Characterization of HVAC Supply Chains in Northern Illinois

Final Report

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ComEd

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Executive Summary

On behalf of Commonwealth Edison (ComEd), NMR Group and Apex Analytics (the team) completed this study to characterize the HVAC equipment market and supply chains in Northern Illinois. ComEd currently incentivizes energy-efficient HVAC equipment at the point of installation, but market transformation literature advocates targeting market actors further upstream as a means of reducing barriers to adopting high-efficiency HVAC equipment. In addition to increasing the likelihood of causing permanent changes to markets, working with the relatively small number of midstream and upstream market actors can be a more cost-efficient way for programs to affect end-users' equipment choices. This study explores the potential for ComEd to move residential and commercial HVAC equipment programs upstream.

Overarching Research Objectives

Characterize the HVAC market and map the supply chain in ComEd's service area in Northern Illinois

Assess how the HVAC market and supply chain is changing

Identify opportunities to influence the market toward energy-efficient equipment, with a focus on moving programs to a midstream or upstream intervention

Research Activities

1. Conducted a literature review to identify HVAC programs that migrated to midstream/upstream approaches
2. Characterized the market by estimating the number of HVAC systems installed annually and describing the flow of systems through the supply chain, based on triangulation from secondary data sources
3. Identified trends in the HVAC supply chain and assess the direction of the market using interviews with HVAC manufacturers, distributors, and contractors
4. Conducted interviews with administrators of mature midstream programs to identify best practices and lessons learned

Key Findings and Recommendations

1 **While large volumes of HVAC equipment are installed in Northern Illinois in a given year, the majority of these systems are standard-efficiency, representing a substantial opportunity for ComEd to shift the market to high-efficiency systems.**

In the residential market, only about 22% of central ACs were high-efficiency systems. Despite the availability of high-efficiency ASHPs, 41% of residential ASHPs were standard efficiency products. Even in the commercial market, only about 14% of packaged roof top units (RTUs) were high-efficiency variants.

Recommendations. ComEd should consider beginning the process of developing a midstream program so as to take advantage of this opportunity. This process would involve engaging with manufacturers, distributors, and contractors to incorporate their feedback into program design.

2 **The substantial number of emergency HVAC replacements in the ComEd service area underscores the opportunity for a midstream intervention.**

Market actors estimated that about half of the installations in the residential and small-medium commercial market segments were for emergency replacements (51% of residential installs and 54% for small-medium commercial) and about one-fifth replaced near-failure systems (21% of residential installs and 20% for small-medium commercial). New construction, early retirements, and supplemental installations made up the remainder. In the large commercial market segment, market actors estimated that about 60% of installations are emergency replacements, 18% replace near-failure systems, and most of the remainder are in new construction.

Midstream programs incentivize distributors to stock efficient equipment, making these systems readily available to installers. Immediate availability is critical in emergency replacement scenarios, where even short delivery delays may cause a customer to choose the immediately-available option.

3 **Distributors are the fulcrum in the supply chain. Their unique position offers comprehensive coverage of the market and midstream programs depend on their active engagement.**

Distributors have a broad view of the market. They interact with the manufacturers who design systems and the contractors who influence end-users' equipment choices. That said, demand drives their stocking decisions, and many of their contractor customers favor standard-efficiency equipment.

Residential and small-medium commercial systems (less than 25 tons of input capacity) typically flow through the wholesale distributor supply channel. Large commercial systems (at least 25 tons) and highly customized ("applied") systems typically follow a different path to the end-user, often through a manufacturer representative, bypassing distributors. However, distributors and manufacturers both indicated that even large commercial systems (particularly heat pumps) may flow through a more traditional supply channel path that includes distributors.

Program experiences in other jurisdictions indicated that by reaching distributors with significant market share rather than a fragmented end-user market, midstream and upstream programs reduce participation barriers and can boost participation rates.

Recommendations. ComEd should look for ways to strengthen its distributor relationships, including ways to articulate the midstream value proposition and how the incentives will improve their business outcomes. In addition to incentivizing distributors to increase their stocking of high-efficiency systems, look for opportunities to help them *drive* demand. Helping distributors drive sales means not only incentivizing equipment to reduce first-costs, but it could also incorporate strategies to focus on contractors:

- incentives for distributors to offer floor/display space for high-efficiency systems
- technical training to help contractors get comfortable with advanced systems
- sales training to help contractors understand that efficient systems can be profitable to install, and to help them explain the value proposition to their customers
- training distributors to get installers to think about high-efficiency products for their *next* installation, even if it is too late to influence their current job
- developing an elite tier of highly-trained installers to help drive customer confidence

4 **The supply chain will remain stable and distributor-focused over the next few years. In that same time frame, ASHPs (including variable refrigerant flow systems) seem poised to win a larger share of the market.**

The small but potentially growing channel represented by online-only HVAC retailers represent a potential to disrupt the market, but any disruption is expected to be minor at least for the next several years, and its impact limited to the residential market. In terms of equipment, market actors expected an increase in ASHPs using inverter compressors (e.g., ductless mini-splits and VRF systems), including more options to retrofit this technology into existing distribution systems.

5 **Utilities with midstream programs have seen high-efficiency installations increase after shifting away from downstream programs, as midstream programs can help drive demand for and encourage adequate supply of high-efficiency equipment.**

Organizations such as the Midwest Energy Efficiency Alliance (MEEA) support shifting to midstream approaches. Midstream programs present significant opportunities to program administrators, such as: improving distributor stocking practices so that efficient systems are readily available for emergency installation scenarios, and boosting participation by targeting market actors with significant market share rather than a fragmented end-user market.

6 **Programs are more likely to succeed at market transformation when they are designed with clear and measurable indicators of market changes.**

Measuring market progress before, during, and after an intervention will allow a program to better track any changes to the market that might have occurred due to the program.

Recommendation. Prior to initiating a midstream intervention, ComEd should clearly lay out a program theory that identifies the outcomes of the intervention and indicators of market effects.

7 **With guarantees of confidentiality, market actors may share sales data that can inform ComEd's program approach.**

The HVAC industry is highly protective of sales data, but key players said they might share data under mutually beneficial data sharing partnerships that protect the confidentiality of their data. By obtaining such data, ComEd can better understand its programs' influence on the market.

Recommendation. ComEd should strategize about obtaining manufacturer and distributor cooperation on sharing sales data so as to allay market actors' concerns.

Section 1 Background

This project studied the potential opportunities and challenges for ComEd to move HVAC equipment programs upstream. The market transformation literature advocates targeting upstream market actors. In addition to increasing the likelihood of inducing permanent changes to markets, working with the relatively small number of midstream and upstream market actors can be a less costly way for programs to influence equipment choices available to end-users. However, there is little publicly available information about the HVAC market in Northern Illinois, or about the performance of upstream HVAC programs in other jurisdictions.

1.1 Research Objectives and Overall Approach

This project accordingly had two main objectives. The first was to describe and map the HVAC supply chain in Northern Illinois and assess how it may be changing. The second was to identify program opportunities for ComEd to influence HVAC markets and accelerate the adoption of more energy-efficient products. To meet these objectives, NMR and Apex completed a series of evaluation tasks that included:

- Describing and mapping the current HVAC supply chains in Northern Illinois
- Exploring recent and anticipated changes to these supply chains
- Identifying technological or other developments that could affect program planning
- Identifying changing practices of different types of market actors and customers
- Identifying opportunities for a prospective ComEd HVAC midstream program
- Identifying threats to current approaches to program support and achievement of goals

1.2 Methodology

The team followed a research approach centered around four research tasks, described in the subsections below. The four research tasks resulted in two comprehensive reports, detailed in Appendix A and Appendix B. A compiled detailed methodology for both comprehensive reports is presented in Appendix C. Interview and survey instruments can be found in Appendix D.

1.2.1 Literature Review (Task 1)

The team conducted a literature review to identify relevant HVAC energy-efficiency programs in the United States that have migrated to midstream or upstream delivery mechanisms. The literature review relied on publicly available reports, evaluations, program websites, conference papers, presentations, and other industry resources. The team reviewed materials associated with specific HVAC programs as well as broader industry sources that addressed general issues related to program design and transitioning programs upstream. The research covered a range of relevant topics, including the midstream and upstream HVAC program approaches, equipment types included in programs, program participation levels, participation levels before and after the program approach transition, program opportunities and threats, and lessons learned from these programs (as described by the programs, evaluators, or other market research sources).

1.2.2 HVAC Supply Chain Characterization (Task 2)

The team used several publicly available data sources to develop market size estimates for residential and commercial HVAC equipment. Residential data sources included the 2015 to 2016 Residential Energy Consumption Survey (RECS), 2017 American Community Survey (ACS), 2017 Building Permit Survey, 2012 ComEd baseline study, and 2017 Air-Conditioning, Heating, and Refrigeration Institute (AHRI) national shipment data. Commercial data sources included the 2012 Commercial Buildings Energy Consumption Survey (CBECS), the U.S. Energy Information Agency's (EIA) 2012 to 2017 Annual Energy Outlook projections, and the 2013 ComEd commercial baseline study. The team prorated the national and regional data down to the ComEd territory, then scaled data collected in different years to 2017 for residential equipment and 2018 for commercial equipment. The team then triangulated and synthesized market size estimates for HVAC equipment from the various data sources.

1.2.3 Trends in the HVAC Supply Chain (Task 3)

The evaluation team conducted 23 in-depth interviews with HVAC supply chain market actors to obtain estimates of equipment flows through supply chain channels and assess where the market is headed. The team offered respondents $150 for completing an interview. The team completed four interviews with major HVAC manufacturers, ten interviews with HVAC distributors located in the ComEd service territory, and nine interviews with HVAC contractors who work in the ComEd service territory.

1.2.4 Benchmarking Upstream HVAC Utility Energy-Efficiency Programs (Task 4)

From the midstream HVAC programs identified during the literature review, the team selected three of these utility programs for interviewing the program administrators in order to fill in information gaps in the secondary sources. The programs selected for interviews – Xcel Energy, Pacific Gas & Electric, and National Grid – were among those with the longest histories of operating midstream or upstream HVAC programs that the literature review identified.

Section 2 Detailed Summary of Findings

2.1 Background and Objectives

This study sought to assist ComEd program planning in its assessment of opportunity for moving support for residential and C&I HVAC equipment upstream. To help inform this assessment, the study sought to describe and map the HVAC supply chain in Northern Illinois and assess how it may be changing. The study also sought to distill lessons learned from the experience of upstream HVAC programs in other jurisdictions. Specific objectives of the study included:

- Describing and mapping the current HVAC supply chains in Northern Illinois
- Exploring recent and anticipated changes to these supply chains
- Identifying technological or other developments that could affect program planning
- Identifying changing practices of different types of market actors and customers
- Identifying opportunities for a prospective ComEd HVAC midstream program
- Identifying threats to current approaches to program support and achievement of goals

2.2 Methodology

To address these objectives, the team conducted four main research tasks, described below. The research tasks resulted in two comprehensive reports, detailed in Appendix A and Appendix B. A detailed methodology for each research task is provided in Appendix C. The four main research tasks included:

- Conducting a literature review to identify HVAC programs that migrated to midstream/upstream approaches (Task 1)
- Characterizing the market by estimating the number of HVAC systems installed annually and describing the flow of systems through the supply chain, based on triangulation from secondary data sources (Task 2)
- Identifying trends in the HVAC supply chain and assess the direction of the market using interviews with HVAC manufacturers, distributors, and contractors (Task 3)
- Conducting interviews with administrators of mature midstream programs to identify best practices and lessons learned (Task 4)

This findings presented in this section include high-level findings across research tasks. Appendix A presents consolidated results from the literature review (Task 1) and the benchmarking effort (Task 4), while Appendix B presents the detailed results of the market characterization effort (Task 2) and is supplemented with the related qualitative results about market trends (Task 3).

2.3 THE HVAC MARKET IN NORTHERN ILLINOIS

2.3.1 Equipment Segments and Market Size

HVAC Equipment Segments. The HVAC industry typically segments the market based on equipment size (i.e., system input capacity) and feature set, rather than the actual installation location. Accordingly, systems specified as residential grade may be installed in commercial applications, and vice versa. When appropriate, this report separately describes residential, small and medium commercial systems, and large commercial systems, as those may have different equipment flows.

Cooling equipment is segmented based on tonnage as follows.

Table 1: Cooling Equipment Segments

	Equipment Size (tons)
Residential	<5
Small-Medium Commercial	5 – 25
Large Commercial	>25

While furnace and boiler equipment is segmented based on Btus, there are no clear, specifications-based cut-points, particularly for distinguishing small and medium-sized commercial units from large commercial furnaces and boilers. Interviews with industry market actors revealed the following typical heating equipment size ranges for the different segments.

Table 2: Furnace and Boiler Equipment Segments (kBtuh)

	Furnaces	Boilers
Residential	<225	<300
Small-Medium Commercial	225-400	300-500
Large Commercial	>400	>500

HVAC Market Size. This study included estimates of the volumes of HVAC equipment installed in the ComEd territory and of the equipment flows through the HVAC supply chain channels. Due to the limitations of the available data, it is important to caution that the values presented in this report represent approximations rather than actual counts.

- The market size estimates are based on triangulation and synthesis of information from multiple secondary data sources.
- The supply channel estimates are based on integrating the market size estimates with results from primary data collection conducted through this study (online surveys and in-depth interviews with market actors).
- The residential estimates are for 2017 and the commercial estimates are for 2018.[1]

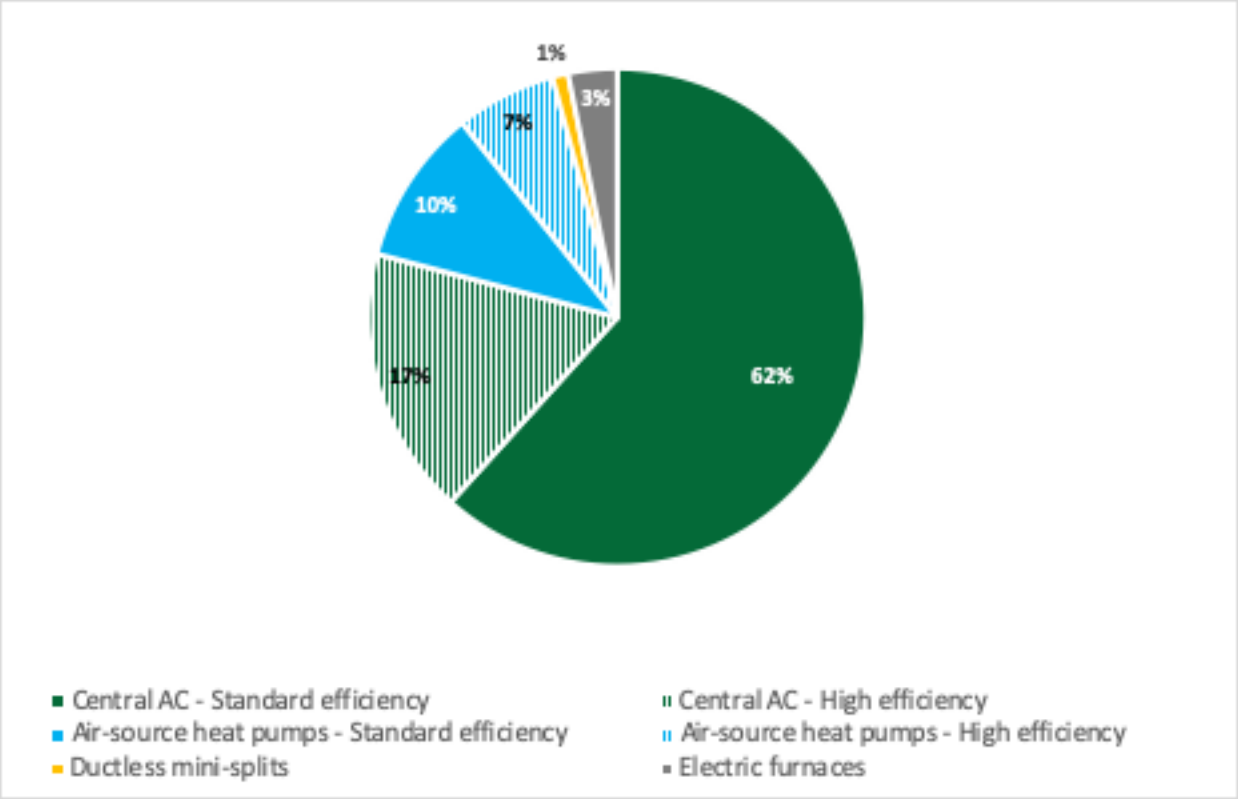
[1] Residential estimates for 2018 were not projected due to US Census permit counts not being available for 2018.

- When possible, installation volumes are broken into standard-efficiency and high-efficiency equipment.

Residential Electric HVAC Equipment Volumes. In 2017, approximately 191,000 units of residential electric HVAC equipment were installed in the ComEd service territory (Figure 1).

- Central air conditioners (central AC or CAC) accounted for about four out of five of these units with about three-fifths of the entire market (62%) being standard-efficiency units and slightly under one-fifth of the market (17%) being high-efficiency CAC units.
- Air source heat pumps (ASHP) accounted for slightly under one in five of the installed units with one-tenth of the whole residential electric market (10%) being standard-efficiency units and slightly under one-tenth of the market (7%) being high-efficiency ASHPs.

Figure 1: Estimated 2017 Installations in ComEd Service Area of Residential Electric HVAC Equipment (N=~191,000 units)[2]



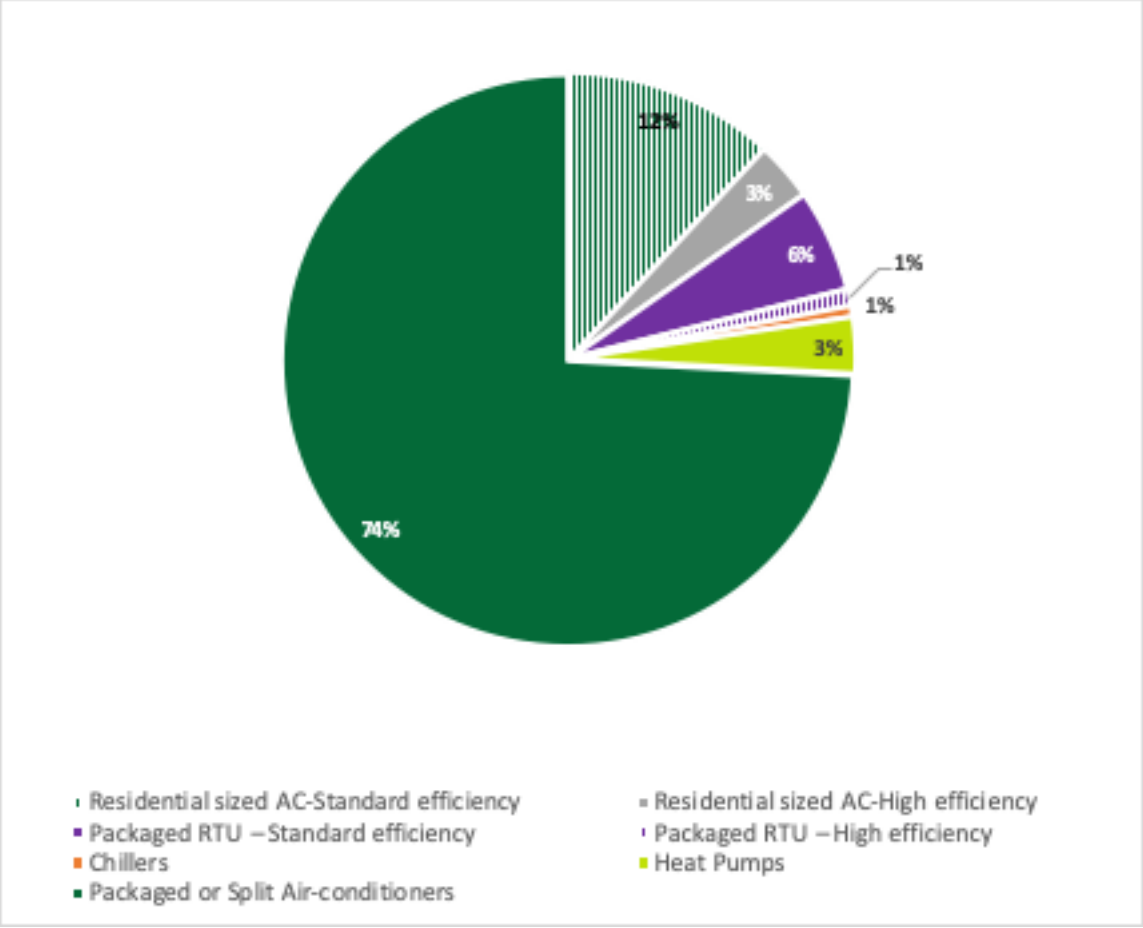
[2] Values for efficiency splits are based on ENERGY STAR penetration rates. They are not available for all equipment types where estimate values were generated.

Commercial Electric Cooling Equipment Volumes. In 2018, approximately 42,000 units of commercial electric cooling equipment were installed in the ComEd service territory (Figure 2).

- Residential-sized central ACs accounted over four out of five of commercial cooling systems, with about three-fourths of the commercial cooling market (74%) being standard-efficiency residential-sized CACs and slightly over one-tenth (12%) being high-efficiency residential-sized CACs.

- Packaged RTUs accounted for slightly under one in ten of all commercial cooling units installed (7%). The large majority of those packaged RTUs were standard efficiency, representing about 6% of the commercial cooling market.

Figure 2: Estimated 2018 Installations in ComEd Service Area of Commercial Electric Cooling Equipment (N=~42,000 units)[3]



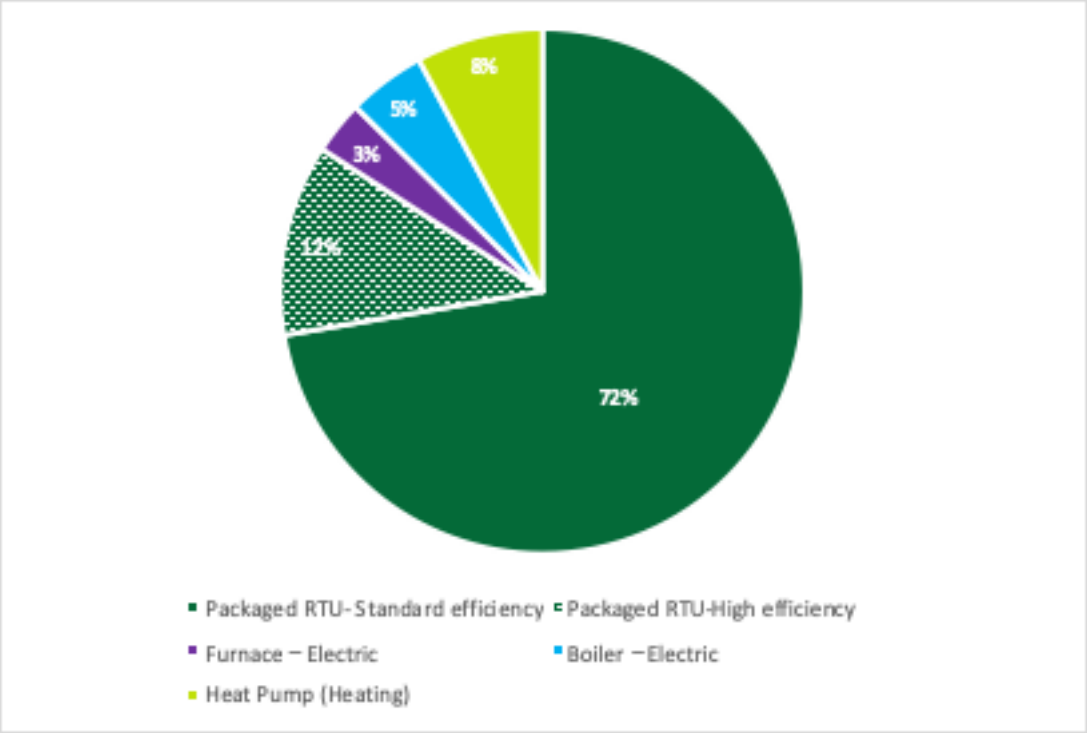
[3] Values for efficiency splits are based on ENERGY STAR penetration rates. They are not available for all equipment types where estimate values were generated.

Commercial Electric Heating Equipment Volumes. In 2018, approximately 20,200 units of commercial electric heating equipment were installed in the ComEd service territory (Figure 3).

- Packaged RTUs accounted for over four out of five systems included in this market, with slightly under three-fourths of the commercial heating market (72%) being standard-efficiency packaged RTUs and slightly over one-tenth (12%) being high-efficiency packaged RTUs.

- Heat pumps accounted for slightly under one in ten (8%) of the commercial heating units installed.

Figure 3: Estimated 2018 Installations in ComEd Service Area of Commercial Electric Heating Equipment (N=~20,200 units)[4]



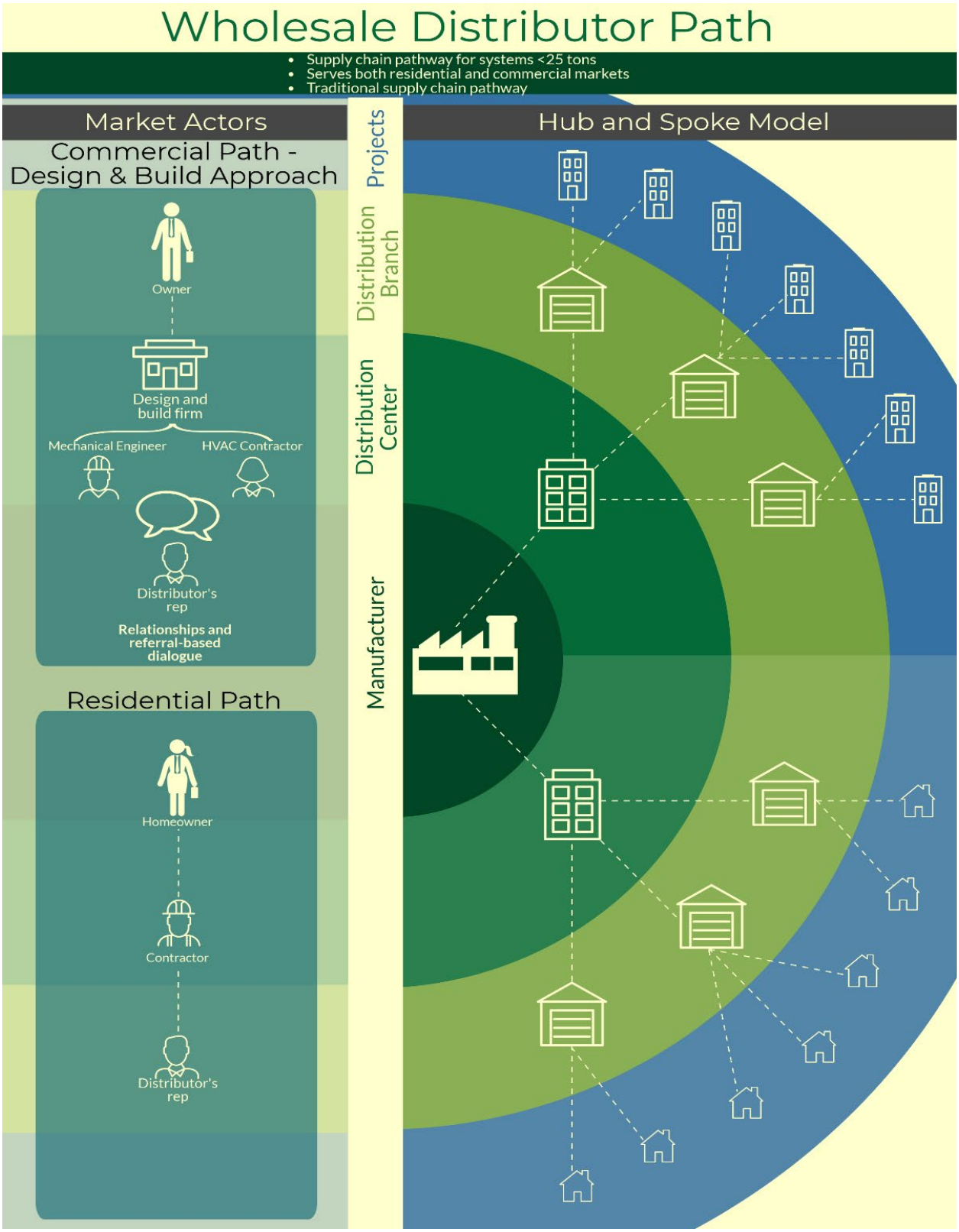
2.3.2 HVAC Supply Chain

Residential and Small-Medium Commercial Supply Chain. Residential and small-medium commercial equipment (less than 25 tons of input capacity) typically flows through the wholesale distributor supply channel, generally through a hub-and-spoke model. Although products in both market segments (residential and small-medium commercial) generally follow the distribution supply channel, the market actors involved in the purchase decision differ between residential and commercial end-users. In both sectors, there are a large number of contractors relative to the

[4] Values for efficiency splits are based on ENERGY STAR penetration rates. They are not available for all equipment types where estimate values were generated.

relatively small number of distributors. Figure 4 depicts the residential and small-medium commercial market actors that are commonly engaged with the wholesale distributor channel.

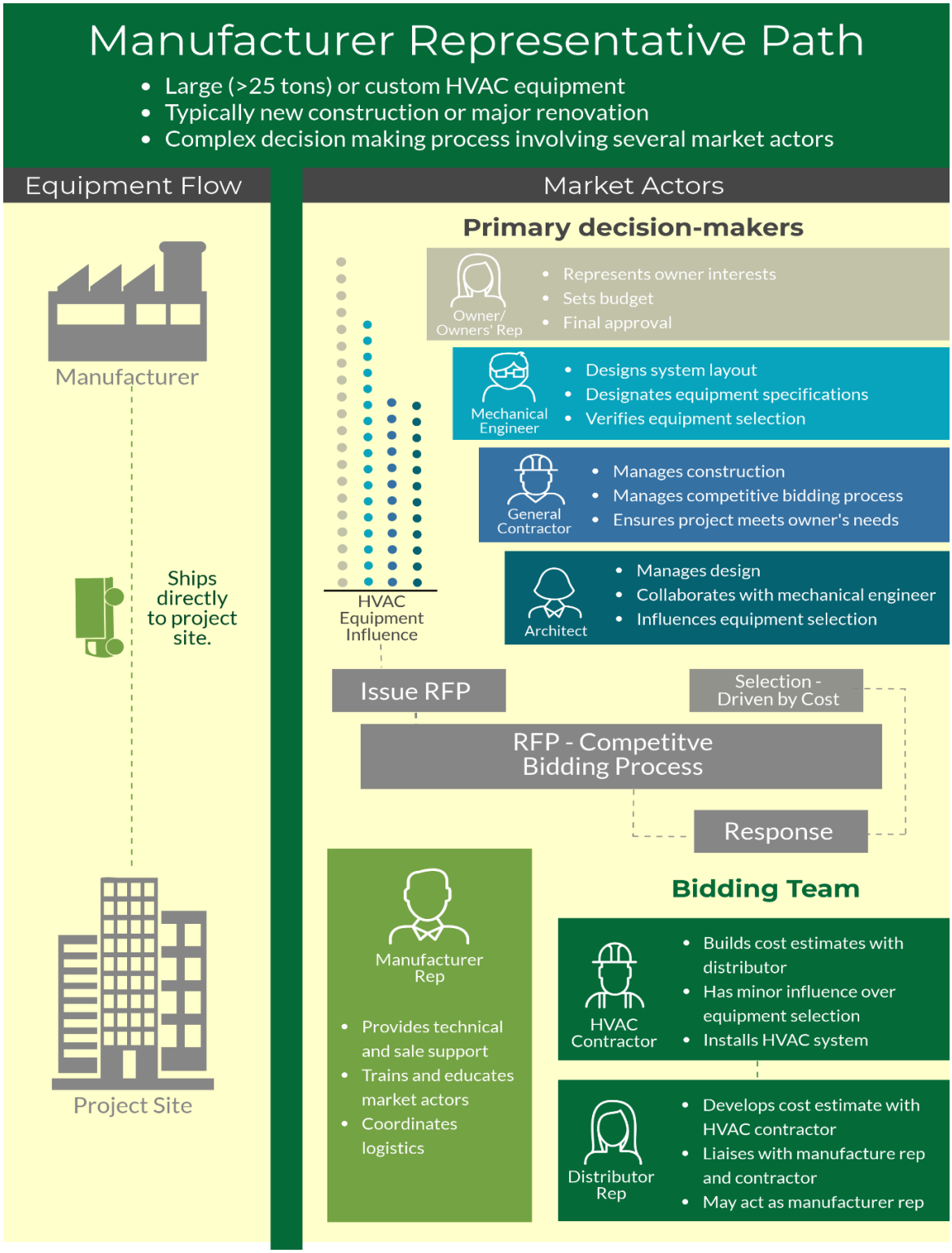
Figure 4: Residential and Small-Medium Commercial Supply Chain



Large Commercial Supply Chain. Though this distinction is based on convention rather than system specifications, equipment that is at least 25 tons is often considered large commercial HVAC equipment. These systems, along with highly customized (sometimes called “applied”) systems designed for a specific commercial facility, may follow a different path to the end-user, often through a manufacturer representative, thus bypassing distributors. However, interviewed distributors and manufacturers both indicated that systems for large commercial facilities, particularly when those systems are heat pumps, may frequently be flowing through a more traditional supply channel path that includes distributors, emphasizing the importance of distributors in the supply chain for all market segments.

