Scaling Heat Pump Retrofits through Aggregation and Bulk Procurement

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Prepared for:

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dunsky Energy + Climate

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The Atmospheric Fund
https://taf.ca/
416-359-7802

Prepared by:

Dunsky Energy + Climate Advisors
50 Ste-Catherine St. West, suite 420
Montreal, QC, H2X 3V4

www.dunsky.com | info@dunsky.com
+ 1 514 504 9030

About Dunsky

Dunsky supports leading governments, utilities, corporations and others across North America in their efforts to accelerate **the clean energy transition**, effectively and responsibly.

With deep expertise across the Buildings, Mobility, Industry and Energy sectors, we support our clients in two ways: through rigorous **Analysis** (of technical, economic and market opportunities) and by designing or assessing **Strategies** (plans, programs and policies) to achieve success.

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EXECUTIVE SUMMARY

Energy consumption from buildings represents the largest portion (44%) of greenhouse gas (GHG) emissions in the Greater Toronto and Hamilton Area (GTHA), and nearly two thirds (60%) of emissions from the City of Toronto.[1] Heat pump technologies are widely viewed as a key tool for improving building energy performance, with the ability to deliver heating energy at efficiencies of more than 300%. However, this critical and emerging decarbonization technology faces some barriers to widespread adoption. These barriers impede building owners, energy utilities, and policymakers from realizing the full potential that heat pump technologies offer.

A handful of demand aggregation and bulk procurement initiatives have shown promise in promoting market transformation and broader adoption of emerging technologies like LED lighting and rooftop solar photovoltaics, and more recently heat pumps. Accordingly, Dunsky Energy + Climate Advisors was retained by The Atmospheric Fund (TAF) to conduct a bulk procurement study to assess the barriers, opportunities, and trade-offs to scaling up heat pump retrofits through aggregation and bulk procurement. The study findings were based on a review of recent bulk buying initiatives in North America, a landscape scan of heat pump barriers and cost saving opportunities, and interviews with key market actors, including heat pump suppliers and installation companies, large building managers, and heat pump incentive program administrators.

Barriers to Heat Pump Adoption

Our research identified six main barriers to scaling heat pump adoption in retrofit applications within Canada and the GTHA. Demand aggregation and bulk procurement approaches can occur at differing scales, some of which offer a more targeted approach to addressing these barriers. The degree to which bulk procurement may reduce barriers to heat pump adoption is dependent on approach and scale and can be uniquely designed to target a specific barrier or group of barriers.

Table 1. Generalized comparison of different bulk procurement approaches and the barriers they address.

Barrier	Community-level	Market-segment	Market-wide
Capital Costs	◑	◑	◑
Technology Awareness	◑	◑	●
Building Topology and Regulations	○	●	◑
Customer Demographics and Split Incentive	○	○	○
Product Availability/Market Size	○	◑	●
Workforce Capacity	◑	◑	●

Legend: ● - Substantially addresses barrier, ◑ - Partially addresses barrier, ○ - Does not address barrier.

[1] The Atmospheric Fund. "GTHA Carbon Emissions Inventory". Accessed February 17, 2023.

Applicability of Bulk Procurement

This study found that upfront cost savings stemming from bulk procurement are likely to be modest and will be primarily associated with shipping discounts associated with securing larger orders. Savings on equipment is highly variable and depend on the scale and nature of each bulk order. Existing bulk procurement initiatives and insights from interviews have noted **equipment savings ranging from 3 – 20% per unit**. The opportunities for heat pump manufacturers to offer price reductions is significantly constrained by a variety of factors before they even receive the product.

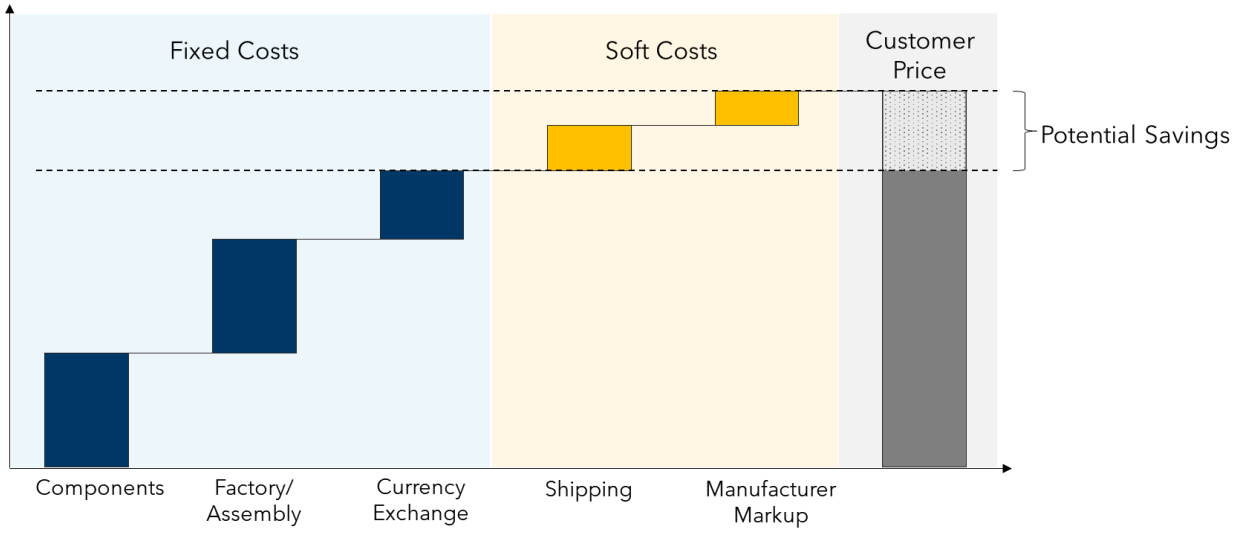

Figure 1. Heat Pump Supply Chain Costs

Beyond this, installation costs are typically fixed and not tied to volume, leaving minimal opportunity for savings via bulk procurement. However, there are some strategies that may provide small installation cost reductions when employed, but the amount of savings is likely to vary significantly from one project to another. Overall, while bulk purchasing may offer some savings, it is not typically enough to significantly impact upfront costs and allow heat pumps to become comparable with combustion heating equipment, on an overall installed costs basis.

Outside monetary savings, bulk procurement offers a range of other benefits which help accelerate heat pump adoption. Organizations considering either participating in or facilitating bulk procurement should weigh the range of benefits offered by bulk procurement within their target markets to determine if this strategy is a good fit to meet their objectives.

Overall, it is worth noting that while this study did not identify significant cost savings opportunities through bulk procurement, the track record of bulk procurements for efficiency equipment is not deep. Moreover, the manufacturers interviewed would logically be expected to avoid making promises of cost reductions based on theoretical purchase orders. Considering the other potential benefits offered by bulk procurement, there remains a strong rationale for energy transition leaders to experiment further with bulk procurement of heat pumps to expand the body of evidence and work in more concrete terms with manufacturers to find cost reduction opportunities.

