more votes for gas homes. The findings quantify the relative attitudes about electric and gas homes among homebuyers who live in those different types of homes.

The team also ran this analysis grouping respondents by primary heating fuel. For that analysis, we added the seven homes to the electric group that use gas for cooking and/or water heating (the primary classification for these homes was natural gas or delivered fuel because they used that fuel onsite for at least one end use). This subset of buyers may be enthusiastic about electrification measures like heat pumps but not prepared to give up gas entirely. Expanding the first group Figure 5 in to include electrically heated homes also using fossil fuels for another end-use does little to dampen the enthusiasm that group demonstrated for electrified homes.

Figure 5: Homebuyer Comparisons of All-electric and Gas Homes



Section 4 Interview Feedback on Solutions to Electrification Barriers

The study asked interviewees for their thoughts on how to increase the adoption of electrification measures in the Massachusetts RNC market. This feedback, along with survey data and the results of the literature review, informed the development of program considerations presented earlier in the report. Interviewees who see the benefits of electrification measures frequently cited the need for more education across the market on the capabilities and benefits of those systems. Given the diversity of responses collected in interviews and the inconsistency around topics like cold climate performance, installation costs, and system complexity, it is clear that numerous knowledge gaps remain in the market. The survey findings on homebuyer interactions with market actors regarding electrification measures suggest that those market actors with proper awareness of electrification measures can effectively influence customers to seek those equipment types out when buying or building a new home.

4.1.1 Training and Education

Interviewees reported that there is much work left to be done educating the market about the capabilities and benefits of electrification measures. Several respondents suggested dedicating more resources to advertising and educational campaigns aimed at homebuyers. Builders were frequently identified as priorities for educational outreach on the benefits of heat pump systems given their decision-making role in spec home construction and their influence in the custom home market. Based on their feedback in interviews, spec builders need to see signals from the market that electrification measures would be accepted by a typical buyer showing up to an open house – these pieces of equipment need to be palatable and appealing to the broader market, not just those committed to electrification.

Builders and developers suggested educational seminars providing data on the cost effectiveness of electrification measures and guidance on how to implement these measures within their traditional home designs. This type of forum is one option for introducing builders to the findings from the Energy Optimization work being funded by the PAs. Respondents also suggested linking equipment manufacturer representatives to builders and developers to expose more market actors to existing training and education geared toward professionals. The educational seminars suggested above could facilitate these interactions as well.

Another suggestion aimed at builders, developers, and HVAC contractors is providing experiential case studies of heat pump installations in new homes. These training visits provide an opportunity to understand the installation process and how the equipment functions in the home before committing to using it. Viewing installations in progress may not be realistic if installers are not comfortable with competitors gaining insight from their work, but post completion case studies can be facilitated by offering additional incentives to homebuilders who participated in the RNC program and had heat pumps installed.

> *"Invite [us] to a training or a tour of a house that has [electrification measures] installed for us to see them working and to see what the draw is from the panel. Prove that it can be an efficient and financially beneficial solution. It's hard to get people to go look at something, they don't have much extra time. So maybe we can pay them a little to get them out to a case study. They want to see them working, how it gets mounted, understanding the nuts and bolts. Does the unit rattle? Can you put units up in the ceiling, and how do they fit into the floor joists?"* ***–Low Volume Builder***

Interviewees also proposed expanded training opportunities for HVAC installers as a solution to increase market adoption. One suggestion was for Mass Save to dedicate more resources to linking contractors to existing HVAC installer certificate programs offered by government agencies, educational institutions, or manufacturers. Another interviewee reported a perception that residential HVAC installers are not required to be licensed in the same way that electricians and plumbers are, and this can yield more variability in experience and quality of work. While Mass Save has certification requirements for inclusion in their Heat Pump Installer Network, several respondents said that enhanced training requirements to be considered a 'recommended' installer may yield improved outcomes for customers. .

4.1.2 Alleviating Electrification Costs

Several interviewees suggested that electric distribution companies need to ease concerns held by ratepayers about volatility in electric prices and the capacity of the grid to handle more electric equipment in homes. The cost of electricity was mentioned frequently as a downside to choosing electric equipment, and interviewees raised doubts about the readiness of the grid for an electrified building stock. Rate increases impacted many Massachusetts customers in late 2022 will only increase the importance of this issue moving forward. Electricity rates jumped by a greater percentage than gas rates for many customers, which may exacerbate existing concerns about the ownership cost gap between gas and electric homes.

Interviewees also pointed out a need to address supply chain issues to lower upfront costs of heat pumps and ease concerns about parts availability. Several HVAC contractors reported issues with equipment availability in Massachusetts over the last few years. Many supply chain issues originate well beyond the reach of program administrators, but where possible they can connect with distributors through midstream interventions that incentivize stocking of heat pumps so long as manufacturers are able to supply them.

4.1.3 Electrification and Code Compliance

One HERS rater suggested using the new Massachusetts energy code as an opportunity to boost heat pump adoption by educating more builders on the efficiency advantages of heat pumps for achieving lower HERS scores. This could be integrated into code compliance training in conjunction with energy optimization research on cost effective construction and equipment packages that achieve code requirements. In municipalities that plan to adopt the Specialized Opt-In code, electrifying the home removes several requirements (lower HERS Index score, rooftop PV) that would otherwise be placed on homes designed to use gas.

Appendix A Respondent Details

A.1 Interview Respondents

This section provides an overview of details about interview respondents, including the volume of work they conduct in the Massachusetts RNC market and where they work (Table 10). HERS raters are not included as they each reported working across the state.

Table 10: Geographic Coverage of Interviewees†

County	HVAC Contractor	Builder/ Developer	Real Estate Agent*
Barnstable		1	
Berkshire	1		
Bristol		1	1
Essex	3	1	
Franklin	1		
Hampden	1		
Hampshire	1		
Middlesex	1	5	1
Norfolk		1	1
Plymouth	1		1
Suffolk			1
Worcester		1	

**One Real estate agent described their coverage area as encompassing most of the state.*

†None of the interviewees worked in Dukes or Nantucket Counties.

Eight respondents in the builder/developer group worked on a small number of new homes, building between one and six per year. The remaining two were larger operations working on between 30 and 55 homes per year. HVAC contractors were also split between lower and higher volume companies—five contractors performed installations in less than 15 new homes per year and four performed 30 or more RNC installations in a typical year. Three real estate agents sold between 15 and 25 new homes per year and the remaining two reported about 5 sales in the last year with some variability year-over-year. Each HERS rater performed a large volume of ratings, not surprising given the use of HERS ratings for code compliance and high RNC program penetration.

Builders performed most of their work in stretch code towns. When asked about the efficiency levels they build to, several reported that they aimed to perform comfortably beyond code HERS Index requirements, though none had attempted a Passive House or Net-Zero project. Builders most often reported building on spec, including low-volume, high-cost spec homes.

A.2 Survey Respondents

A.2.1 Participation Status of Survey Respondents

Just over a quarter of survey respondents were confirmed as program participants through name and address matching against RNC Program tracking data. Our team ran several comparisons of participants and non-participants, but when splitting by home fuel usage or equipment type, the sample sizes on the participant side were low enough to make meaningful comparisons difficult. For example, we found that participants and non-participants registered similar levels of satisfaction for equipment like cook type and shared similar opinions on the benefits of all-electric homes compared to gas homes, but many of these categories included responses of just three to five participating respondents. The prevalence of delivered fuels was high among participants—this could be a combination of small sample size quirks and a sampling strategy that included heavy outreach to homes showing no utility natural gas usage to oversample increase survey completes among all-electric homes.

Table 11: Participation Status of Survey Respondents

Participation Status	n	Percent
Program participant	25	27%
Program non-participant	68	73%

Fuel Type by Participation Status	Participants	Percent	Non-Participants	Percent
All-Electric	5	20%	16	24%
Electric Heat + Other	2	8%	5	7%
Gas	5	20%	27	40%
Propane/Oil	13	52%	20	29%

A.2.2 Homebuyer Equipment

The following tables summarize the equipment types found in homes of survey respondents, who were recent purchasers or new homes in Massachusetts.

Table 12: Home Heating Equipment

Heating Type and Fuel	n	Percent
Natural gas furnace	27	28%
Air-source heat pump (central or ductless heat pumps)	26	27%
Propane furnace	23	24%
Natural gas boiler	8	8%
Oil boiler or furnace	8	8%
Ground-source heat pump (geothermal)	2	2%

Propane boiler	2	2%

Table 13: Home Water Heater Type

Water Heater Type and Fuel	n	Percent
Natural gas storage tank	24	25%
Propane tankless	20	21%
Electric hybrid/heat pump	19	20%
Natural gas tankless	11	11%
Electric resistance storage tank (not hybrid/heat pump)	10	10%
Oil (indirect or traditional storage)	6	6%
Propane storage	6	6%

Table 14: Home Cooktop Details

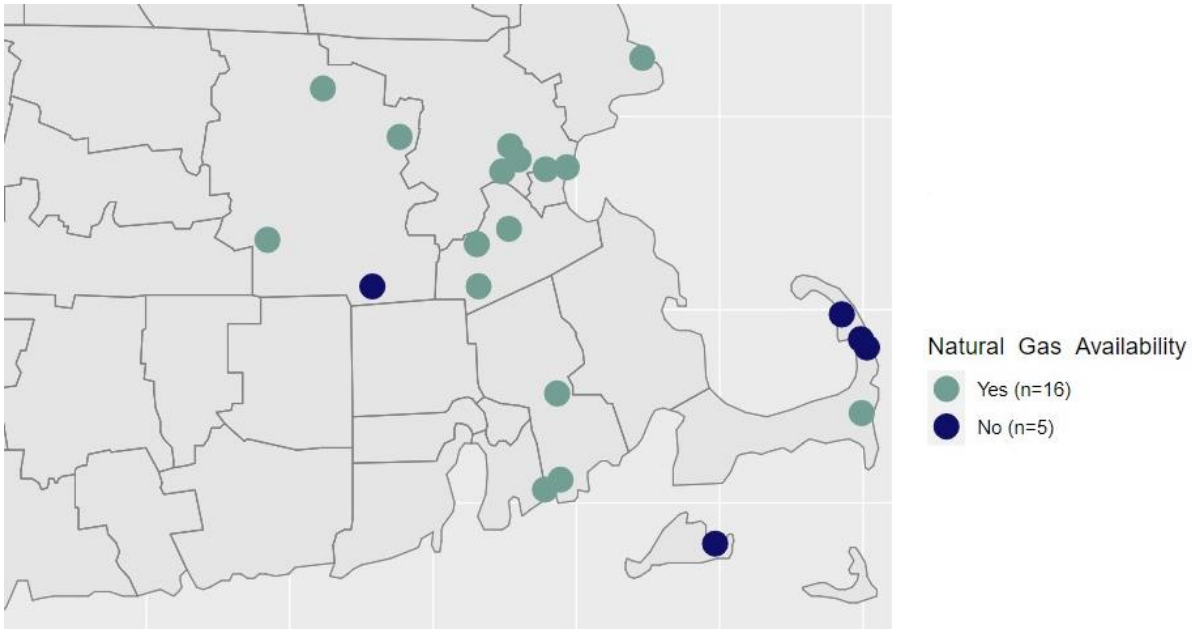
Cooktop Type and Fuel	n	Percent
Natural gas	34	35%
Electric induction	24	25%
Propane	22	23%
Electric resistance (not induction)	16	17%

A.2.3 All-electric Homes and Natural Gas Availability

The figure below shows roughly where in the state all-electric homes were located and if there was natural gas availability in each jurisdiction. Note that the availability of natural gas in a city or

town does not always guarantee that a specific new home or development can access the distribution network.

Figure 6: Natural Gas Availability for All-Electric Survey Respondents



Appendix B Literature Review Summary

The study included a literature review of evaluations and research regarding RNC electrification barriers from markets outside of Massachusetts. The team presented slides to the PAs as an early study deliverable. The results informed the design of the interview and survey instruments included in Appendix C.