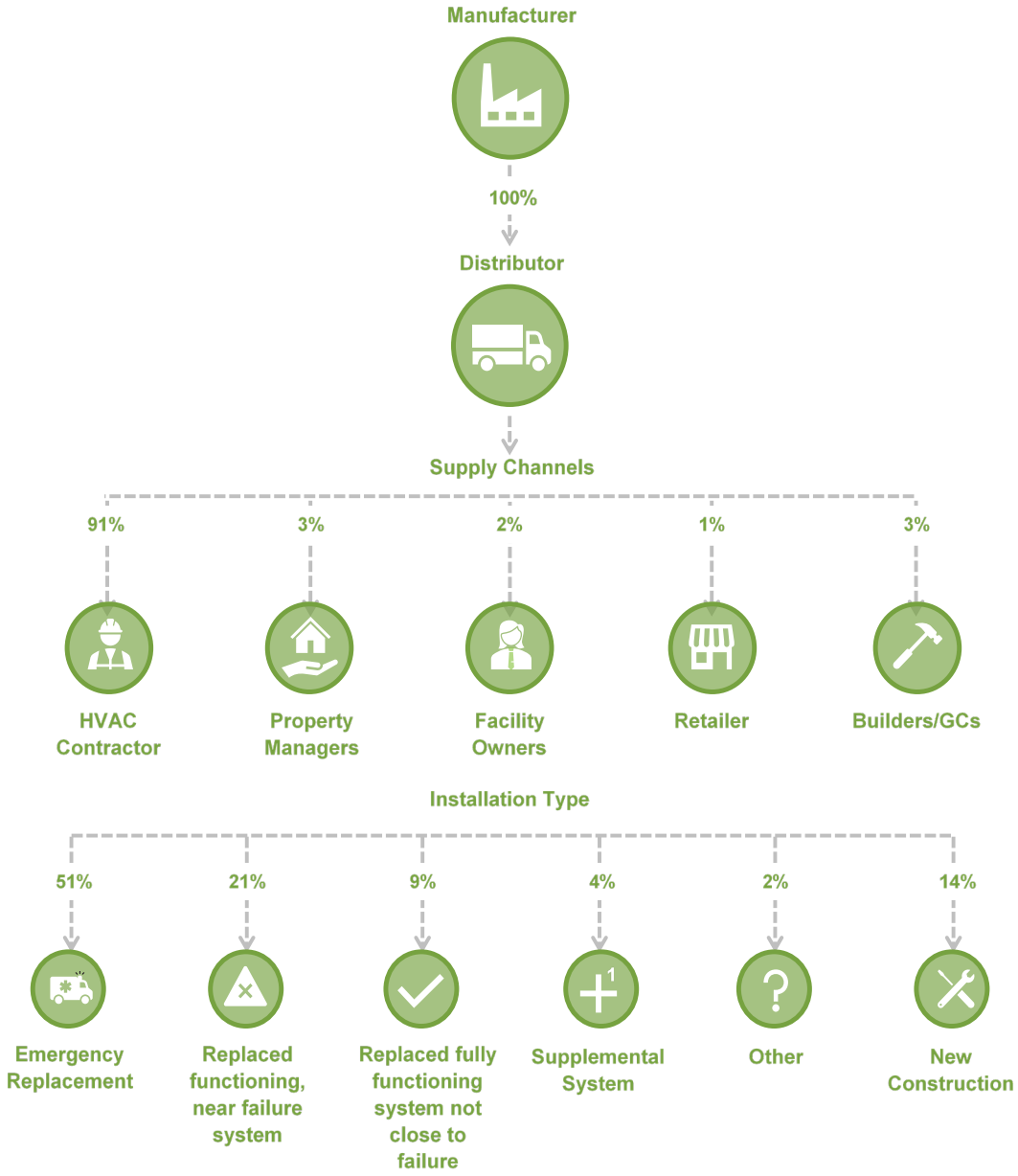
Figure 5 depicts both the equipment shipment channel and a general example of interactions with the various market actors.

Figure 5: Large Commercial Supply Chain



Equipment Flows by Supply Channel and End-use Market Segments. The team investigated the flow of systems through different supply channels and how those systems flow to different end-use market segments (i.e., emergency replacement, planned replacement, and new construction) using primary and secondary research. Figure 6 depicts how residential products flow through the various supply channels and the proportion of equipment installed by end-use, based on distributor responses.[5]

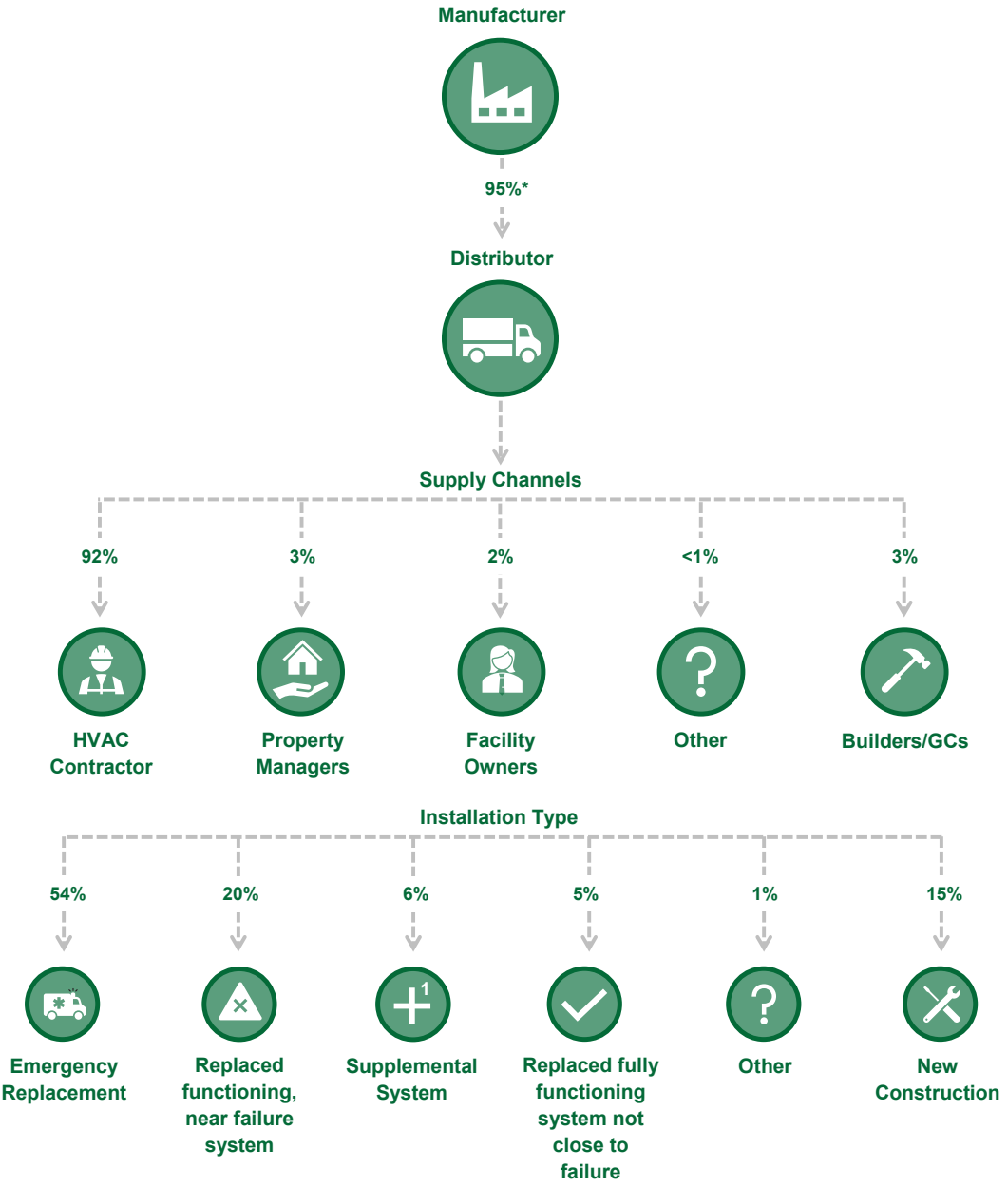
Figure 6: Residential Supply Channel Flows and Installation Scenarios



[5] The proportion of residential equipment flowing to distributors is based on manufacturer responses. The small amount of residential equipment flowing outside of wholesale distributors is presumed to be negligible.

Based on distributor responses, Figure 7 depicts the flow of small-to-medium-sized commercial equipment through various supply channels and displays the proportion of equipment installed by end-use.

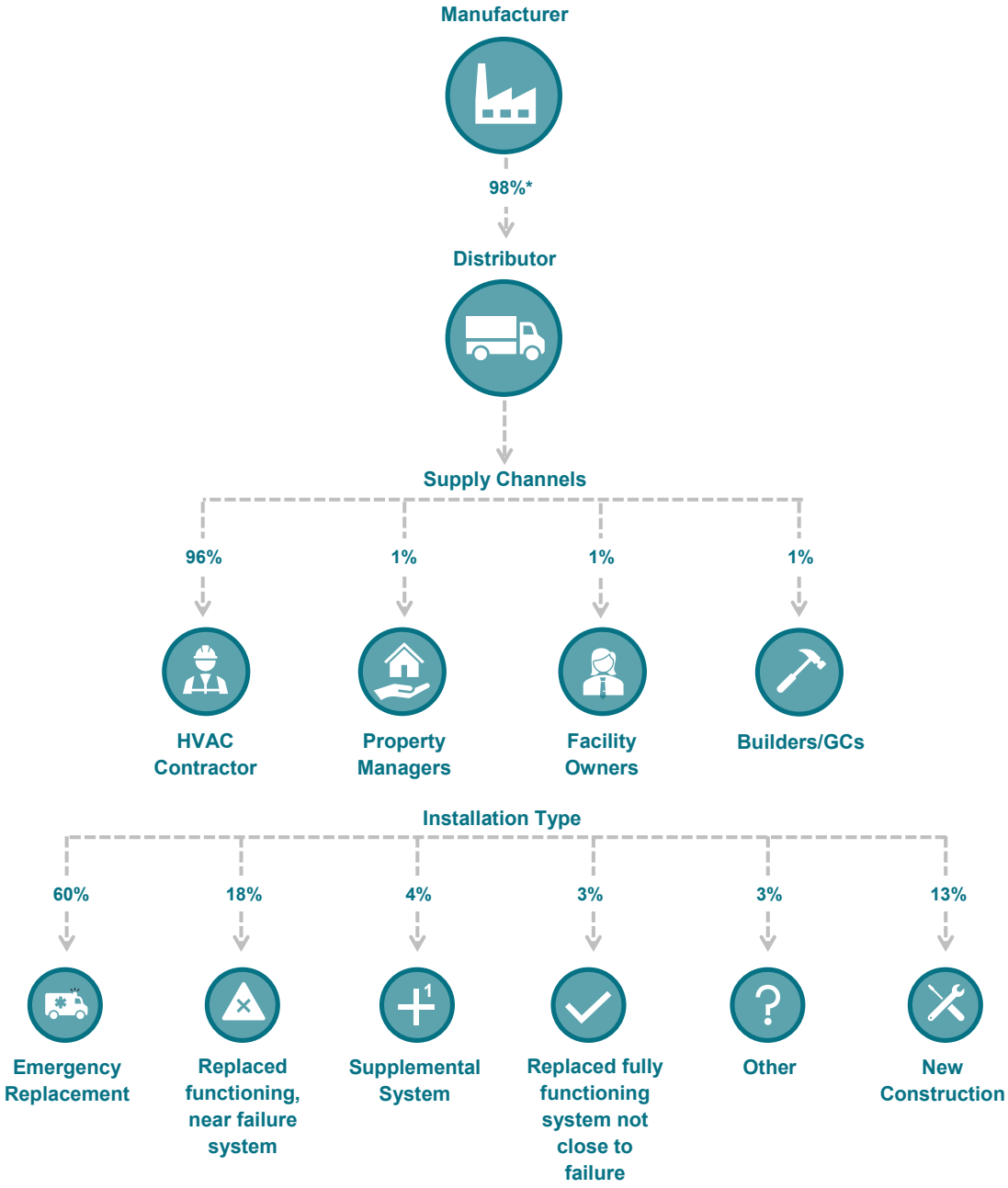
Figure 7: Small-to-Medium Commercial Supply Channel Flows and Installation Scenarios



*Manufacturers indicated that 5% of equipment sales in this market segment are direct to facility owners.

Based on distributor responses, Figure 8 depicts the flow of large commercial equipment through various supply channels and displays the proportion of equipment installed by end-use.

Figure 8: Large Commercial Supply Channel Flows and Installation Scenarios



*Manufacturers indicated that 2% of equipment sales in this market segment are direct to facility owners.

2.3.3 Market Actor Decision-Making and Segments

Purchase Decision Makers and Influencers. The purchase decision process across all sectors is generally quite similar. The end-user, developer, or business owner is most often the primary decision maker, as they control the budget that in turn governs equipment choices. Depending on

the market segment, these decisions are influenced by different market actors, as shown in Table 3.

Table 3: Market Actor Decision-Makers and Influencers

	Decision-Maker	Decision-Influencers
Residential Replacements	Owner	Primary: Contractors Other: Distributors, EE Programs
Residential New Construction	Owner/ Developer	Primary: Contractors Other: Distributors, EE Programs
Small-Medium Commercial Replacements	Owner	Primary: Contractors Other: Distributors, EE Programs
Large Commercial Replacements	Owner	Primary: Engineers, Contractors Other: Architects, EE Programs, Distributors/Mfg. Representative
Commercial New Construction	Owner/ Developer	Primary: Engineers, Architects Other: Contractors, EE Programs, Distributors/Mfg. Representative

Distributor Stocking Practices. Distributors base stocking decisions largely on market demand and most of their contractor base often install standard-efficiency equipment, particularly in the residential and small-medium commercial market sectors where emergency replacements (and tight budgets) are often the norm.

Promoting High-Efficiency Equipment. Higher-efficiency equipment sales often offer greater margins for both distributors and contractors. However, distributors noted that stocking more high-efficiency equipment occupied valuable space if the equipment failed to turn over quickly in their warehouses. Additionally, customers may not always understand the value proposition of high-efficiency equipment and contractors may not always be skilled to explain the benefits. This could limit contractors' willingness to recommend this equipment.

Market Segments and Motivations. The market segments across most sectors are generally either driven by cost considerations or focused on the overall value proposition of the equipment, including improved comfort and return on investment. Note that our market actor interviews suggested that the small-medium commercial sector is completely price-driven. The team believes that some of these market actors may be focused on a broader value proposition, but capital limits can make first-costs their driving factor.

Table 4: Key Market Actors and Their Motivations

	Cost-Driven Market Actors	Value-Driven Market Actors
Homeowners	First cost, reliability, warranties	Comfort, payback period, environmental impacts, reliability, warranties
Residential Contractors	Standard equipment installers: equipment familiarity, installation ease, customer call-backs	Value-focused installers: value proposition for customers and themselves
Residential New Construction Builders	Spec builders: first cost, code minimum	Custom builders: quality, marketability, end-user comfort
Small-Medium Commercial End-Users	First cost, reliability, warranties	*No mention of value-driven segment*
Large Commercial End-Users	Property managers: first cost, reliability	Owner-occupants: first cost, ROI, reliability, energy savings

2.3.4 Market Actor Perspectives on Utility Programs

Market actors interviewed for this study provided their perspectives on the relative merits of the different types of utility program interventions: downstream, midstream, and upstream. Downstream programs usually target the end-user, midstream programs typically target distributors, and upstream programs target manufacturers.[6]

- Downstream programs put the burden of participation on end-users or contractors, and require program administrators to interact with a large number of customers. To be effective, downstream programs typically require large scale marketing efforts. Customers may not know about these programs and may find them confusing to navigate. A significant benefit of downstream programs is that the end-user receives the full and direct financial benefit.
- Upstream programs may have the potential to cost-effectively impact the market on a much broader scale, because the programs would impact manufacturers, thereby affecting the supply of products for the entire market. However, program implementation and evaluation can be quite difficult with this approach. Given that manufacturers sell products regionally and nationally, it can be challenging with this approach to ensure that ratepayer money is being spent only on systems installed in a given utility service territory. Success in this space may require coordination across a coalition of regional utilities, to overcome issues with geographic boundaries and being the furthest supply chain actor from the installation.

[6] Some midstream programs may be referred to as upstream programs, in that they operate upstream of the end-user, but for the sake of clarity, this report uses the terms midstream and upstream to refer to different program delivery mechanisms.

- A midstream intervention provides combines the dual benefit of working with fewer market actors than with a downstream intervention, and being closer to the installation contractors and end-user than an upstream intervention. Providing incentives in a midstream intervention reduces the paperwork barriers that deter contractor or end-user participation in a downstream program. This administrative burden in a midstream program typically falls on distributors. Accordingly, some programs may allow distributors to keep a portion of the incentive or provide support for the administrative overhead, in addition to the benefits of the increase in sales for higher margin, higher efficiency equipment.

2.3.5 Trends in the HVAC Industry

Market actors were asked about: (i) anticipated changes in the supply chain channels and (ii) significant HVAC technology changes they have experienced in the *last* three to five years and the technological changes they anticipate in the *next* three to five years.

Changes in Supply Channel Structure. Most market actors reported that there would not be major changes to the traditional supply chain in the near future. Shifting completely away from the current supply chain model would require a massive effort and be costly. However, market actors noted that there is an online-only retailer or wholesaler presence in the HVAC market and anticipate that new players in the market may use these channels to try and disrupt the traditional supply chain model. These online vendors are distinct from traditional brick-and-mortar distributors who may also have an online portal for purchasing equipment. These online-only channels tend to represent small installation quantities and primarily impact the residential market segment, but could grow over time and win sales from traditional distributors if they can effectively compete on price. None of the market actors anticipated that the commercial market is likely to adopt these channels, as commercial equipment is larger and more complex, and may require more customization than off-the-shelf solutions.

While respondents generally saw the supply chain as stable, several anticipated issues in the next few years from an increased market share for the online-only channel. Online-only sellers, including those that are headquartered out of state, can sell directly to consumers, bypassing contractors and traditional brick-and-mortar distributors. Some interviewees noted that any such online-only sellers do not have the practical experience or technical expertise to help diagnose situations in the field – or the resources to meet contractors on-site to troubleshoot installation issues. Contractors purchasing through this channel due to price sensitivity may be particularly discouraged from promoting higher-efficiency equipment, due to the perceived lack of support for these advanced systems.

Changes to HVAC Technologies and Adoption.

- Residential Sector. Market actors noted that the residential sector has seen an increased adoption of inverter compressors, the technology utilized in the ASHPs commonly referred to as ductless mini-splits (DMS). However, they did not see DMS systems replacing traditional HVAC systems on a large scale – such whole-home replacements typically require an extremely tight and highly insulated building envelope in the northern Illinois heating-dominated climate.

- Small and Medium Commercial Sector. Market actors noted that more variable refrigerant flow (VRF) ASHP systems were being installed in small and medium commercial settings over the past few years – however, this market segment is still heavily driven by first-costs, so adoption levels are not as high as in larger commercial segments.
- Large Commercial Sector. Market actors have noticed a shift towards VRF system adoption in large commercial settings and anticipate increased VRF installations in larger multifamily buildings. Contractors and distributors noted that VRF systems are also being installed in schools, hospitals, and office buildings.
- Inverter Kits. Manufacturers mentioned that inverter kits that can be used to convert traditional equipment to heat pump technology will become more common in the market, allowing upgrades without fully replacing an existing system. Distributors also were aware of this technology and anticipate it will very soon come to market on a broader scale – first for commercial applications and followed by residential applications.
- Advanced Controls. Distributors and manufacturers both anticipate that more advanced controls would be adopted on a wide-scale by all market segments. Currently the large commercial HVAC market segment already utilizes building management systems and automated controls. Market actors anticipate greater adoption by the residential and small-medium commercial market segments, due to the desire for better control over occupant comfort. However, small commercial end-users who are particularly cost-sensitive are likely to have lower adoption levels.

2.4 Review of Midstream HVAC Programs

2.4.1 Current Midstream Programs

The team conducted a literature review of 18 HVAC programs in 15 states that have migrated to midstream or upstream delivery mechanisms. These programs target market actors further upstream from the end-user. Though some call themselves *upstream* programs, they can all be considered “midstream” programs, as they are primarily focused on contractors and distributors. Table 5 shows the HVAC programs identified by this literature review.

Table 5: Midstream HVAC Programs

Sponsor	State	Residential	C&I
PG&E	CA		✓
SCE	CA		✓
SDG&E	CA		✓
SMUD	CA		✓
NV Energy	NV		✓
Efficiency Vermont	VT	✓	✓
Efficiency Maine Trust	ME	✓ (HPWH only)	✓
National Grid	MA		✓
National Grid	RI		✓
Eversource, United Illuminating	CT	✓	✓
Xcel Colorado	CO		✓
PNM	NM		✓
Georgia Power	GA		✓
NYSERDA	NY		✓
Duke Energy	N/A[a]		N/A
CenterPoint Energy	N/A[a]		N/A

[a] Unable to determine due to operation in multiple states and limited program information.

2.4.2 Midstream Program Characteristics

Midstream HVAC programs can operate successfully in the residential or C&I sectors, and in some cases operate in both. Programs that incentivize residential and C&I equipment tend to focus their commercial efforts on small and medium-sized systems, rather than large commercial equipment.[7]

When implemented with intentionality and thoughtful planning, programs that have shifted upstream often tend to increase their savings and drive the market toward higher efficiency HVAC equipment.

Industry organizations such as Midwest Energy Efficiency Alliance, Southwest Energy Efficiency Project (SWEEP), Northwest Energy Efficiency Alliance (NEEA), Northeast Energy Efficiency Partnerships (NEEP) and Association of Energy Services Professionals (AESP) support moving HVAC programs to midstream or upstream channels. Our review of the results of HVAC midstream programs often corroborated this recommendation.

2.4.3 Moving Upstream: Opportunities and Challenges

This literature review identified notable opportunities and challenges that programs face in shifting away from downstream approaches.

[7] The industry refers to residential HVAC equipment to be less than 5 tons, small commercial equipment to be between 5 and 25 tons, and large commercial equipment to be greater than 25 tons.

Opportunities Associated with Moving Programs Upstream

- Improving distributor stocking practices. Midstream programs incentivize distributors to stock efficient equipment, making these systems readily available to installers.
- Serving the emergency replacement market. When efficient equipment is readily available, and contractors are aware of its benefits, it can be installed in situations where the customer cannot wait for a special-order product.
- Serving the new construction market. Midstream and upstream programs can build relationships with key manufacturers, distributors, system designers, and large-scale builders and encourage them to install efficient systems in their many projects.
- Boosting program participation. By reaching market actors with significant market share rather than a fragmented end-user market, midstream and upstream programs reduce participation barriers and can boost participation rates.
- Driving uptake of higher equipment efficiency levels. Adopting tiered incentive structures that provide higher incentives for equipment meeting greater efficiency levels, midstream programs can encourage market actors to promote more efficient equipment and identify efficiency tiers that provide the greatest benefit to the program.

Challenges Associated with Moving Programs Upstream

- Reduced focus on end-users. Program sponsors risk becoming more disconnected from end-users (who are often customers).
- Restrictions on incentives. By requiring midstream market actors to pass discounts along to their customers, programs risk alienating potential midstream participants.
- HVAC installation quality. Programs that focus on manufacturers and distributors rather than contractors may have limited leverage or ability to require contractors to follow sound installation practices.
- Lack of end-user data. Downstream programs generate rich databases of end-user data. Upstream and midstream market actors may not be willing to share sales data with program sponsors, and they may have limited information about end-users.
- Double-counting program savings. Programs risk double-counting savings if they incentivize the same products via upstream and downstream channels.
- Meeting cost-effectiveness requirements amid changing efficiency standards. Efficiency standards increase baseline efficiency levels, reducing the savings programs can claim for installation of efficient equipment. This, among other factors, can make it difficult for midstream programs to meet their cost-effectiveness targets.

2.4.4 Design Considerations for Midstream Programs

The literature review identified key design considerations that programs may benefit from integrating into their planning and implementation efforts, along with selected real-world lessons from program sponsors and implementers.

Program Design Considerations for Midstream Programs

- Conduct sufficient market intelligence. By understanding how their market operates, programs are best positioned to intervene effectively.
- Engage with distributors. Programs will need to develop and invest in relationships with their distributors, who are key drivers of midstream programs.
- Communicate the midstream value proposition. Programs need to understand and be able to explain how these incentives will affect distributors' business outcomes.
- Strategize about getting sales data from distributors. Programs benefit from detailed sales data, but distributors may be averse to responding to burdensome requests for sensitive data.
- Choose the best equipment to shift upstream. Programs will need to identify which technologies to shift upstream based on program goals, savings potential, and market potential; and recognize the challenges associated with operating simultaneous midstream and downstream programs.
- Set the proper incentive structure and amount. Programs should work with distributors to set incentive levels and structures that encourage participation by key market actors.

Real-world Lessons from Midstream Program Managers

- Keep abreast of local economic conditions. Challenging local economic conditions can reduce program outcomes, without concerted program efforts.
- Non-program equipment may catch up to efficiency of program equipment. Programs may need to be flexible and adjust their offerings to stay ahead of baseline performance.
- Market transformation programs must track indicators of market progress. Without tracking indicators or market progress, programs may not be able to measure their impacts on the market, limiting their ability to claim market effects or market transformation.
- Participating distributors can become inactive. Continual engagement with distributors is needed to keep low-interest distributors from failing to actively engage with the program.

2.5 CONCLUSIONS AND RECOMMENDATIONS

1) Data suggest that a midstream program offering would position ComEd to drive the market toward greater adoption of high-efficiency HVAC equipment.

   Recommendation. ComEd should consider beginning the process of developing a midstream program through an assessment of internal and external factors including identifying the appropriate equipment types and market segments to target. Such a process would also involve engaging with manufacturers, distributors, and contractors to incorporate their feedback into the program design process. The remaining conclusions and recommendations provide additional guidance about factors to incorporate into such a planning process.

2) In the ComEd service area, an estimated three out of four residential electric AC system installations and four out of five commercial cooling and heating systems installations were standard efficiency.[8]

   Relevance to midstream program design. The fact that such a large number of systems installed in a given year are standard efficiency represents a significant opportunity for ComEd to drive the market toward high-efficiency systems.

3) Around four out of five residential and commercial retrofit installations were emergency replacements, rather than planned replacements. Distributors base stocking decisions largely on demand and many of their contractor customers primarily install standard-efficiency equipment. Choosing standard-efficiency products is particularly common in the residential and small-medium commercial market sectors, where market actors are sensitive to price and buying systems in emergency replacement scenarios, where they have less time to research options that might provide better value over the long-term. Midstream programs incentivize distributors to stock efficient equipment, making these systems readily available to installers. Immediate availability is critical in emergency replacement scenarios, where even short delivery delays may cause a customer to choose the immediately-available option. The substantial number of emergency HVAC replacements in the ComEd service area underscores the opportunity for a midstream intervention.

   Recommendation. In designing a midstream program, in addition to incentivizing distributors to increase their stocking of high-efficiency systems, look also for opportunities to drive demand. Helping distributors drive sales means incentivizing equipment to reduce first-costs, but it could also incorporate strategies to focus on contractors:

   - incentives for distributors to offer floor/display space to efficient systems
   - technical training distributors can offer to help contractors gain comfort with installing and servicing efficient equipment
   - sales training to help contractors understand the value proposition for them to install efficient systems (e.g., high profit margins) and for their customers to choose them (e.g., payback periods)
   - training distributors to push installers to think about high-efficiency products for their next installation, even if the contractor has already decided on their current needs
   - developing a pool of or encouraging customers to select from an elite tier of contractors/installers may help drive customer confidence in high-efficiency systems (manufacturers such as Mitsubishi encourage customers to use contractors from their own branded installer pool[9])

[8] Estimated for 2017 for residential systems, and for 2018 for commercial systems.
[9] https://www.mitsubishicomfort.com/articles/personalized-comfort/the-diamond-contractor-a-homeowners-best-friend

4) Decision makers in the residential and commercial sectors included market actors who were focused on first costs and tend to choose standard-efficiency equipment. Indeed, the small-medium commercial sector was described as almost entirely driven by sensitivity to first costs. A midstream program would increase the likelihood of overcoming the first cost barrier for customers to purchase high-efficiency equipment, making these systems more cost-competitive with standard efficiency systems. Additionally, contractors are among the most influential market actors in terms of influencing an end-user to choose a high-efficiency system.

5) The research on the HVAC supply chain found that in both the residential and small-medium commercial sectors, contractors are fragmented over a large geographic area that is serviced by relatively few distributors. The end-users themselves, particularly in these sectors, are of course part of the widely-dispersed, fragmented mass market.

   Distributors are the fulcrum in the supply chain whose unique position offers comprehensive coverage of the market. The review of program experiences from other jurisdictions found that by reaching distributors with significant market share rather than a fragmented end-user market, midstream and upstream programs reduce participation barriers and can boost participation rates.

   Relevance to midstream program design. A midstream intervention focused on distributors would reduce the number of market actors the program needs to reach – there are far fewer distributors than there are end-users. This shift can result in a more streamlined approach to achieving energy savings, where the program can focus on influencing the influencers rather than having to market their programs to the large, fragmented market of end-users and contractors.

6) Most market actors do not think there will be major changes to the traditional supply chain in the near term. That said, several market actors anticipated issues arising from direct-to-end-user sales in the residential market. They noted that retailers and online-only wholesalers do not have the practical experience or technical expertise to provide comprehensive support to contractors. Market actors generally viewed online-only wholesalers as a small, though potentially growing market segment, but none of them anticipated that the commercial market was likely to shift to these channels, as commercial equipment is larger and more complex.

   Relevance to midstream program design. The prospect of supply chain disruption and distributor disintermediation appears to be limited for the foreseeable future and the effectiveness of a midstream intervention will likely not be diminished by possible online sales.

7) As the research on the HVAC supply chain and the review of other programs revealed, midstream programs depend on the active participation and engagement of distributors.

   Recommendation. ComEd should consider the relationships it has with distributors and strategize for ways to strengthen these relationships, in order to build a pool of distributors who will actively participate in a midstream program. A critical element of the relationship building effort will be to clearly and persuasively articulate to distributors the midstream

value proposition and how the incentives will improve their business outcomes. This should include working with distributors to set appropriate incentive levels and structures, including developing guidelines concerning the extent to which incentives need to be passed along to contractors.

8) The review of program experience from other jurisdictions found that a successful transition to a midstream intervention also requires a clear understanding of the market in which a program operates. Understanding the market prior to a midstream intervention also allows a program to better track any changes to the market that might have occurred due to the program. Programs are more likely to succeed at market transformation when they are designed with the intention of market transformation and design their programs with clear and measurable indicators of market changes.

   Recommendation. Prior to initiating a midstream intervention, ComEd should clearly lay out a program theory that identifies the short, medium, and long-term outcomes of the intervention and indicators of market effects that can be tracked so as to measure market progress.

9) Some of manufacturers and distributors we interviewed were willing to share sales data, but expressed a need for a protective contract such as a non-disclosure agreement (NDA), memorandums of understanding (MOUs), and/or a collaborative data-sharing partnership.

   Recommendation. ComEd should strategize about obtaining manufacturer and distributor cooperation on sharing sales data. In particular, a midstream program would benefit from detailed distributor sales data that includes all products, not just incentivized units. It is important to allay any concerns manufacturers and distributors may have around sharing sensitive data.

Appendix A Tasks 1 & 4: Literature Review & PA Interviews

This appendix[10] describes the results of a comprehensive literature review, supplemented by interviews with select program managers, designed to develop a better understanding of the benefits and challenges of moving HVAC programs upstream, identifying programs with upstream components and describing the lessons learned from implementing upstream programs or shifting to an upstream program design. That said, the appendix focuses on midstream programs, as all of the *upstream* HVAC programs identified can more rightly be considered midstream programs, as they focus on distributors rather than manufacturers.

This research described in this appendix included the following tasks:

- Identifying HVAC programs that have migrated from downstream to midstream or upstream channels.
- Identifying and describing midstream and upstream HVAC programs around the country.
- Reviewing industry reports on the downstream, midstream, and upstream supply channels and market actors.
- Conducting in-depth interviews with three program managers to fill in gaps in information available from secondary sources.
- Describing opportunities, challenges, and lessons learned from migrating HVAC programs upstream.

A.1 Methodology

The evaluation team compiled the methodology for various research tasks conducted into a separate methodology in Appendix C. The methods for this appendix are detailed in Appendix C.1:

- The methods used to conduct the literature review are described in Appendix C.1.1.
- The methods for midstream HVAC program interviews are described Appendix C.1.2.

A.2 Current Midstream HVAC Programs

HVAC programs may shift from a downstream (end-user) focus to a midstream focus (distributors or contractors) or upstream focus (manufacturers) to more cost-effectively achieve energy savings and expand the reach of their programs. Program sponsors can drive participation by

[10] This appendix represents an updated version of the Task 2 memo that presented preliminary findings to ComEd, prior to the completion of the referenced in-depth interviews with utility program staff.

leveraging the reach of a smaller number of market actors who operate further upstream without having to directly engage with each end-user.

This section describes active HVAC programs that transitioned away from a purely downstream approach. These programs all primarily focus on distributors (or contractors) and can therefore be considered midstream programs, rather than true upstream programs, which would focus on manufacturers. This section includes a summary of each program's performance in the market, based on available data.[11] We have summarized these programs using publicly available resources such as evaluation reports, conference papers, program materials, and other industry sources.[12] Lessons that can be distilled from the experiences of these programs are described in Section A.3 and Section A.4.

A.2.1 California Upstream HVAC Distributor Incentive Program

Pacific Gas and Electric (PG&E) in California piloted the first C&I midstream HVAC program in 1998, with a stated goal of addressing missed savings opportunities in the emergency replacement market. By skipping the end-user and directly incentivizing distributors to stock more efficient equipment, they hoped to overcome traditional barriers associated with the adoption of efficient equipment, such as long lead times, high cost, and low customer awareness.

PG&E switched back to a downstream approach in 2002,[13] which caused a huge drop in the number of systems incentivized by the program (as shown in in Figure 9 and Figure 10), and thus in the program's savings.[14,15] Accordingly, PG&E shifted back to a midstream approach in 2004. Southern California Edison (SCE) began implementing upstream programs for commercial HVAC equipment in 2004 and has seen similar success in increasing participation and savings.

In addition, PG&E chose to work with distributors due to their central position in the supply chain, although program staff noted that it was important for the program to maintain contact with manufacturers. Frequent communication with manufacturers allows the program to keep abreast of products in development and ensure that the program is prepared to incorporate new, efficient products as they enter the market. Program staff also noted that manufacturers are increasingly developing their own distribution operations, and the program has begun to work with these manufacturers in the same way they work with more traditional distributors.