Table 2. Opportunities and limitations to bulk procurement and aggregation of heat pumps

Opportunities	Limitations
• Some reduced costs, primarily associated with shipping savings • Standardized administrative logistics and costs • Streamlined supply chains and minimized disruptions and supply delays • Increased customer awareness and knowledge • Increased market penetration and attract emerging technologies • Improved local heat pump supplies/inventories by demonstrating demand and market size • Increased demand for local contractor/installer services • Improved local knowledge and skillsets with technology	• Highly variable capital costs on a case-by-case basis, make it hard to determine savings potential • Even in the optimal case, upfront cost savings from bulk procurement appear to be minimal • There is no economy of scale on labour and installers already purchase required materials in bulk, likely eliminating any installation cost savings. • Aggregation does not eliminate peripheral cost barriers associated with retrofits (e.g., electrical panel and control system upgrades)

Structuring Bulk Procurement Initiatives

Although upfront cost savings are limited, a series of recommended practices should be deployed to ensure that programs capture the full suite of benefits (including cost savings) that may be offered via bulk procurement. To maximize success, this report has identified these opportunities and proposes eight practical recommendations which may be used as guidelines for structuring future bulk procurement initiatives.

Eight Recommendations for Structuring Bulk Procurement Initiatives

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1. Introduction

Currently, energy consumption from buildings represents the largest portion (44%) of greenhouse gas (GHG) emissions in the Greater Toronto and Hamilton Area (GTHA), and nearly two thirds (60%) of emissions from the City of Toronto.[2] This is primarily due to the use of natural gas for space heating in most buildings in the region. Thus, any strategy striving to eliminate the majority of the carbon emissions in the region must include building decarbonization strategies. Considering Ontario's low carbon electricity supply, heating electrification offers a significant opportunity to achieve this objective.

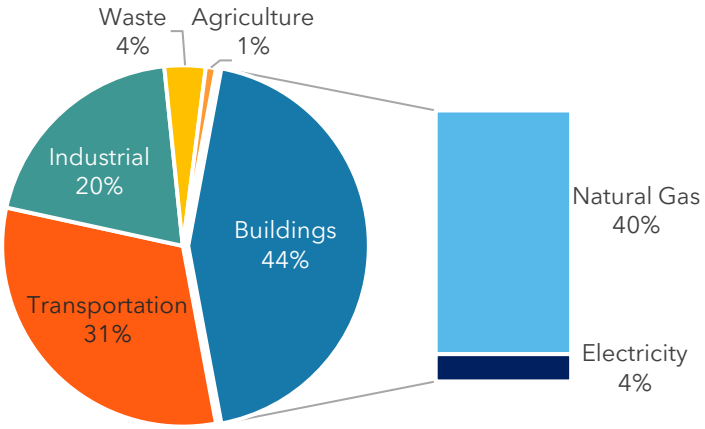

Figure 2. GTHA GHG emissions by sector[2]

Heat pump technologies are widely viewed as a key tool for improving building energy performance, with the ability to deliver heating energy at efficiencies of more than 300%. However, this critical and emerging decarbonization technology faces some barriers to widespread adoption. These barriers impede building owners, energy utilities, and policymakers from realizing the full potential that heat pump technologies offer. Barriers to widespread heat pump adoption include high upfront costs associated with equipment purchase and installation, technology awareness by homeowners and installers, workforce capacity and the lack of suitable heat pump units for certain applications. Eliminating or minimizing these barriers will be vital to achieving regional and federal decarbonization goals such as the TransformTO Net Zero Strategy and the Canadian Net-Zero Emissions Accountability Act.

Given the scale of the market, heat pump adoption must occur at an accelerated pace to achieve the desired GHG emission reductions targets.[3] In its TransformTO Net Zero Strategy the City of Toronto determined it would require 134 $MtCO_2e$ fewer emissions emitted from buildings in Toronto between 2020 and 2050, and an 87% reduction in emissions from buildings to achieve net zero by 2040.[4] The majority of these reductions are projected to come from the electrification of space and water heating. A handful of demand aggregation and bulk procurement initiatives have shown promise in promoting market transformation and broader adoption of emerging technologies like LED lighting and rooftop solar photovoltaics, and more recently heat pumps. Accordingly, Dunsky Energy + Climate Advisors was retained by The Atmospheric Fund (TAF) to conduct a bulk procurement study to assess the barriers, opportunities, and trade-offs to scaling up heat pump retrofits through aggregation and bulk procurement.

The key elements of this study include:

1. Identifying key barriers to heat pump adoption in retrofit applications within the GTHA region,

[2] The Atmospheric Fund. "GTHA Carbon Emissions Inventory". Accessed February 17, 2023.
[3] The City of Toronto. 2021. Net Zero Existing Buildings Strategy.
[4] The City of Toronto. 2021. TransformTO Net Zero Strategy.

2. Engaging with heat pump industry stakeholders to assess the impacts and benefits that may be offered by bulk procurement initiatives and aggregation to increase heat pump uptake in the GTHA and,
3. Developing practical recommendations for structuring and implementing aggregation and/or bulk procurement

1.1 Methodology

The methodology sought to leverage experience and insights from a range of key initiatives and stakeholders who are focused on increasing heat pump adoption and addressing market barriers to energy efficient technologies through bulk procurement strategies. Broadly speaking, the research focussed on the following two tasks.

Literature Review and Landscape Scan

The purpose of the literature review was two-fold. First, to better understand the heat pump retrofit market, and identify barriers to scaling heat pump adoption. This included research to ascertain the installed costs of heat pump systems in the GTHA. This work was supplemented with Dunsky's internal expertise in heat pump technology and market size to provide accurate information on cost breakdown and the level of potential cost savings that can be achieved through aggregation and bulk procurement for a range of use cases pertinent to air-source heat pump retrofits in the Canadian context.

The second objective was to extract findings from various sources (whitepapers, market reports, technical articles) about existing bulk procurement initiatives in Canada and around the world. This helped inform and highlight the barriers, benefits, and trade-offs of demand aggregation and bulk procurement approaches at different scales.

The findings from this research were synthesized and used to help identify relevant industry stakeholders and bulk procurement program administrators/participants we could engage with during the second task.

Market Actor Interviews

Following the results of the literature review and landscape scan, we conducted eight 60-minute interviews with an array of local professionals as well as key actors who have implemented or participated in technology aggregation and bulk procurement initiatives. We also engaged with managers of large building portfolios and heat pump incentive program administrators who could benefit from bulk purchase initiatives. The information obtained was used to refine and verify the results of the literature review and develop practical recommendations for the establishment of future bulk procurement programs. A summary of the organizations interviewed is shown below.