MA21R44 RNC Electrification Barriers Literature Review

Summary of Key Takeaways

Matt Woundy

March 3, 2022

NMR Group, Inc.

Regions and Organizations Covered

- MA, New England, CA, NY, CO, MN, and publications with national scope
- NYSERDA, NEEP, CA Utilities/New Buildings Institute, Sierra Club, Emerald Cities Collaborative, Urban Sustainability Directors Network, Greenlining Institute, Synapse Energy Economics, Rocky Mountain Institute, ACEEE

Literature Review Findings: Market/Regulatory Issues

- Cost effectiveness/return on investment issues where fossil fuel prices are low and electric prices are high
  - Lower electric use may not create operational savings relative to gas use
  - High electric bills from previous home can scare off customer from electric NC
- Phasing out of HFC refrigerants (planned in CA, WA)
  - If MA follows, could limit equipment selection and drive prices up
- Customers interested in electrification need help finding trained professionals
  - The chosen contractor can be the deciding factor on heating/water heating equipment type
  - Lack of searchable contractor databases

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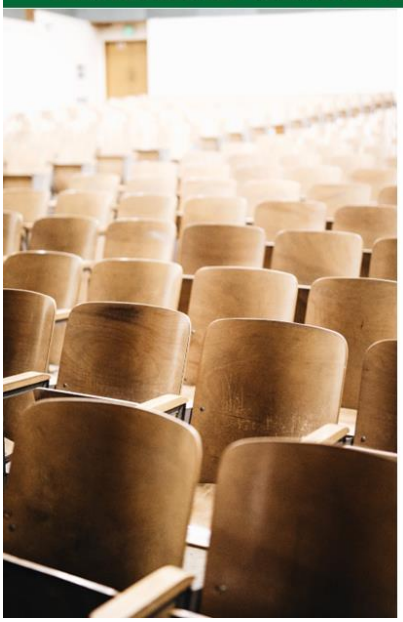
Customer Awareness and Education



- Lack of customer awareness and education is a common barrier across equipment types
  - Knowledge/awareness gaps persist across topic areas (costs, health and safety, reliability)
  - Lack of awareness-building efforts targeted at general population

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Customer Attitudes and Awareness

- Some customers believe gas heating offers resiliency benefits over electric (e.g., rign blackouts).
- Negative associations with electric resistance technology
- Customer familiarity with gas cooking
  - Induction stoves considered expensive (unit itself and new pans)
  - Some prefer open flame cooking
- Successful marketing of gas as a “clean energy” solution
- Homeowners valuing aesthetics over efficiency
  - Could impact choice of electric equipment if upfront costs are higher (ASHP vs. furnace/CAC + better countertops)

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Supply-Side Market Actors

- Contractors are key influencer in equipment decisions
  - Willing to work with HPs, or stuck on familiar?
  - Bandwidth to learn new tech/installation methods
  - Installation quality a key determinant of performance
  - Most MA contractors interviewed for EO installed MSHPs, but were split on reliability and simplicity of install
- Spec builders assume gas is more marketable than electric (cooking, fireplaces)
- Distributor stocking practices can impact costs and contractor behavior
  - May be less of an issue in MA

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Cold Climate Performance

- Perceptions about cold climate performance
  - Lack of awareness of performance improvements over time
    - EO modeling showed even small HPs can meet heating loads with minimal backup heating in coldest days of winter in optimized homes
  - Contractor reluctance to recommend HPs in cold climates
  - Backup systems and integrated controls create new opportunities for poor user experience, customer callbacks
    - More customer callbacks on integrated controls may limit contractor recommendations later

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HPWHs

- Concerns about cooling space if installed in conditioned area
- Space and aesthetics can favor tankless systems
  - Space availability (e.g., no garage or basement)
- Perceptions of noisiness can impact decision depending on location

HP Dryers

- Expensive relative to other options
- Low customer awareness
- Longer drying time than traditional systems
- Limited availability for typical capacities

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Equity and Cultural Issues

- Choosing electric equipment can be difficult for lower-income groups where gas costs are low and up-front costs matter more
  - Use of gas stoves for home heating in electrically heated homes due to high costs of electricity
- Gas cooking can hold significance in terms of family traditions, rituals, etc.
- Environmental justice community advocates may lack capacity to effectively engage in electrification program planning

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Other Issues and Considerations

- Induction and pacemakers
  - Older literature suggests slight risk under very specific scenarios
  - Web searches show inconsistent messaging on current risks, if any
- Limited evidence on importance of gas fireplace inserts, or of preferred alternatives
  - Some spec builders may assume gas fireplaces are attractive

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Topics for IDI/Survey Research: Contractors/Builders	Topics for IDI/Survey Research: Homeowners and Realtors
• Equipment familiarity • Existence and magnitude of barriers in MA market • Type of equip. recommendations made, how they vary by scenario • Logic behind equip. recommendations • Equipment and parts availability	• Awareness of and attitudes toward electrification measures • What homeowners look for in new construction • Experience with electric equipment in new homes • How best to market electrification to diverse customer base

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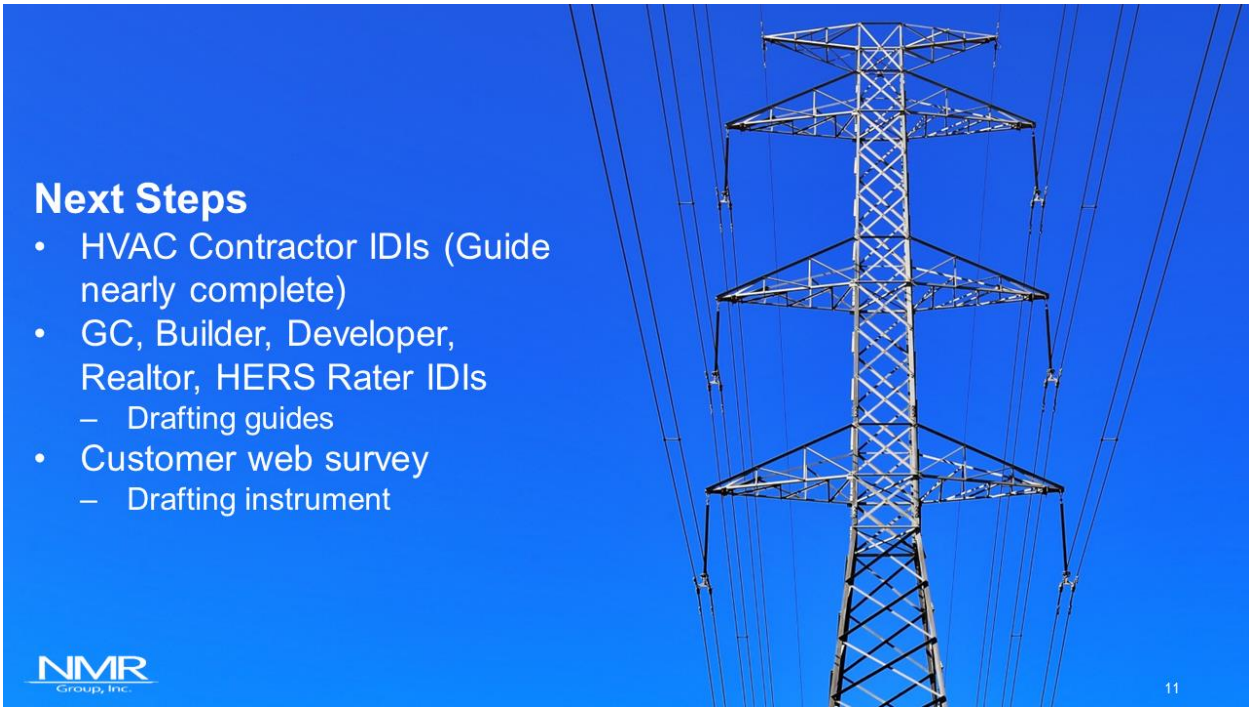

Appendix C Data Collection Instruments

C.1 Homebuyer Survey

This homebuyer survey will quantify real and perceived behavioral and informational barriers to electrification from the perspective of recent new construction homebuyers. We plan to conduct a web survey of 70 to 100 homebuyers, depending on the number needed to fill desired strata. We are targeting 30 to 60 completes from recent all-electric homebuyers and 40 to 70 completes from recent fossil-fuel homebuyers. Respondents will receive a $50 e-gift card for completing the survey, which can be redeemed at a retailer of their choice, in the form of a VISA gift card, or the amount can also be donated to a charity of their choice.

Table 15 maps the research topics included in the Work Plan to the relevant survey questions.

Table 15: Study Research Topics and Corresponding Interview Question(s)

Research Questions	Interview Question
Depth of understanding among all-electric homebuyers and those who may have some electrification measures on how to use the equipment alone or with integrated back-up heating systems	Identify their equipment types: 1, 5, 9,13,17,18,24,27,40,41
Perceptions of and confidence in status-quo versus electrification measures, including benefits and drawbacks; specific questions will probe on health, safety, comfort, system noise, resale value, performance, and installation and other associated costs	Satisfaction with their electric equipment: 2,3,4,6,7,8,10,11,12, 14,15,16,19,20,21,38,39,42,43 Homebuyer opinions on electric vs conventional equipment: 22,23,25,26,27,28,29,30,31,32,33,34, 35,36,37
Degree to which their contractor, builder, real estate agent, or developer discussed or offered electric appliances, space heating, and water heater equipment	Market actors who mentioned electric measures: 44,45
Type of information contractors, builders, or developers shared on the short- and long-term cost-effectiveness, climate, environmental, and societal benefits of electrification	Type of information shared: 46a,b,c Influence of this information: 47
(Supplemental, not in workplan) Self-directed research on equipment and appliances	Do homebuyers do their own research: 48 Sources of information: 49

C.1.1 Introduction

[Note to reviewers: the introduction page of the survey will have Mass Save and Mass Save Sponsor logos]

Thank you for your interest in participating in our survey for recent homebuyers in Massachusetts. The Sponsors of Massachusetts' Mass Save® energy efficiency programs have contracted with NMR Group to conduct this survey. Your participation will help the Mass Save sponsors continue to offer high-quality programs that improve the energy efficiency of homes in Massachusetts.

If you qualify and complete this survey by **[DATE],** NMR Group will send you an electronic $50 gift card that you can redeem for vendors of your choice or as a VISA gift card. The survey should take about 20 minutes to complete. You can stop and return to the survey at any time. Your responses will be saved for you to pick up where you left off. All your responses are completely confidential and will be aggregated with all the other responses in this study.

If you have any questions or would rather complete the survey over the phone, please contact NMR Group at [EMAIL] or [PHONE].

C.1.2 Screening Questions

S1. Our records indicate that you purchased or built a newly constructed home at [ADDRESS] in the last five years. Is that correct? [SINGLE RESPONSE]

a. Yes [SKIP TO S3]

b. No, I did not purchase or build a newly constructed home in the last five years. [SKIP to TERM]

c. No, I purchased or built a newly constructed home in the last five years but at a different address.

S2. Please enter the address of the most recent home you purchased or built:

a. Street (number and name): [open end]

b. City: [open end]

c. State: [open end] [IF State ≠ Massachusetts or MA, SKIP to TERM]

d. ZIP: [ZIP FORMAT]

S3. Which of the following best describes your home? If you purchased or built multiple homes in the past five years, please answer all questions in the survey for your most recent home. [SINGLE RESPONSE]

a. A detached single-family home (a home that does not share a wall with any other homes)

b. An attached home that shares a wall with at least one other home, but has its own utilities, and no other homes above or below it.

c. A unit that has another home above or below it in a building with 4 units or less.

d. A unit in a building with 5 units or more. [SKIP to TERM]

S4. Is this home your primary residence?

a. Yes

b. No

S5. Are you involved in making decisions about the home, such as making major purchases of appliances?

a. Yes

b. No

S6. Does your home have a connection to utility natural gas (from a line that runs to your home from the street)?

a. Yes

b. No

S7. Does your home have a propane tank (excluding small units for outdoor gas grills or tiny tanks for camping) located on the property?

a. Yes

b. No

[TERM. Thank you for your interest but unfortunately you do not qualify for this survey.]