The success of the midstream approach inspired program administrators to use the distributor channel to introduce new technologies such as variable refrigerant flow (VRF) systems[16] and water-cooled chillers. Program staff expect that water-cooled chillers will be an important measure

[11] The extent of available information about each program varied considerably.
[12] The sections below include three cases of midstream programs, which reverted to a downstream focus. A fourth case, CenterPoint Energy, appears to have discontinued their upstream program but the team found limited information. Note also that the team found evidence that Duke Energy has a midstream HVAC program, however we were unable to obtain publicly available information regarding the program history, experience, or impacts.
[13] We were unable to uncover the specific reason the program reverted in the literature but speculate it may have been a utility attempt to re-engage with end-users.
[14] Daniel Cornejo and Brian Barnacle. "The 900 percent solution: Upstream Best Practices across HVAC and Multiple Technologies," presented at the ACEEE Conference, 2016.
[15] Hector Lefbad. "Market Effects of Commercial Upstream Programs: Flexibility Leads to Creativity," presented at the ACEEE conference, November 1, 2017.
[16] A VRF system is a commercial-grade mini or multi-split system. The system configuration is more flexible than traditional mini-split systems and can heat one area of a building while simultaneously cooling another area.

for the program going forward, and are also working to gain regulatory approval to offer incentives on other emerging cooling technologies, which they see as future energy saving opportunities. California programs have also expanded the Upstream HVAC Distributor Incentive Program to include food service equipment and water heating equipment.

PG&E does not place incentive passthrough requirements on distributors in the midstream HVAC program. Program staff see giving distributors freedom to choose how they will use the incentives as the most effective way to achieve the program's goal of increasing the volume of qualified equipment sold. PG&E's only reporting requirement is that distributors provide a zip code for the location the equipment will be installed to verify the installation is within PG&E's service territory. Program staff noted that many distributors will voluntarily include additional information.

PG&E's goals for the midstream HVAC program focus on the tonnage of equipment incented and the resulting energy and demand savings, as well as meeting the program's incentive spending goals. The program does not currently have goals focused on achieving specific market transformation metrics, although staff does see the program as influencing the market. PG&E has a defined procedure for when to end intervention to support a particular technology: if efficiency standard changes eliminate the technology's savings opportunity, PG&E gives the market 60 days' notice before ending incentives. Staff noted that this can be challenging, as changes to efficiency standards may occur more quickly than the market can adapt.

Investor-owned utilities (IOUs) in California still have large midstream programs for commercial HVAC equipment. From 2010 to 2012, 82 GWh of savings were attributed to the Upstream HVAC Distributor Incentive Program (PG&E and SCE combined)[17,18] The program incentivizes small and large HVAC equipment; PG&E implemented a pilot for residential HVAC equipment in 2014, but it was not expanded in 2015.[19] Responding to a California Public Utilities Commission mandate that 60% of efficiency programs operate statewide, in 2020, PG&E's midstream HVAC program will merge with other California IOUs' programs to form a statewide program, which San Diego Gas & Electric will administer.

[17] The Upstream HVAC Distributor Incentive Program originally included: PG&E, SCE, San Diego Gas and Electric (SDG&E), NV Energy, and Sacramento Municipal Utility District (SMUD).
[18] Program summary provided by program implementor, Energy Solutions. https://energy-solution.com/project/distributor-hvac-program/
[19] DNV GL. "Impact Evaluation of 2015 Upstream HVAC Programs (HVAC1)," provided to CPUC April 4, 2017.

Figure 9: PG&E HVAC Program Performance, Downstream vs. Upstream[20]

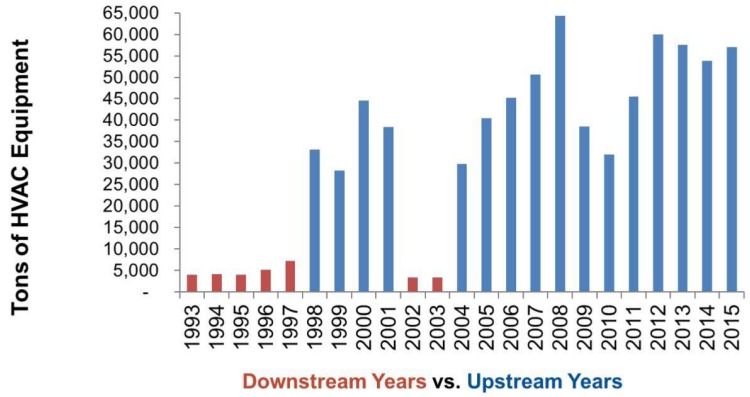
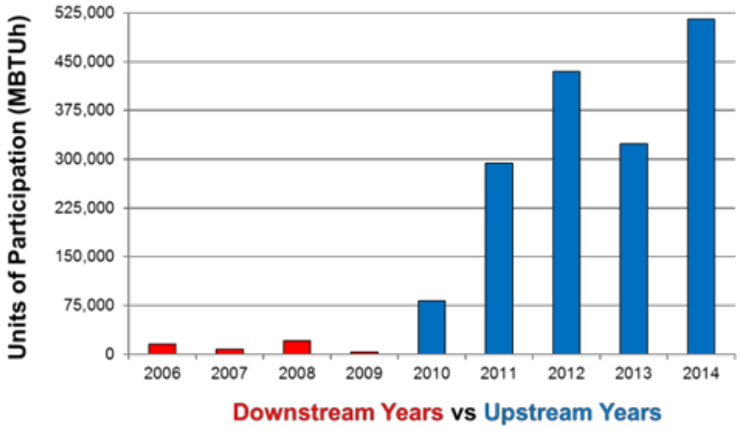


Figure 10: PG&E Water Heater Program, Downstream vs. Upstream[21]

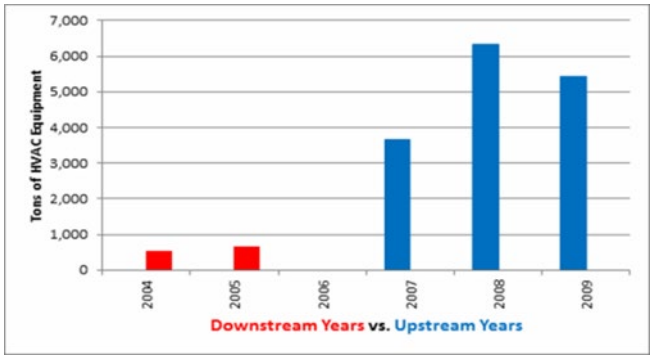


A.2.2 NV Energy

NV Energy began a midstream program for commercial HVAC and motors in 2007.[22] Figure 11 shows the increase in incented HVAC units that resulted from the transition to the upstream program. The commercial HVAC program was discontinued but the team was unable to uncover the reason for discontinuation. NV Energy implemented a midstream residential air-conditioning program in 2018 and will not be conducting any evaluations on the program until 2019 but provides little other information about the status of current programs.

[20] Hector Lefbad. "Market Effects of Commercial Upstream Programs: Flexibility Leads to Creativity," presented at the ACEEE conference, November 1, 2017.
[21] Ibid.
[22] Daniel Cornejo and Brian Barnacle. "The 900 percent solution: Upstream Best Practices across HVAC and Multiple Technologies," presented at the ACEEE Conference, 2016.

Figure 11: NV Energy Sure-Bet HVAC Program, Downstream vs. Upstream[23]



A.2.3 Efficiency Vermont

Efficiency Vermont began its first midstream program in 2009.[24] Program materials describe adding a midstream effort in addition to their downstream program to promote increased availability, sales, and installation of efficient equipment. The program targeted influencing distributor stocking practices, reducing financial barriers, and streamlining administrative processes.

Efficiency Vermont added a midstream program for circulator pumps, heat pump water heaters, and cold-climate air-source heat pumps (both residential and C&I applications) and C&I evaporator fan motors. The new midstream focus resulted in a dramatic increase in the sales of efficient equipment, as presented in Table 6, far outpacing sales from the downstream channel.

There appears to be evidence that the Efficiency Vermont midstream support for HPWHs helped transform the local market. Vermont consists of 0.2% of the population for the United States yet consists of 6% of U.S. HPWH sales. The penetration for HPWHs in Vermont was 7% before midstream intervention and 60% after midstream intervention. The midstream initiative had substantial impacts on the sales of high-performance circulator pumps (HPCPs), a technology that had a very limited market share before program support (Figure 12). The sales for HPCPs in the upstream program met the total annual average sales of the downstream program every 2.5 days.[25]

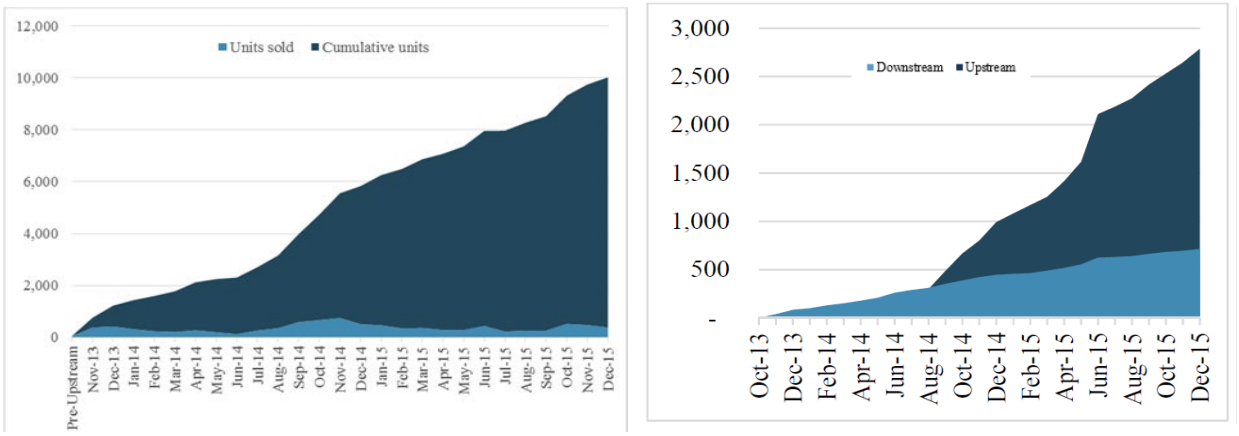
Table 6: Efficiency VT: Effect of Upstream Shift on Program Equipment Sales

	High Performance Circulator Pumps	Heat Pump Water Heaters	Cold-Climate Air Source Heat Pumps
Downstream	50	215	1,324
Upstream	4,324	1,795	1,904
Improvement	8,548%	735%	44%

Source: Howard Merson, Huessy Levin, and Russom (VEIC). "Driving Upstream Markets through Strategic Partnerships and Excellence in Supply Chain Management," presented at ACEEE Conference, 2016.

[23] Daniel Cornejo and Brian Barnacle. "The 900 percent solution: Upstream Best Practices across HVAC and Multiple Technologies," presented at the ACEEE Conference, 2016.
[24] The evaluation team reclassified this "upstream" program to midstream due to the program rebating distributors.
[25] Howard Merson, VEIC. "Market Madness: Coordinating Supply Chain Players on the HPWH Court," presented at the ACEEE Hot Water Forum, February 26, 2017.

Figure 12: Efficiency VT Downstream vs. Midstream Sales for High-Performance Circulator Pumps (Left) and HPWHs (Right)[26]



A.2.4 Efficiency Maine Trust

The Efficiency Maine Trust residential ENERGY STAR certified HPWH program has implemented midstream intervention strategies and seen a 423% increase in program participation between 2016 downstream results and 2017 midstream results.[27] Midstream incentives for a subset of C&I HVAC equipment also began in 2016. The rebated equipment in the midstream channel consisted of boilers (less than 500 MMBtu/hr), furnaces (less than 300 MMBtu/hr), low-intensity infrared heaters, warm air heaters, and tankless water heaters. The Efficiency Maine Trust kept the downstream C&I rebate component intact, which consists of 11 separate equipment types. The midstream delivery mechanism accounted for approximately 25% of C&I HVAC equipment incentives during 2017.[28]

A.2.5 Massachusetts Upstream HVAC/Heat Pump Initiative

The Massachusetts Program Administrators [29] shifted the C&I HVAC program from the downstream channel to a distributor-focused upstream channel in the spring of 2013. The initial focus of the program included central air conditioning and heat pumps, water-source heat pumps, ground-source heat pumps, and measures such as ECMs and ventilation systems. The Massachusetts Program Administrators recently added VRF systems to the program and are considering incorporating controls, although one program manager suggested that downstream incentives may be more appropriate for advanced rooftop controls and other controlling mechanisms, although midstream outreach could raise awareness of these offerings.[30]

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[26] Howard Merson, Huessy Levin, and Russom (VEIC). "Driving Upstream Markets through Strategic Partnerships and Excellence in Supply Chain Management," presented at ACEEE Conference, 2016.
[27] ENERGY Star website. https://www.energystar.gov/products/retailers/midstream_programs/astonishing_results
[28] Michaels Energy for Efficiency Maine Trust. September 13, 2018. "Appendix H: Midstream HVAC Potential Study."
[29] The MA Program Administrators sponsor the Mass Save initiative and includes gas and electric providers across Massachusetts: the Berkshire Gas Company, Blackstone Gas Company, Columbia Gas, Cape Light Compact, Eversource, Liberty Utilities, National Grid, and Unitil.
[30] A complete list of measures, including efficiency requirements and incentive levels is available at https://www.nationalgridus.com/media/pdfs/bus-ways-to-save/ee7078-ci-upstream-hvac.pdf. Note that the incentives listed are the customer portion of the discount. For most measures, the distributor receives an additional, equivalent amount.

A program manager reported that the Massachusetts Program Administrators had chosen to focus on distributors because doing so required the program to reach considerably fewer market actors than a focus on contractors or end-users. At the same time, distributors are closer to the end-user than manufacturers, making it easier for the program to track equipment installations and demonstrate attribution.

The Massachusetts Program Administrators transitioned from an incentive structure that did not restrict the distributors' use of incentive funds to a requirement that distributors pass through 50% of the incentive funds in June of 2018. The Program Administrators made this transition to increase the program's visibility to end-users, who may not previously have been aware their equipment received program support, and contractors, who may have been confused when the program removed downstream rebates for equipment receiving midstream support. A program manager described the portion of the incentive the distributor does not pass through as "an administrative fee," to cover the costs of tracking and submitting program-qualified sales. Distributors are required to submit information on where incentivized equipment is being installed, including the building address, that the Program Administrators can use to support quality assurance and evaluation.

The Massachusetts Program Administrators define goals for the midstream program in terms of energy savings and spending targets. Goals do not explicitly address specific market transformation metrics. The interviewed program manager did not describe an established procedure for identifying equipment for which the market has transformed and removing it from the program, noting that decision would be a result of market studies the Program Administrators conduct on a regular basis.

Participation in the upstream program surged over the prior year's downstream program (86% increase in unit volume).[31] Participating manufacturers and distributors reported that roughly 80% of sales were replace-on-failure, suggesting that the program is reaching an end-user type that was previously hard to reach with downstream program designs. The program paid $400,000 in incentives for 960 incented units and achieved over 1 million kWh in gross annual savings in 2013.[32]

National Grid, one of the program administrators in Massachusetts, also implements the upstream HVAC/Heat Pump Initiative in Rhode Island, allowing for cross-state synergies.[33]

A.2.6 Energize Connecticut

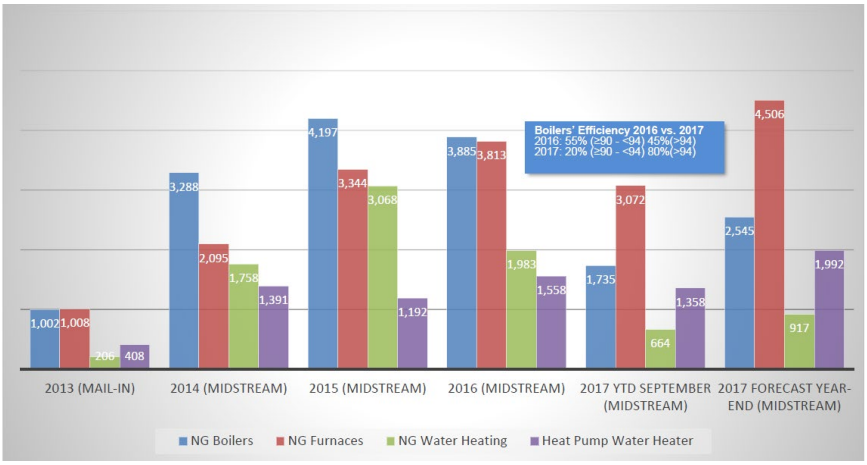
The Energize Connecticut residential water heater program, sponsored by Eversource and United Illuminating, transitioned from downstream to midstream in 2014. The stated goal of the midstream approach was to transform the residential water heater market in Connecticut. The program planned to achieve market transformation with a focus on increasing high-efficiency equipment stocking practices and improving market actor awareness of and interest in high-

[31] Despite this increase, reports indicate that the program may have had limited impact its first year, as distributors had already placed equipment orders for the 2013 cooling season.
[32] Rishi Sondhi, Strong, and Arnold. "The End of Prescriptive Rebate Forms? Massachusetts Moves Upstream," presented at ACEEE Conference, 2016.
[33] DNV GL. "Upstream HVAC Initiative Process Evaluation." provided to *Massachusetts PA's and EEAC*, October 2017.

efficiency equipment. The program includes 52 participating distributors and 14 participating retailers. Program and evaluation reports indicate that the program experienced increased installation contractor participation (from 176 to 481 participating contractors), reduced paperwork and rebate costs, and a significant increase in C&I program participation. Accordingly, the Connecticut program sponsors eventually launched a midstream C&I program in 2016.[34],[35]

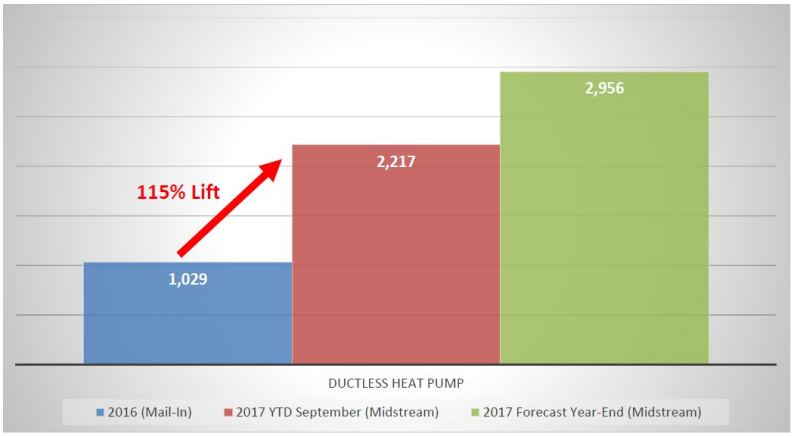
The results of the midstream intervention on residential equipment is displayed in Figure 13 and Figure 14. The number of incentivized HPWHs increased by 241% between 2013 and 2014, and incentivized ductless mini-splits increased by 115% between 2016 and 2017.[36]

Figure 13: Energy CT HVAC and DHW Program Activity, Downstream vs. Midstream[37]



[34] Energize CT rolled out an upstream C&I space heating and hot water program in 2016. The evaluation team was unable to find publicly available information detailing program results.
[35] Jennifer Parsons. "Energize CT Hot Water Program," presented at ACEEE Hot Water Forum, February 23, 2016.
[36] ENERGY Star Midstream Technical Advisory Group. "Gain Steam, Go Midstream! Distributor-Focused Residential HVAC and Water Heater Incentives," presented at ENERGY Star Products Partner Meeting, October 24, 2017.
[37] Ibid.

Figure 14: Energize CT Ductless Heat Pump Activity, Downstream vs. Midstream[38]



A.2.7 Xcel Colorado

Xcel Energy in Colorado introduced a midstream delivery channel into its commercial Cooling Efficiency Product Program in 2015. Like other program administrators, an Xcel program manager stated that working with distributors allows the program to target a much smaller number of market actors than if targeting installers. This program manager suggested that distributors may not face the same type of financial pressure to sell jobs as installers, making distributors better able to promote efficient equipment. This program administrator noted that distributors typically have a greater local presence than manufacturers.

Xcel does not require distributors to pass incentives through to the contractor or end-user, although program staff reported that distributors frequently do pass through at least some of the incentive. Xcel's incentives are structured in tiers, with higher incentives available for equipment at greater efficiency levels. Xcel also offers bonus incentives for equipment sold for installation at certain facility types with particularly high energy loads. In order to receive an incentive, Xcel requires distributors to provide details about the equipment (manufacturer, model, number of units installed, serial numbers), about the installation site (business name, address of installation, customer contact information), and the invoice number and date.

The structure of Xcel's HVAC program goals did not change when the program transitioned measures from a downstream to a midstream approach, although the goals increased with the increase in program volume. Goals remain focused on energy savings targets. Xcel does not have explicit goals related to achieving specific market transformation metrics.

In its first three months, the midstream channel achieved 60% of the savings generated by the downstream program in 2014.[39] The midstream channel includes packaged and split AC units, water-source heat pumps, air-cooled chillers, and PTAC/PTHP units. The program maintained the downstream delivery channel for centrifugal chillers, direct evaporative pre-coolers,

[38] ENERGY Star Midstream Technical Advisory Group. "Gain Steam, Go Midstream! Distributor-Focused Residential HVAC and Water Heater Incentives," presented at ENERGY Star Products Partner Meeting, October 24, 2017.
[39] Bickford, Adam. "Utilities are Heading Upstream to Increase Energy Efficiency." Southwest Energy Efficiency Project (SWEEP). February 9, 2016. http://www.swenergy.org/utilities-are-heading-upstream-to-increase-energy-efficiency.

electronically-communicated motors (ECMs), heat exchangers, and variable frequency drives (VFDs). The program sorted its measures into one of the two channels to avoid double-counting energy savings, a common challenge that midstream programs with downstream counterparts may face.[40]

Table 7 displays the cumulative savings achieved from the midstream channel. For 2015 and 2016, the midstream channel accounted for 51% of program savings, downstream accounted for 46%, and custom measures retained the final 2% of program savings. Four of the participating distributors accounted for 75% of midstream savings, supporting the idea that midstream programs can operate well by engaging the distributors with the largest market share.[41]

Xcel Colorado also claims the midstream program was a key reason that Trane built an HVAC distribution center dedicated to high-efficiency commercial equipment in the Denver area in 2016.[42]

Table 7: Xcel Colorado Cooling Efficiency Product Savings (2015-2017)

	Air-Cooled Chiller	DX/RTU	PTAC	Water-source Heat Pump
Savings (kWh)	2,812,362	4,360,655	855,695	1,591,313

*Source: EMI Consulting. "Xcel Colorado Cooling Efficiency Product 2017 Evaluation." Submitted to *Xcel Energy Colorado,* January 15, 2018.

A.2.8 Public Service Company of New Mexico

The Public Service Company of New Mexico (PNM) incorporated a midstream incentive channel into their Commercial Comprehensive program for commercial HVAC equipment in late 2015. The program achieved 532,169 kWh savings in the first few months. PNM requires that 40% of the distributor incentive is passed through to the end-user, so that the end-user shares in the reduced equipment cost.[43] In 2017, the midstream component of the Commercial Comprehensive program achieved over 1,300 MWh of net savings, or 4% of the program savings.[44]

[40] Double-counting is when a program administers the same equipment type in both downstream and midstream channels, and attributes energy savings to both channels, resulting in overstating claimed savings. This is something that should be considered early in the program design and planning phase.
[41] EMI Consulting. "Xcel Colorado Cooling Efficiency Product 2017 Evaluation." Provided to *Xcel Energy Colorado*, January 15, 2018.
[42] Bickford, Adam. "Utilities are Heading Upstream to Increase Energy Efficiency." Southwest Energy Efficiency Project (SWEEP). February 9, 2016. http://www.swenergy.org/utilities-are-heading-upstream-to-increase-energy-efficiency.
[43] ADM Associates. "Evaluation of 2015 Public Service Company of New Mexico Energy Efficiency & Demand Response Portfolio." Provided to New Mexico Energy Efficiency Evaluation Committee, March 2016.
[44] Evergreen Economics. "Evaluation of the 2017 Public Service Company of New Mexico Energy Efficiency and Demand Response Programs." Provided to *New Mexico Energy Efficiency Evaluation Committee*, 2018.

A.2.9 Georgia Power Company

The Georgia Power Authority (GPA) began incentivizing specific commercial HVAC equipment through the midstream channel in 2017. The program offers split or packaged ACs and ASHPS, water-source heat pumps, and VRF systems. In the first year, the program incented 356 measures and achieved 2,257 MWh in savings, through five participating distributors.[45]

The program does not require that the participating distributor notify the contractor of the incentive. This may be correlated to another finding in the program's process evaluation that 20% of trade allies did not understand or support the midstream program – presumably they were either unaware of or not receiving the benefit of the incentives.[46,47]

A.2.10 NYSERDA

NYSERDA began implementation of its upstream HVAC program in 2010 but discontinued it due to poor performance. Table 8 describes key findings from a process evaluation of the program, completed only 18 months after the program began.[48]

Table 8: NYSERDA Process Evaluation Findings

Key Takeaways	
➢ No clear metrics to assess market transformation ➢ Low program awareness among distributors ➢ Unclear list of eligible products	➢ Limited distributor and program collaboration ➢ Marketing and sales strategies of the distributors were not aligned with the equipment offerings of the program ➢ 39 Participating distributors, but only one-third actively participated

NYSERDA transitioned their ASHP program to the midstream channel in 2017. The program seeks to sidestep the mistakes of the previous iteration and focuses on the contractor. It provides a $500 incentive to participating installation contractors, subject to additional quality assurance guidelines. The participating contractors must maintain various certifications, follow specific installation criteria, and select qualifying equipment. NYSERDA also conducts site inspections to ensure that equipment is properly installed.[49]

[45] Nexant and Cadmus. "Evaluation of Georgia Power Company's 2017 DSM Programs – Volume 1." Provided to *Georgia Power Company*, August 14, 2018.
[46] One distributor noted that their marketing strategy was geared towards builders, developers, and building representatives due to higher interest in efficient systems. In addition, participating distributors reported that the administrative processing was cumbersome and recommended a streamlined process such as an online portal.
[47] Nexant and Cadmus. "Evaluation of Georgia Power Company's 2017 DSM Programs – Volume 1." Provided to *Georgia Power Company*, August 14, 2018.
[48] DNV GL . "Upstream HVAC Initiative Process Evaluation." Provided to *Massachusetts PA's and EEAC*, October 2017.
[49] NYSERDA Air-Source Heat Pump Program details and requirements can be found here: https://www.nyserda.ny.gov/All-Programs/Programs/Air-Source-Heat-Pump-Program

A.2.11 Program Sponsors Considering Midstream Programs

The team also identified programs in the United States that do not currently have a midstream program but are actively considering one.

DTE Electric Company of Michigan has begun to assess the potential for a C&I midstream HVAC program. DTE's initial efforts include a review of other midstream programs, interviews with market actors, and identifying the program design that best suites the local market.[50] Similarly, the EmPOWER utilities[51] in the Mid-Atlantic region are currently transitioning their HVAC programs from a downstream to a midstream approach, with a target implementation date in late 2018.[52]

A.3 Moving Upstream: Opportunities and Challenges

Given that the HVAC programs identified by this study focus on the midstream (distributors and contractors) channel rather than the true upstream (manufacturer) channel, this section explores the opportunities and challenges that exist for sponsors of midstream energy-efficiency programs.

A.3.1 Opportunities for Moving HVAC Programs Upstream

The following describes some of the benefits and opportunities of shifting programs away from downstream approaches.

A.3.1.1 Improving Distributor Stocking Practices

By keeping supply houses stocked with standard-efficiency equipment, distributors meet the needs of budget-minded end-users and installers. Accordingly, installers may have less familiarity with high-efficiency systems, making them more likely to recommend less-efficient options. Even customers interested in efficiency may be stymied if efficient options are not readily available.

Midstream programs incentivize distributors to stock more high-efficiency equipment, making it more readily available (potentially at a discount). As a result, installers become more familiar with the products, helping them to recommend and install it more frequently. As demand increases, manufacturers may respond with more efficient products. Therefore, altering stocking practices is a key component to market transformation, which is a goal of many upstream programs.

Two of the interviewed program managers reported that influencing distributor stocking practices was a key objective of their programs. One of these noted that a large distributor in their territory had dedicated a warehouse exclusively to high-efficiency equipment. Program managers also noted that some manufacturers are developing distribution capabilities and are important to include in midstream efforts. These program managers did not view manufacturers with

[50] Tobin Galvin, Navigant. "Mid-Stream Programs: Overview." Presented to *Energy Waste Reduction Collaborative*, February 20, 2018.
[51] The EmPOWER energy-efficiency program consists of six utilities in the Mid-Atlantic region: Baltimore Gas & Electric, The Potomac Edison Company, Potomac Electric Power Company, Delmarva Power and Light Company, Southern Maryland Electric Cooperative Inc., and Washington Gas Light Company.
[52] Status report of the Midstream Program Implementation Midstream Program Work Group before the Public Service Commission of Maryland. August 15, 2018.

distribution capabilities as a threat to a midstream program approach, but noted that the programs must be flexible enough to work with any actor serving in a distribution role.

Program sponsors should work directly with distributors to obtain their continued buy-in regarding altering stocking practices, as this helps maintain distributor participation as programs mature. Section A.4.1.2 provides suggestions for communicating this value proposition to distributors.

A.3.1.2 Serving the Emergency Replacement Market

The emergency replacement market is estimated to be 70% to 80% of HVAC sales.[53,54] This market segment is often a missed opportunity for downstream programs, because such customers are difficult to identify and influence. These customers need a product immediately and have limited time to research their options. If they install an inefficient product, this is a lost opportunity for the life of the equipment – potentially decades. As one program manager noted, "*The equipment will be in there for years and if your equipment dies, you need to get [a replacement] in there right away*."

In the event of equipment failure, the end-user often relies on the contractor's recommendation, which reflects what is available and affordable. If a midstream program has influenced distributor stocking practices and made efficient products readily available, programs help make efficient products available for time-sensitive installations. For end-users with budget constraints, the midstream incentive may also help an emergency replacement customer choose a more efficient product. Collaborating with distributors on midstream sales training for contractors may also better leverage the role of contractors in the emergency replacement market.[55,56]

A.3.1.3 Serving the New Construction Market

In the residential new construction market, large production builders may negotiate the purchase of HVAC equipment directly with manufacturers or distributors.[57] Midstream and upstream programs have an opportunity to influence the equipment (and efficiency level) these builders end up choosing by targeting these high-volume market actors.

Midstream programs can also impact the non-residential new construction market, which often sources small and medium C&I HVAC equipment from distributors. For larger commercial projects, midstream and upstream programs have an opportunity to drive the selection of higher efficiency equipment by focusing marketing and training efforts towards key builders, design

[53] DNV GL. "Net-to-gross Evaluation of 2013-14 Upstream HVAC Programs (HVAC1)." Provided to *CPUC*, September 2016.
[54] Rishi Sondhi, Strong, and Arnold. "The End of Prescriptive Rebate Forms? Massachusetts Moves Upstream," presented at ACEEE Conference, 2016.
[55] Bonneville Power Administration. "HVAC Market Intelligence Report." April 2016.
[56] Maureen Quaid and Howard Geller, Southwest Energy Efficiency Project. "Upstream Utility Incentive Programs: Experience and Lessons Learned." May 2014.
[57] NMR Group, Inc. "Energy-Efficient Central Air Conditioning and Heat Pumps: Market Progress and Evaluation Report." Provided to *Long Island Power Authority*, February 2004.

teams, manufacturers and manufacturers' representatives,[58] rather than individual building occupants.[59]

A.3.1.4 Boosting Program Participation

Interviewed program managers emphasized the central role of distributors in the supply chain. Each of the program managers discussed the effectiveness of communication with a limited number of distributors compared to the vast number of contractors or end-users, making it easier for their programs to reach a larger portion of the market. According to one, "*We are affecting the marketplace pretty significantly compared to downstream capacity because we are dealing with distributors who all of the downstream actors source from. Those distributors have significant market outreach and a market perspective*." Finally, one program manager suggested that building relationships with distributors could have additional benefits across multiple programs and utility initiatives since distributors may carry a variety of products, ranging from lighting to HVAC equipment to electric vehicle charging equipment.

By removing participation barriers common to downstream programs, successful midstream programs have experienced increased participation. Midstream programs place fewer demands on end-users (e.g., end-users do not have to submit rebate forms), making it less burdensome to participate. Also, when supply house shelves are stocked with more affordable, efficient products, contractors may have more reason to suggest high-efficiency options to consumers who lack awareness of higher-efficiency HVAC products.[60]

All the interviewed program managers cited increased participation as both a motivator for, and an outcome of, their shift to a midstream approach. Two program managers reported their programs typically incentivized between four- and seven thousand tons of HVAC equipment capacity in a year under a downstream approach. After switching to a midstream approach, these program managers reported incentivizing between 30- and 50 thousand tons of equipment capacity in a year.

Additionally, by influencing key actors in the distributor channel, programs are able to incentivize more products than by targeting the fragmented market of end-users. A CPUC study[61] described the outsized impact of the HVAC distributor on the purchasing process: 90% of transactions were influenced by distributors, 81% of buyers purchase what distributors recommend, 70% of some markets are replace on failure (indicating the importance of impacting the market upstream rather than downstream), and only 4% of buyers consider efficiency tiers during the purchase decision (further emphasizing that end-users may not be the best target for programs).

[58] A manufacturer representative manages the sale of equipment for the manufacturer. This may be either out-sourced to another person or firm or managed as a division within the manufacturing company.
[59] HVAC Market Intelligence Report. April 2016, Bonneville Power Association.
[60] Bickel, Burns, Rivett, Vida, Nelson, Parsons, Merson in Collaboration with HARDI. "Swimming to Midstream: New Residential HVAC Program Models and Tools," presented at ACEEE Conference, 2016.
[61] DNV GL. Provided to *CPUC*, September 2016. "Net-to-gross Evaluation of 2013-14 Upstream HVAC Programs (HVAC1)."

A.3.1.5 Driving Uptake of Higher Equipment Efficiency Levels

One interviewed program administrator suggested that incentive structures can help programs motivate distributors to promote increasingly efficient equipment. This program administrator was one of two who reported their programs used tiered incentive structures, providing higher incentives for equipment that exceeds code efficiency levels to a greater extent. These larger incentives for higher efficiency equipment sought to motivate distributors to alter their stocking practices. One program administrator reported these tiered incentives allowed the program to identify the efficiency levels with the greatest potential and to gradually remove incentives for less efficient equipment if they did not provide sufficient benefit to the program. This program administrator also offered bonus incentives for equipment installed in facilities with particularly high loads.