Table 3. List of organizations interviewed.

Organization	Role/Rationale
NYC Housing Authority (NYCHA)	• Largest public housing authority in North America • Organized Clean Heat for All bulk procurement initiative
Vancouver Economic Commission (VEC)	• BC organization focused on market and economic transformation • Offers various programs including Project Greenlight (technology pilot program)
Ottawa Community Housing (OCH)	• Second-largest housing provider in Ontario • Portfolio of approximately 15,000 homes
Mitsubishi	• Large, international manufacturer with substantial product line of heat pumps • Premium heat pump product line
Daikin	• Large, international manufacturer with substantial product line of heat pumps • Nine Ontario-based distribution branches
A1 Air Conditioning and Heating	• Residential and commercial HVAC installer • Works on large-scale projects
Northeast Energy Efficiency Partnerships (NEEP)	• Non-profit accelerating energy efficiency in the Northeast • Operates several heating electrification initiatives
Toronto Hydro	• Owns and operates the city of Toronto electricity distribution system • Large customer base which may be interested in heat pump adoption

2. Barriers to Heat Pump Adoption

This section provides an overview of common barriers to scaling heat pump adoption in Canadian retrofit applications. Desktop research was conducted and supplemented with our internal expertise, and findings from previous projects to determine a comprehensive list of barriers. In total, six main barriers were identified, and a synthesis of our findings is presented below.

1. Capital Costs

High upfront costs associated with equipment purchase and installation can be one of the most important barriers to heat pump adoption in retrofit applications. While these upgrades may result in long-term energy savings, the capital investment required for retrofitting existing homes and buildings can be a deterrent. When comparing the combined upfront costs of heat pumps to that of standard fossil fuel HVAC technologies (e.g., gas furnace), building owners and managers are often much more influenced by the high upfront cost of the heat pumps, and often heavily discount the value of future potential energy bill savings, especially since the energy savings in fossil fuel-heated buildings are largely dependent on the progression of Canada's carbon tax.

2. Technology Awareness

Building owners and contractors have limited knowledge and awareness of heat pump technologies. Compared to well established combustion heating equipment, the operation and performance of heat pumps is relatively more complex to understand. Accordingly, public interest and perception of heat pumps may not include recent performance improvements. One such example is the misconception that heat pumps do not perform well in cold climates.[5] Given that the market penetration of heat pumps in Canada and more specifically the GTHA is still relatively low, HVAC professionals often lack adequate training and experience with these technologies. Combined with the absence of restrictions on fossil fuel HVAC equipment, professionals are likely to recommend technologies they are familiar with and are simple to procure.

3. Building Topology and Regulations

Incorporating heat pump technologies into existing buildings introduces additional complexities when compared to new construction applications. Retrofitting heat pumps in existing buildings may require upgrades of the building's electrical systems. Ownership structures (such as condominiums) and local regulations can pose further barriers to heat pump retrofits, making it difficult to locate the compressor unit within or exterior to the building or preventing owners from installing a heat pump in their own unit.

4. Customer Demographics and Split Incentive

Widespread adoption of heat pumps can be challenging for a variety of demographics, particularly low-income households and renters. As indicated in the 2021 Census, the city of Toronto has a larger low-income population (11%) than the rest of Canada, with the remainder of the GTHA having an average of 8%. Low-income households often have competing needs for income and may not opt to prioritize energy efficiency measures. Additionally, the GTHA region of Ontario has a high percentage of renters. Property owners serving as landlords are typically not incentivized to adopt various energy efficiency improvements (including heat pumps) since it is common for the tenant to

[5] While some models may not operate at lower temperatures, advancements in heat pump technologies enable them to perform at outdoor temperatures well below -20°C. Additionally, dual fuel or hybrid heating systems can combine heat pumps with gas-fired back ups to meet heating needs when outdoor temperatures drop below the heat pumps operating range.

pay the utility bill. Similarly, tenants are often reluctant to invest in energy efficiency improvements for a home they do not own or alternatively, do not have the authority to implement such upgrades. This discrepancy between home ownership and occupation is referred to as a "split incentive".

5. Product Availability/Market Size

The North American market for air-to-air products is large and mature. However, for more niche products (such as cold-climate all-in-ones), the small size of the Canadian market may limit the amount manufacturers are willing to invest in developing, certifying, and importing products. Furthermore, countries that manufacture heat pumps will often prioritize their own market or other large, established markets before meeting other countries' needs.

Additionally, the GTHA building stock has a high percentage of multi-unit residential buildings (MURBs). Currently, there are limited options for low-capacity heat pumps that are well suited to smaller apartments and homes. More models and options for low-capacity (< 9kBtu/h) standard-voltage heat pumps, and low voltage (120V) in-room heat pumps, are needed to meet the market need for units that can serve apartments and individual rooms.

6. Workforce Capacity

Another significant barrier is the lack of a qualified workforce to design and install heat pumps. Heat pump adoption in Canada remains relatively low, particularly in Ontario where natural gas heating is predominant, is relatively cheap, and is absent of restrictions on the installation or replacement of fossil fuel HVAC equipment. Accordingly, technicians and experts likely have had limited experience designing, sizing, and installing heat pumps. A lack of a qualified workforce and capacity can pose a reputational risk to manufacturers if systems are poorly designed, installed, or serviced. Further, if a heat pump system is poorly installed, this can negatively impact the experience of the customer who is then unlikely to recommend installing a heat pump to their networks.

3. Bulk Procurement

Bulk procurement is often proposed as a solution to many of the barriers emerging technologies face including high upfront costs, lack of consumer awareness, and more. There are many successful examples of bulk procurement in other sectors leading to mass adoption, including LED lighting[6], rooftop solar photovoltaics, and ENERGY STAR refrigerators.[7] While these examples highlight how demand aggregation and bulk procurement initiatives can be successful, they also point to the associated limitations. For example, both lighting and refrigeration technologies have simple installation and are standardized across households in North America. However, building design and HVAC configurations are diverse, which may limit the ability of bulk procurement to meet local heat pump market needs.

3.1 General Approaches to Aggregation / Bulk Procurement

Demand aggregation and bulk procurement approaches can occur at differing scales, some of which offer a more targeted approach. Below are three examples of demand aggregation/bulk procurement approaches at differing scales.