C.1.3 Current Heating and Cooling Equipment

As a reminder, all the following questions should be answered about the **most recent new home you had purchased or built in the last 5 years** in Massachusetts.

1. Which of the following is your **primary** heating equipment in this home? [SINGLE RESPONSE]

a. Natural gas furnace

b. Natural gas boiler

c. Propane furnace

d. Propane boiler

e. Electric air-source heat pump (central heat pump or mini-split heat pumps)

f. Electric ground-source heat pump (also known as a geothermal system)

g. Other please specify: [open end]

2. How satisfied are you with your **primary** home heating equipment**?**

a. Very satisfied

b. Somewhat satisfied

c. Neither satisfied nor dissatisfied

d. Somewhat dissatisfied

e. Very dissatisfied

3. [IF 2=a] Why are you very satisfied with your primary home heating equipment? [OPEN END]
4. [If 2=e] Why are you very dissatisfied with your primary home heating equipment? [OPEN END]
5. What is the **primary** air conditioning equipment used to cool your home?
    a. Central air conditioner
    b. Air-source heat pump (central heat pump or mini-split heat pumps)
    c. Ground source heat pump (also known as a geothermal system)
    d. Non-permanent air conditioner (window, wall, or free-standing unit)
    e. No air conditioning is used
6. [IF 5≠e] How satisfied are you with your **primary** home cooling equipment**?**
    a. Very satisfied
    b. Somewhat satisfied
    c. Neither satisfied nor dissatisfied
    d. Somewhat dissatisfied
    e. Very dissatisfied
7. [IF 6=a] Why are you very satisfied with your primary home cooling equipment? [OPEN END]
8. [If 6=e] Why are you very dissatisfied with your primary home cooling equipment? [OPEN END]

C.1.4 Current Water Heating Equipment

9. What is the **primary** water heater do you have in this home?
    a. Natural gas storage water tank
    b. Natural gas tankless water heater (tankless units are rectangular, mounted on a wall)
    c. Propane storage water heater
    d. Propane tankless water heater (tankless units are rectangular, mounted on a wall)
    e. Electric resistance storage tank (not hybrid/heat pump)
    f. Electric hybrid/heat pump water heater
    g. Solar water heater
    h. Other please specify: [open end]
10. How satisfied are you with your **primary** water heater?

a. Very satisfied
b. Somewhat satisfied
c. Neither satisfied nor dissatisfied
d. Somewhat dissatisfied
e. Very dissatisfied

11. [IF 10=a] Why are you very satisfied with your water heater? [OPEN END]
12. [IF 10=e] Why are you very dissatisfied with your water heater? [OPEN END]

C.1.5 Appliances

13. Which fuel is used by your kitchen cooktop?
    a. Natural gas
    b. Propane
    c. Electricity (not induction cooktop)
    d. Electric induction cooktop (Induction cooking requires certain pots and pans and provides rapid heating using magnetism)
14. How satisfied are you with your cooktop?
    a. Very satisfied
    b. Somewhat satisfied
    c. Neither satisfied nor dissatisfied
    d. Somewhat dissatisfied
    e. Very dissatisfied
15. [IF 14=a] Why are you very satisfied with your cooktop? [OPEN END]
16. [IF 14=e] Why are you very dissatisfied with your cooktop? [OPEN END]
17. Which fuel does your clothes dryer use?
    a. Natural gas
    b. Propane
    c. Electricity
    d. Don’t know
    e. Don’t have a clothes dryer
18. [If 17 = c] What kind of electric clothes dryer do you have?
    a. Conventional (vented to outdoors)
    b. Heat pump or condensing (not vented to outdoors)
    c. Don’t know

19. How satisfied are you with your clothes dryer?
    a. Very satisfied
    b. Somewhat satisfied
    c. Neither satisfied nor dissatisfied
    d. Somewhat dissatisfied
    e. Very dissatisfied
20. [IF 19=a] Why are you very satisfied with your dryer? [OPEN END]
21. [IF 19=d] Why are you very dissatisfied with your dryer? [OPEN END]

Now, we would like to ask you a series of questions about homes and equipment that use electricity versus fossil fuels and how you think they compare.

C.1.6 Homebuyer Perceptions

C.1.6.1 Homes Using Gas or Propane

[GAS_USE=1 IF S6=**Error! Reference source not found.** OR (1=a **or** b) OR (9=a **or** b) OR 13=a OR 17=a]

[PROPANE_USE=1 IF S7=**Error! Reference source not found.** OR (1=c **or** d) OR (9=c **or** d) OR 13=b OR 17=b]

[IF GAS_USE ≠1 AND PROPANE_USE ≠ 1, skip to 32]

22. **An all-electric home** is a home that uses electric equipment for heating, water heating, cooking, and clothes drying. There is no gas or propane used in the home. **A fossil-fuel home** uses natural gas or propane for at least some of these activities. Please consider these two home types and choose the type of home that you feel has:
    a. Lower purchase costs [RADIO BUTTON]
    b. Lower utility bills
    c. More comfort in extremely cold weather
    d. Greater equipment reliability
    e. Less negative impact on the environment
    f. Better indoor air quality
    g. Higher resale value

    [RESPONDENTS WILL BE ASKED TO CHOOSE ONE OF FOLLOWING RESPONSES FOR EACH FEATURE LISTED ABOVE]

        i. All-electric homes
        ii. Fossil-fuel homes

iii. Both home types are the same

iv. Don't know

23. Please compare electric heat pumps to **gas furnaces and boilers.** Which type of system do you feel has:

    a. Lower purchase costs [RADIO BUTTON]

    b. Lower utility bills (cost to operate)

    c. Lower maintenance costs

    d. Longer life-span

    e. Better comfort in cold weather

    f. Better reliability during blackouts

    g. Lower noise levels

    h. Less negative impact on the environment

    i. Better indoor air quality

    [RESPONDENTS WILL BE ASKED TO CHOOSE ONE OF FOLLOWING RESPONSES FOR EACH FEATURE LISTED ABOVE]

        i. Electric heat pump

        ii. Gas furnace or boiler

        iii. Both types are the same

        iv. Don't know

24. [If 9 ≠ f] Heat pump water heaters, also known as hybrid water heaters, are electric storage water tanks that use heat pump technology with a backup electric resistance heating system. They dehumidify and cool the spaces they are in while using a refrigerant cycle to pull heat from the surrounding air. Had you heard of them before this survey?

    a. Yes

    b. Yes, but I don't know what it is

    c. No

25. [If 9 = f OR 24 = a] Please compare a heat pump water heater to a **gas storage tank water heater**. Which type of water heater do you feel has:

    a. Lower purchase costs [RADIO BUTTON]

    b. Lower utility bills (cost to operate)

    c. Lower maintenance costs

    d. Better reliability over time

    e. Better capability to meet hot water demand

f. Less negative impact on the environment
g. Less noise
h. Better indoor air quality

[RESPONDENTS WILL BE ASKED TO CHOOSE ONE OF FOLLOWING RESPONSES FOR EACH FEATURE LISTED ABOVE]

i. Heat pump water heater
ii. Gas storage tank water heater
iii. Both types are the same
iv. Don't know

26. [If 9 = f OR 24 = a] Please compare a heat pump water heater to a **gas tankless (instantaneous) water heater**. Which type of water heater do you feel has:

a. Lower purchase costs [RADIO BUTTON]
b. Lower utility bills (cost to operate)
c. Lower maintenance costs
d. Better reliability over time
e. Better capability to meet hot water demand
f. Less negative impact on the environment
g. Less noise
h. Better indoor air quality

[RESPONDENTS WILL BE ASKED TO CHOOSE ONE OF FOLLOWING RESPONSES FOR EACH FEATURE LISTED ABOVE]

i. Heat pump water heater
ii. Gas tankless (instantaneous) water heater
iii. Both types are the same
iv. Don't know

27. [IF 13≠d] Induction cooktops use electricity, require certain pots and pans, and provide rapid heating using magnetism) Had you heard of them before this survey?

a. Yes
b. Yes, but I don't know what it is
c. No

28. [IF 27 = a OR 13=d] Please compare an **induction cooktop** to a **natural gas or propane cooktop**. Which type of cooktop do you feel has:

a. Lower purchase costs [RADIO BUTTON]

b. Lower utility bills (cost to operate)
c. Lower maintenance costs
d. Better safety
e. Faster heating
f. Better cooking experience
g. Less negative impact on the environment
h. Better indoor air quality

[RESPONDENTS WILL BE ASKED TO CHOOSE ONE OF FOLLOWING RESPONSES FOR EACH FEATURE LISTED ABOVE]

i. Induction cooktop
ii. Gas/propane cooktop
iii. Both types are the same
iv. Don't know

Now, we would like to ask you some questions about your decision-making process for your new home.

29. [IF GAS_USE =1] You indicated that the new home you built or purchased uses natural gas for heating, water heating, or cooking. Before you acquired your new home, which of the following statements best describes your preferences about the fuels used in a new home?
    a. I wanted a home that had natural gas service
    b. I preferred an all-electric home, but chose this home for reasons that outweighed fuel preferences
    c. I preferred an all-electric home, but my builder didn't give me an all-electric option
    d. I had no preferences for the fuels used in the home
30. [IF 29 = a] Why did you want to have natural gas service in your new home? Select all that apply
    a. Better cooking experience
    b. Better home heating
    c. Concern about utility costs
    d. Reliability of gas equipment
    e. Other [Please specify]

31. [IF 29 = b or c] Why did you prefer an all-electric home? Select all that apply.
    a. Better indoor air quality
    b. Safety (lower risk for fires/burns)
    c. Induction cooking
    d. Concern for the environment
    e. Other [Please specify]

C.1.6.2 All-Electric Homes

Now, we would like to ask you some questions about your decision-making process to purchase/or build your new home and how satisfied you are with your home since moving in.

[IF GAS_USE ≠1 AND PROPANE_USE ≠ 1]

32. You indicated that the new home you built or purchased is an all-electric home, where heating, water heating, and appliances are all fueled by electricity. Before you acquired your new home, which of the following statements best describes your preferences about the fuels used in a new home?
    a. I wanted an all-electric home
    b. I preferred natural gas or propane for some uses, but chose this home for reasons that outweighed fuel preferences
    c. I preferred natural gas or propane for some uses, but my builder didn't give me a natural gas or propane option
    d. I had no preferences for the fuels used in the home.
33. [IF 32 = a] Why did you want an all-electric home? Select all that apply.
    a. Better indoor air quality
    b. Safety (lower risk for fires/burns)
    c. Induction cooking
    d. Concern for the environment
    e. Other [Please specify]

34. [IF 32 = b or c] Why did you prefer to have natural gas or propane as an option in your new home? Select all that apply
    a. Better cooking experience
    b. Better home heating
    c. Concern about utility costs
    d. Reliability of gas equipment

e. Other [Please specify]

35. Before you moved into your new home, did you have any concerns about owning an all-electric home?
    a. Yes
    b. No [SKIP TO 38]
36. [IF 35 = a] What kind of concerns did you have about an all-electric home, compared to a home that used gas or propane? Select all that apply
    a. Upfront/purchase costs
    b. Resale value
    c. Utility bills
    d. Durability of equipment and appliances
    e. Maintaining comfortable temperature in extreme weather
    f. Cooking experience
    g. Reliability in storms and power outages
    h. Noise issues
    i. Other [please specify]
37. Now that you have lived in your all-electric home, what has your experience been for each of these issues?
    a. Upfront/purchase costs
    b. Resale value
    c. Utility bills
    d. Durability of equipment and appliances
    e. Maintaining comfortable temperature in extreme weather
    f. Cooking experience
    g. Reliability in storms and power outages
    h. Noise issues
    i. [IF 36 = i] Other [please specify]