A.3.2 Challenges to Moving HVAC Programs Midstream

While there are many benefits for incorporating a midstream component into HVAC programs, program sponsors should recognize the challenges associated with the transition identified in this literature review, as described in the following subsections.

A.3.2.1 Reduced End-User Focus

Downstream HVAC programs have historically focused on engaging end-users through various marketing channels and branding strategies. To receive the rebate that was marketed to them, an end-user might submit an application and other supporting documents, such as contractor invoices. In contrast, midstream program sponsors indicate that end-users are often unaware they participated in a program, making it hard to assess program satisfaction levels.[62,63]

This also creates more of a distance between program sponsors and end-users, reducing their interaction, which may be a concern for program sponsors who prefer to keep awareness of their program high in the minds of their end-users.[64] However, some sponsors may choose to continue to market their programs and products to mitigate this effect, using strategies outlined in Table 9, along with an example of midstream marketing materials that are consumer-oriented.

[62] Howard Merson, Huessy Levin, and Russom (VEIC). “Driving Upstream Markets through Strategic Partnerships and Excellence in Supply Chain Management,” presented at ACEEE Conference, 2016.
[63] Dave Backen, Burmester, and Sheehan. “Moving to the Middle – How to Navigate the Ins and Outs of C&I Midstream Programs.” *Association of Energy Service Professionals*, July 2016. https://www.aesp.org/general/custom.asp?page=MidstreamPrograms
[64] Maureen Quaid and Howard Geller, Southwest Energy Efficiency Project. “Upstream Utility Incentive Programs: Experience and Lessons Learned.” May 2014.

Table 9: Program Marketing and Branding Strategies

Potential Strategies
➢ Post-sale direct-to-customer communication ➢ Point of purchase marketing ➢ Billboard and radio advertisements ➢ Targeted direct mailing ➢ Educational brochures, videos, and webpages ➢ Trade-ally training sessions

Source (and image source): Gain Steam, Go Midstream! Distributor-Focused Residential HVAC and Water Heater Incentives. October 2017, ENERGY STAR Products Partner Meeting.

The interviewed program managers noted that a midstream approach reduced their contact with end-users, and suggested that communication with contractors and end-users was an important consideration in shifting from a downstream to a midstream approach. One program manager reported shifting to a midstream intervention with little notice to contractors and end-users that program incentives moved to the distributor level had created confusion. Contractors perceived that the program was no longer supporting the equipment with prescriptive incentives, not knowing that support continued at the midstream level. However, another program manager suggested that publicizing distributor incentives too widely could constrain distributors' freedom to use the incentives in ways that would result in the greatest increase in sales. Nonetheless, both program managers reported it was important to develop end-user-facing communication materials to raise awareness of efficient equipment.

A.3.2.2 Restrictions on Incentives

Some midstream programs require distributors to pass-through some of the incentive to the end-user. This incentive structure provides some benefit to the distributor and the end-user, but it may affect the willingness of distributors and contractors to participate. Distributors may be unhappy with a program that increases their administrative burden while limiting their share of the incentive, especially if the sponsors do not clearly convey to them the value proposition of participation (e.g., higher sales, better profit margins). As one interviewed program manager stated, "*There is no incentive to [the distributor], if they pass [the incentive] on, to put in the extra effort to track and submit invoices for payment. Why should they? Why put in that extra work? They can sell code minimum all day long without any extra effort*."

Midstream programs that require 100% of the incentive to be passed down to the customer risk alienating distributors who want to cover their administrative costs. With incentive structures that require 100% pass-through, there are also challenges with verifying that the contractor then passes along the discount to the end-user.[65] The interviewed program managers noted these

[65] DNV GL. October 2017. Provided to *Massachusetts PA's and EEAC*, "Upstream HVAC Initiative Process Evaluation."

verification challenges, but one stated that, by informing end-users about the incentive and further emphasizing the utility's support by inspecting a sample of installations, they can put some pressure on contractors to pass on the incentive.

An open incentive structure allows the distributor freedom to choose how the incentive is allocated. This structure encourages distributor participation; it is commonly used and recommended by midstream program implementer, Energy Solutions.[66] Distributors may use incentive funds to cover the increased marginal costs of more efficient stock or to drive sales by offering trainings to engineers, architects, and contractors.[67]

Two of the three interviewed program managers did not place requirements on the ways distributors use incentive funds. The third had recently instituted a requirement that distributors pass through half of the incentive amount, but gave the distributor discretion to choose how they would use the other half. The interviewed program managers stated that limiting the restrictions on the incentives paid to distributors gave them the greatest leeway to increase sales of efficient products. According to one program manager, "*We believe [not requiring passthrough] affords greater participation of distributors, which is what we want. We want to get that equipment moving off the shelf, and how to do that, we believe, is to give the distributor flexibility on how to use the incentive*."

The program managers who did not require distributors to pass through incentives nonetheless reported that distributors participating in their programs chose to pass through at least some of the incentives they received. One program manager estimated that approximately 70% of the participating distributors passed through at least some of the incentives they received. Another estimated that 55% of incentive funds were passed through. This program manager described an example of a distributor that opted to pass through all of their incentives on water source heat pumps and, in doing so, was able to significantly increase their sales volume.

Sponsors should consider the goals of their program and how the incentive structure will support those goals.

Table 10 below outlines questions for the program sponsor to consider in making this decision.

Table 10: Midstream Program Incentive Structure

Incentive Structure Questions
➢ Does the incentive structure align with the program goals, design, and market actors?
➢ Should incentives be passed along to the end-user, and what program design would achieve that?
➢ If the incentive is not required to be passed through to the customer, will the program influence what the incentive is used for (i.e., stocking practices, training, etc.)?
➢ Does the incentive structure foster participation from the local and regional distributors?
➢ How will the incentive structure impact the contractor and their ability to sell high-efficiency equipment to the end-user?
➢ Are different incentive structures needed for different equipment?

[66] Daniel Cornejo and Brian Barnacle. "The 900 percent solution: Upstream Best Practices across HVAC and Multiple Technologies," presented at ACEEE Conference, 2016.
[67] EMI Consulting. "Xcel Colorado Cooling Efficiency Product 2017 Evaluation." Provided to *Xcel Energy Colorado*, January 15, 2018.

A.3.2.3 HVAC Installation Quality

A midstream program that focuses on distributors may have little interaction with installers, limiting the program's ability to ensure high quality installation practices.[68] Downstream programs in contrast can drive installation quality by requiring end-users to hire trained or certified installers.

The Midwestern Energy Efficiency Alliance (MEEA) reported strong distributor support for the HVAC SAVE program in Iowa, a HVAC performance program that offers HVAC contractor trainings. These trainings helped ensure that distributors' products functioned properly, which in turn helped the reputation of their products. Although the HVAC SAVE program does not focus on the midstream channel, it does provide evidence for the ability of midstream programs to reach HVAC installation contractors through the distributor channel.[69]

One of the interviewed program managers reported requiring distributors to report an installation address for units receiving an incentive and using these data to conduct inspections on 10% of the projects submitted. These inspections verify that the equipment distributors reported selling was installed at the reported address and that the installation is eligible for program incentives (i.e., it is in the program administrator's service territory and is not connected to a residential meter). The program seeks to resolve any inconsistencies between the installed and reported equipment or other issues the inspections identify. If it is not possible to resolve an issue, the program may debit future incentive payments to that distributor to recover the cost of incentives determined to be invalid. This program manager noted that performing onsite inspections increases the program's visibility to end-users and can encourage contractors to pass along cost savings distributors offer as a result of program incentives.

A.3.2.4 Evaluation, Measurement, and Verification Challenges

Midstream programs present a challenge for evaluation, measurement, and verification (EM&V). Downstream HVAC programs typically require the customer to submit a rebate application and, in some cases, have the equipment installed by a participating contractor. The rebate application includes detailed data about the product, the end-user, and installation location. Midstream program tracking data is distributor-based, meaning these programs do not have detailed information about the end-users of these products, which may be valuable for program planning or evaluation purposes.

Two of the three interviewed program managers required distributors to provide an address where the incentivized equipment would be installed. The third program required only an installation zip code. The interviewed program managers reported pressure to collect detailed data on incented equipment installation locations for EM&V purposes, as well as challenges in doing so. One program manager noted that large contractors may maintain their own stock of equipment and thus do not always know where a piece of equipment will be installed when they purchase it from

[68] This is of particular concern given that a typical HVAC system may use about 25% more energy than expected if not installed properly. Constance Harvey. 2013. "Best Practices in Small Commercial HVAC Programs at California Utilities."
[69] Sarah Edwards, Baker, and Graham of Midwestern Energy Efficiency Alliance (MEEA). "HVAC SAVE: A Case Study in the Next Evolution of Residential Quality Installation Programs." December 2015.

the distributor. Program managers noted that, generally, requiring less data about the installation location would ease the participation process for distributors.

Program administrators reported that maintaining strong distributor relationships and effective communication with distributor staff were important in gaining distributors' cooperation in providing these data. According to one program administrator, "*You have to educate their sales staff, their counter staff on the ground doing all the work…why do we need this information. Otherwise they will either not collect it or be upset thinking it is a pain in the butt because they don't know why*." This program administrator reported educating participant distributor staff about the necessity for data collection requirements allows the administrator to continue incentivizing equipment, which in turn helps the distributor offer lower prices on higher-margin, higher-efficiency equipment and win more business. This program administrator also noted that an easy-to-use data submission portal was important in gaining distributors' cooperation.

The interviewed program managers stated that midstream programs may require a different approach to estimating free-ridership rather than a traditional approach, which is based on an end-user's report of program influence on a specific transaction. Depending on the program design, end-users may not even be aware the equipment they installed received a program incentive. One program manager noted that, even when distributors pass through the incentive, they may present it as a discount from the distributor rather than a utility-sponsored program. This approach is not the most effective way to assess the influence of a midstream program. Instead of focusing on end-users, program managers suggested that evaluators should estimate net-to-gross ratios for midstream programs based on distributor interviews and analysis of the change in equipment sales over a baseline. As discussed in Section A.4.1.5, the interviewed program managers reported that distributors were often reluctant to share the types of detailed sales data that could contribute to baseline estimation. Most programs instead prioritized broader distributor participation rather than requiring detailed sales data reporting.

Additionally, some distributors may be unwilling to provide program sponsors with detailed sales figures due to the highly competitive nature of this industry. Participation barriers such as intensive data collection requirements may also reduce distributors' willingness to participate.[70,71] Sponsors and evaluators should map out what data is needed to conduct impact, process, and market transformation assessments to the level of rigor the program desires.[72]

Midstream programs must also be careful to avoid offering overlapping downstream and upstream program offerings, so as to avoid the risk of incentivizing the same piece of equipment through two channels (and thereby double-counting savings). Sponsors may also consider how current programs, such as new construction, will interact with the midstream program – this may entail

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[70] Michaels Energy. "Appendix H: Midstream HVAC Potential Study." Provided to *Efficiency Maine Trust*, September 13, 2018.
[71] Maureen Quaid and Howard Geller, Southwest Energy Efficiency Project. "Upstream Utility Incentive Programs: Experience and Lessons Learned." May 2014.
[72] Typical verification techniques include applying deemed installation rates, conducting phone interviews, and performing onsite verification visits. The verification activities depend on the level of rigor of the evaluation. Low Rigor evaluation relies on purchased data and deemed savings, low study cost, and accuracy meeting industry standards. Medium rigor activities rely on self-reported installation verification, phone interviews, medium cost, higher than industry standards. High Rigor includes conducting site visits for verification, evaluators check installation rates, high cost, highest level of accuracy.

sharing savings associated with new buildings between programs or determining that savings will only be claimed by one program.

A.3.2.5 Meeting Cost-Effectiveness Requirements Amid Changing Standards

All three of the interviewed program administrators reported challenges in meeting cost-effectiveness (TRC) targets for their programs. Increasing baseline efficiency levels due to more stringent codes and standards and falling avoided costs contributed to these challenges. Other contributing factors included the net-to-gross ratios applied to the program and the way cost-effectiveness tests incorporate their incentives. Incentives are typically considered a transfer payment that do not affect the TRC. However, one program administrator explained that, in their jurisdiction, only incentives paid to the end-user receive this treatment. Incentive funds that distributors retain are considered program costs. As a result, this program administrator carefully assesses and documents the extent to which distributors pass through incentives.

Interviewed program managers reported that changes to efficiency standards, in particular, posed challenges to their programs' efforts to cost-effectively provide midstream incentives. The severity of these challenges varied somewhat by jurisdiction. A program manager from a state with significant efficiency standards activity reported that changes can occur so quickly that, in some cases, the program has only a few months to promote new qualifying equipment levels and distributors may be left with a backlog of equipment that no longer qualifies. This program manager also noted that the regulatory process for claiming savings from a new product often lags the pace at which manufacturers develop products. As a result, he stated that it was important for the program to proactively engage with manufacturers and understand what they are developing.

The other interviewed program managers did not describe the same types of challenges with frequent changes to standards, but noted that increasingly stringent codes and standards made it more difficult for their programs to meet cost-effectiveness targets. As standards increase, programs shift incentives to higher efficiency levels, but raised baselines limit the savings they can claim from that higher-efficiency equipment. One program manager reported considering a dual baseline that accounts for savings from the existing equipment through the end of its useful life in early replacement installations. This program manager noted, however, that some contractors who earn more revenue from service than equipment replacement may be reluctant to promote early replacements.

A.4 MIDSTREAM PROGRAM DESIGN AND LESSONS LEARNED

This section explores specific program design considerations of which program sponsors should be mindful as they transition to midstream or upstream program approaches. Finally, this section also identifies key lessons learned by HVAC program managers who have transitioned to midstream or upstream programs.

A.4.1 Midstream Program Design Considerations

This section of the report summarizes the program design considerations from a few sources, detailed in the footnotes. These program materials convey various aspects of a midstream

intervention, with special focus on designing the midstream program to address potential challenges that can occur during the initial planning and program design phase.[73,74,75,76,77] Findings from interviews with midstream HVAC program managers supplement these findings from program materials.

A.4.1.1 Obtaining Sufficient Market Intelligence

Programs looking to shift upstream should first attempt to characterize the HVAC market that they seek to influence. This includes identifying local and regional distributors and manufacturers, sales volumes and flows, and key market actors in the supply chain. The market intelligence that is gathered during initial research can be considered the blueprint used to design the midstream intervention. With a clear understanding of the market, sponsors can be strategic in terms of designing their market intervention.

The interviewed program managers noted, in particular, the importance of understanding the market shares of efficient products and market saturation as well as which distributors sell high-efficiency equipment and which distributors sell the highest volume of HVAC equipment generally. One program manager also noted that it was important to gather information from manufacturers about the types of high-efficiency equipment they are developing and how that equipment might align with efficiency standards the program might use to set incentive criteria.

A.4.1.2 Engaging with Distributors

Shifting to a distributor-focused midstream program requires substantial planning, particularly for sponsors of downstream programs who have little interaction with distributors. To have maximum impact on the market, sponsors will need to identify and persuade large distributors to participate. Fostering strong and ongoing relationships with these distributors is critical to keeping them aware of and interested in the program. One interviewed program manager stated that establishing partnerships with distributors prior to program launch had been important to the program's success. This program manager noted that working with an implementation contractor that had strong, existing relationships with distributors made those distributors more willing to cooperate with the program.

Distributor outreach efforts may include training efforts to help distributors better understand the program or better communicate the value proposition of high-efficiency equipment to their customers. The interviewed program managers noted that it was important to inform staff throughout the distributor's organization, including lower-level management and counter staff, about the program and the benefits of efficient equipment. One program manager noted that understanding the program could make these lower-level staff members more likely to promote

[73] Daniel Cornejo and Brian Barnacle. "The 900 percent solution: Upstream Best Practices across HVAC and Multiple Technologies," presented at ACEEE Conference, 2016.
[74] Howard Merson, Huessy Levin, and Russom (VEIC). "Driving Upstream Markets through Strategic Partnerships and Excellence in Supply Chain Management," presented at ACEEE Conference, 2016.
[75] Rishi Sondhi, Nathan Stron, and Horenstein. "Are we There Yet? 2.0: the future of Upstream Energy Efficiency Programs," presented at ACEEE Conference, 2016.
[76] Bickel, Burns, Rivett, Vida, Nelson, Parsons, Merson in Collaboration with HARDI. "Swimming to Midstream: New Residential HVAC Program Models and Tools," presented at ACEEE Conference, 2016.
[77] Upstream with Residential Programming in the NE

efficient equipment and more willing to collect the required information. These programs also need to establish a feedback loop with distributors to implement their feedback and limit attrition. Establishing communication channels early will assist with program design and establishing a strong foundation for the program.[78]

By engaging with distributors that control a majority of the market, programs can have the biggest impact on sales of efficient equipment. This strategy may also put pressure on smaller distributors to participate to remain competitive with the bigger distributors. One program manager reported providing participating distributors with quarterly reports showing how they rank against other, anonymized, participants in total incentives and tonnage for various equipment types. The program manager stated that these reports can motivate distributors to take steps to increase sales of efficient equipment in order to improve their rankings.

A.4.1.3 Communicating the Midstream Value Proposition

Program sponsors must ensure that distributors recognize the value proposition associated with program participation – that these programs can have a positive impact on overall sales and on sales of higher-margin equipment. The success of the midstream program relies on the distributor, and poor communication about the program's value may pose a barrier to participation.

All of the interviewed program managers indicated that they seek to consider their program's offerings from a participating distributors' perspective. One noted that it was important for the program to ensure incentives were available for new equipment types that are desirable to distributors' customers. Another suggested that frequent contact with distributors was important in communicating the program's value proposition, saying distributors "*have plenty of other things to worry about other than high-efficiency equipment sales. You have to remind them about the program and why it is a value to them and the customers they are interacting with*."

After identifying key distributors, sponsors can conduct initial outreach to potential distributors to discuss the goal of a midstream intervention and communicate the value proposition. HVAC distributor business models typically operate using a return on net assets (RONA) metric (formula below).

Program sponsors should be able to explain to distributors how the midstream program will affect key inputs into the RONA metric – essentially, how participation will improve distributors' bottom line. Key questions programs should consider and be prepared to ask, or answer are described in Table 11. A hypothetical example of the RONA model is included in Section A.5.

Table 11: RONA Business Model Considerations

Factors Driving Profit	Business Considerations for Distributors
Distributor Net Income	• How does high-efficiency equipment affect gross margins and net income? • Will high-efficiency equipment boost profit relative to standard-efficiency equipment? • What incentive level is needed to increase gross margins?

[78] Howard Merson, VEIC. "Market Madness: Coordinating Supply Chain Players on the HPWH Court," presented at the ACEEE Hot Water Forum, February 26, 2017.

Factors Driving Profit	Business Considerations for Distributors
Inventory	• What SMIT (sales, marketing, inventory, and training) planning strategies best fit the specific distributor (see Section 4.1.1) • Will manufacturers penalize installers who return already-purchased low efficiency equipment? • What trainings will staff/installers need to understand these products?
Accounts Receivable	• How long are the accounts receivable terms for participating distributors? (Industry avg: 50-55 days) • What can the program do to distribute the incentive faster than the customer's term?
Accounts Payable	• How can the program work with manufacturers to increase payment terms? (Industry avg: 30-35 days) • Will increased payment terms influence high-efficiency stocking practices?

A.4.1.4 Identifying the Best Equipment for Midstream Programs

When it comes to choosing which equipment should be included in a midstream program there are three general approaches taken by programs: include the same equipment types in downstream and midstream channels, offer selected equipment types only in the midstream channel, or include equipment in the midstream channel based on cost-effectiveness tests. The advantages and disadvantages of these three approaches are described in Table 12.

Table 12: Identifying Equipment to Include in Midstream Programs

Midstream Equipment Offerings	Advantage	Disadvantage	Example Program
Mirror Downstream Equipment	➢ Midstream can boost sales for all equipment types, including emerging technologies ➢ Cost-effectiveness assessed at program level	➢ Competes with downstream ➢ Administrative burden of two overlapping offerings ➢ Potential to double-count savings ➢ May include equipment types that are not cost-effective	CPUC; various programs implemented by Energy Solutions[79]
Key Equipment in Midstream Only	➢ Boost savings by targeting key equipment types ➢ No double-counting savings ➢ Lighter admin burden on distributor and program staff	➢ Equipment excluded from midstream (due to lower sales volumes, emerging tech, etc.) will not benefit from midstream sales boost ➢ Missed opportunities for broader market savings opportunities	Xcel Colorado
Cost-effective Equipment in Midstream Only	➢ Only incentives equipment that are cost-effective ➢ Vets equipment for savings opportunities relative to market share	➢ Potential to double-count savings ➢ No focus on emerging technology ➢ Missed opportunities for broader market savings opportunities	Efficiency Maine

A.4.1.5 Obtaining Sales Data from Midstream Partners

Program sponsors benefit from gathering detailed information about the products they incentivize and the customers who buy their products. This information can help with program planning, marketing, and evaluation efforts. That said, some distributors may be unwilling to participate in programs that come with too much of an administrative burden or that ask them to give up sensitive sales data that might undermine their competitive advantage were it to be seen by competitors.

Table 13 lays out the basic reasons why programs typically benefit from requesting detailed sales data from their midstream partners, along with the concerns distributors have about providing this

data. A key issue for programs to consider is limiting the data they request to only the necessities for program purposes, thereby limiting the administrative burden on distributors. For example, one program originally drafted a plan that captured 25 data points and after incorporating feedback from distributors reduced the plan to 14 data points. Program administrators and distributors should work together to finalize the data requirements and procedures needed to receive the incentive.

Table 13: Balancing Program Data Needs with Distributors Concerns

Why Programs Request Detailed Sales Data	Why Distributors Resist Providing Data	Potential Resolutions
➢ Measure past savings ➢ Project future savings ➢ Track sales trends ➢ Assess cost-effectiveness of equipment types ➢ Identify market actors with large market share ➢ Learn about contractors and end-users and how to best influence them	➢ Administrative burden ➢ Highly competitive industry – must avoid releasing sensitive data that undermines competitive advantage ➢ Protecting customers' privacy ➢ Unsure of why programs need it	➢ Develop EM&V roadmap of essential data ➢ Limit requests to essential data points ➢ Incentivize for providing "nice-to-have" data ➢ Keep requests consistent from year to year ➢ Emphasize program value proposition (increased sales) ➢ Streamline data collection process (provide templates, adjust form to match distributor's tracking system) ➢ Hasten/simplify rebate processing ➢ Consider incentivizing equipment based on SKU or model number[1] ➢ Assure and ensure that data is treated confidentially ➢ Provide aggregated sales figures back to participants

[1] Providing equipment offerings using stock keeping units (SKUs) or model numbers reduces administrative and is used to inform program tracking data. This method preferred by distributors compared to identification using eligible equipment maps (typically based on equipment size and efficiency ranges).

The interviewed program administrators confirmed that distributors are often reluctant to share detailed sales and customer data, and suggested that their programs sought to balance their need to gather data with a desire to minimize the burden on distributors – and thus maximize distributor participation.

A.4.1.6 Sales, Marketing, Inventory, and Training Planning

Midstream interventions can benefit from strategic planning regarding how the program impacts sales, marketing, inventory, and trainings of the participating distributor (SMIT plan).[80] This presents another opportunity for collaboration with the distributors. For example, during the initial

[79] Daniel Cornejo and Brian Barnacle. "The 900 percent solution: Upstream Best Practices across HVAC and Multiple Technologies," presented at ACEEE Conference, 2016.
[80] Howard Merson, Huessy Levin, and Russom (VEIC). "Driving Upstream Markets through Strategic Partnerships and Excellence in Supply Chain Management," presented at ACEEE Conference, 2016.

planning phase, Efficiency Vermont requested that all potential participants submit a proposal and present their SMIT plans. The program administrators worked with the distributors to develop a finalized plan that was tailored for that specific distributor. This process increased the up-front time requirements but improved distributor support for the program and helped align the goals of the program and distributors. Table 14 identifies components for each aspect of the SMIT plan request, outlined by Efficiency Vermont.

Table 14: SMIT Plan Components

Sales	Marketing	Inventory	Training
➢ Trade show participation ➢ Distribution channels ➢ Sales strategies ➢ Communication channels ➢ Leveraging current working relationships	➢ Marketing materials ➢ Cooperative marketing programs ➢ Cooperative advertising ➢ Communication channel with program for support and technical assistance ➢ Market to builders, developers, and building representatives	➢ Strategy for inventory stocking ➢ Anticipate demand from midstream program ➢ No penalty arrangement with manufacturer to swap for high-efficiency inventory ➢ Equipment warranties	➢ Strategy to communicate with partners and existing customers ➢ Understanding equipment eligibility, rebate process, and data collection procedures ➢ Leverage programs trade ally network ➢ Contractor sales and program training

Source: Howard Merson, Huessy Levin, and Russom (VEIC). 2016. 2016 ACEEE Conference Proceeding. "Driving Upstream Markets through Strategic Partnerships and Excellence in Supply Chain Management."

A.4.1.7 Incentive Structure

As discussed in Section A.3.2.2, establishing a rebate structure that encourages participation is key to program success. Programs also need to think through pass-through requirements (how much of the incentive the distributor must pass along to contractors or end-users) before establishing the final requirements.

All program requirements and procedures that are developed during the initial program planning and design phase should be included in a distributor participation agreement or memo of understanding. In addition, programs may wish to set no-tolerance rules for distributors who violate program rules.

A.4.2 Real-World Lessons from Program Sponsors and Implementors

In addition to the principles described Section A.4.1, this subsection describes specific lessons learned by HVAC program managers, implementors, and industry experts from running midstream programs. The lessons described in Table 15 focus on key failures or obstacles experienced by programs in trying to achieve their goals of market transformation.

Table 15: Lessons Learned

Issue	Outcome	Lesson Learned	Recommended Strategy
Challenging local economic conditions[1]	SMUD discontinued midstream HVAC program	Challenging local economic conditions can stymie program efforts	➢ Assess local economic conditions ➢ Align equipment offerings with distributor sales projections ➢ Keep abreast of distributor concerns
Non-program equipment becomes more efficient without program intervention[2]	Midstream program saw reduced savings and cost-effectiveness	Programs must adapt to baseline conditions and adjust equipment offerings	➢ Offer tiered efficiency levels ➢ Increase efficiency requirements periodically ➢ Introduce new technology ➢ Support efficient equipment with low market shares
Failing to track metrics of market transformation[2]	Programs fail to understand their impact on the market	Measure baselines and market changes in the broader market, not just the participant sector	➢ Identify key performance metrics for evaluation ➢ Assess a "baseline" market condition, prior to midstream intervention
Distributors express interest but fail to actively participate[3]	Midstream intervention does not meet savings goals and became cost-prohibitive	Distributors may sign-up, but this does not guarantee that they will be active participants.	➢ Continually engage with distributors ➢ SKU or model number-based equipment offerings ➢ Provide participants with performance reports ➢ Streamline program requirements

[1] Constance Harvey. 2013. "Best Practices in Small Commercial HVAC Programs at California Utilities."
[2] EMI Consulting. "Xcel Colorado Cooling Efficiency Product 2017 Evaluation." Submitted to *Xcel Energy Colorado*, January 15, 2018.
[3] DNV GL. "Upstream HVAC Initiative Process Evaluation." Submitted to *Massachusetts PA's and EEAC*, October 2017.

A.5 RONA Model

Table 16 shows a hypothetical example of how participating in a midstream program that supports high-efficiency equipment can impact a distributor's RONA outcome. It demonstrates how a $400 pass-through incentive that benefits the end-user can result in no net change to typical costs and margins for manufacturers, distributors, and contractors. This may come at some administrative cost to distributors, but one could also expect increased sales based on other program experiences. Of course, as discussed in Section A.3.2.2, programs do not have to require distributors and contractors to completely pass the incentive along to the end-user.

Table 16: Example of Midstream Incentive on RONA Model

Purchase Decision Channel	Standard-Efficiency Equipment	High-Efficiency Equipment	Difference
Manufacturer Gross Margin			
Manufacturer Cost	$400	$800	$400
Sale Price to Distributor	$500	$1,000	$500
Manufacturer Gross Margin	**$100**	**$200**	**$100**
Distributor to End-User without Midstream Incentive			
Sale Price to Contractor	$600	$1,200	$600
Distributor Gross Margin	**$100**	**$200**	**$100**
Sale Price to End-user	$700	$1,400	$700
Contractor Gross Margin	**$100**	**$200**	**$100**
Distributor to End-User with Midstream Incentive			
Sale Price to Distributor	$500	After $400 incentive: $600	$100
Sale Price to Contractor	$600	$800	$200
Distributor Gross Margin	**$100**	**$200**	**$100**
Sale Price to End-user	$700	$1,000	$300
Contractor Gross Margin	**$100**	**$200**	**$100**

*The values in this table are all assumptions and just in place to show how the midstream rebate interacts through the supply chain. This is also assuming the distributor and contractor passed through 100% of the rebate to the end-user.

Appendix B HVAC Market Characterization (Task 2)

This appendix presents information to help characterize the HVAC market and supply chains in Northern Illinois.

This appendix represents an update to the preliminary market characterization memo provided to ComEd in April 2019 as the deliverable for Task 2. The content included in this appendix builds on the literature review conducted as a part of Task 1 (Appendix A).

This appendix includes additional results from the in-depth interviews conducted with manufacturers, distributors, and contractors as a part of the Task 3 portion of this study. Given that the information provided in these interviews was qualitative in nature, the information presented here should be treated as anecdotal information about the market.

B.1 Methodology

A detailed methodology for the market characterization is presented in Appendix C. Specifically, the methods are presented by the following subsections:

- Estimated HVAC market size methods are in Appendix C.2.1.
- Estimated residential HVAC equipment methods are in Appendix C.2.2.
- Estimated commercial HVAC equipment methods are in Appendix C.2.3.
- Data limitations are detailed in Appendix C.2.4.
- Market actor interview details are in Appendix C.2.5.

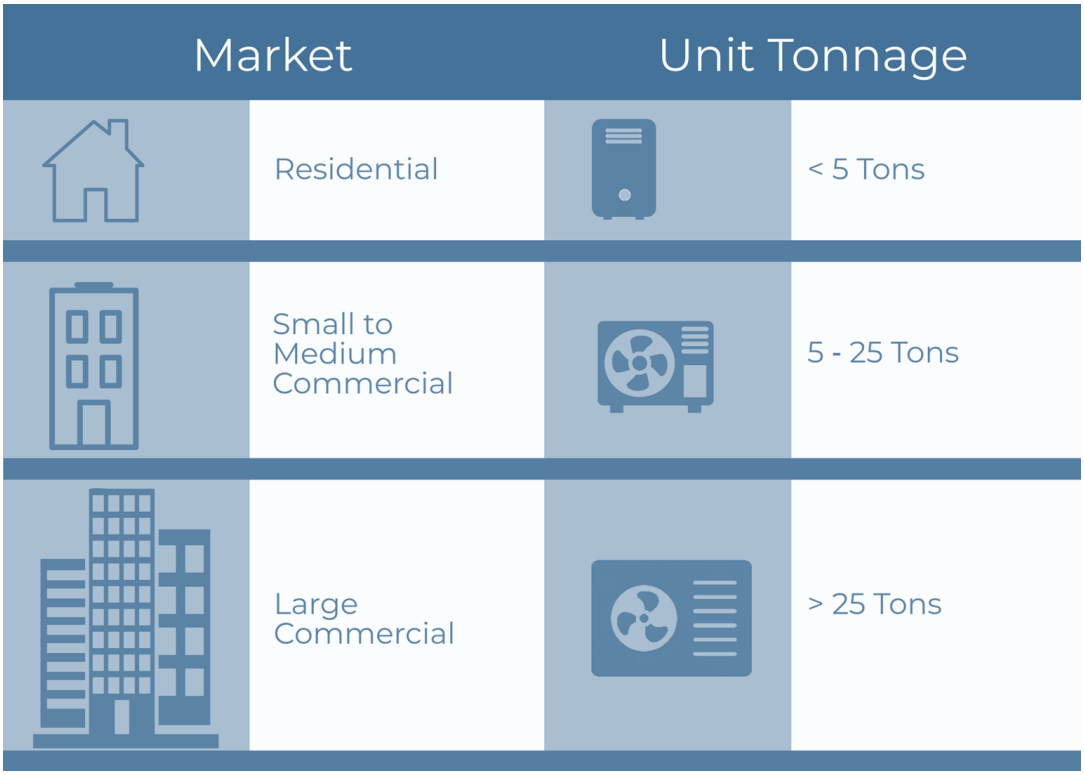
B.2 HVAC Equipment Segments

The HVAC industry typically segments the market based on equipment size (i.e., system input capacity) and feature set, rather than the actual installation location or size. Interviews with market actors, including manufacturers, distributors, and contractors confirmed that segmenting equipment based on system specifications rather than installation location was how they typically classified equipment.

However, utility energy-efficiency programs may use different classification systems than the HVAC industry to segment equipment types. Utility programs may classify HVAC equipment based on the site type of the installation, which the programs target at either residential or commercial end-users. A residential-duty HVAC system might be installed in a small commercial facility, for example, leading to a potential mismatch in how these products are classified by efficiency program administrators and the HVAC industry.

This report uses the HVAC industry segmentation approach based on equipment size and feature set, based on the size categories described in Figure 15.

Figure 15: Segments by Cooling Equipment Size



Furnace and Boiler Equipment Segments. The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) specifies furnaces with input capacities up to 225 kBtuh and boilers up to 300 kBtuh as residential. However, there is not a clear, specifications-based cut-point for distinguishing small and medium-sized commercial units from large commercial furnaces and boilers.

Table 17 describes the system capacities that market actors consider to be small-medium commercial and those that they consider to be large commercial. The threshold between small-medium commercial and large commercial systems varies by organization and is not standardized.[81] The size differentiation between small-medium commercial and large commercial equipment may have implications for program design given that the supply channels and decision-makers may vary in these different market segments.

[81] In some cases, respondents reported that they considered systems small-medium commercial even below the AHRI designated cut-off for commercial systems, further complicating the use of "residential" and "commercial" terminology.