1. **Community-level bulk purchasing campaigns** are group-purchasing programs initiated by a municipality or local volunteer organization. The grassroots nature of these programs is more likely to generate demand for local energy service businesses/professionals when members of a single community or group of neighbouring communities jointly purchase and install equipment. The structure of this type of program relies on strong community relationships and depends on friends, neighbours, and local leaders to spearhead the campaigns, increase technology awareness, and make an informed home energy purchase together.
2. **Market segment-specific bulk procurement initiatives** are demand aggregation for mass-deployment of a single heat pump technology targeted at a building segment with common characteristics, such as community housing. By focusing on buildings with similar characteristics, these initiatives help streamline technology needs and retrofit costs by reducing variability in the targeted applications. They are also useful in building buy-in for a "guaranteed" number of units as community housing authorities typically manage multiple residencies and can benefit from economies of scale.
3. **Market-wide bulk procurement schemes** use trade coalitions to spur the supply of heat pumps at the municipal, provincial, or national level. These initiatives put emphasis on increasing market size and attractiveness. Individual jurisdictions alone may not appeal to manufacturers who are experiencing high demand from other jurisdictions where heat pumps are already widely deployed. Jurisdictions participating in market-wide initiatives may benefit from regional collaboration and alliances with other localities that have a similar climate and building stock. This facilitates supply chain development and bolsters product availability by increasing the perceived market size.

[6] Mapp, Jim., and Smith, Barbara. 2012. *LED Installations through Government Procurement Initiatives*. ACEEE Summer Study on Energy Efficiency in Buildings
[7] Nolden, Sandra L.., and Morgan, Stephen J. 1996. *Super-Efficient Refrigerators for Apartments: The NYPA/NYCHA Project as a New Market Transformation Model.* ACEEE

Selecting the most appropriate bulk procurement approach should involve an understanding of project goals and desired outcomes. There are also influencing factors unique to each jurisdiction or demographic that may influence the suitability of different procurement approaches.

3.2 Initiatives

Through desktop research we identified six relevant examples of bulk procurement or product aggregation initiatives within the clean energy industry. For each of these initiatives, we collected information regarding program details, progress, outcomes (where applicable), and benefits and challenges (to the extent they were documented). These initiatives are useful to provide lessons learned and potential models that could be promising for heat pump procurement in the GTHA.

A summary of the six initiatives that were identified is provided in the table below, and a more detailed table of findings is appended.

Table 4. Summary of relevant bulk procurement initiatives

Legend: - Technology innovation, - Improve affordability, - Increase demand/market size, - Build workforce capacity

Initiative	Brief Description	Benefits and Impacts	Goals
Clean Heat for All Challenge (New York)	**Market Segment Model:** The challenge calls upon manufacturers to *develop a packaged cold climate heat pump that can be installed through an existing window opening* to provide heating and cooling on a room-by-room basis **Anticipated volume:** 30,000 units	• Focuses on a single product to satisfy the heating and cooling needs for the majority of units • Development of replicable procurement mechanism for the multifamily sector across the Northeast. • Increased perceived market size and niche product bulk procurement led to new technology available to affordably meet the needs of small apartments.	
Clean Heating and Cooling Community Campaigns and HeatSmart (USA)	**Community Level Model:** Non-profit campaign run by a community-based organization, sometimes facilitated with utilities that offer free, expert guidance on installing heat pumps at scale and benefitting from bulk discount prices **Anticipated volume:** N/A	• Encourages market uptake by increasing product awareness, offering low- or no-cost support from professionals, and leveraging community networks. • Reduces costs by accessing products at wholesale prices and procuring skilled installation contractors via a bulk RFP. • Customers received average price reductions of around 20%[8]	
Solarize (USA) and Solar Together London (UK)	**Community level Model:** Non-profit, community-based solar PV group-purchasing program for building and homeowners **Volume to date:** 1000+ installations (solar + storage)	• Established model to provide guidance on how to run local solarize campaigns, including contractor training, instructions on tax credit and incentive applications, and bulk service RFPs.	

[8] WePowr. "HeatSmart Northampton: Pricing Guide". Accessed February 17, 2023.
New York State Association of Conservation Commissions. "HeatSmart Tompkins: Cost, Comfort, Climate: Harnessing the Efficiency of Heat Pumps and Improving Home Energy Performance in Tompkins County". Accessed February 17, 2023.

Initiative	Brief Description	Benefits and Impacts	Goals
		• Reduce costs by capitalizing on both wholesale product prices and energy rates as participated scales.	
Project Greenlight (BC)	**Market Wide Model:** An alternative to traditional procurement processes, which uses calls for innovation to solicit proposals from small- and medium-sized businesses that may not regularly track traditional procurement channels *(Does not include an explicit pathway for procurement, but successful projects may lead to large-scale deployment)* **Anticipated volume:** N/A	• Expedites technology adoption and innovation by rapidly sourcing, screening, and scaling solutions. • Helps test and apply technologies to real-world applications, by helping technology providers reach a wider pool of customers and niche applications than would typically flow through conventional RFP processes.	
EuroAccess – LIFE Clean Energy Transition sub-programme: LIFE-2022-CET-HEATPUMPS (EU)	**Market Segment Model:** Open call for a proposal to "Accelerate deployment and affordability of heat pumps through collective purchase actions and procurement" **Anticipated volume:** N/A (5 proposals submitted in 2022)	• Comprehensive RFP asks for solutions to a broad range of market barriers, including increasing customer awareness, offering financing options and building sufficient contractor capacity. • Aims to increase affordability by minimizing up-front equipment costs by capitalizing on wholesale pricing and securing installation services to support mass adoption.	
Energy Efficiency Service Limited India – Super-Efficient AC Program (ESEAP) (India)	**Market Wide Model:** A 2017 government-led bulk procurement of 100,000 efficient air conditioners from global manufacturers, sold to distribution utilities via an online marketplace **Volume to date:** 100,000 units contracted	• Bulk order and competitive (sealed bidding reduced the cost of efficient AC products, and associated installation and maintenance services. • A lack of public engagement meant demand for the product was adversely affected. In particular, the program was modelled after LED procurement but neglected to consider that AC equipment has higher costs, maintenance requirements, and liability. Also, lowest-cost bidding eliminated innovative products such as low global warming potential (GWP) refrigerant units.	

3.3 Tuning Bulk Procurement Strategies to the GTHA Market

In the GTHA for example, there are a few key factors that program operators should consider when designing future bulk procurement initiatives to maximize their success.

- **The prevalence of large Multi-family Buildings:** The GTHA has a high number of high-rise and multi-use residential buildings. This could lend itself well to bulk procurement as there are lots of smaller residential units with similar heating and cooling needs clustered together. Community-level programs that promote technology awareness via pre-existing relationships can be utilized on a small scale to leverage trust between individuals and organizations to

promote positive experiences with heat pumps. These programs can be designed to target residents within specific neighbourhoods or condominium buildings. Alternatively, market-segment approaches may also take advantage of pre-existing relationships between residents living in proximity in addition to targeting building types with similar heating and cooling demand. By targeting a specific building topology, a bulk procurement program may be able to focus on a few unit models/sizes to meet the needs of all residents. This reduced customization from home to home can be beneficial in ensuring consistent quality of installation. However, different building ownership structures and the large quantity of rental units may raise notable regulatory and logistical hurdles as well as split-incentive barriers that are difficult to address via bulk procurement.