    [Respondent to choose one of the below options for each item above]

        i. My home performs better than expected
        ii. My home met my expectations
        iii. My home performs worse than expected
        iv. Too early to know for sure

38. [IF 35 =b] Since moving into your new home, have any concerns or issues come up that you weren't expecting?
    a. Yes
    b. No
39. [If 38=a] What kind of concerns or issues have come up? Select all that apply
    a. Upfront/purchase costs
    b. Resale value
    c. Utility bills
    d. Durability of equipment and appliances
    e. Maintaining comfortable temperature in extreme weather
    f. Cooking experience
    g. Reliability in storms and power outages
    h. Noise issues
    i. Other [please specify]
40. Have you made or plan to make any changes in the efficiency of the building, insulation, windows, air tightness?
    a. Yes
    b. No
41. [If 40 =a] Why have you made or plan to make such changes? [OPEN END]
42. Would you recommend an all-electric home to someone who was in the market for a new home?
    a. Yes
    b. No
    c. Undecided
43. [If 42=b] What are the main issues preventing you from recommending an all-electric home to someone?
    a. Upfront/purchase costs
    b. Resale value
    c. Utility bills
    d. Durability of equipment and appliances
    e. Maintaining comfortable temperature in extreme weather
    f. Cooking experience
    g. Reliability in storms and power outages

h. Noise issues

i. Other [please specify]

C.1.7 Market Actor Influence on Homebuyers

44. Did you speak with any professionals about using modern electric equipment like heat pumps and induction cooktops in your new home instead of natural gas or propane equipment?

    a. Yes

    b. No [SKIP TO 48]

45. [IF 44=a] Who did you speak with about these equipment choices in your home? Select all that apply.

    a. Builder or developer who built your new home

    b. HVAC contractor for your new home

    c. Different builder or contractor

    d. Real estate agent

    e. Home Energy Rating System (HERS) rater

    f. Contact from your utilities or Mass Save (not a HERS rater)

    g. Appliance dealer

    h. Big box store salesperson or representative

    i. Other (please specify) [PROVIDE TEXT FIELD]

46. [Cycle through all contacts chosen in 45] We'd like to know more about the feedback you received.

    a. What kind of equipment did the **[Choice #1 from 45]** talk to you about? Select all that apply.

        i. Central or mini-split heat pumps for heating and cooling

        ii. Ground-source heat pump for heating

        iii. Heat pump water heater for water heating

        iv. Induction cooktop

        v. Heat pump or condensing dryer

    [CYCLE THORUGH EACH EQUIPMENT TYPE CHOSEN IN 46a]

    b. Was the feedback they provided on **[Equipment type 1]** positive or negative?

        i. Positive [superior to gas alternatives]

        ii. Neutral [Not better or worse than gas]

        iii. Negative [worse than gas alternatives]

c. [AS NEEDED] Was the feedback they provided on **[Equipment type 2]** positive or negative?

i. Positive [superior to gas alternatives]

ii. Neutral [Not better or worse than gas]

iii. Negative [worse than gas alternatives]

[REPEAT 46a THROUGH 46c FOR EACH MARKET ACTOR TYPE CHOSEN]

47. [If 44 =a] Did the feedback you received impact your final decisions on the equipment and appliances used in your home?
    a. Caused me to avoid electric equipment or appliances
    b. Caused me to seek out electric equipment or appliances
    c. It did not impact my choice of equipment or appliances
48. Did you do your own research into the best appliances and heating and cooling equipment for your new home?
    a. Yes
    b. No
49. [If 48=a] What sources did you use for this research?
    a. General internet research (articles and reports)
    b. Checked the website of my local utility or energy provider
    c. Called my local utility or energy provider
    d. Asked an employee at a retail location who sold these items (e.g., Home Depot)
    e. Other (Please specify)
50. Are you aware of any recent changes in energy prices?
    a. Yes
    b. No
51. [If **Error! Reference source not found.**=a] How did these recent changes in energy prices impact your opinion of all-electric versus fossil-fuel homes?
    a. Increased preference for all-electric
    b. No impact on all-electric preference
    c. Decreased preference for all-electric

C.1.8 Closing

52. Thank you for taking the time to complete this survey. Please enter the email address where you'd like to receive your e-gift card.

[PROVIDE TEXT FIELD]

C.2 BUILDER/DEVELOPER/GENERAL CONTRACTOR INTERVIEW GUIDE

C.2.1 Background for Reviewers

This interview guide is designed to gather builder, general contractor, and developer insights regarding barriers to electrification in single-family new homes in Massachusetts, for the MA21R44 RNC Electrification Barriers Study. Respondents will have been screened to ensure they currently build or develop new single-family homes in Massachusetts and will be offered a $100 incentive to participate in a 45-minute conversation.

Table 16 maps the research questions included in the Work Plan to the relevant interview questions.

Table 16: Study Research Questions and Corresponding Interview Question(s)

Research Questions	Interview Question
Are consumers, contractors, and builders aware of electrification measures?	2),3),4),6),8)
Do consumers, contractors, and builders believe there are energy, carbon reduction, and other benefits of electrification measures?	10),11),12),13)
Are consumers, contractors, and builders aware of the economic benefits of electrification?	5), 7)a), 9)a), 15)
To what degree do consumer and contractor preferences for incumbent technology limit installation of electrification measures?	2), 3), 7), 17), 18)
What are the specific characteristics (perceived or actual) of incumbent technology that consumers and contractors believe electrification measures fall short on?	14), 19), 19)
What design changes must contractors, architects, and developers make to accommodate electric measures?	21)
What programmatic steps can the PAs take to reduce behavioral and informational barriers to electrification to enable greater consumer and contractor adoption of electric measures?	1.a)
Multifamily-specific issues	22)

C.2.2 Recruitment Scripts

Information in brackets is for interviewers.

Fill in the fields below, select all (Ctrl-A), and update references (F9) to update scripts.

	Interviewee	Interviewer
Name	[IntervieweeName]	[InterviewerName]

Company	[InterivieweeCompany]	[InterviewerCompany]
Phone	[InterivieweePhone]	[InterviewerPhone]
Email	[InterivieweeEmail]	[InterviewerEmail]

- Date and time of interview: [InterviewDate] at [InterviewTime]

C.2.2.1 Pre-recruitment Postcard

On behalf of the sponsors of the Mass Save energy efficiency programs, NMR Group is conducting interviews with **builders, general contractors, and developers who work in the new single-family homes market in Massachusetts**. The sponsors of Mass Save want to learn more about the heating and cooling equipment installed in newly constructed single-family homes. If you **build or develop new single-family homes** and participate in a **45-minute interview with us,** we can offer you a **$100 incentive.**

We will follow up over email or phone to schedule an interview. If you would like to contact NMR Group about an interview, you can reach me at [InterviewerEmail] or [InterviewerPhone].

If you have any questions about the legitimacy of the study, please contact Kiersten Williams of Eversource at Kiersten.Williams@eversource.com or (603) 634-3034.

Thank you for your time.

Sincerely,
[InterviewerName]

C.2.2.2 Phone and Email Recruitment Script

[SCRIPT MAY BE ADJUSTED DEPENDING ON NUMBER OF CONTACT ATTEMPTS AND INCLUDE OTHER CUSTOMIZATIONS.]

Greetings,

I am reaching out to you on behalf of the sponsors of the Mass Save energy efficiency programs. My company, NMR Group, is conducting interviews with **builders, general contractors, and developers who work in the new single-family homes market in Massachusetts**. The sponsors of Mass Save want to learn more about what heating and cooling systems are installed in new single-family homes. We are interested in speaking with professionals who are building and developing new single-family homes. The interview will take about 45 minutes, and **we can offer you a $100 incentive to thank you for your time.**

Your input will be held completely confidential and will help the Mass Save sponsors continue to provide support to contractors like you.

Are you available in the next week for an interview? Please feel free to call me if you would like to discuss the study further. If you have any questions about the legitimacy of the study, please contact Kiersten Williams of Eversource at Kiersten.Williams@eversource.com or (603) 634-3034.

Thank you for your time.

Sincerely,
[InterviewerName]
[InterviewerPhone]
[InterviewerEmail]

Berkshire Gas, Cape Light Compact, Eversource, Liberty Utilities, National Grid and Unitil work together as Mass Save® to help residents and businesses across Massachusetts save money and energy, providing energy efficiency programs and services while simultaneously leading the state to a clean and energy efficient future.

C.2.2.3 Scheduling Confirmation Email Script

[SCRIPT MAY BE ADJUSTED DEPENDING ON NUMBER OF CONTACT ATTEMPTS AND INCLUDE OTHER CUSTOMIZATIONS.]

Dear [InterviewеeName],

Thank you for agreeing to speak with me. I have you scheduled for [InterviewTime] on [InterviewDate] and will call you at [InterviewеePhone] from [InterviewerPhone]. We anticipate the call will take about 45 minutes.

We will be speaking about your new single-family home projects in Massachusetts and the factors that drive which HVAC and water heating equipment types are chosen. Your input will remain confidential, and we will not share your name or the name of your company. We are looking forward to speaking with you.

Sincerely,
[InterviewerName]

C.2.3 Introduction

[Note to reviewers: the following represents an example introduction that an interviewer might use. Interviewers will not follow a set script and will not be expected to follow this introduction, or the interview guide itself verbatim.]

Thank you for speaking with us today regarding your work at [Company Name]. Today, we are hoping to ask you about your experience [building, developing] new homes in Massachusetts. **We will focus on work in new single-family homes; this includes detached homes and townhomes, but we are happy to hear your perspectives on low-rise multifamily buildings as well**.

We highly value your input; we need the real-world experience and feedback from people who work in this field. [IF NECESSARY: Your feedback will help the Mass Save program sponsors continue to offer support for new home construction and efficient equipment.] This interview will take approximately 45 minutes to complete, and we will send you a $100 electronic gift card to thank you for your time and feedback. Your responses will remain confidential and will only be used for research purposes and will be reported in aggregate – we will not use your name or your company's name in any public materials or provide them to the Mass Save sponsors. I would like to record our conversation so that I can focus on our discussion rather than worry about trying to write everything down in my notes as we go. Do I have your permission to record our call? Do you have any questions before we begin?

C.2.4 Are consumers, contractors, and builders aware of electrification measures?

1) Roughly how many **new single-family homes** does your company build in a typical year?
    a. What portion of those are built in stretch code communities?
    b. In terms of energy efficiency, do you typically build homes that are around code levels of efficiency or above code efficiency?
        i. [IF THEY BUILD BEYOND CODE]: Have you recently built any homes that met or were close to various high-performance standards, like net-zero energy or NZE-ready homes, ENERGY STAR, or Passive House?

HVAC Equipment

2) For a new home or development where natural gas hookups are available, what is your preferred equipment choice for heating and cooling equipment?
    a. What about water heaters?
    b. And cooking equipment?
3) And for a new home or development where natural gas hookups are **not** available – what systems do you prefer? [PROBE FOR HEATING, COOLING, WATER HEATING, AND COOKING]
4) What percentage of the new homes you built in Massachusetts in the past three years used heat pumps for heating and cooling?
    a. What type(s) was most common?
    b. What portion included backup or supplemental systems, like furnaces or electric resistance baseboard heating? Why is that?
5) How much more or less does it cost to put in [COMMON HEAT PUMP] rather than [PREFERRED SYSTEM] in new homes in Massachusetts? What drives those differences?

Water Heaters

6) What percentage of the new homes you built in the past 3 years in Massachusetts used heat pump water heaters? [DEFINE, CLARIFY DIFFERENCE BETWEEN HPWHS AND TANKLESS GAS AS NECESSARY]

7) When you *do not* put in HPWHs, what types of water heaters do you usually install in new homes?

    a. How much more or less do those cost to install in new homes than HPWHs? What drives those differences?