Table 17: Market Actor Segments for Commercial Furnaces and Boilers (kBtuh)

	Small-Medium Commercial Furnaces	Large Commercial Furnaces	Small-Medium Commercial Boilers	Large Commercial Boilers
Distributor 1	115*-400	>400	250*-600	>600
Distributor 2	225-250	>250	>300**	>300**
Distributor 3	>225**	>225**	>300**	>300**
Distributor 4	45*-180*	>180*	45*-300	>300
Distributor 5	75*-400	>400	300-2,000	>2,000
Distributor 6	225-800	>800	N/A	N/A
Distributor 7	250-500	>500	300-500	>500
Distributor 8	225-400	>400	N/A	N/A
Manufacturer 1	225-700	>700	300-900	>900
Typical Range	**225-400**	**>400**	**300-500**	**>500**

*Residential capacity based on AHRI-standards.
**Distributor doesn't distinguish between light and large commercial systems.

B.3 Supply Chain Channels and Decision-Making

There are two common channels that HVAC equipment flows through to reach the end-user. The first channel is through a wholesale distributor. The second channel uses a manufacturer representative. Both channels are described in greater detail in the subsections below.

Note that the flow of HVAC equipment is not limited to these channels. Additional pathways may include retail stores or online wholesaler websites that operate independently of traditional distributors with brick and mortar locations. The number of systems that flow through these secondary channels are not included in the supply channel segmentation detailed in the subsections below, due to smaller equipment flows and limited quantitative information provided by interviewed market actors and available from secondary sources.

B.3.1 Residential and Small-Medium Commercial Supply Chain

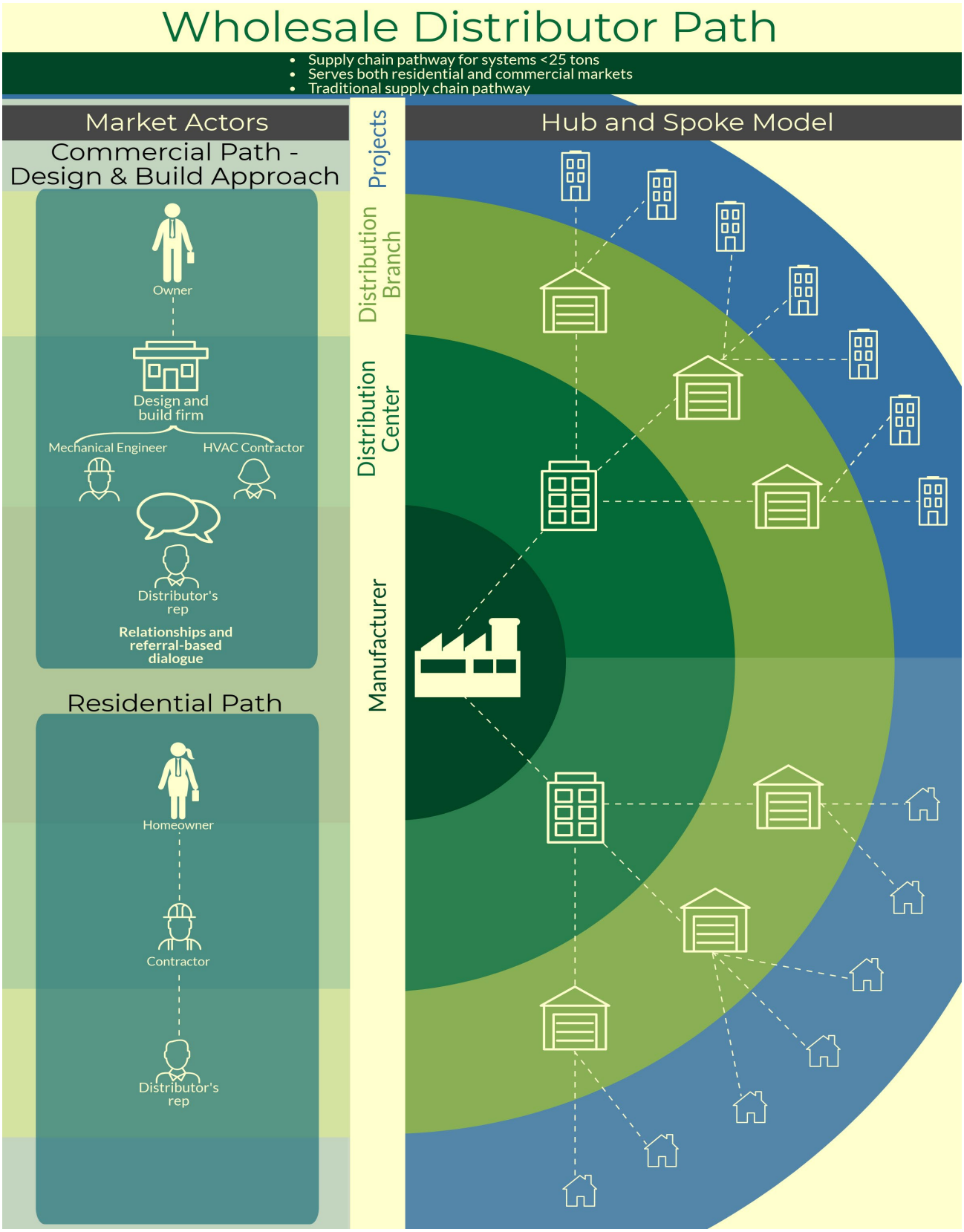
Residential and small-medium commercial equipment (less than 25 tons of input capacity) typically flows through the wholesale distributor supply channel, generally through a hub-and-spoke model.[82] Distributors may sell the products of a single manufacturer or multiple manufacturers. The equipment is transferred through the distribution channel in the following manner:

- the manufacturer to a regional distribution center;
- regional distribution center to a local distributor branch;
- local distributor branch to HVAC contractor; and
- HVAC contractor to end-user.

[82] The retailer and online wholesaler channel operate very similar to the wholesaler distribution channel. Often the contractor is making the actual sale to the end-user in the retail channel, and the retailer is acting as the distribution warehouse and may offer financing. The online wholesaler is slightly different, in that the equipment purchaser may be more likely the end-user, however the equipment is flowing in a similar manner.

This distribution channel encompasses HVAC systems commonly intended for residential and small-medium commercial applications. Although products in both market segments (residential and small-medium commercial) generally follow the distribution supply channel, the market actors involved in the purchase decision differ between residential and commercial end-users. In both sectors, there are a large number of contractors relative to the relatively small number of distributors. Figure 16 depicts the residential and small-medium commercial market actors that are commonly engaged with the wholesale distributor channel.

Figure 16: Residential and Small Commercial Supply Chain



B.3.1.1 Residential Sector Market Actors

The residential market includes a relatively small number of actors, including the homeowner, the installation contractor, the distributor, and the manufacturer. For HVAC system replacements, both planned and emergency, the contractor provides the homeowner with one or more quotes for equipment. The quote from the contractor would generally include equipment and labor costs–and may also include equipment specifications, such as efficiency information. The contractor's sales pitch and quote influence the homeowner's decision and, inherently, the efficiency of the selected system. The contractor will pick up the equipment from the local distributor on an installation basis.[83] Note that very small commercial market actors may follow this route too.

Residential End-User Market Segments. Contractors described homeowners as belonging to one of two market segments.

1. **Price-Conscious Homeowners.** These homeowners are driven exclusively by price. They focus on equipment first-costs and are not interested in the payback period or return on investment (ROI) represented by energy bill savings spread across multiple years.
2. **Value-Driven Homeowners.** These homeowners are driven by motivations that typically extend beyond initial cost. This includes people who value thermal comfort, have greater financial means, are long-term residents in their homes, are environmentally friendly, ask questions beyond costs, understand the concept of a payback period for efficient equipment, and may have done some sort of research on equipment or rebates.

Contractor Segments. Distributors and manufacturers described contractors as falling into two main market segments, similar to the two main homeowner market segments.

1. **Standard Equipment Installers**. These contractors promote equipment that they are familiar with installing. They prefer the "tried-and-true" systems, typically present only standard-efficiency options, replace like-for-like equipment, and aim to provide the lowest quote to the homeowner. This segment of contractors is motivated by familiarity with equipment, ease of installation, and provides a single quote based on their perception of the homeowner's needs. Other factors that deter this contractor segment from offering high-efficiency equipment is the risk of customer call-backs, more complex installations, and more technical training requirements. Some distributors suggested that roughly 75% of their contractors fell into this group.
2. **Value-Focused Installers.** These contractors will seek to ask questions and understand the end-user's comfort issues, educate homeowners on the benefits of high-efficiency options, ROIs, leverages rebates, and present "good, better, best" options.

[83] Distributors may ship the equipment to the project site. Large contractors or contractors serving rural areas may also have on-site storage for commonly installed equipment to avoid frequent trips to the distributor branch.

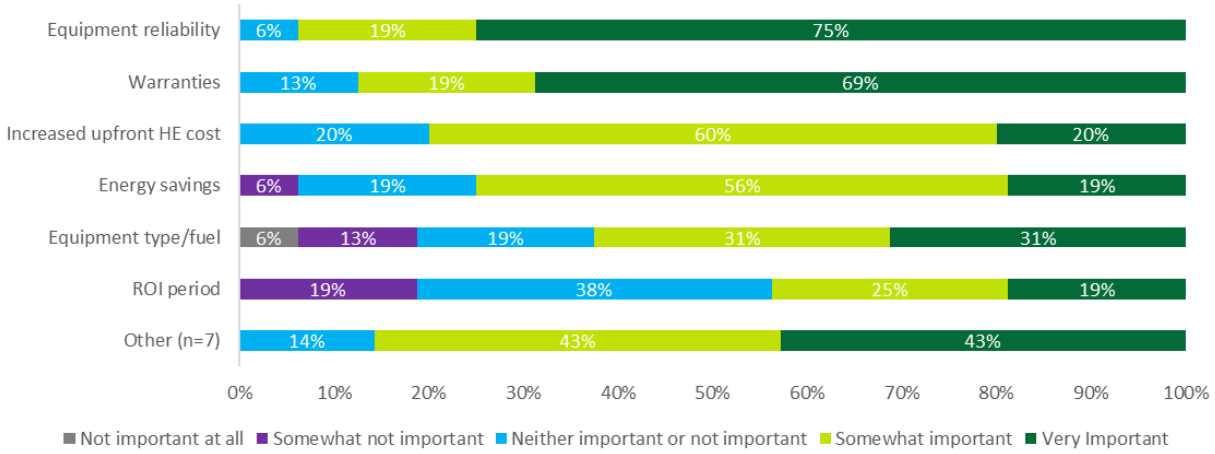
Ultimately the "salesmanship" and the technical knowledge of the contractor drive what type of equipment is being presented to the end-user, and eventually installed. Typically, the end-user cannot select a high-efficiency option that is not presented to them. Distributors are in a position to provide both sales and technical training to their contractors, helping to generate more higher-margin, higher-efficiency sales, but this requires sufficient program engagement with and buy-in from distributors. Not all contractors are responsive to distributor offerings because they are resource constrained, overwhelmed by constantly changing HVAC technology, or simply uninterested in offering different solutions. However, as one distributor said, "*some [contractors] don't get it, some do – the ones that do are the successful ones*." Contractors who can clearly and confidently explain the value proposition of high-efficiency equipment and who can offer a full endorsement of the system, stand a better chance of getting their customers to accept the recommendation for a high-efficiency unit. Contractors who understand that high-efficiency systems have higher sales margins than base-level equipment, which can help their bottom line, are better incentivized to recommend these systems.

Homeowner Purchase Decision Process. The homeowner makes the ultimate purchase decision and can often be constrained by budget. The contractor's influence is typically contained within the budget parameters set by the homeowner, but they are still in a position to influence the decision of the homeowner. While a contractor strongly influences a homeowner's ultimate equipment selection, individual contractors will have less influence on a regional basis. In contrast, a smaller group of distributors service a major portion of the market in the same geographic area. Utility-sponsored energy-efficiency programs that intervene at the distributor-level have concentrated market actor engagement efforts and influence sales of high-efficiency HVAC equipment sales at a regional scale.

The interviews with manufacturers, distributors, and contractors confirmed that the homeowners were the ultimate decision makers and the contractor is the primary influencer for the homeowner's purchase decision. The distributor was described as a minor influencer due to their position to educate, train, and provide sales tools to their contractor base. Additionally, some contractors noted that the equipment distributors keep in stock impacts their ability to sell high-efficiency equipment, especially in emergency replacement scenarios. If high-efficiency systems are not kept in stock at local distributor branches, customers who want systems installed immediately may choose a less-efficient option rather than experience even a brief wait for the delivery of a system that has to be shipped from a distributor's regional warehouse.

Homeowner Purchase Decision Drivers. Distributors and contractors were asked to rate the level of importance that various factors had on the residential purchase decision, using a scale from one to five, with one being "not important at all" and five being "extremely important." The categories included factors such as the increased upfront cost of high-efficiency equipment to the importance of warranties. Figure 17 displays the frequency of how important each factor is for the residential purchase decision. Overall, the reliability of the equipment was identified by both market actors as the most important factor. The next most important factors identified were warranties, increased upfront costs, and energy savings. "Other" drivers include rebates, brand reputation, and contractor reputation.

Figure 17: Residential Purchase Decision Drivers (n=16)



Residential New Construction Segments and Purchase Decision Drivers. In the residential new construction market, high-volume builders or their installation contractors may negotiate directly with the manufacturer to facilitate special pricing for bulk-orders (i.e., large national builders, subdivisions, and complexes). In these cases, the equipment would bypass the wholesale distributor and ship directly to the project site.

New construction and builders are often driven by code requirements. According to interviewed market actors, they often rely on the HVAC contractors to select appropriately sized and code-compliant equipment. Interviewees discussed residential builders as generally being either builders of spec (or tract) homes or of custom homes, that align similarly with the dichotomous market segments described above for homeowners and contractors.

1. **Spec Builders.** Build homes to set specifications and look for the most cost-effective solution that meets minimum code requirements. Essentially, they are first-cost driven.
2. **Custom Builders.** Rather than completing an off-the-shelf home and then selling it, custom builders customize the home in accordance with a specific buyer's demands. Depending on the customer's interests, they may be more interested in higher-efficiency, higher-quality brands for HVAC solutions. Essentially, they are comfort and quality driven.

B.3.1.2 Small and Medium Commercial Sector Market Actors

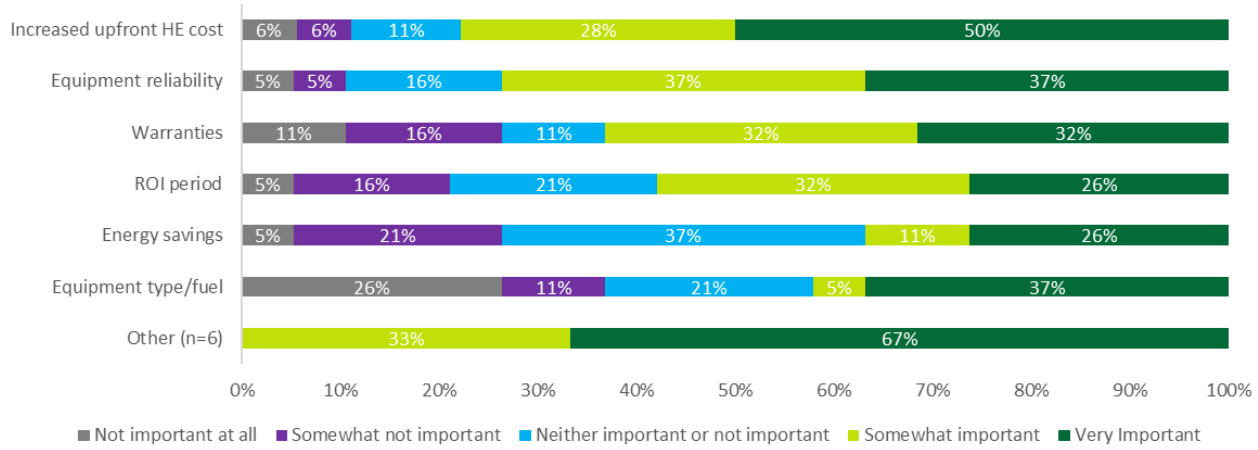
The small and medium commercial market actors commonly include the distributor, the contractor, the manufacturer, and the end-user. Typically, this purchase process is similar to the residential process, where the distributor provides equipment to the HVAC contractor who installs it for the end-user. For slightly larger or complex projects, the purchase decision may follow a *design-build* approach. In the *design-build* approach, which covers both new construction and retrofit markets, the project delivery is typically contracted to a single firm that provides both design and construction services for a project. To select HVAC equipment, the end-user hires a design-build firm, typically with a mechanical engineer and installation capabilities. The contractor will engage with the distributor to develop bid packages. The distributor and contractor interaction is often relationship-based without competitive bidding constraints.

Small and Medium Commercial Segment. The interviewed market actors suggested that price was the single most important factor for small and medium commercial end-users. This is especially the case in emergency replacement scenarios where end-users may not have sophisticated enough facilities management to engage in long-term planning to accommodate the replacement of their HVAC. Due to time and money constraints, the HVAC contractor may be most successful bidding with a like-for-like standard-efficiency replacement system. One distributor explained, "*Price is a bigger or [the] biggest influencing factor, especially compared to residential. [For a] five to twenty-five-ton RTU replacement, not a lot of people [are] planning to replace stuff before it fails. They need to decide right there. [It] comes down to who can do it the quickest, cheapest and can get them up and running again*."

Small and Medium Commercial Purchase Decision Process. Similar to the residential market, the contractor is a key influencer over the purchase decision as they help provide the system choices that meet the owner's budget. Energy-efficiency programs may influence the installation of high-efficiency equipment by providing incentives or training through distributor or contractor interventions.

Small and Medium Commercial Purchase Decision Drivers. Distributors and contractors were asked to rate the level of importance that various factors had on small and medium commercial end-users' purchase decision, using a scale from one to five, with one being "not important at all" and five being "extremely important." Figure 18 displays the frequency of how important each factor was in the small-to-medium commercial purchase decision, according to distributors and contractors. Overall, the increased upfront cost of high-efficiency equipment and the reliability of the equipment were identified by both market actors as the most important factors. "Other" driving factors included rebates, funding, and equipment lead time. As one commercial contractor reported, *"[Rebates] and what [equipment] is available has a big impact on what we recommend to the customer*." However, it should be noted that first cost was consistently mentioned as the most important factor, and often the only factor driving decision-making for this market segment.

Figure 18: Small-Medium Commercial Purchase Decision Drivers (n=19)



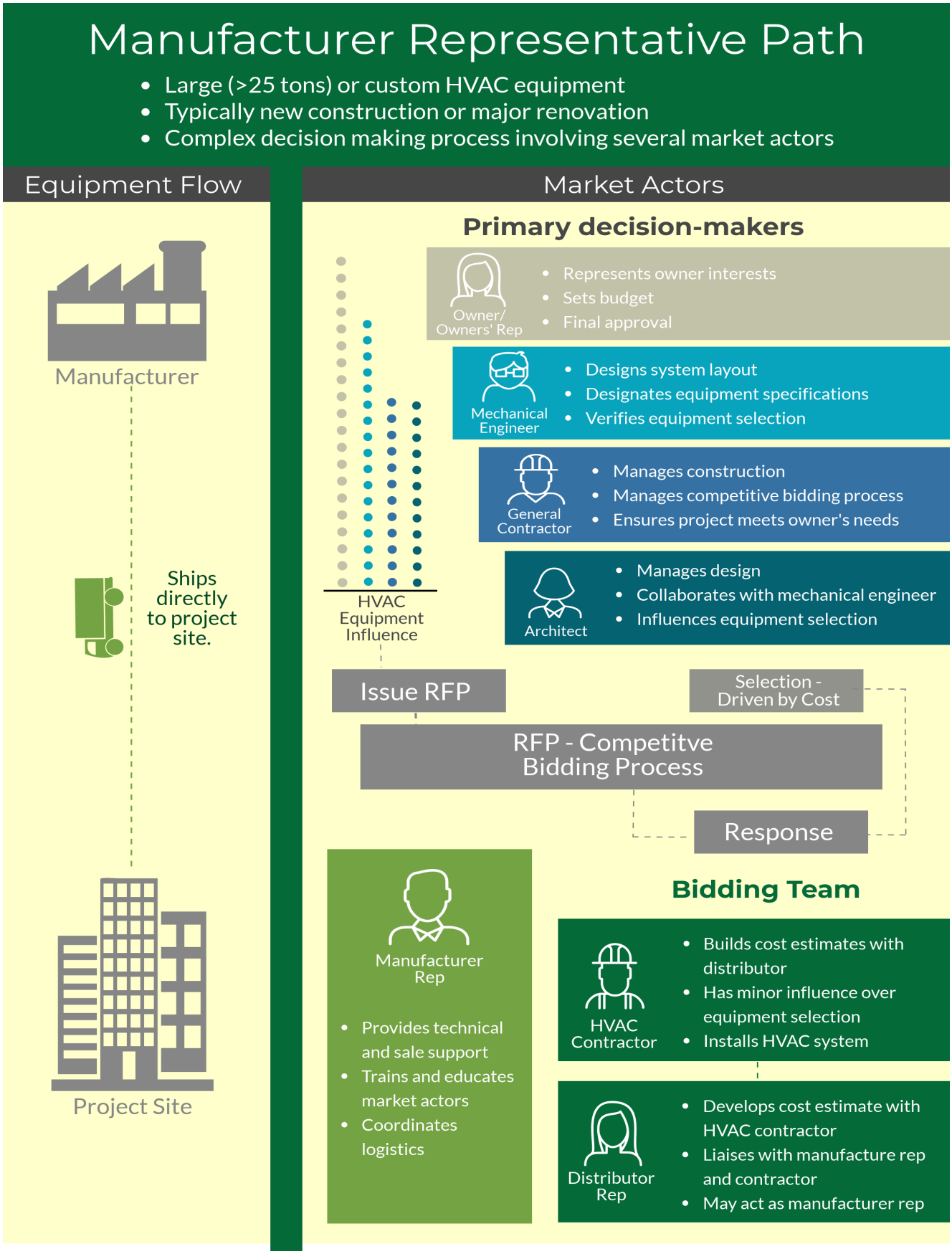
B.3.2 Large Commercial Supply Chain

Commercial HVAC equipment that is at least 25 tons is often considered to be large commercial HVAC equipment. These systems, along with highly customized (sometimes called "applied") systems designed for a specific commercial facility, may follow a different path to the end-user, often through a manufacturer representative, thus bypassing distributors.

However, interviewed distributors and manufacturers indicate that systems for large commercial facilities can also flow through a more traditional supply channel path that includes wholesale distributors, emphasizing the importance of distributors across all market segments. Distributors' involvement with large commercial equipment depends on the size of the distributor, the market segments they are engaged in, their technical expertise, and the manufacturers' preferred arrangement for large commercial equipment sales. The distributor involvement for large commercial equipment is typically positioned between the HVAC contractor, who sources the installation job, and the manufacturer. In addition, the physical flow of the equipment may still go directly from the manufacturer to the project site to simplify logistics and avoid crowding distributor warehouses.

Figure 19 depicts both the equipment shipment channels and a general example of interactions with the various market actors using the manufacturer representative pathway. The interactions and influence may vary from project to project. For example, the manufacturer representative may be brought in earlier in the design process to provide initial guidance on HVAC solutions. Another variation may be that HVAC contractors respond to an RFP rather than teaming with a distributor to cost out the equipment for the project.

Figure 19: Manufacturer Representative Supply Chain Pathways



B.3.2.1 Large Commercial Sector Market Actors

The large commercial sector market actors commonly include the owner or owners' representative, the architect or mechanical engineer, the HVAC contractor, the distributor, the manufacturer, and the manufacturer representative.

Large Commercial End-User Segments. Market actors described the large commercial market segment as falling into two main subsegments.

1. **Property Managers.** Owners that act as property managers are not motivated to pursue higher-efficiency options because they don't pay the utility bills – their tenants do. Owners commonly want to find the most cost-effective solutions that meets their needs, with less concern about consumption in spaces where the tenants pay the utility bills.
2. **Owner-Occupants.** Occupants of the space are much more invested in higher-efficiency options with advanced building controls as they pay the utility bills and directly realize any utility bill savings.

Owners may also need to consider other complicating factors such as replacing roofs or relocating tenants to accommodate an installation.

Large Commercial Market Actor Roles. Projects that require large commercial HVAC equipment often follow the *plan and spec* model, which the project team develops a detailed project description that includes the project goals, objectives, and specifications required to complete the envisioned project. Plan and spec projects involve multiple market actors, complex purchase decisions, and a competitive bid process. These projects commonly follow a traditional *design-bid-build* structure, where the owner contracts a designer and then solicits bids from contractors to complete the work. This is not the only project delivery method for large projects, but it is a common approach.

The owner or owner's representative[84] often hires an architect or mechanical engineer to manage the design of the project and a general contractor to manage the construction of the project. This team comprises the primary market actors, who are key influencers over HVAC equipment specifications, and are involved with issuing request for proposals (RFPs) and awarding contracts.

Once an RFP is issued, an HVAC installation contractor will develop cost estimates for equipment, system components, and labor. At times this happens in collaboration with a distributor. The bidding team has relatively little influence over equipment selection in new construction scenarios, as they are responding to set specifications within a specified budget. They are far removed from the owner and constrained by the competitive bidding process. The distributor may act as the manufacturer representative or serve as liaison to the manufacturer representative. Various interviewed market actors mentioned that the owner may turn directly to an HVAC contractor in a replacement scenario if they have a preexisting relationship, rather than putting the project out to bid. Though some owners may still turn to a mechanical engineer for the system design, the HVAC contractor may be tied to specific brands, equipment types, or receive benefits for quoting certain equipment.

[84] An owner's representative is hired to act on behalf of the owner. They are involved in overall project oversight and management.

The manufacturer representative's function is to focus on sales, technical support, and design support. They are in a unique position to influence both primary market actors and the bidding team due to their specialized product knowledge and customer-facing role. The manufacturer's representative may be in-house or hired as a third-party firm by the manufacturer.

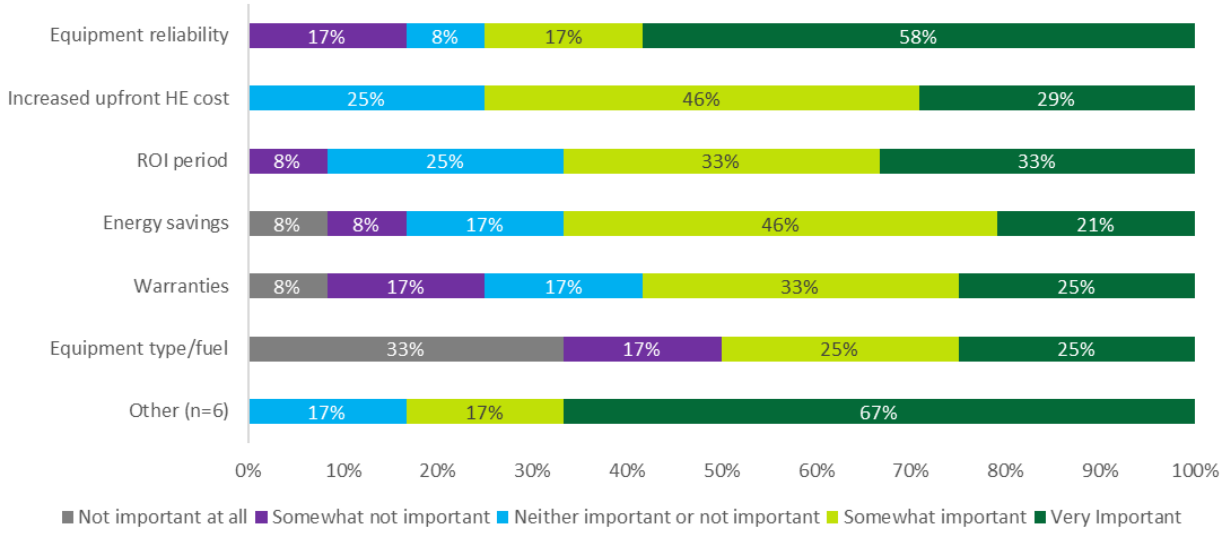
Large Commercial Purchase Decision Process. The final purchase decision is made by the owner or owner's representative and is of course driven by budget constraints, but sometimes less so than in the residential and small-to-medium commercial market. The large commercial market segment may have more access to financing and capital, and may have the staff to weigh the added first costs of higher-efficiency equipment and advanced controls against the advantages of long-term operational savings. Market actors engaged in the large commercial market noted that architects, mechanical engineers and general contractors are key influencers over the owner's decision.

The architects are likely to be most influential in new construction and major renovation projects as they are designing the overall space. The mechanical engineers are typically designing and specifying systems in both new construction and replacement scenarios. In new construction scenarios, the manufacturer representative also has influence over the architect or mechanical engineer. General contractors are more likely to advocate for higher-efficiency equipment types, such as VRFs, after they have initial project experience with these equipment types. In a replacement scenario, the manufacturer representative will be in a position to also influence the HVAC contractor.

In both new construction and replacement cases, the additional benefits of higher-efficiency equipment are more likely to be assessed by project teams. One reason noted by contractors, distributors, and manufacturers is that emergency replacements rarely happen in large commercial settings – they have either planned replacement or have redundancy built into their HVAC systems that allows them to withstand long lead-times (sometimes in the range of 12 to 14 weeks) for purchase of large commercial equipment.

Large Commercial Purchase Decision Drivers. Distributors and contractors identified the level of importance that certain factors – besides first costs, had on the large commercial end-users purchase decision. The interviewees were asked to identify the level of importance, on a scale from one to five, with one being "not important at all" and five being "extremely important." Figure 20 displays the frequency of how important each factor is in the residential purchase decision. Overall, the equipment reliability and increased upfront cost of high-efficiency equipment was identified as the most important factors. Six market actors identified funding and equipment lead time as "other" factors driving large commercial purchase decisions.

Figure 20: Large Commercial Purchase Decision Drivers (n=12)



B.3.3 Distributor Stocking Practices

The following subsection describes the findings from the interviews with market actors regarding the factors that drive distributor stocking practices. The team also explored the impact of the recent federal standard that effectively eliminated the manufacturing of furnaces that use PSC motors.

B.3.3.1 Distributor Stocking Decisions

History and forecasted sales. Most distributors stock their equipment inventory based on sales history and forecasted sales. This includes seasonal demands, what contractors are asking for, and what equipment types manufacturers expect increased demand for. However, distributors noted that manufacturer demand is usually based on national forecasts and may not always be applicable to local markets.

It should be noted that distributors base their decisions largely on experience and market demand and that a large proportion of their contractor base primarily installs standard-efficiency equipment – which drives continued stocking of standard-efficiency equipment in larger quantities than high-efficiency equipment. This particularly affects the residential and small-medium commercial market sectors as stocking decisions of distributors impact what is available for emergency replacements – which are more frequent in this market segment than the large commercial segment, which has more planned replacements. A midstream intervention may provide the program an opportunity to influence the stocking decisions of distributors towards higher-efficiency equipment, especially if some share of the incentive is passed down to the contractor and end-user to encourage the final sale of higher-efficiency HVAC systems.

Utility-sponsored energy-efficiency programs. Some distributors mentioned that utility-sponsored rebates have also had an impact on stocking decisions. However, since not all

contractors participate, it is not considered in stocking decisions as much as sales history and forecasted sales.[85]

Promoting high-efficiency equipment. Both contractors and distributors agreed that the value proposition of high-efficiency equipment generally is self-evident. Distributors offer training to contractors on both the technical aspects and the business aspects for selling high-efficiency equipment to consumers. Higher-efficiency equipment sales offer greater margins for both distributors and contractors. However, distributors noted that stocking more high-efficiency equipment occupied valuable space if the equipment failed to turn over quickly in their warehouse. Additionally, customers may not always understand the value proposition of high-efficiency equipment and contractors may not always be skilled to explain the benefits. This could limit contractors' willingness to recommend this equipment.

B.3.3.2 Federal Standard Impacts – Electronically Communicated Motor Furnace Requirement

Recently, a federal ruling was established on residential furnace fans--essentially that residential furnaces manufactured after July 3, 2019 must employ an electrically communicated motor.[86] The federal standard impacted most of the interviewed distributors stocking practices and they increased their inventory of furnaces with permanent split capacitor (PSC) motors before the federal stand changed. This was done for two primary reasons – to meet their contractor demand for standard-efficiency equipment and to remain competitive with other distributors in the area. All distributors that increased their stock of PSC motors noted that their inventory wouldn't last through the winter and that all market actors would eventually have to adapt to the new mandate. Distributors also noted that they already are conducting trainings for contractors on installation of the new furnaces.

B.4 HVAC Equipment Market Size Estimates

This section details the estimates of the volume of HVAC equipment installed in the ComEd territory. The residential estimates are for 2017 and the commercial estimates are for 2018.[87] The market size estimates are based on secondary data and the supply channel estimates are based on the primary data collected from online surveys and in-depth interviews with market actors, detailed in Task 3: Trends in the HVAC Supply Chain, of the final work plan. Due to the limitations of the available data, it is important that the values presented in this report represent approximations rather than actual counts (data limitations are described in Appendix C.2.4).

[85] Distributors and contractors mentioned that after the ComEd HVAC program required installation contractors to become program participants, there was a decrease in the number of contractors actively pushing the program. Some contractors take advantage of the program and use it to distinguish themselves, others were deterred from the additional paperwork and requirements. However, it was noted that even with the additional requirements of the program, it did not cause a major reversion back to offering standard-efficiency over high-efficiency equipment.

[86] https://www.govinfo.gov/app/details/FR-2014-07-03/2014-15387

[87] Residential estimates for 2018 were not projected due to US Census permit counts not being available for 2018. The team will attempt to update the preliminary results in the final report with new construction estimates for 2018 and current baseline findings, if available.

B.4.1 Residential Equipment Market Size Estimates

The team performed the analyses to triangulate the residential equipment estimates with both top-down and bottom-up approaches. The resulting ranges show the potential equipment volumes flowing through the ComEd territory (Table 18). As stated above, these estimates relied on publicly-available data that was, in some cases, scaled down to the ComEd territory from national or Census-division data and, in the case of the baseline data, scaled up to the ComEd territory. The consistency between sources varies by equipment type, especially for equipment that has a smaller market share or has become more prevalent in the market over the past few years.