- **Natural Gas Heating Predominates:** Natural gas heating is the dominant heating source across Ontario and particularly in the GTHA, and most homeowners still do not recognize heat pumps as being more cost effective, as they often do not account for the potential for gas prices to increase in step with Canada's carbon tax in the coming years. To scale adoption, it will be critical to improve heat pump system reliability and reduce upfront costs. Market-wide initiatives are best suited to promote heat pump technologies across the GTHA by demonstrating the efficacy of heat pumps in cold climates, their potential for energy bill reductions, and generating technology awareness and education. Projects where the primary goal is to increase the supply and demand of heat pumps and skilled labourers would benefit from large-scale initiatives that serve the entire region. Increasing technology awareness and the perceived market size will allow for a greater supply of heat pumps as well as more HVAC professionals certified in heat pump installation.
- **Progressive Climate Goals and Policies:** The City of Toronto is among the leading municipalities for Climate Action policies in Canada. In addition to its TransformTO Net Zero Strategy which strives to reduce city-wide GHG emissions to net zero by 2040, the City also has a Net Zero Existing Buildings Strategy specifically designed to create pathways for decarbonizing the City's buildings sector. As part of these strategies, the City forecasts that the majority of emissions reductions in buildings are projected to come from the electrification of space and water heating.[9] To achieve these benchmarks, establishing a sufficient supply and install capacity will be essential. Market-wide initiatives are excellent levers for generating technology awareness across both the City and GTHA as well as incenting manufacturers to maintain larger local inventories.

[9] The City of Toronto. 2021. TransformTO Net Zero Strategy.

4. Heat Pump Installed Costs

Given that upfront costs are one of the primary barriers to heat pump adoption, it is important to establish baseline technology costs to quantify how much, if at all, bulk procurement and aggregation can address this barrier. Through research, interviews, and previous projects, our team has assembled detailed libraries of heat pump equipment and installation costs.

As bulk procurement will impact equipment and installation costs in different ways, Figure 3 first shows a capital cost breakdown.

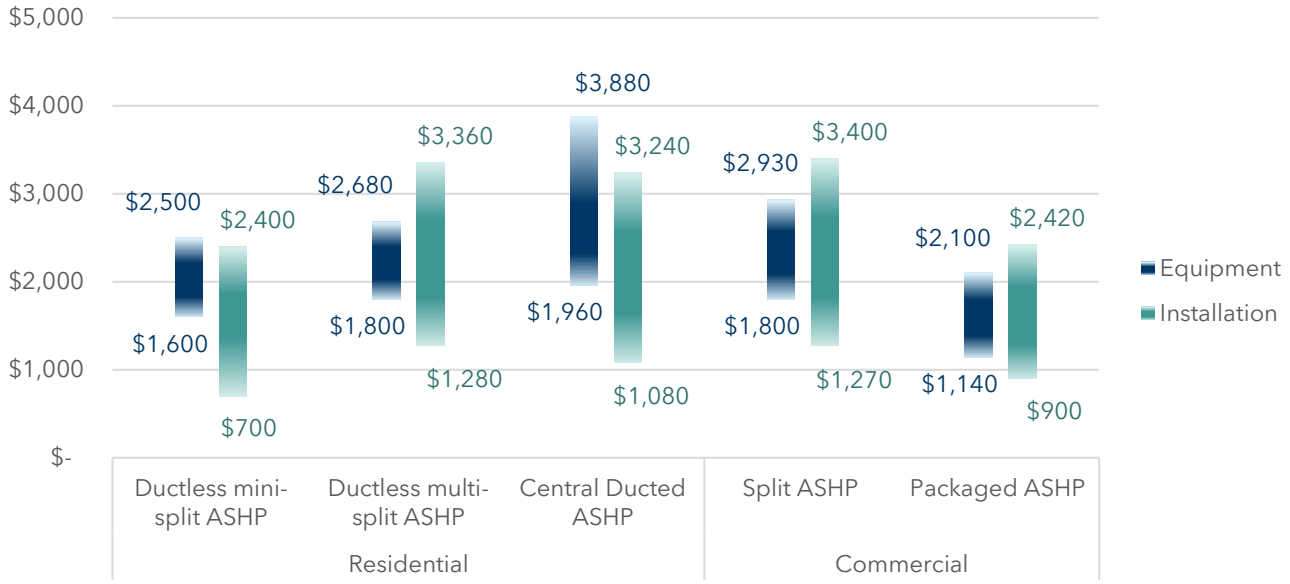

Figure 3. Capital Cost Breakdown (per ton of capacity, without bulk procurement)

Note: These ranges are representative of prices that can typically be found in urban regions in Canada, including the GTHA. In many cases, additional costs would be beneficial or even required, but are not included in the costs above: electrical panel upgrades, supplemental heating equipment (gas or electric), duct corrections or upgrades where applicable, removing existing equipment, permitting, etc.

As shown, ranges are quite high both for equipment (heat pump) and installation (labour) costs. Three typical residential systems are shown: mini-split single-head heat pumps, mini-split multi-head heat pumps, and central ducted heat pumps - all air-source. The single head mini-split is the most affordable, mostly driven by low installation costs inherent to the simplicity of the equipment. On the contrary, multi-head heat pumps require longer refrigerant piping runs inside the home, and central ducted systems require the installation of the air handler and adaptations to the existing ducting. A cause for the very high installation cost range is the fact that heat pumps are still an emerging technology for most customers (and many contractors), which increases the risk factor built into contractor pricing, as well as the high degree of customization which limits opportunities for economies of scale.

Equipment pricing mainly varies depending on manufacturer (brand) and performance (efficiency and cold climate operation). Most residential heat pumps are manufactured in Asia and Europe by a

handful of (very) large manufacturers, and almost identical units can be found in different brands, with varying prices. Therefore, cold-climate heat pumps can be found across the provided price ranges, and pricing will mainly be driven by the brand itself, the distributor, as well as contractor availability. Moreover, for residential applications, technology type (ductless vs central ducted) does not impact costs per unit of heating or cooling capacity (in tons) much, though the range does go higher for ducted units.

Finally, equipment sizing is driven by building floor area, building type, as well as envelope performance. In terms of costs, they are not exactly proportional to capacity - a 2-ton unit will cost a bit less than two single-ton units.

Figure 4 below provides ranges for total installed costs for typical equipment sizing in each application, including both equipment and installation, but again excluding potential additional costs such as electrical panel upgrades, supplemental heating equipment (gas or electric), duct corrections or upgrades where applicable, removing existing equipment, permitting, etc.