Cooking

8) What percentage of those new homes you built in that time frame used electric induction ranges for cooking? [EXPLAIN AS NECESSARY]

9) [IF THEY INSTALL ANY ELECTRIC SYSTEMS] What percentage of the new homes you built in the last three years were all-electric, meaning they used no oil, gas, or propane for heating, water heating, cooking?

    a. Did the fact that these homes were all-electric have an impact on their listing or sales price? How so?

C.2.5 Do consumers, contractors, and builders believe there are energy, carbon reduction, and other benefits of electrification measures?

10) What do you consider to be the benefits of installing traditional heating and cooling systems like furnaces, central air conditioners, or boilers in new single-family homes? These could be benefits to the occupant, to the installer, or to you as the builder/developer. [PROBE ON UPFRONT COST, FAMILIARITY, EASE OF INSTALLATION, RELIABILITY IN COLD WEATHER, AFFORDABILITY OF GAS] What are their downsides?

11) What do you consider to be the benefits of installing heat pump equipment like mini and multi-split heat pumps or central air-source heat pumps in new single-family homes? Again, these might be benefits to the occupant, the installer, or the builder/developer. [PROBE IF THEY SEE CLIMATE CHANGE, ENERGY BILL SAVINGS, HEALTH AND SAFETY, COMFORT, EASE OF INSTALLATION BENEFITS] What are their downsides?

12) To what extent do HVAC contractors agree with your general opinions about the relative merits of heat pumps vs. traditional HVAC and water heating systems for new homes?

13) How about occupants of these new homes? Do they agree with your take on the relative merits of these systems? How common would you say this is?

C.2.6 What programmatic steps can the PAs take to reduce behavioral and informational barriers to electrification to enable greater consumer and contractor adoption of electric measures?

14) In your experience, what do you think is keeping builders and contractors from installing more heat pumps in new, single-family homes in Massachusetts? What needs to change to get more heat pumps installed in new homes? Whose opinion needs to be change – builders? HVAC contractors? Homeowners? Someone else?

    a. Who could help overcome these issues, and what could they do? [PROBE: MASS SAVE PROGRAMS, MANUFACTURERS, OTHERS?] [PROBE FOR STRATEGIES BEYOND INCENTIVES, E.G. EDUCATION AND AWARENESS-BUILDING]?

C.2.7 Are consumers, contractors, and builders aware that electrification can be done in an economically efficient manner?

15) What types of mechanical systems do you usually put into your new homes? How much more would it cost to put in heat pumps instead, for HVAC and water heating?"

    a. How much more would it cost with [MOST COMMON HEAT PUMP SYSTEM THEY INSTALL]?

    b. How much more would it cost with [HEAT PUMP SYSTEMS OTHER THAN MOST COMMON]

    c. What needs to change for this cost gap to close [PROBE FOR EQUIPMENT COSTS, INSTALL COSTS]?

16) Do you build new homes equipped with renewable energy sources like solar and/or battery storage? [IF YES] How does the decision of what mechanical equipment to install relate to the decision to install solar?

C.2.8 The degree to which consumer and contractor preferences for incumbent technology limit installation of electrification measures.

17) [IF NOT MENTIONED] Do you choose different types of mechanical systems for spec homes that are put on the market versus fully custom homes that are designed for a specific customer? How so?

18) What preferences for home configurations are you seeing from homebuyers, in terms of mechanical equipment or cooking appliances? [PROBE FOR MOST COMMON PREFERRED CONFIGURATION]

C.2.9 What are the specific characteristics (perceived or actual) of incumbent technology that consumers and contractors believe electrification measures fall short on?

19) What additional factors that we have not talked about are preventing you from choosing heat pumps in new single-family homes? [PROBE IF NOT MENTIONED FOR]:

1. EQUIPMENT AVAILABILITY FROM LOCAL DISTRIBUTORS
2. COLD WEATHER PERFORMANCE
3. COST TO RUN
4. CUSTOMER CONCERNS/NEGATIVE FEEDBACK
5. COMPLEXITY TO OPERATE
6. RELIABILITY

20) What issues prevent you from choosing electric induction stoves over gas appliances, if any? [PROBE FOR:]

a. BAD EXPERIENCE WITH OLD INDUCTION COOKTOPS
b. PERCEPTION THAT GAS COOKING HAS FINER CONTROL OR HIGHER HEATING CAPACITY
c. NEED TO BUY NEW POTS AND PANS
d. COST OF HIGH-END INDUCTION COOKTOPS
e. LACK OF KNOWLEDGE ABOUT THE DIFFERENCES BETWEEN INDUCTION AND TRADITIONAL ELECTRIC RANGE TOPS.
f. RELIABILITY

C.2.10 What design changes must contractors, architects, and developers make to accommodate electric measures?

21) Are there specific new single-family home characteristics that work for traditional fossil fuel heating systems but do not work well with heat pumps? [PROBE: ISSUES WITH SITING EQUIPMENT IN UNCONDITIONED SPACE, LOOK FOR EFFICIENT BUILDING SHELL TO PAIR WITH HEAT PUMPS]

a. How could home designs change to make it easier or cheaper to install electric heating systems?
b. How does the efficiency of the building shell impact the equipment choice?

C.2.11 Multifamily Housing

22) Have you built or developed new multifamily housing, that is, new buildings with more than one unit, in the past two years?

Yes

No [GO TO CLOSING]

23) [IF NECESSARY, REMIND RESPONDENT OF KEY ISSUES THEY MENTIONED FOR ELECTRIC SYSTEM UPTAKE.] We spoke at length about several key considerations factoring into the installation electric equipment in new homes single-family homes. Are there any additional challenges to choosing electric equipment in small multifamily buildings that are three stories or smaller in size?

a. What about in larger multifamily buildings that are four or more stories?

b. [IF NOT MENTIONED] On the flip side, are there advantages to multifamily properties that make installing and operating electric equipment in multifamily buildings easier?

24) Is there anything else you would like to tell us about choosing all-electric systems in new homes in Massachusetts for HVAC, water heating, and cooking? What else do you think the sponsors of the Mass Save programs should know about electrifying new homes?

Thank you for your time! [GATHER CONTACT INFO FOR INCENTIVES]

C.3 HERS Rater Guide

C.3.1 Background for Reviewers

This interview guide is designed to gather HERS rater insights into barriers to electrification in new single-family homes in Massachusetts, for the MA21R44 RNC Electrification Barriers Study. Respondents will have been screened to ensure they currently perform HERS ratings of new single-family homes in Massachusetts and will be offered a $100 incentive to participate in a 45-minute conversation.

Table 17 maps the research questions included in the Work Plan to the relevant interview questions.

Table 17: Study Research Questions and Corresponding Interview Question(s)

Research Questions	Interview Question
Are consumers, contractors, and builders aware of electrification measures?	25), 0
Do consumers, contractors, and builders believe there are energy, carbon reduction, and other benefits of electrification measures?	10), 28), 10), 28)
Are consumers, contractors, and builders aware of the economic benefits of electrification?	32), 33)
To what degree do consumer and contractor preferences for incumbent technology limit installation of electrification measures?	12), 13), 14), 34)
What are the specific characteristics (perceived or actual) of incumbent technology that consumers and contractors believe electrification measures fall short on?	7, 35), 36), 35)
What behavioral changes do consumers need to adopt to use electric measures effectively and efficiently?	38)
What design changes must contractors, architects, and developers make to accommodate electric measures?	39)
What programmatic steps can the PAs take to reduce behavioral and informational barriers to electrification to enable greater consumer and contractor adoption of electric measures?	14)
Probe for Multifamily-specific issues	22), 41)

C.3.2 Recruitment Scripts

Information in brackets is for interviewers.

Fill in the fields below, select all (Ctrl-A), and update references (F9) to update scripts.

	Interviewee	Interviewer

Name	[InterivieweeName]	[InterviewerName]
Company	[InterivieweeCompany]	[InterviewerCompany]
Phone	[InterivieweePhone]	[InterviewerPhone]
Email	[InterivieweeEmail]	[InterviewerEmail]

- Date and time of interview: [InterviewDate] at [InterviewTime]

C.3.2.1 Pre-recruitment Postcard

On behalf of the sponsors of the Mass Save energy efficiency programs, NMR Group is conducting interviews with **HERS raters who perform energy audits of new single-family homes in Massachusetts**. The sponsors of Mass Save want to learn more about the equipment and heating fuel choices in newly constructed single-family homes. If you **perform ratings of new single-family homes** and participate in a **45-minute interview,** we can offer you a **$100 incentive.**

We will follow up over email or phone to schedule an interview. If you would like to contact NMR Group about an interview, you can reach me at [InterviewerEmail] or [InterviewerPhone].

If you have any questions about the legitimacy of the study, please contact Kiersten Williams of Eversource at Kiersten.Williams@eversource.com or (603) 634-3034.

Thank you for your time.

Sincerely,
[InterviewerName]

C.3.2.2 Phone and Email Recruitment Script

[SCRIPT MAY BE ADJUSTED DEPENDING ON NUMBER OF CONTACT ATTEMPTS AND INCLUDE OTHER CUSTOMIZATIONS.]

(Email: Dear [InterivieweeName]) (Phone: Hello, can I speak with [InterivieweeName]?),

I am reaching out to you on behalf of the sponsors of the Mass Save energy efficiency programs. My company, NMR Group, is conducting interviews with **HERS raters who perform energy audits in new single-family homes in Massachusetts**. The sponsors of Mass Save want to learn more about equipment and heating fuel choices in new single-family homes. We are interested in speaking with HERS raters who perform energy audits of new single-family homes. The interview will take about 45 minutes, and **we can offer you a $100 incentive to thank you for your time.**

Your input will be held completely confidential and will help the Mass Save sponsors continue to provide support to contractors like you.

Are you available in the next week for in an interview? Please feel free to call me if you would like to discuss the study further. If you have any questions about the legitimacy of the study, please contact Kiersten Williams of Eversource at Kiersten.Williams@eversource.com or (603) 634-3034.

Thank you for your time.

Sincerely,
[InterviewerName]
[InterviewerPhone]
[InterviewerEmail]

Berkshire Gas, Cape Light Compact, Eversource, Liberty Utilities, National Grid and Unitil work together as Mass Save® to help residents and businesses across Massachusetts save money and energy, providing energy efficiency programs and services while simultaneously leading the state to a clean and energy efficient future.

C.3.2.3 Scheduling Confirmation Email Script

[SCRIPT MAY BE ADJUSTED DEPENDING ON NUMBER OF CONTACT ATTEMPTS AND INCLUDE OTHER CUSTOMIZATIONS.]

Dear [InterviewеeName],

Thank you for agreeing to speak with me. I have you scheduled for [InterviewTime] on [InterviewDate] and will call you at [InterviewеePhone] from [InterviewerPhone]. We anticipate the call will take about 45 minutes.

We will be speaking about your experience with energy audits of new single-family homes in Massachusetts and the factors that drive which equipment types and heating fuels are chosen. Your input will remain confidential, and we will not share your name or the name of your company. We're looking forward to speaking with you.

Sincerely,
[InterviewerName]

C.3.3 Introduction

[Note to reviewers: the following represents an example introduction that an interviewer might use. Interviewers will not follow a set script and will not be expected to follow this introduction, or the interview guide itself verbatim. Interviewers will adjust the script subject to time constraints and the responses of the interviewee.]

Thank you for speaking with us today regarding your work at [Company Name]. Today, we are hoping to ask you about your experience performing energy audits of new homes in Massachusetts. If you work in other states as well, please limit your responses to your experience in MA, to the extent there are distinctions. **We will focus on work in single-family new homes;**

this includes detached homes and townhomes, but we're happy to hear your perspectives on low-rise multifamily buildings too.

We highly value your input; we need the real-world experience and feedback from people who work in this field. [IF NECESSARY: Your feedback will help the Mass Save program sponsors continue to offer support to new homes that require your expertise.] This interview will take approximately 45 minutes to complete, and we will send you a $100 electronic gift card to thank you for your time and feedback. We will confirm your email address during our conversation we will send you an email with a link to claim your gift card within a few days of your interview. Your responses will remain confidential and will only be used for research purposes and will be reported in aggregate – we will not use your name or your company's name in any public materials or provide them to the Mass Save sponsors. I would like to record our conversation so that I can focus on our discussion rather than worry about trying to write everything down in my notes as we go. Do I have your permission to record our call? Do you have any questions before we begin?