Table 18: Estimated 2017 Residential HVAC Equipment Installations in ComEd Territory (# of Units)

Equipment	2012 ComEd Baseline	*Market Size Estimates*				*Estimated Sales/Market Shares*				
		2012 ComEd Baseline Scaled to 2017	2017 AHRI National Sales Data	2015 RECS Scaled to 2017	*Average*[a]	Standard-Efficiency	High-Efficiency[b]	ComEd Downstream Incentives (2017)[c]	% of HE Units Incented	% of Market Incented
Central ACs	120,515	142,414	145,388	164,401	***150,734***	117,572	33,162	10,450	31.5%	6.9%
Air-Source Heat Pumps[f]	2,146	2,536	73,449	19,468	***31,987***	19,408	12,409	159	1.3%	0.5%
Ductless Mini-Splits	1,651	1,951	--	--	***1,951***	--	--	--	--	--
Fossil Fuel Furnaces	111,287	131,509	88,903	117,403	***112,605***	84,454	28,151	5,076[d]	18.0%	4.5%
Fossil Fuel Boilers	15,096	17,839	--	10,417	***14,128***	7,770	6,358	--	--	--
Electric Furnaces	2,526	2,985	--	8,162	***6,071***	--	--	--	--	--
Storage Tank Water Heaters	194,298	229,604	237,932	186,812	***218,116***	205,029	13,087[e]	--	--	--
Tankless Water Heaters	4,343	5,132	--	22,505	***13,819***	--	--	--	--	--
Heat Pump Water Heaters	1,585	1,873	--	--	***1,873***	--	--	--	--	--

[a] Average estimates exclude the 2012 baseline estimate.
[b] High-efficiency estimates are based on national ENERGY STAR penetration rates.
[c] ComEd incentivized units based on 5th plan data.
[d] Program incentive count is based on high-efficiency furnaces with ECM motors. Navigant. January 27, 2017. "ComEd Heating, Cooling, and Weatherization Rebates Program Evaluation Report (PY8)." Prepared for ComEd.
[e] ENERGY STAR penetration rates for storage tank water heaters were applied to all residential tank sizes.
[f] Ductless mini-splits use air-source heat pump technology. The RECS survey and the AHRI national sales data just provided a broad category, while the ComEd baseline categorized these systems separately; the team decided to show the breakout for these systems.
*Dashed lines (--) indicate no supporting data is available.
**12.2% of water heaters were unidentified in the 2012 baseline study.
***7.7% of heating equipment was classified as *other* or unidentified in the 2012 baseline study.

B.4.2 Commercial Equipment Market Size Estimates

The team triangulated the commercial equipment estimates with both top-down and bottom-up approaches. The potential volume of commercial cooling and heating systems are displayed in units (Table 19) and by tonnage (Table 20).

Table 19: Estimated 2018 Commercial HVAC Equipment Installations in ComEd Territory (# of Units)

Equipment	2012 ComEd Baseline	Market Size Estimates			Estimated Sales/Market Shares				
		2012 ComEd Baseline Scaled to 2018	2012 CBECS Scaled to 2018	Average Units[a]	Standard-Efficiency	High-Efficiency[b]	ComEd Downstream Incentives (2018)[c]	% of HE Units Incented	% of Market Incented
Cooling Equipment									
Residential-Sized Central AC	--	--	6,298	***6,422***	5,009	1,413	--	--	--
Packaged RTU (Cooling)	--	--	2,848	***2,848***	2,449	399	--	--	--
Chillers	219	250	271	***261***	--	--	--	--	--
Heat Pumps[e]	--	--	1,339	***1,339***	--	--	--	--	--
Packaged or Split Air-Conditioners	26,837	30,624	31,765	***31,194***	--	--	--	--	--
Heating Equipment									
Packaged RTU – Electric Heat	--	--	787	***787***	677	110	--	--	--
Packaged RTU – Fossil Fuel Heat	--	--	5,535	***5,535***	4,760	775	--	--	--
Packaged RTU – Combined Cool and Heat	--	--	16,174	***16,174***	13,908	2,266	--	--	--
Furnace – Electric	--	--	661	***661***	--	--	--	--	--
Furnace – Fossil Fuel	--	--	4,824	***4,824***	--	--	--	--	--
Boiler – Electric	--	--	969	***969***	--	--	--	--	--
Boiler – Fossil Fuel	--	--	13,264	***13,264***	--	--	--	--	--
Heat Pump (Heating)	--	--	1,576	***1,576***	--	--	--	--	--
Total Packaged RTU	--	--	--	***25,344***	21,794	3,550	3,949	111%[d]	15.6%

[a] Average estimates exclude the 2012 baseline estimate.
[b] High-efficiency estimates are based on national ENERGY STAR penetration rates. The ENERGY STAR penetration rate is for small-medium commercial HVAC equipment and includes the following: central air-conditioners, heat pumps, packaged units, and variable refrigerant flow systems. Systems qualify if they are at least 6% more efficient than the federal minimum.
[c] Navigant. April 12, 2018. "ComEd Small Business Energy Savings Impact Evaluation Report (PY9)". Presented to Commonwealth Edison Company.
[d] This may be attributed to the increased efficiency requirements for ENERGY STAR qualified systems compared to the ComEd HVAC program requirements for incented packaged systems.
[e] Includes air-source, water-source, and ground-source heat pumps.
* Dashed lines (--) indicate no supporting data is available.

Table 20: Estimated 2018 Commercial HVAC Equipment Installations in ComEd Territory (Tonnage)

Equipment	2012 ComEd Baseline	*Market Size Estimates*			*Estimated Sales/Market Shares*				
		2012 ComEd Baseline Scaled to 2018	2012 CBECS Scaled to 2018	Average Tonnage[a]	Standard-Efficiency	High-Efficiency[b]	ComEd Downstream Incentives (2018)[c]	% of HE Units Incented	% of Market Incented
Cooling Equipment									
Residential Style AC	--	--	34,786	34,786	27,133	7,653	--	--	--
Packaged RTU (Cooling)	--	--	22,782	22,782	19,593	3,190	--	--	--
Chillers	81,914	93,474	101,189	97,332	--	--	--	--	--
Heat Pumps[d]	--	--	6,427	6,427	--	--	--	--	--
Packaged or Split Air-Conditioners[e]	195,363	222,931	237,530	230,231	--	--	--	--	--
Heating Equipment									
Packaged RTU – Electric Heat	--	--	6,294	6,294	6,441	881	--	--	--
Packaged RTU – Fossil Fuel Heat	--	--	44,279	44,279	38,080	6,199	--	--	--
Packaged RTU – Combined Cool and Heat	--	--	129,389	129,389	111,274	18,114	--	--	--
Furnace – Electric	--	--	3,580	3,580	--	--	--	--	--
Furnace – Fossil Fuel	--	--	26,128	26,128	--	--	--	--	--
Boiler – Electric	--	--	7,753	7,753	--	--	--	--	--
Boiler – Fossil Fuel	--	--	106,110	106,110	--	--	--	--	--
Heat Pumps (Heating)	--	--	7,323	7,323	--	--	--	--	--
Total Packaged RTU			--	202,744	174,360	28,384	31,592	111%[f]	15.6%

[a] Average estimates exclude the 2012 baseline estimate.
[b] High-efficiency estimates are based on national ENERGY STAR penetration rates. The ENERGY STAR penetration rate is for small-medium commercial HVAC equipment and includes the following: central air-conditioners, heat pumps, packaged units, and variable refrigerant flow systems. Systems qualify if they are at least 6% more efficient than the federal minimum.
[c] Navigant. April 12, 2018. "ComEd Small Business Energy Savings Impact Evaluation Report (PY9)". Presented to Commonwealth Edison Company.
[d] Includes air-source, water-source, and ground-source heat pumps.
[e] Tonnage values are based on average weighted tonnage from combined CBECs equipment type categories.
[f] This may be attributed to the increased efficiency requirements for ENERGY STAR qualified systems compared to the ComEd HVAC program requirements for incented packaged systems.
* Dashed lines (--) indicate no supporting data is available.

The team also conducted an analysis on both variable refrigerant flow (VRF) and ductless mini-split (DMS) heat pump systems using CBECS microdata (Table 21). The 2013 ComEd commercial baseline did not report on either of these systems. Note that the variables used for these estimates include primary and non-primary equipment. These estimates should be viewed with caution due to the limited evidence on the two equipment types' historical growth rates. The estimates do not capture both equipment types' presumed increase in market share since the last CBECS survey was administered (2012). For example, distributors operating in the Pacific Northwest have indicated that they have seen growth of 35% to 40% in sales for both systems over the past few years.[88]

The team found evidence that VRF systems are projected to have a double-digit growth rate over the next several years.[89] These equipment types were of particular interest during the interviews with manufacturers and distributors to identify past, current and future trends, and how the projected continued growth has impacted the HVAC market in the ComEd territory. The findings from the interviews are presented in detail in Section B.7.

Table 21: Estimated 2018 Commercial Variable Refrigerant Flow and Ductless Mini-split Systems

Variable Refrigerant Flow (VRF)	Ductless Mini-splits
71	1,020

*Please note that estimates provided for VRF and mini-split systems are based on older data that does not capture the potential hypergrowth that has been suggested by secondary research. Additional research on the heat pump market for space conditioning once more recent data for the ComEd territory is made available.

B.5 Equipment Flows by Supply Channel and End-use Market Segments

The team investigated the flow of systems through different supply channels and how those systems deliver to different end-use market segments (i.e., emergency replacement, planned replacement, supplemental installations, and new construction) using primary and secondary research.

B.5.1 Supply Channels

B.5.1.1 Preliminary Estimates Based on Secondary Data Sources

Secondary data sources that quantify the flow of equipment by supply channel are extremely limited. The results of the few secondary sources available are displayed in Table 22. The Bonneville Power Administration (BPA) data represents the Northwest market and the information is based on a limited selection of equipment. The Wisconsin Focus on Energy evaluation report provides useful supply channel information, but only covers the commercial market and was conducted in 2003.

[88] Research into Action and Cadeo. January 25, 2018. "Memorandum of HVAC Market Actor Interviews." Presented to Bonneville Power Association.
[89] https://www.achrnews.com/articles/134465-vrf-market-expected-to-hit-24b-by-2022

Table 22: Supply Channel Flows - Secondary Data Sources

	BPA Residential[1]	BPA Commercial[2]	Wisconsin Commercial[3]	Wisconsin – CAC only[4]
End-Use Segment				
New Construction	44%	30%	50%	33%
Retrofit	56%	70%	50%	67%[a]
Planned Replacement	--	--	*30%*	--
Emergency Replacement	--	--	*20%*	--
Supply Channel				
Manufacturer to Distributor	--	--	57%	--
Manufacturer to Contractor	--	--	40%	--
Manufacturer to Owner	--	--	3%	--
Distributor Channel				
Distributor to Contractor	--	--	90%	--
Distributor to Customer	--	--	10%	--

[a] 40% of this number is attributed to homes (that lacked central AC) adding a central AC system or converting from room air-conditioners to a centralized system.
[1] Statistics only reflect ASHP equipment. Bonneville Power Administration. "HVAC Market Intelligence Report." April 2016.
[2] Bonneville Power Administration. "Commercial HVAC Market Characterization."
[3] Tannenbaum, Bobbi and Quantum Consulting. "Commercial and Industrial Equipment Supply Chains: An Assessment of the HVAC Industry." June 2003. Prepared for Wisconsin Focus on Energy.
[4] Pigg, Scott. "Central Air Conditioning in Wisconsin: A Compilation of Recent Field Research." Wisconsin Focus on Energy. May 2008.

B.5.1.2 Supply Channels Segmentation - Primary Research

In addition to providing qualitative feedback about the HVAC market, interviewed market actors provided feedback to help quantify the flows of equipment through the various supply channels, providing separate estimates for the residential, small-medium commercial, and large commercial market segments, as appropriate for each respondent.

Table 23 depicts the proportion of HVAC equipment moving through each phase of the supply chain channel, by market segment, based on the responses of interviewed distributors, manufacturers, and contractors. Essentially, the interviewed manufacturers, distributors, and contractors were asked to identify the market actors that their HVAC equipment typically flowed to and the proportions that went to each of them. The responses reflect the market actor's perspective based on their position in the market (i.e., a distributor only provided estimates on how much equipment was going to each market actor), and responses were averaged for each market actor group. The respondents suggested that the proportions of systems they sold typically did not deviate substantially for any particular equipment type.

Table 23: Proportion of Equipment Flowing Down the Supply Chain by Market Segment

End-User	Residential Equipment	Small-Medium Commercial Equipment	Large Commercial Equipment
Manufacturer Results			
Sample size	*n=2*	*n=2*	*n=2*
Distributor	100%*	95%	98%
Facility Owners	--	5%	3%
Distributor Results			
Sample size	*n=10*	*n=10*	*n=8*
Homeowner	--	--	--
Facility Owners	2%	2%	1%
Property Managers	3%	3%	1%
Builders/GCs	3%	3%	1%
HVAC Contractor	91%	92%	96%
Retailer	1%	--	--
Other	--	1%	--
Contractor Results			
Sample size	*n=5*	*n=9*	*n=5*
Homeowner	78%	--	--
Facility Owners	6%	56%	60%
Property Managers	12%	29%	21%
Builders/GCs	4%	9%	13%
HVAC Contractor	--	3%	6%
Retailer	--	2%	--
Other	--	--	--

*Not all manufacturers shared this information. Based on the findings from the IDIs, the team believes a small portion of manufacturer sales would be directed to retailers and online wholesalers, depending on the manufacturer's business model.

Only two of the manufacturers provided estimates of their shipments by distinct supply channels, and respondents from both companies indicated relying primarily on distributors for both residential and commercial market segments. They indicated that they only infrequently bypassed the distributor channel to deliver larger, more complex commercial systems to customers. These manufacturers described how most of their large commercial HVAC sales involved an HVAC contractor ordering equipment through a distributor, even if the physical equipment was shipped directly from the manufacturer to the project site. In such cases, the manufacturer representative generally played a role by providing sales and technical support. Some manufacturers may use manufacturer's representatives for a portion of their business, resulting in a complex supply channel with multiple different market actors, even within a single region.[90]

[90] The interviewed market actors indicated that commercial HVAC equipment generally does not flow through retailers or online-only channels. If ComEd can engage with manufacturers to acquire full category sales data and product flow information, we expect that more residential equipment in particular would be identified as flowing through retail and online-only wholesale channels.

B.5.1.3 Installation Type – Primary Research

Table 24 displays the interviewed market actors' average estimates of the percentages of equipment that are installed in different installation scenarios, including those installed in new and existing buildings. For this table, respondents provided the estimated proportions of equipment that fell into each installation scenario for the market – based on their experience and knowledge (i.e., distributors estimated the amount of installations that occurred in each scenario based on their understanding of sales and contractor base operations), and responses were averaged among each market actor group for each installation scenario.

Respondents estimated the percent of equipment installations that were installed for the following installation scenarios:

- New construction
- Existing buildings
  - Supplemental system added to a home or building
  - Emergency replacement (existing system has completely failed)
  - Replacement of a functioning, *near failure system*
  - Replacement of a fully functioning system, *not close to failure*

The distributors estimated that on average, between 51% and 60% of installations across market segments (residential, light, and large commercial, see Table 24) are for emergency replacements (i.e., replacing systems that have completely failed and do not function at all). While market actors suggested that large commercial market actors certainly experience emergency replacement scenarios, they noted that these facilities often have back-up systems that allow for continued operations. In contrast, the small-to-medium commercial market segment is more likely to rely on one system to serve their space conditioning needs, and thus require a more immediate solution upon system failure. HVAC contractors estimated a lower average proportion of emergency replacement installations than distributors (30% to 42%, depending on market segment), and a higher amount was attributed to replacing systems that were close to total failure (39% to 43%, depending on market segment). When combining both emergency replacements and replacements for near failure equipment, both distributors and HVAC contractors suggest that a majority of installations are occurring under these more time-sensitive scenarios.

The results from market actors suggest that end-user purchase decisions in these scenarios are typically more constrained by the equipment stock available from the local distributor. More information regarding what drives distributor stocking decisions is provided in Section B.3.3. One manufacturer did not provide exact estimates but indicated that they summarize the replacement market for unitary (typical residential and small-medium commercial) equipment as 20% planned and 80% emergency replacement; whereas the applied or custom equipment is generally 80% planned and 20% emergency replacement.

Table 24: Percent of Average Estimated Installation Scenarios by Market Segment

Installation Type	Residential Equipment	Small-Medium Commercial Equipment	Large Commercial Equipment
Manufacturer Results*			
Sample size	*n=1*	*n=1*	*n=2*
New construction	5%	25%	30%
Supplemental system	50%	25%	20%
Emergency replacement	20%	25%	28%
Replaced functioning, near failure system	10%	--	10%
Replaced fully functioning system not close to failure	--	--	--
Other	15%	25%	13%
Distributor Results			
Sample size	*n=10*	*n=10*	*n=8*
New construction	14%	15%	13%
Supplemental system	4%	6%	4%
Emergency replacement	51%	54%	60%
Replaced functioning, near failure system	21%	20%	18%
Replaced fully functioning system not close to failure	9%	5%	3%
Other	2%	1%	3%
Contractor Results			
Sample size	*n=5*	*n=9*	*n=5*
New construction	2%	7%	12%
Supplemental system	N/A	N/A	N/A
Emergency replacement	39%	42%	30%
Replaced functioning, near failure system	43%	39%	41%
Replaced fully functioning system not close to failure	16%	12%	17%

*Manufacturer results are for installations are based only on one respondent. The high estimated rate of supplemental systems is likely due to the use of heat pumps in installation scenarios that require supplemental heating or cooling.

Based on the results above, the supply channel and end-use segment estimates for residential equipment are displayed in Table 25. Water heaters were not a focus of research and interview respondents did not provide values for water heaters. However, the evaluation team estimated water heater quantities based on available data (Table 18). Water heater results are based on a combination of secondary and primary data; additional research focused on the volume and supply channel flows of water heaters in the ComEd territory would be necessary to understand this market in greater detail.

Commercial estimates for equipment and tonnage values are displayed in Table 26 and Table 27.[91] Note that these values are projections based on applying the market actor proportions, described above, to the overall secondary research-based market size estimates for heating and cooling systems described in Table 18 and Table 19. Data limitations prevented breaking out small-to-medium-sized and large commercial HVAC equipment into separate estimates. The following data averages the distributor responses for both small-to-medium and large commercial supply channel end-uses and installation end-uses.

[91] The team used the values from interviews with market actors to update the preliminary estimates initially provided as a part of Task 2.

Table 25: Estimated 2017 Residential HVAC Equipment Installations by Supply Channel and End-use Segmentation

Equipment	Average Estimate	Supply Channel – Estimated Volumes				Installation Segment – Estimated Volumes		
		HVAC Contractor	Property Managers or Facility Owners	Builders	Retailers	Emergency Replacement[c]	Planned Replacement	New Construction
Central Air Conditioners[a]	150,734	137,168	7,537	4,522	1,507	107,900	21,580	21,253
Air-source Heat Pump[a]	31,987	29,108	1,599	960	320	22,897	4,579	4,510
Ductless Mini-splits[a]	1,951	1,775	98	59	20	1,397	279	275
Fossil Fuel Furnaces[a]	112,605	102,471	5,630	3,378	1,126	80,606	16,121	15,877
Fossil Fuel Boilers[a]	14,128	12,856	706	424	141	10,113	2,023	1,992
Electric Furnaces[a]	6,071	5,525	304	182	61	4,346	869	856
Storage Tank Water Heaters (not fuel specific)[b]	218,116	162,540	8,834	5,300	41,442	156,135	31,227	30,754
Tankless Water Heaters[b]	13,819	10,298	560	336	2,626	9,892	1,978	1,948
Heat Pump Water Heater[b]	1,873	1,396	76	46	356	1,341	268	264

[a] Assumptions: Based on results from the market size estimate and the results from the market actor interviews with distributors. The proportion of equipment flowing to each market actor in the supply chain is based on distributor results in Table 23; as well as the new construction installation proportion. Emergency and planned replacement segments are based on the contractor responses for residential installation scenario segments in Table 24. Figures assume an even distribution of systems across the region/state, but ComEd indicates the ASHP penetration rate may be lower in ComEd territory than the rest of Illinois; accordingly, estimates may overstate the size of the ASHP market.
[b] Assumptions: 81% through distributors, 19% through retailers (NEEA)[92]; proportion of equipment flowing through distribution is assumed to have the same supply channel proportions as provided in Table 23. Installation end-uses leverage the distributor results from Table 24.
[c] The emergency replacement category includes contractor responses for emergency replacements and near failure replacements.

[92] Cadeo Group. September 27, 2018. "Heat Pump Water Heater Initiative Market Progress Evaluation Report #4." Presented to Norwest Energy Efficiency Alliance. https://neea.org/img/documents/HPWH_MPER4_FINAL.pdf

Table 26: Estimated 2018 Commercial HVAC Equipment Installations by Supply Channel and End-use Segmentation (# of Units)

Equipment	Average Estimate	Supply Channel – Estimated Volume			Installation Segment – Estimated Volume		
		HVAC Contractor	Property Managers or Facility Owners	Builders	Emergency replacement[c]	Planned Replacement	New Construction
Residential Style Central AC[a]	6,298	5,716	460	121	4,540	872	886
Packaged RTU[a]	2,848	2,585	111	55	2,053	394	401
Chillers[a]	261	237	10	5	188	36	37
Heat Pumps[a]	1,339	1,215	50	26	965	185	188
Packaged or Split Air-Conditioners [a, b]	31,194	28,313	1,170	600	22,487	4,320	4,387
Packaged RTU - Electric[a]	787	714	58	15	567	109	111
Packaged RTU – Fossil Fuel[a]	5,535	5,024	405	107	3,990	767	778
Packaged RTU Combined[a]	16,174	14,680	1,183	311	11,660	2,240	2,274
Furnace - electric[a]	661	600	48	13	477	92	93
Furnace - fossil fuel[a]	4,824	4,378	353	93	3,478	668	678
Boiler - electric[a]	969	880	71	19	699	134	136
Boiler - fossil fuel[a]	13,264	12,039	970	255	9,562	1,837	1,865
Heat pump (heating) [a]	1,576	1,430	115	30	1,136	218	222

[a] Assumptions: Based on results from the market size estimate and the results from the market actor interviews with distributors. The proportion of equipment flowing to each market actor in the supply chain is based on distributor results in Table 23; as well as the new construction installation proportion. Emergency and planned replacement segments are based on the contractor responses for commercial installation scenario segments in Table 24. Figures assume an even distribution of systems across the region/state, but ComEd indicates the ASHP penetration rate may be lower in ComEd territory than the rest of Illinois; accordingly, estimates may overstate the size of the ASHP market.

[b] This category includes both packaged RTUs and residential style AC consolidated estimates.

[c] The emergency replacement category includes contractor responses for emergency replacements and near failure replacements.

* Note that facility owner and property manager category include the volume of equipment that was indicated by manufacturers that were flowing directly to these supply channels.

**Note that small-to-medium and large commercial supply chain and installation segments were combined in this table due to limited market size information on commercial segments.

Table 27: Estimated 2018 Commercial HVAC Equipment Installations by Supply Channel and End-use Segmentation (Tonnage)

Equipment	Average Estimate (tons)	Supply Channel – Estimated Tonnage			Installation Segment – Estimated Tonnage		
		HVAC Contractor	Property Managers or Facility Owners	Builders	Emergency replacement	Planned Replacement	New Construction
Residential Style Central AC[a]	34,786	31,573	2,543	670	25,077	4,818	4,892
Packaged RTU[a]	22,782	20,678	1,666	439	16,423	3,155	3,204
Chillers[a]	97,332	88,342	7,116	1,874	70,165	13,480	13,687
Heat Pumps[a]	6,427	5,833	470	124	4,633	890	904
Packaged or Split Air-Conditioners [a, b]	230,231	208,966	16,833	4,432	165,970	31,885	32,376
Packaged RTU - Electric[a]	6,294	5,713	460	121	4,537	872	885
Packaged RTU – Fossil Fuel[a]	44,279	40,189	3,237	852	31,920	6,132	6,227
Packaged RTU Combined[a]	129,389	117,438	9,460	2,491	93,275	17,919	18,195
Furnace - electric[a]	3,580	3,249	262	69	2,581	496	503
Furnace - fossil fuel[a]	26,128	23,715	1,910	503	18,835	3,618	3,674
Boiler - electric[a]	7,753	7,037	567	149	5,589	1,074	1,090
Boiler - fossil fuel[a]	106,110	96,309	7,758	2,043	76,493	14,695	14,922
Heat pump (heating) [a]	7,323	6,647	535	141	5,279	1,014	1,030

[a] Assumptions: Based on results from the market size estimate and the results from the market actor interviews with distributors. The proportion of equipment flowing to each market actor in the supply chain is based on distributor results in Table 23; as well as the new construction installation proportion. Emergency and planned replacement segments are based on the contractor responses for commercial installation scenario segments in Table 24. Figures assume an even distribution of systems across the region/state, but ComEd indicates the ASHP penetration rate may be lower in ComEd territory than the rest of Illinois; accordingly, estimates may overstate the size of the ASHP market.
[b] This category includes both packaged RTUs and residential style AC consolidated estimates.
[c] The emergency replacement category includes contractor responses for emergency replacements and near failure replacements.
* Note that facility owner and property manager category include the volume of equipment that was indicated by manufacturers that were flowing directly to these supply channels.
**Note that small-to-medium and large commercial supply chain and installation segments were combined in this table due to limited market size information on commercial segments.

B.6 Market Actor Perspectives on Utility Program Interventions

The following subsections presents the market actor perspectives on and experience with HVAC programs sponsored by utilities. The findings cover downstream, midstream, and upstream HVAC programs.

B.6.1 Midstream Programs

B.6.1.1 Midstream Incentive Pass-Through Requirements

Many respondents were aware that some utility programs require market actors along the supply chain to pass through some or all of the incentive to the end-user. In general, market actors described how the existence of such incentives could drive sales even if they were not allowed to keep any of the incentive and had to pass it all through to the customer and allowing contractors to keep some of the incentive was a commonly mentioned suggestion. In some cases, they viewed contractors as operating in an extremely tight market, where passing the incentive down to the customers would be a key means of successfully winning work, so they may not keep it even if allowed. Distributors in some cases might appreciate being able to keep some of the incentive to help offset some administrative costs associated with a midstream program, but market actors cited increased sales that would result as a compensating factor. One manufacturer with experience with various utility programs said that it was not the pass-through requirement but the overall quality of the program – and the incentive amounts – that would ultimately dictate its success.

One distributor mentioned specific experience with a utility program that was currently piloting a midstream program. They were apprehensive about the program design, especially related to the incentive requirement structure – there was no requirement on what the distributor did with the incentive. They thought that type of incentive structure created a disconnect between the distributor and their contractors, as if they were keeping a secret from the contractor. The distributor believed that designing a program that shared the incentive structure with the contractor, who could then pass it down to the end-user, would put the distributor in the best position to influence increased adoption of high-efficiency products. The key takeaway for programs looking to administer a midstream intervention is to effectively communicate the incentive structure to participants – including an incentive structure that has no requirements, and what the best practices are for applying those incentives to increase overall sales of high-efficiency equipment.

B.6.1.2 Midstream Participant Data Needs

Several distributors expressed concerns that tracking data typically associated with downstream programs would be more difficult in a midstream or upstream program intervention. Manufacturers ship equipment without knowing its final destination. Distributors may operate over large territories that involve many different utility programs and are limited in their ability to know where installations are occurring. Contractors may operate across multiple service territories, as well as stock their own equipment inventory may not know where the equipment, purchased from the distributor, will ultimately be installed.

Contractors and distributors were most familiar with the downstream program requirements associated with the current ComEd program, and mentioned data requirements such as gathering addresses, utility account numbers, participant contractor processes, and specific equipment requirements. Essentially, market actor concerns were associated with the level of effort required to collect data in order to receive an incentive – and how that would meet the needs of the utility program. As mentioned in the results from the literature review, conducted during the Task 1 research activity, it is imperative for programs that are shifting to a midstream intervention to work with distributors during the initial program design phase to determine the data that can be collected.

A number of manufacturers and distributors were willing to share sales data, though most expressed a need for a protective contract such as a non-disclosure agreement, memorandums of understanding (MOUs), and/or a collaborative data-sharing partnership (i.e., providing program market share percentages relative to total program incentives). A few respondents were more apprehensive about the prospect of sharing their sensitive sales data.

B.6.2 Upstream Intervention

One distributor thought ComEd would be more successful with an upstream rather than a midstream model, as it is likely that the full amount would be passed down in an upstream model. However, some respondents were concerned that the full incentive would not be passed through under this program structure.

Another distributor speculated that upstream programs would lead to the manufacture of more high-efficiency equipment. Other respondents had mixed assessments of an upstream program's success; one distributor did not foresee an upstream program impacting their stocking of high-efficiency equipment.

One manufacturer was enthusiastic about working with utilities and stated that manufacturers are in the best position to work with utilities to design realistic and effective program requirements that are appropriate for different equipment types. The manufacturer stated, "*You can't just say be 18% better than code and we'll give you an incentive… a systems approach is the best way*."

B.6.3 Downstream Program Experience

When asked about the benefits of participating in utility programs, many respondents cited the incentives, which make high-efficiency equipment more affordable to the end-user; and can help contractors win contracts by showing potential customers the reduced cost from the rebate. However, some respondents pointed out that not all programs are easy to participate in. One distributor noted that for programs that are only open to selected trade ally partners, some contractors are unable to participate unless they do so through a participating trade ally who handles the paperwork. Distributors mentioned that they observed a drop in the number of participating contractors in the ComEd territory after it required contractors to become program contractors to receive the full rebate. A contractor noted that strict program requirements can prevent a contractor from correcting an under- or over-sized system, as a differently-sized replacement system would not be eligible for a rebate.

The administrative burden of program paperwork was cited by several respondents as a barrier to participation for some contractors. A contractor that participated in multiple programs expressed frustration that the length of time for a technical review for applied equipment varied significantly, not only across programs, but within a single program as well. Another contractor pointed out that while prescriptive programs had a relatively low barrier to entry, custom program participation requires specialized training and engineering knowledge to calculate energy models.

While most observations were directed at program participation in general, a contractor and ComEd trade ally lamented that it was difficult to get in touch with ComEd to discuss participation in the commercial or business programs. Another contractor said they had filled out the entire commercial application twice and received no response.

B.6.4 Comparative Assessment of Program Interventions

Market actors identified pros and cons for each type of program intervention: downstream, midstream, and upstream.

- Downstream programs put the burden of participation on end-users or contractors, and require program administrators to interact with a large number of customers. To be effective, downstream programs require large scale marketing efforts. Customers may not know about these programs and may find them confusing to navigate. A significant benefit of downstream programs is that the end-user receives the full and direct financial benefit.
- Upstream programs may have the potential to cost-effectively impact the market on a much broader scale, because the programs would impact manufacturers, thereby affecting the supply of products for the entire market. However, program implementation and evaluation can be quite difficult with this approach. Given that manufacturers sell products regionally and nationally it can be challenging with this approach to ensure that ratepayer money is being spent only on systems installed in a given utility service territory. Success in this space may require coordination across a coalition of regional utilities to overcome issues with geographic boundaries and being the furthest supply chain actor from the installation.
- A midstream intervention provides combines the dual benefit of working with a fewer market actors than with a downstream intervention, and being closer to the installation contractors and end-users than an upstream intervention. Providing incentives in a midstream intervention reduces the paperwork barriers that deter contractor or end-user participation in a downstream program. This administrative burden in a midstream program typically falls on distributors. Accordingly, some programs may allow distributors to keep a portion of the incentive or provide support for the administrative overhead, in addition to the benefits of the increase in sales for higher margin, higher efficiency equipment.

All programs interventions that use prescriptive requirements are best served to stay with unitary equipment, as applied HVAC equipment will still likely require custom energy savings calculations.

B.6.5 Other Program Design Considerations

Several respondents across each market actor group advocated for incentives going only to the end-users, who are responsible for making the decision and paying the bills, or contractors who work directly with the end-users. One manufacturer suggested that ComEd strategically design programs with the intended market actor in mind, recognizing that downstream programs require contacts with many more people (potential end-users) than programs further upstream (key manufacturers or distributors in the area).

One manufacturer cited code as an important consideration when designing programs. If there is a replacement project without a knowledgeable engineer or contractor, code requirements drive equipment decision-making, followed by any incentives that would reduce the incremental cost. Ultimately, that respondent thought targeting manufacturers would be most effective. Citing an environment of minimal code enforcement in the Northern Illinois market, a contractor expressed concern that mid- or upstream programs would bypass knowledgeable contractors and lead to incorrect installations.

B.7 HVAC Industry Trends

Market actors were asked about: (i) anticipated changes in the supply chain channels; and (ii) significant HVAC technology changes they have experienced in the last three to five years and the technological changes they anticipate in the next three to five years. The resulting findings are presented in the following subsections.

B.7.1 Changes to Supply Channels

Most market actors reported that there would not be major changes to the traditional supply chain in the near future. Shifting completely away from the current supply chain model would require a massive effort and be costly. However, market actors noted that there is an online-only retailer or wholesaler presence in the HVAC market and anticipate that new players in the market may use these channels to try and disrupt the traditional supply chain model. These channels tend to represent small installation quantities and primarily impact the residential market segment but could grow over time and win sales from traditional distributors if they can effectively compete on price. None of the market actors anticipated that the commercial market is likely to adopt these channels, as commercial equipment is larger and more complex, and may require more customization than off-the-shelf solutions. Market actors expect these non-traditional channels to gain a larger residential market share over time, and chip away at the margins of wholesale distributors.[93] However, market actors speculated the traditional supply chain will remain intact. In response to the growth of these channels, several interviewed distributors have developed or are considering deploying an online platform for their contractors to place orders at their

[93] One manufacturer noted that the HVAC industry can be classified as two main product types – unitary and applied. Unitary is like a commodity, it could be bought online by the end-user and have a contractor come install it – there is a lot of possibility it changes this way, but the infrastructure isn't there at least for the next five years. Applied equipment are typically custom HVAC solutions, and that is a long way off before online purchasing could come into play.

convenience. Loyalty or rewards programs for installation contractors were also mentioned by distributors as a way to retain market share.

Some manufacturers use factory-owned stores for distribution already, though this still is essentially the traditional supply channel model.[94] Some distributors noted that contractors often end up having to go to independent wholesalers to get additional parts and supplies.