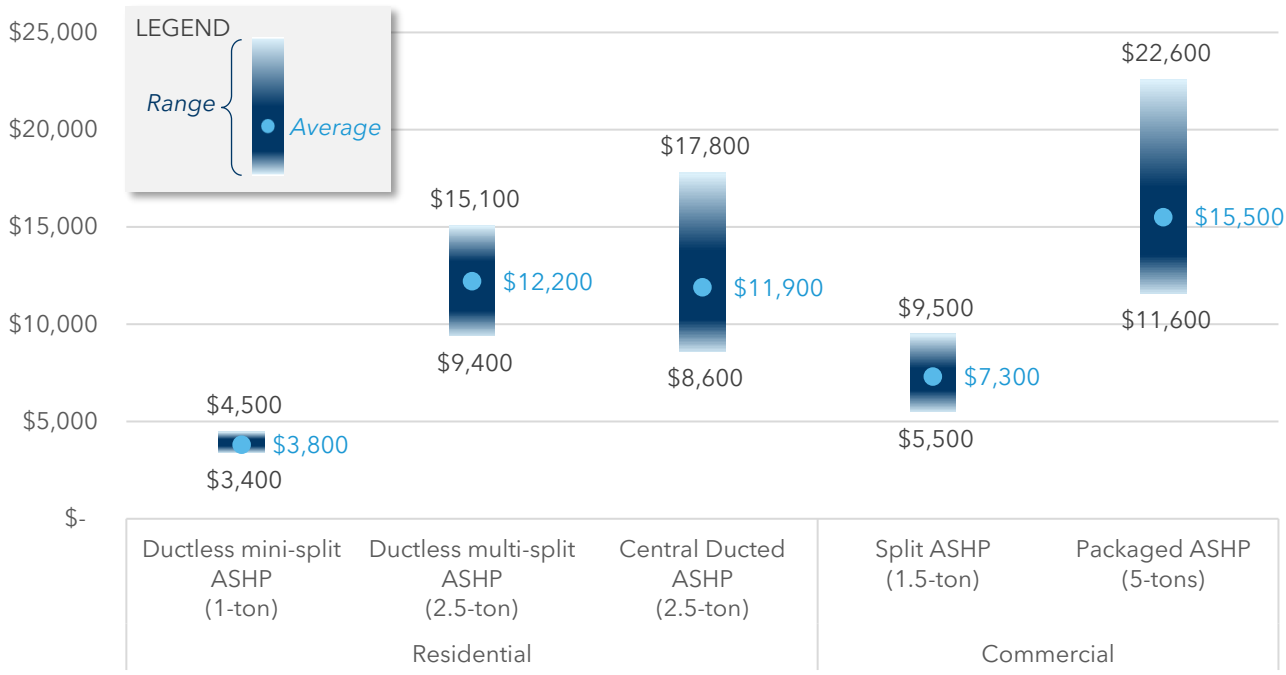

Figure 4. Total Installed Cost Ranges for a Typical Size (Equipment & Installation cost, without bulk procurement)

5. Findings

Based on the results of our desktop research and interviews with relevant industry professionals, it was observed that **bulk procurement of heat pumps can be expected to have only a minimal impact on upfront cost reduction but, may offer benefits that can address other barriers**.

To minimize the capital cost barrier, bulk procurement initiatives must reasonably reduce equipment and/or installation costs. Our findings suggest that equipment savings are highly variable and depend on the scale and nature of each bulk order, with the highest quoted savings totalling approximately 20% per unit. Beyond this, installation costs are typically fixed and not tied to volume, leaving minimal opportunity for savings via bulk procurement. However, there are some strategies that may provide small installation cost reductions when employed. Similarly, the amount of savings that may be recovered will vary greatly on a project-by-project basis. Accordingly, while bulk purchasing may offer some savings, it is not typically enough to significantly impact upfront costs and allow heat pumps to become comparable with combustion heating equipment, on an upfront cost basis.

However, there are other benefits that may arise from these initiatives which can be beneficial to program organizers and building owners/managers. Organizations considering either participating in or facilitating bulk procurement should weigh the motivations behind their programming and consider the full suite of opportunities that bulk procurement provides to determine if these initiatives are ideal for them. The degree to which bulk procurement may reduce barriers to heat pump adoption is dependent on approach and scale and can be uniquely designed to target a specific barrier or group of barriers.

Table 5. Generalized comparison of different bulk procurement approaches and the barriers they address.

Barrier	Community-level	Market-segment	Market-wide
Capital Costs	◑	◑	◑
Technology Awareness	◑	◑	●
Building Topology and Regulations	○	●	◑
Customer Demographics and Split Incentive	○	○	○
Product Availability/Market Size	○	◑	●
Workforce Capacity	◑	◑	●

Legend: ● - Substantially addresses barrier, ◑- Partially addresses barrier, ○ - Does not address barrier. *Note, these are generalizations and the degree to which each approach addresses a given barrier will be affected by individual program design.*

Community-level programs are often successful at generating cost reductions and technology awareness on a small-scale. This is typically confined to one neighbourhood/region, as these initiatives rely on local relationships and word-of-mouth to secure participation. Conversely, market-

segment programs target certain building topologies. These initiatives identify a need specific to a particular building segment/type and aim to reduce costs and increase product availability to meet constraints unique to these buildings. Finally, market-wide programs are best suited for generating technology awareness, availability, and adequate workforce capacity on a large-scale. These initiatives demonstrate the size of the market to manufacturers and HVAC professionals, thereby increasing the supply of product and skilled labourers and subsequently, opportunities for cost savings.

Although upfront cost savings are limited, a series of recommended practices should be deployed to ensure that programs capture the full suite of benefits (including cost savings) that may be offered via bulk procurement. Below is a summary of eight key recommendations for structuring bulk procurement or product aggregation initiatives.

Eight Recommendations for Structuring Bulk Procurement Initiatives

In the following sections we discuss each of the eight recommendations in more detail, and connect them to the various barriers facing heat pump adoption in retrofit applications to assess the degree to which bulk procurement strategies may help to mitigate each barrier.

5.1 Equipment Costs

RECOMMENDATION 1: Reduce or mitigate the effects of Canada's long, circuitous heat pump supply chain

Customers or program operators should embark in long-term planning to capture efficiencies along the supply chain and reduce soft costs built into the unit price that manufacturers charge.

Manufacturing and assembly of heat pumps mostly take place overseas, primarily in Asia and Europe. These manufacturing plants are established and located near export hubs which have traditionally dominated the heat pump market. Furthermore, materials and component manufacturing are well-established industries which have refined supply chains and automation processes. One study from the UK determined that component manufacturing has become so refined and developed in absence of the UK heat pump market that it would be near impossible to shift the location of manufacturing for these parts. It concluded that the sourcing of these components would continue to come from these specialized businesses, regardless of surging demand.[10] Heat pump demand in the Canadian market, while growing, remains negligible compared to these established markets throughout the world. Accordingly, Canada is likely too small to provide a mass market transformation as it relates to product and component manufacturing.