C.3.4 Consumers, contractors, and builders awareness of electric measures

25) How many HERS ratings did you conduct at **new single-family homes** last year in Massachusetts?

HVAC Equipment

a. What percentage of those homes used heat pumps for heating and cooling?
   i. What type of heat pumps were most common?
   ii. How aware is the typical homebuilder or developer about the availability and capabilities of heat pumps for space heating?

Water Heaters

b. What percentage of those homes used heat pump water heaters?
c. How aware is the typical homebuilder or developer about the availability and capabilities of HPWHs?

Cooking

d. What percentage of those homes used induction ranges for cooking?
e. How aware is the typical homebuilder or developer about the availability and capabilities of induction cooktops?

26) What percentage of the new homes you performed ratings for in the last few years would you estimate were fully electric, meaning they used no natural gas or propane for heating, water heating, or cooking?

a. How common is it for you to see dual fuel or supplemental heating systems in new single-family homes? [EXPLAIN AS NECESSARY: WE ARE FOCUSED ON ELECTRIC AND GAS EQUIPMENT HERE, NOT WOOD, PELLETS, OR OTHER BIOMASS OPTIONS]

C.3.5 Do consumers, contractors, and builders believe there are energy, carbon reduction, and other benefits of electrification measures?

27) What do you consider to be the benefits of installing traditional heating and cooling systems like furnaces, central air conditioners, or boilers in new single-family homes? These could be benefits to the occupant, to the installer, or to the builder/developer. [PROBE ON UPFRONT COST, FAMILIARITY, EASE OF INSTALLATION, RELIABILITY IN COLD WEATHER, AFFORDABILITY OF GAS] What are their downsides?

28) What do you consider to be the benefits of installing heat pump equipment like mini and multi-split heat pumps or central air-source heat pumps in new single-family homes? Again, these might be benefits to the occupant, the installer, or the builder/developer. [PROBE IF THEY SEE CLIMATE CHANGE, ENERGY BILL SAVINGS, HEALTH AND SAFETY, COMFORT, EASE OF INSTALLATION BENEFITS] What are their downsides?

29) To what extent do HVAC contractors agree with your general opinions about the relative merits of heat pumps vs. traditional HVAC and water heating systems for new homes?

30) How about builders and developers of these new homes? Do they agree with your take on the relative merits of these systems? How common would you say this is?

C.3.6 What programmatic steps can the PAs take to reduce behavioral and informational barriers to electrification to enable greater consumer and contractor adoption of electric measures?

31) In your experience, what do you think is keeping builders and contractors from installing more heat pumps in new, single-family homes in Massachusetts?

    b. Who could help overcome these issues, and what could they do? [PROBE: MASS SAVE PROGRAMS, MANUFACTURERS, OTHERS?] [PROBE FOR STRATEGIES BEYOND INCENTIVES, E.G. EDUCATION AND AWARENESS-BUILDING]?

C.3.7 Consumer, contractor, and builder awareness of the economic viability of electrification

32) What feedback do you hear from builders and developers about the cost to construct homes using electric equipment like heat pumps versus homes using more traditional gas equipment?

    a. Have you observed additional components in electric homes that impact construction price compared to gas homes, for example improved insulation or windows, or more expensive interior finishes?

33) Do you review the utility cost data for the homes you perform energy modeling on? How do the utility costs of homes using electric equipment like heat pumps and induction stoves compare to homes using gas [PROBE FOR DIFFERENCES WHERE NATURAL GAS IS AVAILABLE COMPARED TO PROPANE]?

    a. [IF YES] Do you share this information with homebuilders or developers you work with? How do they react?

C.3.8 To what degree do consumer and contractor preferences for incumbent technology limit installation of electrification measures?

34) What preferences for home configurations are you seeing from homebuilders and developers recently, in terms of mechanical equipment and cooking appliances?

    a. How does this vary by spec homes versus custom designed homes?

C.3.9 Specific characteristics (perceived or actual) that consumers and contractors believe electrification measures fall short on

35) What additional factors that we haven't talked about might present issues for builders and developers when considering heat pumps in new single-family homes? [PROBE IF NOT MENTIONED FOR:]

    i. EQUIPMENT AVAILABILITY FROM LOCAL DISTRIBUTORS
    ii. COLD WEATHER PERFORMANCE
    iii. COST TO RUN
    iv. CUSTOMER CONCERNS/NEGATIVE FEEDBACK
    v. COMPLEXITY TO OPERATE
    vi. RELIABILTY

36) What kind of feedback have you heard from builders, developers, or homeowners on why they would not replace gas appliances with electric induction cooktops? [PROBE FOR:]

    i. BAD EXPERIENCE WITH OLD INDUCTION COOKTOPS
    ii. PERCEPTION THAT GAS COOKING HAS FINER CONTROL OR HIGHER HEATING CAPACITY
    iii. NEED TO BUY NEW POTS AND PANS
    iv. COST OF HIGH-END INDUCTION COOKTOPS
    v. LACK OF KNOWLEDGE ABOUT THE DIFFERENCES BETWEEN INDUCTION AND TRADITIONAL ELECTRIC RANGE TOPS.

37) Besides mechanical and cooking equipment, are there other natural gas/propane appliances or equipment that would be difficult to replace to create an all-electric home? What about gas fireplace inserts?

C.3.10 Behavioral changes that consumers may need to adopt to use electric measures effectively and efficiently

38) Have you heard of any feedback from customers in homes that use electric systems about their level of satisfaction with the performance of the equipment?

a. [IF SOME ARE UNSATISFIED] What are typical sources of complaints with electric equipment, including heat pumps and induction cooktops [PROBE FOR HEAT PUMPS AND INTEGRATED CONTROLS, COMFORT]?

C.3.11 What design changes must contractors, architects, and developers make to accommodate electric measures?

39) Are there specific new single-family home characteristics that work for traditional fossil fuel heating systems but don't work well with heat pumps? [PROBE: ISSUES WITH SITING EQUIPMENT IN UNCONDITIONED SPACE, LOOK FOR EFFICIENT BUILDING SHELL TO PAIR WITH HEAT PUMPS]

b. What challenges do HVAC installers run into with heat pumps in new single-family homes? How prevalent are these? [PROBE BY SYSTEM TYPE]

c. How could architects adjust their designs to make it easier or cheaper to install electric heating systems?

d. Have you noticed any patterns in the relationship between building shell efficiency and the type of HVAC equipment chosen for the home?

C.3.12 Multifamily Housing

40) Have you performed energy audits at new multifamily housing, that is, new buildings with more than one unit, in the past two years?

Yes

No [GO TO CLOSING]

41) [IF NECESSARY, REMIND RESPONDENT OF KEY ISSUES THEY MENTIONED FOR ELECTRIC SYSTEM UPTAKE.] We spoke at length about several key considerations factoring into the installation electric equipment in new homes single-family homes. Are there any additional challenges to choosing electric equipment in small multifamily buildings that are three stories or smaller in size?

e. What about in larger multifamily buildings that are four or more stories?

f. [IF NOT MENTIONED] On the flip side, are there advantages to multifamily properties that make installing and operating electric equipment in multifamily buildings easier?

42) Is there anything else you'd like to tell us about choosing all-electric systems in new homes in Massachusetts for HVAC, water heating, and cooking? What else do you think the sponsors of the Mass Save programs should know about electrifying new homes?

C.4 HVAC CONTRACTOR GUIDE

C.4.1 Background for Reviewers

This interview guide is designed to gather HVAC (including plumbing) contractor insights into barriers to electrification in single-family new homes in Massachusetts, for the MA21R44 RNC Electrification Barriers Study. Respondents will have been screened to ensure they currently perform HVAC installations in new single-family homes in Massachusetts and will be offered a $100 incentive to participate in a 45-minute conversation.

Table 18 maps the research questions included in the Work Plan to the relevant interview questions.

Table 18: Study Research Questions and Corresponding Interview Question(s)

Research Questions	Interview Question
Are consumers, contractors, and builders aware of electrification measures?	44), 46), 48)
Do consumers, contractors, and builders believe there are energy, carbon reduction, and other benefits of electrification measures?	0, 11)
Are consumers, contractors, and builders aware of the economic benefits of electrification?	32), 55), 33), **Error! Reference source not found.**
To what degree do consumer and contractor preferences for incumbent technology limit installation of electrification measures?	57), **Error! Reference source not found.**, **Error! Reference source not found.**, **Error! Reference source not found.**
What are the specific characteristics (perceived or actual) of incumbent technology that consumers and contractors believe electrification measures fall short on?	19), **Error! Reference source not found.**, **Error! Reference source not found.**
What behavioral changes do consumers need to adopt to use electric measures effectively and efficiently?	**Error! Reference source not found.**, 38)
What design changes must contractors, architects, and developers make to accommodate electric measures?	21), 61)
What programmatic steps can the PAs take to reduce behavioral and informational barriers to electrification to enable greater consumer and contractor adoption of electric measures?	14)
Maintenance, customer satisfaction, and other topics of interest	63)

Multifamily-specific issues	22), 23)

C.4.2 Recruitment Scripts

Information in brackets is for interviewers.

Fill in the fields below, select all (Ctrl-A), and update references (F9) to update scripts.

	Interviewee	Interviewer
Name	[IntervieweeName]	[InterviewerName]
Company	[IntervieweeCompany]	[InterviewerCompany]
Phone	[IntervieweePhone]	[InterviewerPhone]
Email	[IntervieweeEmail]	[InterviewerEmail]

- Date and time of interview: [InterviewDate] at [InterviewTime]

C.4.2.1 Pre-recruitment Postcard

On behalf of the sponsors of the Mass Save energy efficiency programs, NMR Group is conducting interviews with **contractors who install heating and cooling equipment in new single-family homes in Massachusetts**. The sponsors of Mass Save want to learn more about the heating and cooling equipment installed in newly constructed single-family homes. If you **install heating and cooling systems in new single-family homes** and participate in a **45-minute interview,** we can offer you a **$100 incentive.**

We will follow up over email or phone to schedule an interview. If you would like to contact NMR Group about an interview, you can reach me at [InterviewerEmail] or [InterviewerPhone].

If you have any questions about the legitimacy of the study, please contact Kiersten Williams of Eversource at Kiersten.Williams@eversource.com or (603) 634-3034.

Thank you for your time.

Sincerely,
[InterviewerName]

C.4.2.2 Phone and Email Recruitment Script

[SCRIPT MAY BE ADJUSTED DEPENDING ON NUMBER OF CONTACT ATTEMPTS AND INCLUDE OTHER CUSTOMIZATIONS.]

(Email: Dear [IntervieweeName]) (Phone: Hello, can I speak with [IntervieweeName]?),

I am reaching out to you on behalf of the sponsors of the Mass Save energy efficiency programs. My company, NMR Group, is conducting interviews with **contractors who**

install heating and cooling equipment in new single-family homes in Massachusetts. The sponsors of Mass Save want to learn more about what heating and cooling systems are installed in new single-family homes. We are interested in speaking with installers of heating and cooling systems in new single-family homes. The interview will take about 45 minutes, and **we can offer you a $100 incentive to thank you for your time.**

Your input will be held completely confidential and will help the Mass Save sponsors continue to provide support to contractors like you.

Are you available in the next week for in an interview? Please feel free to call me if you would like to discuss the study further. If you have any questions about the legitimacy of the study, please contact Kiersten Williams of Eversource at Kiersten.Williams@eversource.com or (603) 634-3034.

Thank you for your time.

Sincerely,
[InterviewerName]
[InterviewerPhone]
[InterviewerEmail]

Berkshire Gas, Cape Light Compact, Eversource, Liberty Utilities, National Grid and Unitil work together as Mass Save® to help residents and businesses across Massachusetts save money and energy, providing energy efficiency programs and services while simultaneously leading the state to a clean and energy efficient future.