B.7.1.1 Potential for Disintermediation

Market actors were specifically asked about the potential for disintermediation in the HVAC market. Disintermediation is the reduction in the role of intermediaries between manufacturer and end-use customer. Most market actors do not think there is a real threat of disintermediation happening in the HVAC industry. Some distributors suggested that the non-traditional supply channels could impact the distributors' and the contractors' margins if direct to end-user sales become commonplace.

A few distributors anticipate that the consolidation of smaller and mid-sized wholesalers into larger distributors will happen – larger distributors will be more inclined to absorb the smaller organizations rather than compete directly in their territory.

B.7.1.2 End-User Direct Purchases

While respondents generally saw the supply chain as stable, several market actors expressed concern and anticipated issues to occur in the next few years from an increased market share for the online-only channel. Online-only sellers, including those that are headquartered out of state, can sell directly to consumers, bypassing contractors and traditional brick-and-mortar distributors. Some interviewees noted that any such retailers and online-only sellers do not have the practical experience or technical expertise to help diagnose situations in the field – or the resources to meet contractors on-site to troubleshoot installation issues, especially with newer technology equipment. Contractors purchasing through this channel due to price sensitivity may be particularly discouraged from promoting higher-efficiency equipment, due to the perceived lack of support for these advanced systems.

Contractors noted that they infrequently encountered homeowners who had already purchased their equipment. Only in rare situations were contractors likely to install something that had been purchased directly by an end-user – typically in scenarios where the end-user is very educated, and the contractor is comfortable with the equipment selection. However, the ability for homeowners to go online and compare contractor quoted equipment prices represents a challenge for contractors, in terms of price competition and the fact that some manufacturers may provide lower-end versions of their produces for sale through retail or through non-traditional channels and a professional-grade models through wholesale. Contractors will increasingly need to communicate the potential difference between equipment available online and equipment available through wholesale distribution. One distributor emphasized the need for manufacturers

[94] Factory-owned distribution stores are essentially manufacturer owned distributors, also referred to as "captive" distributors. Manufacturers that employ this business model may still sell to independent wholesalers, especially in territories where they do not have a factory-owned store. Distributors noted that certain manufacturers have been already been doing this, and independent wholesalers have adjusted. It does cause issues when a factory-owned distribution center moves into the same territory as an independent wholesaler that is selling that particular brand.

to support contractors by making sure they hold equipment to minimum advertised prices in all channels.

Contractors expressed additional concerns about end-users attempting to conduct do-it-yourself (DIY) installations. Contractors described that when a direct to end-user purchase happens, the manufacturer is assuming the end-user is an expert. Some contractors noted that this has caused issues with both equipment selection and installation. Market actors were unclear how handling of and acquiring of refrigerants for do-it-yourself (DIY) installations would be regulated if such installations become much more common and widespread throughout the industry. While the market actors had very limited insight into the quantity of direct to end-users purchases, one contractor indicated that they experienced direct sales in approximately 10% of their projects.

B.7.2 Changes to HVAC Technologies and Adoption

Residential Market Segment. Market actors noted that the residential market segment has seen an increased adoption of inverter compressors, commonly referred to as ductless mini-splits (DMS), being used to condition new additions, finished basements, supplemental heating (to solve comfort issues in existing homes), or add cooling capabilities for homes with only hydronic heating in recent years.[95] Market actors did not see DMS systems replacing traditional systems on a large scale – those replacements typically require an air-tight, highly insulated building envelope in the northern Illinois heating-dominated climate (typically high-performance new construction, like Passive House construction).[96] Contractors and distributors suggested that the costs for replacing traditional systems with inverter-driven technology are prohibitive for most homeowners. It should be noted that one major-manufacturer of inverter technology suggested that the DMS market in the Chicago Metro area was five to eight years behind more developed heat pump markets such as the northeast, New York City, and Los Angeles. They even suggested the market was much further behind in adoption of the technology compared to neighboring state, Iowa – roughly one-third of the population of the Chicago Metro area.

Contractors and distributors are skeptical that heat pumps will are able to meet the heating requirements for Northern Illinois winters – traditional hydronic and forced-air systems still dominate the market. One manufacturer suggested cold-climate heat pumps may not perform as efficiently in more typical temperature ranges, due to the refrigerant mix required to extract heat from the air at very low ambient temperatures. Distributors noted that higher saturation of central air-conditioners with higher SEER levels were flowing through distribution compared to previous years and anticipate this trend to continue – though 13 SEER equipment, the federal minimum standard, still accounted for the largest share of sales.

Small-Medium Commercial Market Segment. Market actors noted that more VRF systems were being installed in small and medium commercial settings over the past few years – however,

[95] Interviewed manufacturers noted that there has been an 18% increase in the ductless mini-split market, nationwide. They anticipate this growth to maintain or even increase due to emphasis on strategic electrification by state, city, and building codes pursuing fossil-fuel free construction policy.
[96] Passive House construction is based on a set of design principles that include on air-tight construction, super insulated building envelopes, optimized window performance, optimize solar and internal gains, and balanced heat and moisture recovery ventilation.

this market segment is still heavily driven by first-costs, so adoption levels are not as high as in larger commercial segments.

Large Commercial Market Segment. Market actors have noticed a shift towards VRF system adoption in large commercial settings. Some market actors have observed more collaboration between HVAC contractors, mechanical engineers, and end-users to find the right HVAC solution. Market actors anticipate more VRF installations in larger multifamily buildings, for example: a single 50-ton central VRF system replacing the installation of individual-unit furnaces. Overall, the adoption of VRF is seeping into the Northern Illinois market commercial market – once people have project experience, they are more likely to pursue it. One distributor noted, *"[VRF] is like ductless on steroids. It's becoming very big, big business*." Contractors and distributors noted that VRF systems are also being installed in schools, hospitals, and office buildings. Another distributor suggested, "*People performance is actually better with VRF systems. The more thermally comfortable you are, the better you are able to perform*." Market actors noted these systems are most likely to be installed in buildings without cooling, existing duct systems, or in new construction scenarios.

B.7.2.1 Inverter Compressor Technology

Interviewed manufacturers mentioned that there will be inverter kits that can be used to convert traditional equipment to heat pump technology, without fully replacing the system. Distributors also were aware of this technology and anticipate it will very soon come to market on a broader scale – first for commercial applications and followed by residential applications.

One manufacturer provided this scenario to describe the new technology, "*For the commercial side, picture: a factory, very clean, there is ductwork that is very maintained – [the facility has] an air-handling unit that has been upgraded with new, high-efficiency motors. But the split-system is showing its age. They [end-users] want better efficiency, but the air-handler is above the assembly line and is very large… Getting it out is a major mechanical job and causes cleanliness issues. We remove [the] existing coil, have a new coil sized to work with our refrigerant flow and [is] sized to fit in the physical limitation of the air-handler. Then we put in our VRF control valve and boards, located in separate enclosures – piped out to VRF outdoor units. [The system is] still using the same motor. Blending existing upgraded technology with VRF technology*."

For residential applications, including multifamily, the process uses an inverter-driven outdoor compressor and the indoor conversion kit (DX kit-control boards, refrigerant control valves), which is installed into the indoor coil. Manufacturers noted that they are working on development of inverter-driven add-on kits to operate with existing traditional furnaces – with gas heat available as a backup – essentially dual fuel capabilities. In addition, they also noted continued innovation on the efficiency and performance cold-climate heat pumps, which will be necessary for broader scale adoption in the ComEd territory.

One potential concern was raised by a distributor – the life-span of the DMS system. They suggest the lower life-span (than traditional HVAC equipment), coupled with the rapid changes in the technology may cause issues down the road for repairs and replacements. They anticipate a challenge to find indoor replacements that are compatible with the outdoor inverter-compressor.

Essentially posing the potential threat of needing to replace the entire system in the case of one faulty indoor wall-mount.

B.7.2.2 Advanced Controls

Distributors and Manufacturers both anticipate that more advanced controls would be adopted on a wide-scale by all market segments. Currently the large commercial HVAC market segment is utilizing building management systems and automated controls – market actors anticipate greater adoption by the residential and small-medium commercial market segments – due to the desire for better comfort controls. However, very small commercial end-users who are very cost-sensitive are likely to have lower adoption levels due to increased costs. Distributors suggested that automated smart controls were lower-margin products – and have observed contractors using the retail and online markets for these products – due to their ability to sell at lower costs. Both contractors and distributors noted that advanced controls provide the benefit of being able to connect into an HVAC system remotely and diagnose operational issues before arriving on-site.

One manufacturer suggested that energy codes may move to requiring building management systems and integrated controls. They expect continual innovation of integrated control platforms potentially to a point where artificial intelligence is controlling the building climate. Another manufacturer suggested as controls advance, utilities may potentially be able to align building controls with utility demand response programs.

B.7.2.3 Other Trends

Strategic Electrification. Manufacturers and distributors noted that with an increasing emphasis on strategic electrification, there is an emphasis on continuing to improve the operational ability and efficiencies of heat pumps in cold climates. Additionally, developing new refrigerants is a high priority for inverter-compressor manufacturers. Manufacturers are looking for refrigerant solutions with the lowest possible global warming potential – especially with the emphasis on strategic electrification. One manufacturer suggested that employing technology on a large scale with the wrong refrigerant could counteract climate reduction targets. The solution to the refrigerant issue still remains unclear, according to interviewees.

Manufacturers anticipate that with strategic electrification, there will be large carbon reduction and water reduction goals that become priorities for city and state policies. One manufacturer predicted "*Systems that do not use water at all may become more desired*."

Air-to-water solutions are currently being explored by at least one of the interviewed manufacturers. They have installed a custom system that essentially separates the refrigerant from occupied spaces, which was referred to as a hybrid-VRF system. The refrigerant is piped from the outside into a non-occupied space, and then goes through a branch box – which transfers heating or cooling energy from the refrigerant to pipes filled with water, which are distributed throughout the occupied space. The interviewee was excited as the system has potential to significantly reduce reliance on refrigerants. The system reduces concern for refrigerant leaks in occupied spaces – which is a potential barrier for VRF adoption. the interviewee suggested that hybrid VRF may come to market in the next three years for large commercial applications.

B.7.2.4 Barriers to Adoption

Manufacturers and distributors noted barriers to widespread adoption of newer technologies, regardless of equipment type. They suggested that among contractors the primary barriers that will need to be overcome include fear of customer call-backs, lack of education, lack of awareness, and additional training needs. Distributors described the fear of call-backs as a reason that many contractors will down sell, to install a simpler, more familiar system rather than selling a high-efficiency unit that the end-user may have been interested in.

In addition, some distributors suggested that it was common for HVAC contractors to be unwilling to seek training on new and emerging technologies. This may be due to the rapid pace of technological advancements for various equipment types in an industry that is historically slow to change. It takes money and time to participate in training courses – contractors have limited resources, and training requires time, money, and loss of potential jobs. Also, the rapid pace of technological change discourages contractors because they feel that they cannot keep up. Though distributors noted that highly trained contractors are more successful in the long run. Manufacturers and distributors will need to identify a way to provide contractor training that is practical and not overly technical to gain the widespread adoption of increasingly sophisticated and higher-efficiency equipment.

As technology becomes more sophisticated both manufacturers and distributors need to prioritize training for market actors lower in the supply chain: HVAC contractors, architects, engineers, and end-users. One manufacturer noted that contractor education and training will likely fall on the distributors, as the contractor interacts regularly with the distributor. In addition, as system controls become more sophisticated, the need to train end-users – especially in all the commercial sector segments, will become a higher priority for manufacturers, distributors, and contractors.

Appendix C Methodology

C.1 Methodology for Appendix A

The following subsections describe the detailed methodology for Appendix A, which includes the following research tasks:

- Task 1 Literature review – A comprehensive literature review of midstream HVAC programs, typical program design structures, experiences, and best practices.
- Task 4: Interviews with Midstream Program Managers – A series of three in-depth interviews with program managers that operate midstream HVAC programs, identified during the literature review.

C.1.1 Literature Review

The evaluation team conducted a literature review to identify relevant HVAC energy-efficiency programs in the United States that have migrated from downstream to midstream or upstream delivery mechanisms. The literature review relied on publicly available reports, evaluations, program websites, conference papers, presentations, and other industry resources. Detailed, program-specific findings from impact and process evaluations were only available for a subset of the programs identified.

The team reviewed materials associated with specific HVAC programs as described in Section A.2, and also broader industry sources that addressed general issues related to program design and transitioning programs upstream. The team used this additional contextual literature to inform the findings outlined in Section A.3 and Section A.4.

The research covered a range of relevant topics, including the midstream and upstream HVAC program approach, equipment types included in programs, program participation levels, participation levels before and after the program design shift, program opportunities and threats, and lessons learned from these programs (as described by the programs, evaluators, or other market research sources).

C.1.2 Program Manager In-Depth Interviews

The team supplemented findings from this literature review with in-depth interviews with managers of midstream HVAC programs from three utilities across the United States. The programs selected for interviews – Xcel Energy, Pacific Gas & Electric, and National Grid – were among those with the longest history of operating midstream or upstream HVAC programs that the literature review identified. Each interview lasted approximately one hour and focused on filling gaps in the secondary research about each program.

C.2 METHODOLOGY FOR APPENDIX B

The following subsections describe the detailed methodology for Appendix B, which includes the following research tasks:

- Task 2 Northern Illinois HVAC Market Characterization – A comprehensive review of secondary data sources to identify supply channel structures of the HVAC market, the estimated size the HVAC market in the ComEd territory and identify how equipment is flowing through the HVAC supply chain channels.
- Task 3: Interviews with Market Actors – A series of 23 in-depth interviews with manufacturers, distributors, and contractors to understand the current state of the HVAC industry, common practices, and industry perspectives on various topics.

C.2.1 Estimated HVAC Market Size Methodology

The team used publicly-available data to estimate the size of the market for commercial and residential HVAC equipment. For the purposes of this report, the size of the market refers to equipment installations in a given year.[97] These estimates were developed based on triangulation of data from multiple sources and, as such, they represent approximations rather than exact counts.

Counts of equipment installations were primarily derived from the Residential Energy Consumption Survey (RECS)[98] and the Commercial Building Energy Consumption Survey (CBECS).[99] Additional data sources include the following:

- Air-Conditioning, Heating, and Refrigeration Institute (AHRI) national shipping estimates[100]
- ENERGY STAR penetration rates[101]
- ComEd evaluation reports[102]
- Evaluation reports from other jurisdictions[103]

Due to differences in the available residential and commercial data sets, the team used separate methodologies, discussed below, to pro-rate the national and regional data down to the ComEd territory. The separate methodologies are also displayed in Figure 21.

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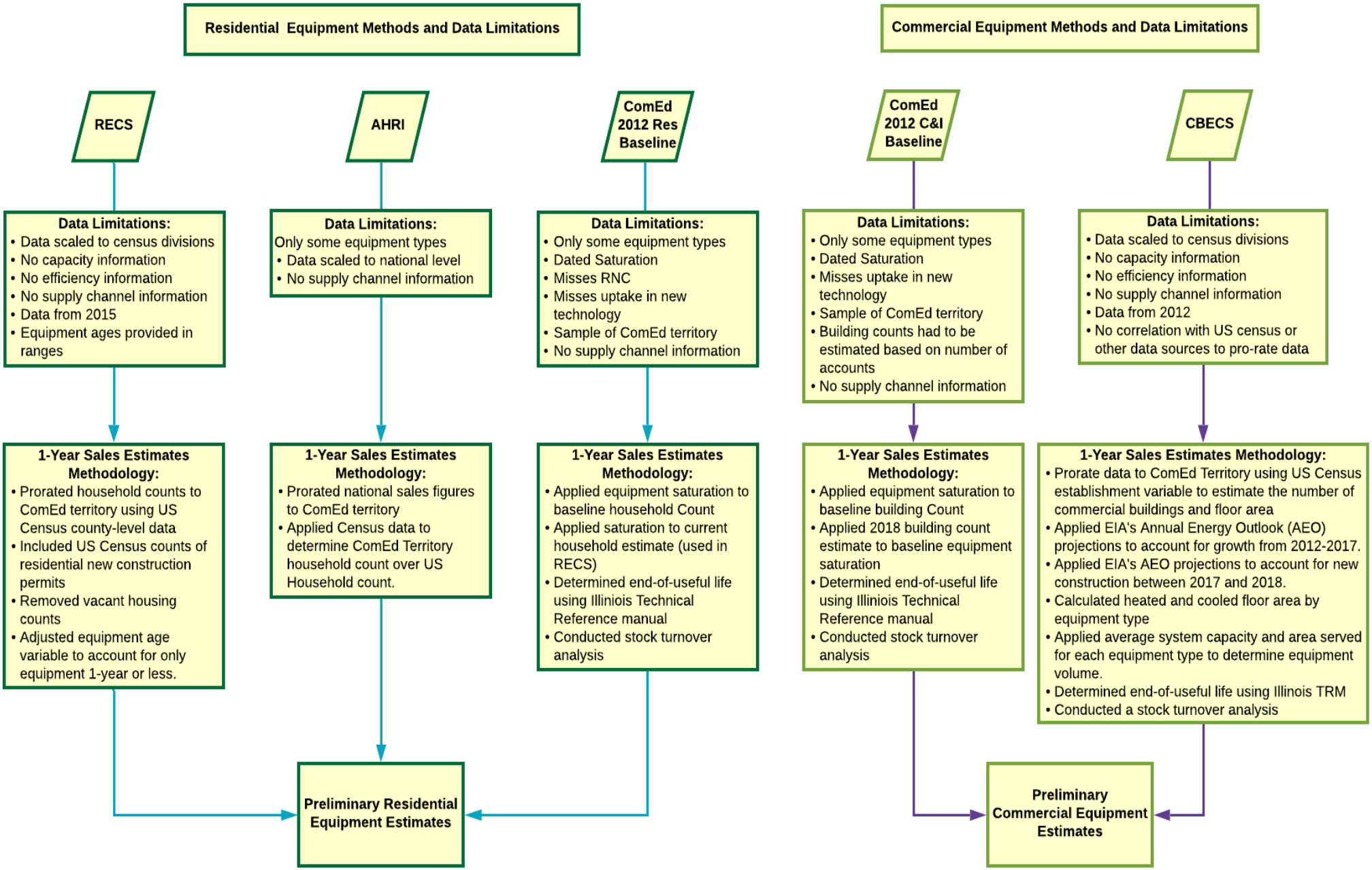
[97] The data used for the market sizing effort may reflect unit sales in some cases and installations in others. This study assumes that systems are sold and installed in the same year.
[98] https://www.eia.gov/consumption/residential/data/2015/index.php?view=methodology
[99] https://www.eia.gov/consumption/commercial/
[100] The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) provides national shipping data for specific equipment: http://ahrinet.org/statistics
[101] ENERGY STAR penetration rates for 2017 by equipment type can be found at the following page: https://www.energystar.gov/ia/partners/downloads/unit_shipment_data/2017/2017%20Unit%20Shipment%20Data%20Summary%20Report.pdf?db99-2bb3
[102] The evaluation team researched ComEd evaluation reports to determine volumes of HVAC equipment flowing through the program and leveraged the previous baseline study results to inform estimate assumptions.
[103] The team researched evaluation reports from Wisconsin, Oregon, California, Massachusetts, and the Northwest Energy Efficiency Alliance that focused on sizing HVAC markets or equipment to identify alternative methodologies and corroborate the one used to generate the preliminary estimates detailed in this memo.

The market size estimates should be interpreted with caution due to limitations of the publicly available data.[104] These datasets did not provide quantitative insights into the volume of equipment that flows through unique supply channels. The team found very few secondary sources that showed proportions of equipment flowing through supply channels. This information was often focused on specific equipment types and could not readily be generalized to other equipment types or market segments.

[104] The limitations for market sizing with the data include limited equipment types, national or census-division level scale, and somewhat dated sources. ComEd specific data was used when available, but was also dated from 2012-2013.

Figure 21: Preliminary Estimate Methods and Data Limitations



C.2.2 Residential HVAC Equipment Installation Volumes

The team generated market size estimates for residential HVAC equipment using the RECS microdata, AHRI national sales data, and the 2012 ComEd baseline data.

The RECS survey was implemented in 2015 and 2016 and is weighted to the U.S. Census' American Community Survey (ACS) household estimates by the U.S. Energy Information Administration (EIA).[105] The team used ACS 2017 household estimates at the county level to determine the occupied household counts in ComEd territory. The team then normalized the data at the Census division-level to remove vacant housing. To account for growth since the last RECS was administered, the team used Building Permit Survey data from the U.S. Census Bureau for the ComEd territory counties.[106] The RECS questionnaire provides the count of systems by age. The team used the count of systems that were less than two years old and adjusted the counts to reflect only one year of sales.

The team conducted additional research and stock-turnover analyses to provide additional point estimates and to check the validity of the initial RECS estimate. To perform a stock-turnover analysis on equipment with available data, the team used the 2012 ComEd baseline study HVAC saturation results.[107,108] The team used the household estimates from the RECS analysis to account for growth since the baseline study. The team was only able to replicate this process for residential equipment categories included in the baseline study. The team also analyzed the 2017 AHRI national shipment data as an additional data source. The team pro-rated the national shipment data based on the number of households in ComEd territory from the number of households in the U.S.

The team did not attempt to gather full category HVAC equipment sales data during the Task 3 IDIs due to the sensitivity of this data from the perspective of the respondents. In the future, some manufacturers may be willing provide such information subject to confidentiality protections. However, the team did collect data on the supply channel and end-use estimates from online surveys and IDIs with supply chain market actors. While the market size estimates remain unchanged from the initial Task 2 memo, the supply channel equipment flow (Table 23) and installation type (Table 24) results from the Task 3 interviews were used to adjust the estimates of HVAC equipment flows through the market.

C.2.3 Commercial HVAC Equipment Installation Volumes

The team developed preliminary market size estimates for commercial HVAC equipment using the CBECS microdata and the ComEd commercial baseline study.

[105] https://www.eia.gov/consumption/residential/reports/2015/comparison/index.php
[106] https://www.census.gov/construction/bps/
[107] Opinion Dynamics. 2013. "ComEd Residential Saturation/End-use, Market Penetration & Behavioral Study." Prepared for ComEd.
[108] 2019 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 7.0 Volumes 4 and 5.

Unlike the RECS data, the CBECS data did not include a weighting scheme that correlated commercial building counts with Census data. The team calculated the ratio of establishments at the Census division, state, and county levels to determine ComEd territory commercial building counts using CBECS microdata. The team used the Energy Information Agency's Annual Energy Outlook projections for commercial floor area and building counts to determine growth projections from 2012 to 2017.[109] We developed equipment estimates using a stock turn-over analysis based on square footage, average capacity (tons), average floor area served per ton, and end-of-useful life values. The commercial floor area growth rate between 2017 and 2018 was considered new construction and is included in addition to the stock-turnover analysis. [110,111,112,113,114]

The preliminary commercial estimates include both the primary and secondary heating and cooling equipment identified in the CBECS survey. The analysis considers the percent of the building heated or cooled and the percent of the building each equipment type serves. The proportions were identified through variables provided in the CBECS microdata.

We used the 2013 ComEd commercial baseline study results to perform a stock-turnover analysis on equipment with available data for an additional estimate reference and to check the validity of the CBECS estimates.[115] In order to conduct this analysis, the team estimated the number of commercial buildings in the ComEd territory using the available commercial account and building characteristic data. The team also applied the current commercial building count estimate generated during the CBECS analysis to integrate growth rates into the estimate. The baseline report includes both packaged and split air-conditioning systems into one category. The team assumed that this category included both packaged rooftop units and residential-style air-conditioning units, which were split into two variables in the CBECS dataset. The CBECS estimates were summed to compare the estimate to the ComEd baseline estimate.

C.2.4 Data Limitations

The team encountered some limitations in developing the HVAC equipment volume estimates for the entire market, as well as in determining the volume of equipment flowing through unique supply channels. Most of those challenges stemmed from limitations in the level of information included in publicly-available data. Most of the data sources the team identified included data at the national or regional level – rather than at the ComEd service territory level – and some data sources were somewhat dated.

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[109] https://www.eia.gov/outlooks/aeo/
[110] The team utilized multiple sources to determine average equipment capacities, floor area served per ton of capacity, and the end-of-useful life. ComEd specific data was used when available and additional sources were leveraged to fill in data gaps.
[111] Opinion Dynamics. 2013. "ComEd Residential Saturation/End-use, Market Penetration & Behavioral Study." Prepared for ComEd.
[112] 2019 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 7.0 Volumes 4 and 5.
[113] Pigg, Scott. May 2008. "Central Air Conditioning in Wisconsin: A Compilation of Recent Field Research." Wisconsin Focus on Energy.
[114] DNV GL. November 2016. "MA C&I Market Characterization On-Site Assessments and Market Share and Sales Trends Study, Volume 1 – Main Report." Prepared for the Massachusetts Program Administrators and Energy Efficiency Advisory Council EM&V Consultants.
[115] Opinion Dynamics. 2013. "ComEd Commercial and Industrial Saturation/End-use, Market Penetration & Behavioral Study." Prepared for ComEd.

Without the protection of non-disclosure agreements (NDA), manufacturers interviewed in Task 3 provided limited detail to quantify the supply channels into which their products were sold. The manufacturer respondents that provided product flow information (n=2) employed business models that almost exclusively operated through the distribution channel, rather than retail or direct-to-end-user. Therefore, the team created estimates of the market size by triangulating several data sources. ComEd also indicates that ASHP penetration may be lower in ComEd territory than in the rest of the state, given a milder climate and more active heat pump programs in the southern portion of Illinois. Because the ComEd market size estimates are based on scaled-down regional or statewide numbers, the data may therefore overestimate the size of the ASHP market in ComEd territory relative to the rest of Illinois.

C.2.5 Market Actor In-Depth Interview Methodology

The team compiled the sample using contacts provided by ComEd, data available on InfoUSA and trade group websites, and companies identified through Internet searches. The team also utilized LinkedIn and company websites to identify which branch or sales managers serve the ComEd territory in Northern Illinois. The team first contacted potential interviewees by email, where available, and made several follow-up phone calls and voicemails. Obtaining cooperation from manufacturers and distributors for interviews can be a challenge. To overcome this challenge, the team sent interviewees recruitment letters from ComEd on ComEd letterhead and offered a $150 incentive for their cooperation.

Table 28 shows the sample sizes, target interviews, and completed interviews for HVAC manufacturers, distributors, and contractors in Northern Illinois. The team attempted to interview five of the nine major manufacturers identified in the workplan and achieved four of the five interviews. According to sales data from InfoUSA, distributor interviews may have captured as much as 91% of the market in counties in the ComEd service territory.[116] The team attempted to recruit participants involved the residential, light, and large commercial market segments, breakouts for market segments served by market actor type are displayed in Table 29.

Table 28: IDI Completes

	Sample	Target	Completes	Response Rate
Manufacturers	9	5	4	56%
Distributors	75[a]	10	10[b]	13%
Contractors	220	10	9	4%

[a] Using data obtained from InfoUSA, the team originally identified over 500 HVAC distributors in Northern Illinois, but many turned out to be contractors, duplicates, or no longer in business. Some distributors are subsidiaries of larger distributors.
[b] Two separate individuals interviewed at from one distributor organization.

[116] After cleaning out businesses that had closed or were not actually HVAC distributors from the InfoUSA data, we calculated that our interviews captured 91% of the market, according to InfoUSA sales data. However, two of the companies were interviewed were not captured in the InfoUSA data pull, and it is unclear how many other distributors in the area were also excluded from that list.

Table 29: Market Segments Covered by Interviewees

	Residential Market	Small-medium commercial Market	Large Commercial Market
Manufacturers	4	4	4
Distributors	10	10	8
Contractors	4	9	5

Appendix D Interview Guides

This appendix includes the in-depth interview guides that guided conversations with distributors, manufacturers, and HVAC contractors. Distributors and manufacturers were asked also to fill out an online survey to help expediate the interview process; those questions are provided at the end of each guide. Interviewees were not asking every question verbatim; these were in-depth conversations that allowed for greater gathering of contextual information.

D.1 Distributor Interview Guide

Interviewer: _____

Date of Interview: _____

Time Begun_____ Time Ended _____

Respondent Name: _____

Respondent Title: _____

Phone Number(s): _____

E-mail Address: _____

D.1.1 Introduction

1. Does your company distribute HVAC equipment that is shipped to or sold directly to the Northern Illinois region?

IF YES: Which types of HVAC equipment do you distribute in this region? Which market segments (residential, small commercial, large commercial?) [BE SURE TO CAPTURE SEGMENTS SERVED. NOTE THAT HVAC INDUSTRY MAY CLASSIFY MARKET SEGMENTS BY TONNAGE AND MAY NOT HAVE SPECIFIC KNOWLEDGE OF WHERE PRODUCTS ARE INSTALLED]

2. Would you say that you are VERY familiar with current HVAC trends, interactions in the supply chain, and new HVAC product development and distribution strategies for the Northern Illinois Market?

3. What geographical areas does your company serve? [TERMINATE IF THEY DO NOT SERVE NORTHERN ILLINOIS/COMED TERRITORY] In case you happen to know, what portion of your work is inside ComEd territory, and how much is outside?

[ASK Q4 IF DISTRIBUTOR OPERATES IN COMMERCIAL MARKET (FROM Q1), ELSE SKIP TO Q4]

4. Does large commercial HVAC equipment (>25 tons) flow through your company's distribution centers? If so, which equipment types?

[IF ONLINE SURVEY HAS BEEN COMPLETED, REVIEW RESPONSES THAT ARE UNCLEAR]

5. Thank you for completing the brief online survey. We have a few follow up questions to your responses. [PROVIDE FOLLOW UP QUESTIONS OR CONFIRM THEIR RESPONSES.]

6. In general, how confident are you in the percentages you provided in that survey?

7. In the survey you filled out, you described the portion of your residential heating and cooling systems that are sold to various types of customers. [REPRISE SURVEY RESPONSE.] Do you sell any residential heating or cooling system types that deviate substantially from the percentages you gave? What are they? Why is that?

   [PROBE ABOUT THE PORTION OF SYSTEMS SOLD TO EACH CUSTOMER TYPE AND INSTALL SCENARIO FROM SURVEY.]

8. What about for commercial heating and cooling systems? [REPRISE SURVEY RESPONSE.] Do you sell any commercial heating or cooling systems that deviate substantially from the percentages you gave? What are they? Why is that?
   [PROBE ABOUT THE PORTION OF SYSTEMS SOLD TO EACH CUSTOMER TYPE AND INSTALL SCENARIO FROM SURVEY.]

[IF ONLINE SURVEY HAS NOT BEEN COMPLETED]: We had emailed you a link to a survey that would help ComEd understand the how HVAC equipment is flowing through the Northern Illinois market. We would like to spend some time walking through this with you. [WALK THROUGH KEY QUESTIONS FROM ONLINE SURVEY]

D.1.2 Purchase Decision Processes

9. Who are the key influencers and decision makers for HVAC equipment purchase decisions, including the efficiency level of the equipment? Which people have only minor influence, and which are the ultimate decision makers?
   a. Residential? [PROBE: CONTRACTORS, DISTRIBUTORS, END-USERS, BUILDERS, OTHERS?]
   b. Small and Medium Commercial? [PROBE: OWNER, DESIGN/BUILD FIRMS, DISTRIBUTORS]
   c. Large commercial? [PROBE: OWNER, ARCHITECTS/ENGINEERS, GENERAL CONTRACTORS, HVAC CONTRACTORS, DISTRIBUTORS, AND MANUFACTURER REPRESENTATIVES?]

D.1.3 Upstream and Midstream Supply Chain and Market Actors

Now, I'm going to ask you some questions about the HVAC market and key players in this market. Key supply chain market actors may include manufacturers, distributors or suppliers, retailers, contractors/installers, and end-users.

10. How do you anticipate the supply chain for HVAC equipment will change or evolve over the next 3-5 years? [PROBE ON MANUFACTURERS, DISTRIBUTORS, CONTRACTORS, END-USERS]

    a. Are online sales or online retailers changing the traditional HVAC supply chain? How so?

11. How will the different market actors and their relationships be affected by these changes? [PROBE: RETAILERS, ONLINE SALES (increase in market share over next 3-5 years?), DIRECT TO CONSUMER]

12. How might you need to adapt your business models in response to those changes you described? How would other market actors deal with these changes?

D.1.4 Disintermediation

Now, I'd like to ask you some questions about the potential for disintermediation of distributors, suppliers, retailers, contractors/installers, also referred to as midstream market actors, in the HVAC market. By disintermediation, I mean a reduction in the role of intermediaries between manufacturers and end use customers. For example, some product flows could shift from manufacturers directly to contractors or to end use customers.

13. What is the potential for disintermediation in the market, where some intermediaries like distributors, suppliers, and installers' role in the supply chain might be reduced? [PROBE: DIRECT TO CONTRACTOR/END-USER, ONLINE SALES, TRENDS OF REDUCED SHIPPING VOLUMES TO DISTRIBUTORS]
    a. [IF RESPONDENT INDICATES POTENTIAL FOR DISINTERMEDIATION]: Which market actors are at greatest risk, and why?

D.1.5 New HVAC Technology Development and Distribution

The next set of questions are about your perspective on new HVAC technologies and what impacts these options may have on distribution.

14. What new HVAC technologies are you anticipating will be entering the market in the next 3-5 years?
    a. Which equipment types will this technology replace?

15. Which market segment will they target? [RESIDENTIAL, SMALL COMMERCIAL, LARGE COMMERCIAL]

16. What impact will the introduction of these new technologies have on the business models of the different market actors in the supply chain (if appropriate, add "in the supply chain for the technologies they will replace")?

17. In the past 3-5 years, have you seen shifts in the market shares of current HVAC technologies? For example, ductless mini-splits replacing traditional HVAC systems in residential applications or VRF installations in commercial applications?
    a. Which equipment types are these newer systems replacing?
    b. What concerns have been raised about these emerging technologies, and do the benefits outweigh the concerns? [PROBE: ADDITIONAL SERVICE REQUIREMENTS, WARRANTY ISSUES WITH MENTIONED PRODUCTS, EFFICIENCY PERFORMANCE]

18. [IF THEY SELL FURNACES] My understanding is that there are new federal standards for furnace motors that would essentially require that they include ECM motors. How are you responding to that change?
    a. What impact will that have on your sales and stocking practices?
    b. Will you want to stockpile the older systems? Why or why not?