One manufacturer interviewed suggested that there is minimal room for price reductions because they are only one link in a very long and circuitous supply chain. Existing bulk procurement initiatives and insights from interviews have noted equipment **savings ranging from 3 – 20% per unit**.[11] The opportunities for heat pump manufacturers to offer price reductions is significantly constrained by a variety of factors before they even receive the product (Figure 5). Additionally, when a product is purchased through an independent distributor, there may be an additional markup not captured here.

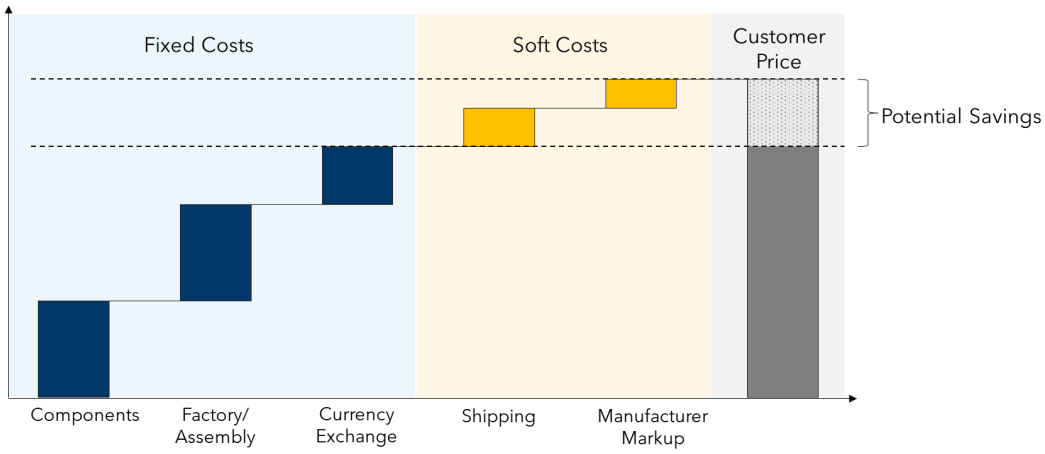

Figure 5. Heat Pump Supply Chain Costs

[10] UK Department for Business, Energy and Industrial Strategy. 2020. Heat Pump Manufacturing Supply Chain Research Project.
[11] WePowr. "HeatSmart Northampton: Pricing Guide". Accessed February 17, 2023.
New York State Association of Conservation Commissions. "HeatSmart Tompkins: Cost, Comfort, Climate: Harnessing the Efficiency of Heat Pumps and Improving Home Energy Performance in Tompkins County". Accessed February 17, 2023.
Clean Energy States Alliance. "Community Campaignsfor Renewable Heating and Cooling Technologies". Accessed February 17, 2023.

SUPPLY CHAIN OVERVIEW

There are six key elements to Canada's heat pump supply chain that are involved in bringing heat pumps to the Canadian market. Understanding each of these components is crucial to capturing efficiencies through bulk procurement in addition to realizing the limitations it poses. Below is a high-level overview of each of the six players making up Canada's heat pump supply chain.

1. Parts Supplier: Entities that source and procure raw materials to create components necessary to build heat pumps including controls, pumps, compressors, etc. They are typically well established and located overseas near key export hubs.

2. Manufacturer: Develops heat pump technologies and purchases sub-components and materials from parts suppliers to assemble heat pumps. Canada predominately receives heat pumps from manufacturers located in or near established heat pump markets in Europe and Asia.

3. Shipping: Companies that transport and deliver the heat pumps from manufacturing facilities to local distributor warehouses.

4. Distributor: Local distribution branches which act as intermediaries between the manufacturing facility and customer who are responsible for supplying heat pumps through local distribution channels. A distributor can be a representative working directly for the manufacturer or an independent business.

5. Retail Sales: This includes big box stores where customers may purchase heat pumps "off the shelf" directly. Depending on the customer, they may choose to purchase directly from a distributor rather than a store. In the case of bulk procurement initiatives, it is likely this link will be excluded.

6. Installers/Contractors: Responsible for overseeing the installation and customer support once equipment has been procured. May also provide equipment through their own distribution channels. These companies are also largely responsible for operations and maintenance of equipment during its warrantied lifetime.

Considering the supply chain constraints, the interviews revealed that reduced shipping costs could offer the most promising upfront cost reduction potential resulting from bulk purchasing. However, given that **cost savings are highly dependent on the scale and nature of each bulk order, it is not possible to define a specific expected cost reduction associated with bulk orders**. The manufacturers and installers interviewed all indicated that order size can influence shipping savings, and that even orders of relatively low volumes (ranging from 15 to 100+ units) could be eligible for some shipping cost reductions. It is difficult to establish what percentage of heat pump costs can be reasonably reduced from shipping because there are a variety of factors influencing shipping costs. This includes heat pump type, location of manufacturing, volume-to-weight ratios and more. The shipping/logistics contributions to the overall price of equipment can range from around 2-12%. One manufacturer indicated that unit pricing for heat pumps directed at commercial buildings (including medium to large MURBs) is directly proportional to sales volume but that this same

dependency did not exist for their residential products. We also heard that large purchases (> $50,000 USD) may translate to significant shipping savings as these orders can be exceptionally shipped direct to Canada from a U.S. warehouse rather than overseas.

On a larger scale, organizations with sizeable building portfolios such as community housing and condominium corporations may reduce equipment costs by committing to long-term purchase planning. To a certain degree, this can lead to cost savings as it helps the manufacturer plan its production schedule efficiently. By analyzing and engaging in long-term portfolio planning a manager may be able to work closely with a manufacturer/distributor to design their installation schedule such that it captures small efficiencies along the supply chain. For example, a community housing corporation with thousands of units may put together a multi-year retrofit strategy wherein they commit to a given number of units over the duration of the strategy. Foresight into this plan can allow factories to streamline component procurement and equipment production in a manner that saves time and money on otherwise fixed costs. These savings would be transferred down the supply chain to the customer, enabling more savings than purchases placed on an as-needed basis. Customers exploring this option should bear in mind that technological advancements enable equipment changes yearly, so this approach should be based on the capacity needs for a building fleet, rather than pre-ordering specific models.

RECOMMENDATION 2: Take advantage of unique marketing opportunities to attract manufacturers

Customers and program operators should highlight unique opportunities that make projects desirable for manufacturers and installers. Demonstrating the benefits that can be gained by participating in a bulk order can help solicit a greater number of bids with competitive pricing.