C.4.2.3 Scheduling Confirmation Email Script

[SCRIPT MAY BE ADJUSTED DEPENDING ON NUMBER OF CONTACT ATTEMPTS AND INCLUDE OTHER CUSTOMIZATIONS.]

Dear [InterviewerName],

Thank you for agreeing to speak with me. I have you scheduled for [InterviewTime] on [InterviewDate] and will call you at [InterviewerPhone] from [InterviewerPhone]. We anticipate the call will take about 45 minutes.

We will be speaking about your heating and cooling system installations in new single-family homes in Massachusetts and the factors that drive which equipment types are chosen. Your input will remain confidential, and we will not share your name or the name of your company. We're looking forward to speaking with you.

Sincerely,
[InterviewerName]

C.4.3 Introduction

[Note to reviewers: the following represents an example introduction that an interviewer might use. Interviewers will not follow a set script and will not be expected to follow this introduction, or the interview guide itself verbatim. Interviewers will adjust the script subject to time constraints and the responses of the interviewee.]

Thank you for speaking with us today regarding your work at [Company Name]. Today, we are hoping to ask you about your experience installing heating and cooling equipment and, if applicable, water heating equipment in new homes in Massachusetts. If you work in other states as well, please limit your responses to your experience in MA, to the extent there are distinctions. **We will focus on work in single-family new homes; this includes detached homes and townhomes, but we're happy to hear your perspectives on low-rise multifamily buildings too**.

We highly value your input; we need the real-world experience from people who work in this field. [IF NECESSARY: Your feedback will help the Mass Save program sponsors continue to offer support for the kinds of mechanical systems that you sell.] This interview will take approximately 45 minutes to complete, and we will send you a $100 electronic gift card to thank you for your time and feedback. We will confirm your email address during our conversation we will send you an email with a link to claim your gift card within a few days of your interview. Your responses will remain confidential and will only be used for research purposes and will be reported in aggregate – we will not use your name or your company's name in any public materials or provide them to the Mass Save sponsors. I would like to record our conversation so that I can focus on our discussion rather than worry about trying to write everything down in my notes as we go. Do I have your permission to record our call? Do you have any questions before we begin?

C.4.4 Consumers, contractors, and builder awareness of electrification measures

43) I'd like to start by asking what type of equipment you install, and roughly how many installs your company performs **in new single-family homes** during a typical year in Massachusetts [ASK THEM TO ANSWER FOR THEIR ENTIRE COMPANY IF THEY CAN, OR FOR THEMSELVES IF THEY CANNOT ANSWER FOR THE ENTIRE COMPANY. NOTE WHICH VALUE THEY PROVIDE]:

    a. In the past year, at how many new single-family homes did your company install heating and/or cooling systems? [IF NONE, THANK AND TERMINATE INTERVIEW]

    b. Do you install water heaters? [IF YES] How many did you install in the past year in new single-family homes?

44) Just for reference, how many employees does your company have in Massachusetts?

45) Over the last few years, about what percentage of the **new, single-family homes in Massachusetts** where you've performed installs used central, ducted air source heat pumps? [DEFINE AS NECESSARY]

    a. What percent of your new, single-family home projects in MA used ground source heat pumps?

b. What percent of your new, single-family home projects in MA mini or multi-split heat pumps?

c. [IF THEY INSTALL WATER HEATERS]: What percent of your new, single-family home projects in MA used heat pump water heaters?

46) [FOR EACH HEAT PUMP SYSTEM NOT INSTALLED]: Why do you not install [EQUIPMENT] in new single-family homes?

47) [IF THEY INSTALL HEAT PUMPS] How common is it for you to install dual fuel heating systems in new single-family homes? [EXPLAIN AS NECESSARY]

a. Do your heat pump installs in new homes typically include backup heating systems? This might include dual fuel furnace/heat pump systems, or electric resistance backup, or other options. If so, what types do you generally install, and why?

48) In your experience, who generally decides which type of mechanical equipment is installed in new single-family homes? [PROBE: BUILDERS, DEVELOPERS, INDIVIDUAL HOMEOWNERS] How involved are you in that decision-making process?

a. Typically, how aware are those individuals of heat-pump based heating and water heating systems? [PROBE FOR DIFFERENCES IN AWARENESS BY CUSTOMER TYPE]

C.4.5 Consumer, contractor, and builder beliefs about the energy, carbon reduction, and other benefits of electrification measures, and preferences for traditional systems

49) What do you consider to be the benefits of installing traditional heating and cooling systems like furnaces, central air conditioners, or boilers in new single-family homes? These could be benefits to the occupant, to you as the installer, or to the builder. [PROBE ON UPFRONT COST, FAMILIARITY, EASE OF INSTALLATION, RELIABILITY IN COLD WEATHER, AFFORDABILITY OF GAS] What are their downsides?

50) What do you consider to be the benefits of installing heat pump equipment like mini and multi-split heat pumps or central air-source heat pumps in new single-family homes? Again, these might be benefits to the occupant, the installer, or the builder. [PROBE IF THEY SEE CLIMATE CHANGE, ENERGY BILL SAVINGS, HEALTH AND SAFETY, EASE OF INSTALLATION BENEFITS] What are their downsides?

51) How often do you recommend heat pump equipment for installation in new single-family homes? Which types of heat pumps? [PROBE ON TYPE: ASHP, MSHP, GSHP, COLD CLIMATE, AND THEN ELECTRIC RESISTANCE VERSUS HPWH IF APPLICABLE] Why is that?

    a. [IF NO] Why do you not recommend this equipment?

52) Do your customers generally show preferences for traditional fossil fuel equipment in new single-family homes? How so?

53) How do you respond to customers who express negative opinions about electric heating systems? [PROBE: try to correct them? Continue to push for electric systems? Accept it and move on to fossil fuel systems?]

C.4.6 Consumer, contractor, and builder awareness that electrification can be done in an economically efficient manner

54) [ASK FOR EACH HP TYPE THEY INSTALL] Again, just focusing on new single-family homes in Massachusetts, how do the installation costs of your [CENTRAL AIR SOURCE, MINI-SPLIT] heat pump projects typically compare to fossil fuel projects, **before** factoring in any utility incentives or tax credits? [PROBE ON DIFFERENT MSHP SCENARIOS, IF APPLICABLE]

    a. [IF DIFFERENT] What drives these cost differences? [PROBE: INSTALLATION COSTS VERSUS EQUIPMENT COSTS, WHOLE HOME VS. SUPPLEMENTAL SYSTEMS, DUCTED VS DUCTLESS, COLD CLIMATE, PREFERENCE FOR DUAL FUEL OR AUXILIARY SYSTEMS WITH HPs, ETC.]

    b. [IF NOT ALREADY MENTIONED] Have you found that certain heating or cooling systems are more profitable for your company to install in new homes than others? Why is that?

55) [IF ELECTRIC OPTIONS MORE COSTLY THAN FOSSIL FUEL] How can [SPECIFIC SYSTEM] become cost competitive with the fossil fuel equipment you install in new single-family homes? What's necessary for this to happen?

56) What are your customers' opinions about the costs to buy or run heat pumps relative to fossil fuel equipment in new single-family homes? [PROBE IF APPLIES TO SPECIFIC HP TYPE AND FOR DIFFERENCES IN UP-FRONT COSTS VERSUS UTILITY BILLS]

57) What types of primary heating and cooling systems do you consider the simplest to install in new single-family homes? What is the most difficult?

7. [FOR EQUIPMENT THEY RATE AS DIFFICULT TO INSTALL] What makes [EQUIPMENT TYPE] difficult to install? [PROBE ON THE DIFFERENT WAYS TO INSTALL MSHPS AND HOW THAT IMPACTS COMPLEXITY] What would make it easier?

C.4.7 Specific characteristics (perceived or actual) of incumbent technology that consumers and contractors believe electrification measures fall short on

58) [IF NOT ALREADY COVERED] Are there additional factors we haven't talked about that prevent you from recommending heat pumps in new single-family homes? PROBE IF NOT MENTIONED FOR:

8. EQUIPMENT AVAILABILITY FROM LOCAL DISTRIBUTORS
9. COLD WEATHER PERFORMANCE
10. COST TO RUN
11. CUSTOMER CONCERNS/NEGATIVE FEEDBACK

C.4.8 Behavioral changes that consumers may need to adopt to use electric measures effectively and efficiently

59) In your experience, how often are owners of new homes that use electric systems satisfied with the performance of the equipment?

a. [IF SOME ARE UNSATISFIED]:

   i. Who is unsatisfied – the builders or end-users?

   ii. What type of customers are unsatisfied with heat pumps in new homes, in your experience? Why is that? [PROBE FOR SPECIFICS, INCLUDING ISSUES INTEGRATED CONTROLS, DUAL FUEL SYSTEMS, SPECIFIC CUSTOMER TYPES]

b. [IF NOT MENTIONED ABOVE] Have there been issues with using integrated controls in new single-family homes with backup fossil fuel heating?

c. How often do you receive customer callbacks on heat pumps in new single-family homes? What kind of issues are occurring?

C.4.9 Design changes that contractors, architects, and developers need to make to accommodate electric measures

60) Are there specific new single-family home characteristics that work for traditional fossil fuel heating systems but don't work well with heat pumps? [PROBE: ISSUES WITH SITING EQUIPMENT IN UNCONDITIONED SPACE, LOOK FOR EFFICIENT BUILDING SHELL TO PAIR WITH HEAT PUMPS]

   a. What installation challenges do you run into with heat pumps in new single-family homes? How prevalent are these? [PROBE BY SYSTEM TYPE]

   b. How could builders and architects adjust their designs to make it easier or cheaper to install electric heating systems?

   c. How does the efficiency of the building shell impact your equipment recommendation?

   d. [IF THEY INSTALL WATER HEATERS] How often are you running into designs/layouts in new single-family homes that impact the ability to install a heat pump water heater? What kinds of issues are you seeing?

61) Have your heat pump installations in new single-family homes ever required upgrading to greater than 200-amp electrical service? How often has that happened, and how did you address the issue?

C.4.10 Programmatic steps that the PAs can take to reduce behavioral and informational barriers to electrification to enable greater consumer and contractor adoption of electric measures

62) In your experience, what do you think is keeping builders and contractors from installing more heat pumps in new, single-family homes in Massachusetts?

   a. Who could help overcome these issues, and what could they do? [PROBE: MASS SAVE PROGRAMS, MANUFACTURERS, OTHERS?] [PROBE FOR STRATEGIES BEYOND INCENTIVES, E.G. EDUCATION AND AWARENESS-BUILDING]?

C.4.11 Confidence contractors have in status-quo versus electrification measures in terms of reliability, performance, maintenance costs, and consumer satisfaction

63) In your overall experience with heat pump installs, are the maintenance costs of central ducted air source heat pump systems higher, lower, or the same as a furnace and central

AC? How does this vary by service costs versus repair costs? [Service costs cover preventative maintenance before an issue has occurred, like checking for dirt and obstructions, checking refrigerant charge, and checking wearable components, while repair costs would be fixing actual problems, such as refrigerant leaks or other problems that are affecting operation.]

i. Service costs:

ii. Repair costs:

b. What about for mini-split heat pump systems? [PROBE FOR HOW THIS VARIES BY MSHP INSTALLATION STRATEGY]

i. Service costs:

ii. Repair costs:

c. [IF APPLICABLE]: What about maintenance costs of HPWHs versus other water heating options, including electric resistance, gas storage, or tankless systems?

i. Service costs:

ii. Repair costs:

64) You described [SYSTEM TYPE] as having higher maintenance costs than [SYSTEM TYPE]. Does this play into which type of system your company prefers to recommend for new homes? How so?

C.4.12 Multifamily Housing

65) Have you worked on new multifamily housing, that is, new buildings with more than one unit, in the past two years?