D.1.6 Utility HVAC Energy Efficiency Program Planning and Program Incentives

The next set of questions are about utility-sponsored HVAC energy efficiency programs and will be used to help inform potential changes to ComEd's program design.

19. Do you currently work with any energy-efficiency programs that provide incentives for high-efficiency systems?
    a. IF YES: Which ones?
    b. What are the benefits and pitfalls from partnering with these programs? [PROBE: BEYOND INCREASE IN SALES]
    c. What are the requirements for participating (to receive incentive) [PROBE: INCENTIVE PASS-THROUGH, DATA REPORTING, STOCKING PRACTICES]?

20. Some utilities provide incentives for energy-efficient HVAC equipment to either upstream market actors, like manufacturers, or midstream market actors like distributors, rather than providing the incentives directly to the end-user. Are you involved in any such upstream or midstream incentive programs? In general, what is the likelihood that the full amount of the incentive is passed down to the customer in an upstream versus midstream model?
    a. IF THE FULL AMOUNT OF THE INCENTIVE IS LIKELY NOT PASSED DOWN: why do you think this happens?

21. If a utility requires that all or at least some percentage of a midstream or upstream program incentive is passed down to the customer, how do you think such a requirement would affect participation in the program? [PROBE: REQUIREMENTS TO PASS INCENTIVES DOWN TO CUSTOMER, ISSUES WITH KNOWING IF CONTRACTOR PASSED INCENTIVE THROUGH TO END-USER, ADMINISTRATIVE COMPENSATION IF REQUIREMENTS ARE REQUIRED]

D.1.7 Stocking Practices

22. What factors other than forecasted sales influence your stocking decisions?
    [PROBE ON FACTORS: HIGH-MARGIN EQUIPMENT, HIGH-EFFICIENCY EQUIPMENT, PROMOTING SPECIFIC EQUIPMENT TYPES]

23. What factors drive your decision to promote newer, higher-margin, high-efficiency equipment vs. lower-price, standard efficiency products that might sell at higher volumes?

24. How would stocking of high-efficiency equipment be affected in a midstream intervention—providing incentives to distributors, retailers, or contractors? How about in an upstream intervention—providing incentives directly to manufacturers?

D.1.8 Program Design Suggestions

As we wrap up this interview, we want to be sure to understand your perspective on how ComEd and distributors can work together to promote high-efficiency products.

25. Based on your understanding of the ComEd (Northern Illinois) territory, who would you list as the three largest HVAC distributors operating in this territory?

26. As part of this study we plan to interview HVAC contractors to get their perspectives on these topics. Who would you say are the are the largest contractors in this territory for residential HVAC equipment? And how about commercial HVAC equipment? Are you able to provide their contact information?

27. ComEd is interested in building relationships with distributors. If ComEd gave stringent assurances of confidentiality, would you be willing to periodically share HVAC equipment sales data for ComEd to understand the current state of the HVAC market, set incentive levels, and track overall market progress for adoption of high-efficiency HVAC equipment? Why? Why not?
    a. Are you, or is there someone at your company, that ComEd can reach out to if they decide to pursue an intervention with the midstream or upstream market?

D.1.9 Online Survey

These following represents an online survey respondents were asked to complete prior to the in-depth interview.

On behalf of ComEd (Commonwealth Edison), NMR Group is conducting a study about the HVAC market. Specifically, we are interviewing key distributors to understand the HVAC supply chain. Your input is important for understanding the HVAC market in Northern Illinois, specifically the ComEd territory.

Thank you for taking the time to fill out this survey prior to our scheduled interview. The answers you provide here will help shorten the interview time as well as provide valuable insight for ComEd

as they plan and develop programs that promote the sale of high-efficiency HVAC equipment in northern Illinois.

The information you provide will be completely confidential. We will not share any information about you or your company outside of our study team.

1. What is your name?
2. What is your company's name?
3. Which Manufacturers do you distribute HVAC equipment for? Please select from the list below or provide the name(s) in the "other" boxes.
4. Please identify the equipment types your company distributes in Northern Illinois.

The terms "residential" and "commercial" below are just **based on the size of the equipment, not the actual end-use application**. We recognize that some residential systems are installed in commercial settings and some small commercial systems may be installed in residential settings.

[Provided check-mark box with list of equipment]

Equipment Types	Up to 5 tons/65 kBtuh (Residential systems)	5-25 tons (small and medium commercial systems)	> 25 tons (large commercial systems)
Central Air Conditioners			
Air Source Heat Pumps (traditional ducted)			
Mini or Multi-split Air Source Heat Pumps (including VRF)			
Chillers			

5. What size of furnaces do you distribute in Northern Illinois, if any? Please select all that apply.

Equipment Types	Up to 225 kBtuh (Residential systems)	Small and medium commercial systems	Large commercial systems
Fossil Fuel Furnaces			
Electric Furnaces			

6. What size boilers do you distribute in Northern Illinois, if any? Please select all that apply.

Equipment Types	Up to 300 kBtuh (Residential systems)	Small and medium commercial systems	Large commercial systems
Fossil Fuel Boilers			
Electric Boilers			

Based on industry research, we saw that cooling systems are often categorized into market segments by capacity:

- Residential: up to 5 tons/65 kBtuh
- Small/medium commercial: 5-25 tons
- Large commercial: >25 tons

If respondent indicated commercial sized furnaces are manufactured:

Given that AHRI considers furnaces up to 225 kBtuh to be residential, what are the comparable size categories for small/medium commercial and large commercial furnaces?

Equipment Types	Provide a Range for each category in kBtuh
Small/Medium commercial furnaces (225 to ? kBtuh)	
Large commercial furnaces	

If respondent indicated commercial sized boilers are manufactured:

Given that AHRI considers boilers up to 300 kBtuh to be residential, what are the comparable size categories for small/medium commercial and large commercial boilers?

Equipment Types	Provide a Range for each category in kBtuh
Small/Medium commercial boilers (300 to ? kBtuh)	
Large commercial boilers	

7. **[IF RESPONDENT OPERATES IN RESIDENTIAL MARKET]** Think about the residential-sized heating and cooling systems sold to your customers in Northern Illinois in 2018. What percentage **of those systems** were purchased by each of the following types of customers? Your best estimate is fine.

Customer Types	Residential HVAC Systems
Homeowners	A%
Facility owners	B%
Property Managers	C%
Builders or general contractors	D%
Heating/cooling/plumbing contractors	E%
Retailers	F%
Other [Open-Ended]	G%
Total	**Responses required to equal 100%**

8. **[IF RESPONDENT OPERATES IN RESIDENTIAL MARKET]** What percentage of those **residential** systems were installed in the following scenarios? Your best estimate is fine.

Installation Types	Residential HVAC Systems
Installed in newly-constructed home (prior to occupancy)	A%
Installed as a supplemental system in an existing home	B%
Replaced a completely failed system	C%
Replaced a functioning, but near-failure system	D%
Replaced a fully functioning system that was NOT close to failure	E%
Other	F%
Total	**Responses required to equal 100%**

9. **[IF RESPONDENT OPERATES IN SMALL-TO-MEDIUM COMMERCIAL MARKET]** What percentage of the **small and medium-sized commercial heating and cooling systems your company sold in Northern Illinois in 2018** were purchased by each of the following types of customers? Your best estimate is fine.

Customer Types	Small-to-Medium sized HVAC Systems
Facility owners	A%
Property Managers	B%
Builders or general contractors	C%
Heating/cooling/plumbing contractors	D%
Architects or engineers	E%
Retailers	F%
Other [Open-Ended]	G%
Total	**Responses required to equal 100%**

10. **[IF RESPONDENT OPERATES IN SMALL-TO-MEDIUM COMMERCIAL MARKET]** What percentage of those **small and medium commercial systems** were installed in the following scenarios? Your best estimate is fine.

Installation Types	Small-to-Medium HVAC Systems
Installed in newly-constructed building (prior to occupancy)	A%
Installed as a supplemental system in an existing facility	B%
Replaced a completely failed system	C%
Replaced a functioning, but near-failure system	D%
Replaced a fully functioning system that was NOT close to failure	E%
Other	F%
Total	**Responses required to equal 100%**

11. **[IF RESPONDENT OPERATES IN LARGE COMMERCIAL MARKET]** What percentage of the **large commercial heating and cooling systems your company sold in Northern Illinois in 2018** were purchased by each of the following types of customers? Your best estimate is fine.

Customer Types	Small-to-Medium sized HVAC Systems
Facility owners	A%
Property Managers	B%
Builders or general contractors	C%
Heating/cooling/plumbing contractors	D%
Architects or engineers	E%
Retailers	F%
Other [Open-Ended]	G%
Total	**Responses required to equal 100%**

12. **[IF RESPONDENT OPERATES IN LARGE COMMERCIAL MARKET]** What percentage of those **large commercial systems** were installed in the following scenarios? Your best estimate is fine.

Installation Types	Small-to-Medium HVAC Systems
Installed in newly-constructed building (prior to occupancy)	A%
Installed as a supplemental system in an existing facility	B%
Replaced a completely failed system	C%
Replaced a functioning, but near-failure system	D%
Replaced a fully functioning system that was NOT close to failure	E%
Other	F%
Total	**Responses required to equal 100%**

13. Please select the option that best describes how accurate you believe the sales estimates you provided are:
    a. Guess – I did not rely on actual sales records.
    b. Somewhat accurate – I relied on sales records but made inferences from them.
    c. Highly accurate – I relied on actual sales records.

14. **[IF RESPONDENT OPERATES IN RESIDENTIAL MARKET]** On a scale from 1 to 5, how important are the following factors on your customers' HVAC purchasing decisions in the **residential equipment market**, where 1 is not at all important and 5 is extremely important.

Purchase Factors	1	2	3	4	5
Increased upfront cost for high-efficiency equipment					
Energy Savings from high-efficiency equipment					
Length of pay-back period for high-efficiency equipment					
Equipment type/fuel/configuration					
Reliability					
Warranty Period					
Any other factors driving the purchase decision? (Response)					

15. **[IF RESPONDENT OPERATES IN SMALL-TO-MEDIUM COMMERCIAL MARKET]** On a scale from 1 to 5, how important are the following factors on your customers' HVAC purchasing decisions in the **small/medium commercial equipment market**, where 1 is not at all important and 5 is extremely important.

Purchase Factors	1	2	3	4	5
Increased upfront cost for high-efficiency equipment					
Energy Savings from high-efficiency equipment					
Length of pay-back period for high-efficiency equipment					
Equipment type/fuel/configuration					
Reliability					
Warranty Period					
Any other factors driving the purchase decision? (Response)					

16. **[IF RESPONDENT OPERATES IN LARGE COMMERCIAL MARKET]** On a scale from 1 to 5, how important are the following factors on your customers' HVAC purchasing decisions in the **large commercial equipment market**, where 1 is not at all important and 5 is extremely important.

Purchase Factors	1	2	3	4	5
Increased upfront cost for high-efficiency equipment					
Energy Savings from high-efficiency equipment					
Length of pay-back period for high-efficiency equipment					
Equipment type/fuel/configuration					
Reliability					
Warranty Period					
Any other factors driving the purchase decision? (Response)					

17. Thank you for taking the time to complete this survey prior to our scheduled interview. We look forward to hearing your valuable insight and expertise on the HVAC market in the Northern Illinois (ComEd) Territory.

D.2 MANUFACTURER INTERVIEW GUIDE

Interviewer: _____

Interviewer: _____

Date of Interview: _____

Time Begun_____ Time Ended _____

Respondent Name: _____

Respondent Title: _____

Phone Number(s): _____

E-mail Address: _____

D.2.1 Introduction

D.2.2 Introduction

1. Does your company manufacture HVAC equipment that is shipped to or sold in northern Illinois?

IF YES: Which types of HVAC equipment do you distribute in this region? Which market segments (residential, small commercial, large commercial?) [NOTE THAT HVAC INDUSTRY MAY CLASSIFY MARKET SEGMENTS BY TONNAGE AND MAY NOT HAVE SPECIFIC KNOWLEDGE OF WHERE PRODUCTS ARE INSTALLED]

2. Would you say that you are VERY familiar with current HVAC trends, interactions in the supply chain, and new HVAC product development and distribution strategies for the Northern Illinois Market?
3. Would you say that you are VERY familiar with current HVAC trends, interactions in the supply chain, and new HVAC product development and distribution strategies for the Northern Illinois Market?

4. What geographical areas does your company serve? [TERMINATE IF THEY DO NOT SERVE NORTHERN ILLINOIS/COMED TERRITORY]

[IF ONLINE SURVEY HAS BEEN COMPLETED, REVIEW RESPONSES THAT ARE UNCLEAR]

5. Thank you for completing the brief online survey. We have a few follow up questions to your responses. [PROVIDE FOLLOW UP QUESTIONS OR CONFIRM THEIR RESPONSES.]

6. In general, how confident are you in the percentages you provided in that survey?

7. In the survey you filled out, you described the portion of your residential heating and cooling systems that are sold to various types of customers. [REPRISE SURVEY RESPONSE.] Do

you sell any residential heating or cooling system types that deviate substantially from the percentages you gave? What are they? Why is that?

[PROBE ABOUT THE PORTION OF SYSTEMS SOLD TO EACH CUSTOMER TYPE AND INSTALL SCENARIO FROM SURVEY.]

8. What about for commercial heating and cooling systems? [REPRISE SURVEY RESPONSE.] Do you sell any commercial heating or cooling systems that deviate substantially from the percentages you gave? What are they? Why is that?

D.2.3 Purchase Decision Processes

9. Who are the key influencers and decision makers for HVAC equipment purchase decisions, including the efficiency level of the equipment? Which people have only minor influence, and which are the ultimate decision makers?
    a. Residential? [PROBE: CONTRACTORS, DISTRIBUTORS, END-USERS, BUILDERS, OTHERS?]
    b. Small and Medium Commercial? [PROBE: OWNER, DESIGN/BUILD FIRMS, DISTRIBUTORS]
    c. Large commercial? [PROBE: OWNER, ARCHITECTS/ENGINEERS, GENERAL CONTRACTORS, HVAC CONTRACTORS, DISTRIBUTORS, AND MANUFACTURER REPRESENTATIVES?]

D.2.4 Upstream and Midstream Supply Chain and Market Actors

Now, I'm going to ask you some questions about the HVAC market and key players in this market. Key supply chain market actors may include manufacturers, distributors or suppliers, retailers, contractors/installers, and end-users.

10. How do you anticipate the supply chain for HVAC equipment will change or evolve over the next 3-5 years? [PROBE ON MANUFACTURERS, DISTRIBUTORS, CONTRACTORS, END-USERS]
    a. Are online sales or online retailers changing the traditional HVAC supply chain? How so?

11. How will the different market actors and their interrelationships be affected by these changes? [PROBE: RETAILERS, **ONLINE SALES (increase in market share over next 3-5 years?)**, DIRECT TO CONSUMER]

12. How might you need to adapt your business models in response to those changes you described? How would other market actors deal with these changes?

D.2.5 Disintermediation

Now, I'd like to ask you some questions about the potential for disintermediation of distributors, suppliers, retailers, contractors/installers, also referred to as midstream market actors, in the HVAC market. By disintermediation, I mean a reduction in the role of intermediaries between

manufacturers and end use customers. For example, some product flows could shift from manufacturers such as yourself directly to contractors or to end use customers.

13. What is the potential for disintermediation in the market, where some intermediaries like distributors, suppliers, and installers' role in the supply chain might be reduced? [PROBE: DIRECT TO CONTRACTOR/END-USER, ONLINE SALES, TRENDS OF REDUCED SHIPPING VOLUMES TO DISTRIBUTORS]
    a. [IF RESPONDENT INDICATES POTENTIAL FOR DISINTERMEDIATION]: Which market actors are at greatest risk, and why?

D.2.6 New HVAC Technology Development and Distribution

The next set of questions are about your perspective on new HVAC technologies and what impacts these options may have on distribution.

14. What HVAC technologies are you preparing to enter the market in the next 3-5 years?
    a. Which equipment types will this technology replace?

15. [IF THEY MANUFACTURE FURNACES] My understanding is that there are new federal standards for furnace motors that would essentially require that they include ECM motors. How are you responding to that change? What impact will that have on your manufacturing or sales practices?

16. Which market segments do they target? [RESIDENTIAL, SMALL COMMERCIAL, LARGE COMMERCIAL]

17. What impact will the introduction of these new technologies have on the business models of the different market actors in the supply chain?

D.2.7 Utility HVAC Energy Efficiency Program Planning and Program Incentives

We are about halfway through the interview. The next set of questions are about utility-sponsored HVAC energy efficiency programs and will be used to help inform potential changes to ComEd's program design.

18. Do you currently work with any energy-efficiency programs that provide incentives for high-efficiency systems? [PROBE: UPSTREAM and MIDSTREAM PROGRAMS]
    a. What are the benefits and pitfalls from partnering with these programs? [PROBE: beyond increase in sales]
    b. What are the requirements for participating (to receive incentive)? [PROBE: INCENTIVE PASS-THROUGH, DATA REPORTING, STOCKING PRACTICES]

19. Some utilities provide incentives for energy-efficient HVAC equipment to either upstream market actors, like manufacturers, or midstream market actors like distributors, rather than providing the incentives directly to the end-user. Are you involved in any such upstream or

midstream incentive programs? In general, what is the likelihood that the full amount of the incentive is passed down to the customer in an upstream versus midstream model?

a. IF THE FULL AMOUNT OF THE INCENTIVE IS LIKELY NOT PASSED DOWN: why do you think this happens?

20. If a utility requires that all or at least some percentage of a midstream or upstream program incentive is passed down to the customer, how do you think such a requirement would affect participation in the program? [PROBE: REQUIREMENTS TO PASS INCENTIVES DOWN TO CUSTOMER, ISSUES WITH KNOWING IF CONTRACTOR PASSED INCENTIVE THROUGH TO END-USER, ADMINISTRATIVE COMPENSATION IF REQUIREMENTS ARE REQUIRED]

D.2.8 Manufacturing Practices

21. In general, have incentives from utilities influenced your manufacturing practices for high-efficiency equipment? [PROBE HOW or WHY]

22. What factors influence your decision to focus on newer, higher-margin, high-efficiency equipment vs. lower-price, standard efficiency products that might sell at higher volumes?

23. How would manufacturing high-efficiency equipment be affected in a midstream intervention—providing incentives to distributors, retailers, or contractors? How about in an upstream intervention—providing incentives directly to manufacturers?

D.2.9 Program Design Suggestions

The next set of questions is to understand your perspective on how ComEd and manufacturers can work together to promote high-efficiency products.

24. Based on your understanding of the ComEd (Northern Illinois) territory, who would you list as the three largest HVAC distributors operating in this territory?

25. ComEd is interested in building relationships with manufacturers. If ComEd gave stringent assurances of confidentiality, would you be willing to periodically share HVAC equipment sales data for ComEd to understand the current state of the HVAC market, set incentive levels, and track overall market progress for adoption of high-efficiency HVAC equipment? Why? Why not?

a. Are you, or is there someone at your company, that ComEd can reach out to if they decide to pursue an intervention with the midstream or upstream market?

D.2.10 Online Survey

The following represents an online survey respondents were asked to complete prior to the in-depth interview.

On behalf of ComEd (Commonwealth Edison), NMR Group is conducting a study about the HVAC market. Specifically, we are interviewing key manufacturers to understand the HVAC supply

chain. Your input is important for understanding the HVAC market in Northern Illinois, specifically the ComEd territory.

Thank you for taking the time to fill out this survey prior to our scheduled interview. The answers you provide here will help shorten the interview time as well as provide valuable insight for ComEd as they plan and develop programs that promote the sale of high-efficiency HVAC equipment in northern Illinois.

The information you provide will be completely confidential. We will not share any information about you or your company outside of our study team.

1. What is your name?
2. What is your company's name?
3. Please identify the equipment types your company manufactures.

The terms "residential" and "commercial" below are just based on the size of the equipment, not the actual end-use application. We recognize that some residential systems are installed in commercial settings and some small commercial systems may be installed in residential settings.

[Provided check-mark box with list of equipment]

Equipment Types	Up to 5 tons/65 kBtuh (Residential systems)	5-25 tons (small and medium commercial systems)	> 25 tons (large commercial systems)
Central Air Conditioners			
Air Source Heat Pumps (traditional ducted)			
Mini or Multi-split Air Source Heat Pumps (including VRF)			
Chillers			

4. What size of furnaces do you manufacturer, if any? Please select all that apply.

Equipment Types	Up to 225 kBtuh (Residential systems)	Small and medium commercial systems	Large commercial systems
Fossil Fuel Furnaces			
Electric Furnaces			

5. What size boilers do you manufacture, if any? Please select all that apply.

Equipment Types	Up to 300 kBtuh (Residential systems)	Small and medium commercial systems	Large commercial systems
Fossil Fuel Boilers			
Electric Boilers			

Based on industry research, we saw that cooling systems are often categorized into market segments by capacity:

- Residential: up to 5 tons/65 kBtuh
- Small/medium commercial: 5-25 tons
- Large commercial: >25 tons

However, we could use some help defining comparable categories for heating equipment. We know the threshold between residential and commercial heating systems, but we do not know how the industry typically classifies systems as "small or medium commercial" systems or "large commercial" systems.

If respondent indicated commercial-sized furnaces are manufactured:

Given that AHRI considers furnaces up to 225 kBtuh to be residential, what are the comparable size categories for small/medium commercial and large commercial furnaces?

Equipment Types	Provide a Range for each category in kBtuh
Small/Medium commercial furnaces (225 to ? kBtuh)	
Large commercial furnaces	

If respondent indicated commercial-sized boilers are manufactured:

Given that AHRI considers boilers up to 300 kBtuh to be residential, what are the comparable size categories for small/medium commercial and large commercial boilers?

Equipment Types	Provide a Range for each category in kBtuh
Small/Medium commercial boilers (300 to ? kBtuh)	
Large commercial boilers	

6. [IF RESPONDENT OPERATES IN RESIDENTIAL MARKET] What percentage of the residential heating and cooling systems your company sold in Northern Illinois in 2018 were sold directly to each of following customer types?

Your best estimate is fine, as we recognize that you do not directly communicate with all of the end-users/installers.

Customer Types	Residential HVAC Systems
Distributors	A%
Retailers with brick-and-mortar locations	B%
Online-only retailers	C%
Facility owners	D%
Heating/cooling/plumbing contractors	E%
Property managers	F%
Builders or general contractors	G%
Homeowners	H%
Other [Open-Ended]	I%
Total	**Responses required to equal 100%**

7. [IF RESPONDENT OPERATES IN RESIDENTIAL MARKET] What percentage of those **residential** systems were installed in the following scenarios? Your best estimate is fine, as we recognize that you do not directly communicate with all of the end-users/installers.

Installation Types	Residential HVAC Systems
Installed in newly-constructed building (prior to occupancy)	A%
Installed as a supplemental system in an existing facility	B%
Replaced a completely failed system	C%
Replaced a functioning, but near-failure system	D%
Replaced a fully functioning system that was NOT close to failure	E%
Don't Know	F%
Other	G%
Total	**Responses required to equal 100%**

8. [IF RESPONDENT OPERATES IN **SMALL-TO-MEDIUM COMMERCIAL** MARKET] What percentage of the **small and medium-sized commercial** heating and cooling systems your company sold in Northern Illinois in 2018 were purchased by each of the following types of customers?
   Your best estimate is fine, as we know you may not have direct contact lines with all of these market actors.

Customer Types	Small-to-Medium-Sized HVAC Systems
Distributors	A%
Facility Owners	B%
Property Managers	C%
Heating/cooling/plumbing contractors	D%
Builders or General Contractors	E%
Retailers	F%
Other	G%
Total	**Responses required to equal 100%**

9. [IF RESPONDENT OPERATES IN **SMALL-TO-MEDIUM COMMERCIAL** MARKET] What percentage of those **small and medium commercial/industrial systems** were installed in the following scenarios?

Your best estimate is fine, as we recognize that you do not directly communicate with all of the end-users/installers.

Installation Types	Small-to-Medium HVAC Systems
Installed in newly-constructed building (prior to occupancy)	A%
Installed as a supplemental system in an existing facility	B%
Replaced a completely failed system	C%
Replaced a functioning, but near-failure system	D%
Replaced a fully functioning system that was NOT close to failure	E%
Don't Know	F%
Other	G%
Total	**Responses required to equal 100%**

10. [IF RESPONDENT OPERATES IN **LARGE COMMERCIAL** MARKET] What percentage of the **large commercial** heating and cooling systems your company sold in Northern Illinois in 2018 were purchased by each of the following types of customers?
Your best estimate is fine, and we expect that you may not sell equipment to all of the potential customer types listed below

Customer Types	Large Commercial HVAC Systems
Distributors	A%
Facility Owners	B%
Property Managers	C%
Heating/cooling/plumbing contractors	D%
Builders or General Contractors	E%
Retailers	F%
Other	G%
Total	**Responses required to equal 100%**

11. [IF RESPONDENT OPERATES IN **LARGE COMMERCIAL** MARKET] What percentage of those **large commercial/industrial systems** were installed in the following scenarios?

Your best estimate is fine, as we recognize that you do not directly communicate with all of the end-users/installers.

Installation Types	Large Commercial HVAC Systems
Installed in newly-constructed building (prior to occupancy)	A%
Installed as a supplemental system in an existing facility	B%
Replaced a completely failed system	C%
Replaced a functioning, but near-failure system	D%
Replaced a fully functioning system that was NOT close to failure	E%
Don't Know	F%
Other	G%
Total	**Responses required to equal 100%**

12. Please select the option that best describes how accurate you believe the sales estimates you provided are:
    a. Guess – I did not rely on actual sales records.
    b. Somewhat accurate – I relied on sales records but made inferences from them.
    c. Highly accurate – I relied on actual sales records.

13. We will also be talking to large distributors as a part of this research effort for ComEd. Can you suggest some key heating/cooling distributors (individuals or companies) that we should talk to in order to help us better understand this market?
    a. Open-ended responses provided in survey.

14. Thank you for taking the time to complete this survey prior to our scheduled interview. We look forward to hearing your valuable insight and expertise on the HVAC market in the Northern Illinois (ComEd) Territory.

HVAC Contractor Interview Guide

D.3 HVAC Contractor Interview Guide

Interviewer: _____

Date of Interview: _____

Time Begun_____ Time Ended _____

Respondent Name: _____

Respondent Title: _____

Phone Number(s): _____

E-mail Address: _____

D.3.1 Introduction

D.3.2 Introduction

1. Does your company install HVAC equipment in the Northern Illinois region?

IF YES: Which types of HVAC equipment do you distribute in this region? Which market segments (residential, small commercial, large commercial?) [NOTE THAT HVAC INDUSTRY MAY CLASSIFY MARKET SEGMENTS BY TONNAGE AND MAY NOT HAVE SPECIFIC KNOWLEDGE OF WHERE PRODUCTS ARE INSTALLED]

2. Would you say that you are very familiar with current HVAC trends, interactions in the supply chain, and new HVAC product development and distribution strategies for the Northern Illinois Market?

3. What geographical areas does your company serve? [TERMINATE IF THEY DO NOT SERVE NORTHERN ILLINOIS/COMED TERRITORY] In case you happen to know, what portion of your work is inside ComEd territory, and how much is outside?

[ASK Q4 IF CONTRACTOR OPERATES IN COMMERCIAL MARKET (FROM Q1), ELSE SKIP TO Q5]

4. Does your company install large commercial HVAC equipment (>25 tons)? If so, which equipment types?

5. Are there particular brands of HVAC equipment that you install? IF YES: Which ones?

6. I have a list of HVAC equipment types we're interested in. I'm going to list them – could you please tell me which of them your company installs?
    a. **LIST OF EQUIPMENT**: Central Air Conditioner, Air-source heat pumps, ductless mini-splits, variable refrigerant flow systems (VRF), chillers, furnaces, and boilers

7. What percentage of the residential heating and cooling systems your company installed in Northern Illinois in 2018 were purchased by each of following customer types?

   (Your best estimate is fine, and you may not sell equipment to all of the potential customer types listed below.)

Customer Type	Percentage
Homeowners	
Facility Owners	
Property Managers	
Builders or General Contractors	
Heating/Cooling/Plumbing Contractors	
Retailers	
Other <insert option>	

8. What percentage of the commercial or industrial heating and cooling systems you installed in Northern Illinois in 2018 were purchased by each of following customer types?

   Your best estimate is fine, and we expect that you may not sell equipment to all of the potential customer types listed below.

Customer Type	Percentage
Facility Owners	
Property Managers	
Builders or General Contractors	
Heating/Cooling/Plumbing Contractors	
Retailers	
Other <insert option>	

9. Think about the residential heating and cooling systems you installed in Northern Illinois in 2018. What percentage of those residential systems were installed in the following scenarios? Your best estimate is fine.

Installation Type	Percentage
Installed in a newly-constructed home (prior to occupancy)	
Replaced a completely failed system	
Replaced a functioning, but near-failure system	
Replaced a fully functioning system that was *not* close to failure	
Other <insert option>	

10. Think about the commercial and industrial heating and cooling systems you installed in Northern Illinois in 2018. What percentage of those commercial/industrial systems were installed in the following scenarios? Your best estimate is fine.

Installation Type	Percentage
Installed in a newly-constructed building (prior to occupancy)	
Replaced a completely failed system	
Replaced a functioning, but near-failure system	
Replaced a fully functioning system that was *not* close to failure	
Other <insert option>	

11. Please select the option that best describes how accurate you believe the sales estimates you provided are:
    a. Guess – I did not rely on actual sales records.
    b. Somewhat accurate – I relied on sales records but made inferences from them.
    c. Highly accurate – I relied on actual sales records.

12. [FOR EACH MARKET SEGMENT THAT INTERVIEWEE IS ENGAGED IN] On a scale from 1 to 5, how important are the following factors on your customers' HVAC purchasing decisions, where 1 is not at all important and 5 is extremely important:

Installation Type	Residential	Small/Medium Commercial	Large Commercial
Increased upfront cost for high-efficiency equipment			
Energy savings from high-efficiency equipment			
Length of pay-back period for high-efficiency equipment			
Equipment type/fuel/configuration			
Reliability			
Warranty period			
Other factor driving the purchase decision <INSERT FACTOR>			

D.3.3 Purchase Decision Processes

13. Who are the key influencers and decision makers for HVAC equipment purchase decisions, including the efficiency level of the equipment? Which people have only minor influence, and which are the ultimate decision makers?
    a. Residential? [PROBE: CONTRACTORS, DISTRIBUTORS, END-USERS, BUILDERS, OTHERS?]
    b. Small and Medium Commercial? [PROBE: OWNER, DESIGN/BUILD FIRMS, DISTRIBUTORS]
    c. Large commercial? [PROBE: OWNER, ARCHITECTS/ENGINEERS, GENERAL CONTRACTORS, HVAC CONTRACTORS, DISTRIBUTORS, AND MANUFACTURER REPRESENTATIVES?]

D.3.4 Upstream and Midstream Supply Chain and Market Actors

Now, I'm going to ask you some questions about the HVAC market and key players in this market. Key supply chain market actors may include manufacturers, distributors or suppliers, retailers, contractors/installers, and end-users.

14. How do you anticipate the supply chain for HVAC equipment is changing or evolving? [PROBE ON MANUFACTURERS, DISTRIBUTORS, CONTRACTORS, END-USERS]
    a. Are online sales or online retailers changing the traditional HVAC supply chain? How so?

15. How might you need to adapt your business models in response to those changes you described? How would other market actors deal with these changes?

D.3.5 Disintermediation

Now, I'd like to ask you some questions about the potential for disintermediation of distributors, suppliers, retailers, contractors/installers, also referred to as midstream market actors, in the HVAC market. By disintermediation, I mean a reduction in the role of intermediaries between manufacturers and end use customers. For example, some product flows could shift from manufacturers directly to contractors or to end use customers.

16. How common is it for you to do installations where the HVAC equipment has already been purchased by the customer?
    a. From what sources are these customers purchasing the HVAC equipment?
    b. About what percentage of your projects are accounted for by these types of installations?
    c. About what percentage of your projects do you think these types of installations will constitute in five years? Why do you say that?
    d. In what market segment are these types of installations occurring? Are some equipment types more likely to be purchased this way than others?

17. (IF NOT ADDRESSED IN ABOVE QUESTION) Are you or your customers purchasing HVAC equipment from non-traditional supply channel partners (such as online platforms or through retail channels)?
    a. Why or why not?
    b. What proportion of your company's HVAC installations are going through non-traditional supply channels?

D.3.6 Downstream Market Actors and End-users

We are about halfway through the interview. The next set of questions are about your perspective on changes occurring in the decision-making process and what impacts these changes may have on the HVAC supply channel.

18. Do you work directly with builders on installing HVAC systems for their projects? IF YES: What changes are occurring in the practices of builders with regard to specifying and installing HVAC systems?

19. How are their equipment decision-making behaviors changing, particularly with regard to energy efficiency? [RESIDENTIAL, SMALL COMMERCIAL, LARGE COMMERCIAL]

20. What drives your decision to promote newer, higher-margin, high-efficiency equipment vs. lower-price, standard efficiency products that might sell at higher volumes? [PROBE FOR DIFFERENT MARKET SEGMENTS]

D.3.7 Utility HVAC Energy Efficiency Program Planning and Program Incentives

The next set of questions are about utility-sponsored HVAC energy efficiency programs and will be used to help inform potential changes to ComEd's program design.

21. Do you currently work with any energy-efficiency programs that provide incentives for high-efficiency systems, either to the end user or to distributors or manufacturers?
    a. IF YES: Which ones/types?
    b. What are the benefits and pitfalls from partnering with these programs? [PROBE: BEYOND INCREASE IN SALES]
    c. What are the requirements for participating (to receive incentive) [PROBE: INCENTIVE PASS-THROUGH, REQUIRED FORMS, INSTALLATION PRACTICES]?

22. Some utilities provide incentives for energy-efficient HVAC equipment to either upstream market actors, like manufacturers, or midstream market actors like distributors, rather than providing the incentives directly to the end-user. How would this type of program affect your ability to sell higher-efficiency equipment to end-users? IF NEEDED: By upstream, I mean the program provides the incentive to manufacturers or HVAC equipment producers.

Those are all the questions I have. Thank you for your time!