Yes

No [GO TO CLOSING]

66) [IF NECESSARY, REMIND RESPONDENT OF KEY ISSUES THEY MENTIONED FOR ELECTRIC SYSTEM UPTAKE.] We spoke at length about several key considerations factoring into the installation electric equipment in new homes single-family homes. Are there any additional challenges to installing electric equipment in small multifamily buildings of between 2 and 4 units?

a. What about in larger multifamily buildings of 5 or more units?

b. [IF NOT MENTIONED] On the flip side, are there advantages to multifamily properties that make installing and operating electric equipment in multifamily buildings easier?

67) Is there anything else you'd like to tell us about installing all-electric systems in new homes in Massachusetts, either for HVAC or water heating? What else do you think the sponsors of the Mass Save programs should know about electrifying new homes?

Thank you for your time! [GATHER CONTACT INFO FOR INCENTIVES]

C.5 Real Estate Agent Guide

C.5.1 Background for Reviewers

This interview guide is designed to gather insights from real estate agents into barriers to electrification in new single-family homes in Massachusetts, for the MA21R44 RNC Electrification Barriers Study. Respondents will have been screened to ensure they currently work as buyer and/or seller agents for new single-family homes in Massachusetts and will be offered a $100 incentive to participate in a 45-minute conversation.

Table 19Table 15 maps the research questions included in the Work Plan to the relevant interview questions.

Table 19: Study Research Questions and Corresponding Interview Question(s)

Research Questions	Interview Question
Are consumers, contractors, and builders aware of electrification measures?	69), 70)
Do consumers, contractors, and builders believe there are energy, carbon reduction, and other benefits of electrification measures?	0, 11), 75)
Are consumers, contractors, and builders aware of the economic benefits of electrification?	76), 76)a, 77)
To what degree do consumer and contractor preferences for incumbent technology limit installation of electrification measures?	72),18)
What are the specific characteristics (perceived or actual) of incumbent technology that consumers and contractors believe electrification measures fall short on?	72), 80), 81)
What behavioral changes do consumers need to adopt to use electric measures effectively and efficiently?	82)
What design changes must contractors, architects, and developers make to accommodate electric measures?	83)
What programmatic steps can the PAs take to reduce behavioral and informational barriers to electrification to enable greater consumer and contractor adoption of electric measures?	c

C.5.2 Recruitment Scripts

Information in brackets is for interviewers.

Fill in the fields below, select all (Ctrl-A), and update references (F9) to update scripts.

	Interviewee	Interviewer
Name	[IntervieweeName]	[InterviewerName]

Company	[IntervieweeCompany]	[InterviewerCompany]
Phone	[IntervieweePhone]	[InterviewerPhone]
Email	[IntervieweeEmail]	[InterviewerEmail]

- Date and time of interview: [InterviewDate] at [InterviewTime]

C.5.2.1 Pre-recruitment Postcard

On behalf of the sponsors of the Mass Save energy efficiency programs, NMR Group is conducting interviews with **real estate professionals who work with new single-family homes in Massachusetts**. The sponsors of Mass Save want to learn more about the heating and cooling equipment installed in newly constructed single-family homes. If you work with buyers and/or sellers of **new single-family homes** in Massachusetts and participate in a **45-minute interview,** we can offer you a **$100 incentive.**

We will follow up over email or phone to schedule an interview. If you would like to contact NMR Group about an interview, you can reach me at [InterviewerEmail] or [InterviewerPhone].

If you have any questions about the legitimacy of the study, please contact Kiersten Williams of Eversource at Kiersten.Williams@eversource.com or (603) 634-3034.

Thank you for your time.

Sincerely,
[InterviewerName]

C.5.2.2 Phone and Email Recruitment Script

[SCRIPT MAY BE ADJUSTED DEPENDING ON NUMBER OF CONTACT ATTEMPTS AND INCLUDE OTHER CUSTOMIZATIONS.]

(Email: Dear [IntervieweeName]) (Phone: Hello, can I speak with [IntervieweeName]?),

I am reaching out to you on behalf of the sponsors of the Mass Save energy efficiency programs. My company, NMR Group, is conducting interviews with **real estate professionals who work with newly constructed single-family homes in Massachusetts**. The sponsors of Mass Save want to learn more about what heating and cooling systems are installed in new single-family homes. We are interested in speaking with real estate agents who work with buyers and sellers of new single-family homes. The interview will take about 45 minutes, and **we can offer you a $100 incentive to thank you for your time.**

Your input will be held completely confidential and will help the Mass Save sponsors continue to provide support to contractors like you.

Are you available in the next week for in an interview? Please feel free to call me if you would like to discuss the study further. If you have any questions about the legitimacy of the study, please contact Kiersten Williams of Eversource at Kiersten.Williams@eversource.com or (603) 634-3034.

Thank you for your time.

Sincerely,
[InterviewerName]
[InterviewerPhone]
[InterviewerEmail]

Berkshire Gas, Cape Light Compact, Eversource, Liberty Utilities, National Grid and Unitil work together as Mass Save® to help residents and businesses across Massachusetts save money and energy, providing energy efficiency programs and services while simultaneously leading the state to a clean and energy efficient future.

C.5.2.3 Scheduling Confirmation Email Script

[SCRIPT MAY BE ADJUSTED DEPENDING ON NUMBER OF CONTACT ATTEMPTS AND INCLUDE OTHER CUSTOMIZATIONS.]

Dear [InterviewеeName],

Thank you for agreeing to speak with me. I have you scheduled for [InterviewTime] on [InterviewDate] and will call you at [InterviewеePhone] from [InterviewerPhone]. We anticipate the call will take about 45 minutes.

We will be speaking about new single-family homes in Massachusetts and the factors that drive the equipment and appliance types chosen in those homes. Your input will remain confidential, and we will not share your name or the name of your company. We're looking forward to speaking with you.

Sincerely,
[InterviewerName]

C.5.3 Introduction

[Note to reviewers: the following represents an example introduction that an interviewer might use. Interviewers will not follow a set script and will not be expected to follow this introduction, or the interview guide itself verbatim. Interviewers will adjust the script subject to time constraints and the responses of the interviewee.]

Thank you for speaking with us today regarding your work at [Company Name]. Today, we are hoping to ask you about your experience with sales of new homes in Massachusetts. If you work in other states as well, please limit your responses to your experience in MA, to the extent there are distinctions. **We will focus on sales of new single-family homes; this includes detached**

homes and townhomes, but we're happy to hear your perspectives on low-rise multifamily buildings too.

We highly value your input; we need the real-world experience and feedback from people who work in this field. [IF NECESSARY: Your feedback will help the Mass Save program sponsors continue to offer support for high quality, energy efficient new homes.] This interview will take approximately 45 minutes to complete, and we will send you a $100 electronic gift card to thank you for your time and feedback. We will confirm your email address during our conversation we will send you an email with a link to claim your gift card within a few days of your interview. Your responses will remain confidential and will only be used for research purposes and will be reported in aggregate – we will not use your name or your company's name in any public materials or provide them to the Mass Save sponsors. I would like to record our conversation so that I can focus on our discussion rather than worry about trying to write everything down in my notes as we go. Do I have your permission to record our call? Do you have any questions before we begin?

C.5.4 Are consumers, contractors, and builders aware of electrification measures?

68) I'd like to start by asking how many **new single-family home** sales you're involved with during a typical year:

69) Are you familiar with heat pump technology, for example mini-split heating and air conditioning and heat pump water heaters?

    a. How common is heat pump equipment in the homes you work with? Which types are most common?

70) Are you familiar with induction cooktops?

    a. How common are induction cooktops in the homes you work with?

71) How common are all-electric new homes? This means that heating and water heating equipment, cooking appliances, and any fireplace inserts in the home all use electricity, and the home has no natural gas or propane service [PROBE FOR NUMBER OF ALL-ELECTRIC LISTINGS THEY SEE].

    a. [IF NOT ADDRESSED ABOVE] Have they become more common in recent years?

C.5.5 Programmatic steps can the PAs take to reduce behavioral and informational barriers to electrification

72) In your experience, what do you think is preventing the installation of efficient electric equipment like heat pumps and induction cooktops in new, single-family homes in Massachusetts?

    c. Who could help overcome these issues, and what could they do? [PROBE: MASS SAVE PROGRAMS, MANUFACTURERS, OTHERS?] [PROBE FOR STRATEGIES BEYOND INCENTIVES, E.G. EDUCATION AND AWARENESS-BUILDING]?

C.5.6 Do consumers, contractors, and builders believe there are energy, carbon reduction, and other benefits of electrification measures?

73) What do your customers consider to be the benefits of traditional equipment like furnaces, central air conditioners, and gas ranges in new single-family homes? [PROBE ON UPFRONT COST, FAMILIARITY, RELIABILITY IN COLD WEATHER, AFFORDABILITY OF GAS] What are their downsides?

74) What do your customers consider to be the benefits of heat pump equipment like mini and multi-split heat pumps and induction cooktops in new single-family homes? [IF NOT MENTIONED, PROBE ON SEE CLIMATE CHANGE, ENERGY BILL SAVINGS, HEALTH AND SAFETY, EASE OF INSTALLATION BENEFITS] What are their downsides?

   a. [IF INDUCTION COOKTOPS NOT COVERED ABOVE] What kind of feedback have you heard on induction cooktops? Are homeowners aware of the technology?

75) What are your opinions on the relative merits of heat pumps and other electric equipment compared to more traditional equipment using gas? [IF NEEDED: INCLUDING FURNACES WITH CENTRAL AIR, GAS WATER HEATERS, AND GAS RANGES]

   a. Do you share your opinions on the benefits of various equipment types or appliances with potential homebuyers or sellers? [IF YES] How do they respond?

C.5.7 Are consumers, contractors, and builders aware that electrification can be done in an economically efficient manner?

76) [IF NOT ALREADY COVERED] In your experience, are new homes using heat pumps and other efficient electric equipment like induction cooktops priced higher, lower, or similarly to homes using more traditional gas equipment and appliances?

   a. [IF PRICED DIFFERENTLY] How different are the prices between homes with newer electric equipment compared to gas homes?

   b. [IF YES] Are there other home characteristics in all electric homes that might be influencing the sale prices aside from the HVAC equipment and appliances? (Examples: higher end finishes, better windows, and more efficient insulation)

77) What opinions or concerns have you heard from homebuyers about the cost of ownership for new homes using electric equipment? What about for natural gas/propane homes?

C.5.8 The degree to which consumer and contractor preferences for incumbent technology limit installation of electrification measures

78) What preferences for home configurations are you seeing from homebuyers, in terms of mechanical equipment or cooking appliances?

79) Have you ever had homebuyers pass on an offer for a home because it doesn't have natural gas/propane hookups? What equipment was it they wanted?

C.5.9 Specific characteristics (perceived or actual) of incumbent technology that consumers and contractors believe electrification measures fall short on.

80) Have homeowners ever expressed concerns about home comfort or cold weather performance when considering homes that use heat pumps?

   a. Do homeowners show a preference for some kind of fossil fuel backup or supplemental heating when a home uses electric heat pumps for heating [IF NEEDED: For example, a gas furnace]?

81) [IF CUSTOMERS SHOW PREFERENCE FOR GAS COOKING EQUIPMENT] When people prefer gas ranges to induction cooktops, what are the reasons?

   [PROBE FOR:]

      i. Bad experience with old induction cooktops
      ii. Perception that gas cooking has finer control or higher heating capacity
      iii. Need to buy new pots and pans
      iv. Cost of high-end induction cooktops
      v. Lack of knowledge about the differences between induction and traditional electric range tops

C.5.10 What are the behavioral changes that consumers may need to adopt to use electric measures effectively and efficiently?

82) What kind of concerns or feedback do you hear from homebuyers about the ease of operation of heat pumps?

C.5.11 What design changes must contractors, architects, and developers make to accommodate electric measures?

83) Do potential homebuyers ever complain about the aesthetics of heat pumps, specifically the wall mounted indoor units?