Multiple interviewees also indicated that there are sometimes unique opportunities for price reductions if the project offers distinct benefits to the manufacturer or installer. For example, a project may generate marketing and media attention if it deploys a new product to market. Manufacturers may offer discounts on the first sales of new/innovative products to showcase the technology or for performance monitoring. The exchange can be mutually beneficial as the customer receives cost savings while the manufacturer receives product (and brand) visibility as well as real-world performance data. The Clean Heat for All initiative by the New York Housing Authority utilized this strategy to attain a greater number of bids on their RFP. As part of their outreach process to manufacturers, they demonstrated the market size by including letters with an expression of interest from other jurisdictions and organizations. It was cited as a key component in attracting multiple manufacturers to their initiative.

5.2 Installation Costs

RECOMMENDATION 3: Streamline as many administrative and logistical barriers as possible

Customers or program operators should endeavour to coordinate all logistical barriers such that they minimally affect the effort required by the installer to complete the job in a timely manner. This can include planning timelines, managing tenants, providing access to units, electrical, and mechanical rooms (as necessary) and more.

Installation costs are typically fixed and not tied to volume, leaving minimal opportunity for cost savings. Overall, the interviewees shared a consensus opinion that the labour to install heat pumps will not change with volume and that there is no economy of scale on worker wages. They noted that every building is unique with a high degree of variability, and installers are often reluctant to agree to cost reductions for bulk install contracts. There are also materials costs (wires, pipes, pipe insulation) required for the installation of each unit, that installers already typically purchase in bulk – leaving minimal to no margins for price reductions.

Although worker labour is not reduced by increasing purchase volume, there are some strategies that may provide small cost reductions when employed. Customers should seek (where possible) to minimize the logistical and administrative burden faced by installers when planning a bulk installation. Buildings with complex ownership structures such as condominiums can present more restrictions and consequently, administrative hurdles to ensure proper regulations are adhered to. Conversely, customers who manage portfolios with a high percentage of rentals can offer some economy of scale as they are typically responsible for operations and maintenance of heating and cooling equipment. With sufficient design and preparation, these building owners can coordinate all logistical aspects including arranging for tenants to leave the premises and providing access to electrical infrastructure or mechanical rooms. The absence of proper planning can result in labour delays and subsequently increased cost of service.

RECOMMENDATION 4: Involve installers in bulk procurement initiatives to avoid warrantee and O&M issues and better understand secondary costs

Eliminate unnecessary costs by working with a singular professional service provider as a one-stop shop for product procurement, installation, and O&M. Installers can still provide savings attributed to equipment costs as would be received elsewhere.

Another element to consider is how and from whom the product is procured. Installers are responsible for both proper installation of the product as well as ongoing operations and maintenance (O&M) during the warrantied lifetime. When product procurement and installation are provided by separate service providers it introduces ambiguity surrounding equipment warranty, and who is responsible. Some interviewees indicated that installers will often only do projects where they provide both the equipment and installation services, to avoid these complications.

Accordingly, bulk procurement initiatives should be developed in cooperation with local installers to avoid potential warranty or O&M issues as well as unintended surcharged installation costs.

Early consultations with installers is also recommended as they can also provide insight into supplementary costs that may become an issue with aging building stocks such as electrical upgrades necessary to properly operate heat pumps. One housing provider noted that two thirds of their portfolio is over 60 years old. As a result, these ancillary costs may prove to be prohibitive for organizations which lack the necessary capital to invest in these upfront expenditures. One strategy which could be employed to help mitigate these expenses is bulk bundling. This is a method wherein building owners "package" groups of buildings which have both excellent and weak business cases in an effort to balance costs. For example, buildings which are in better condition can subsidize the added costs for buildings requiring significant upgrades. This approach is often employed in building energy retrofits, where highly cost-effective upgrades are combined with upgrades with marginal returns to create a retrofit project that maximizes savings while still offering a degree of net bill savings. This method would need to be explored on a case-by-case basis.

5.3 Non-Monetary Barriers

RECOMMENDATION 5: Promote heat pumps to new customer groups by leveraging trusted organizations/partners

Organizations looking to offer or facilitate bulk procurement programs should explore partnerships with groups that have pre-existing relationships with potential customers, or who are trusted voices for promoting the initiative in the community.

There are other non-monetary benefits which may persuade customers to pursue bulk procurement, despite minimal cost savings. Overall, the interviewees indicated that the heat pump market is still not fully mature in the GTHA, and any strategies that can help increase market volume, encourage competition, and create industry efficiencies can help lower prices for heat pumps across the board. Thus, while bulk procurement may not achieve significant cost savings itself, it can contribute to growing demand and market transformation and benefit all customers.

For example, bulk procurement and demand aggregation offer opportunities to increase technology awareness and attract more attention from local media and industry leaders. Large projects can also signal to industry professionals the demand for heat pumps, encouraging them to expand their workforce and complete the necessary training and certifications to access this growing market. This increase in qualified heat pump professionals can support more competitive pricing and improve installation reliability, consistency, and quality.

The interviews suggested that showcasing heat pumps to new demographics, generating both public and private interest can also help grow demand. They recommended including an outreach component in bulk procurement initiatives to help shift public perception of heat pumps and garner interest. Where possible, these projects should leverage trusted providers, including utilities, housing/condominium corporations, local volunteer groups or neighbours, by utilizing their trusted customer networks and relationships. Partnering with these organizations can enable more rapid adoption of heat pumps within large building portfolios. One such example is the Clean Home Heating Initiative offered by Enbridge Gas with funding from the Ontario Government.[12] This pilot initiative supports the installation of electric heat pumps by directing efforts at Enbridge Gas customers and providing incentives of up to $4,500. As the program administrator, Enbridge can leverage its relationship with existing customers to generate demand, as well as support heat pump installations in homes currently using natural gas for heating. While this functions primarily as a rebate program, it demonstrates the opportunity available to capitalize on customers who have pre-existing relationships with large organizations.

[12] Enbridge Gas. "Hybrid Heating: Clean Home Heating Initiative". Accessed February 17, 2023.

RECOMMENDATION 6: Commit to long-term product/supply agreements with manufacturers and installers

Long-term product commitments can reduce supply chain constraints and provide certainty of demand for both manufacturers and installers, guaranteeing product availability and adequate worker capacity.

Manufacturers and installers alike indicated that local heat pump inventory is often quite low, with shipments being made on an as-needed basis. **Significantly increasing local demand and sales volumes can encourage local distributors and retailers to increase stocks.** Given the number of links along the Canadian supply chain, increasing local stocks can help reduce project lead times and avoid supply shortfalls during periods of higher demand, which can cause price rises associated with product scarcity. Similarly, difficulties procuring heat pumps in a timely manner can lead to fragmented workflows for installers who may need to shift to other jobs to retain a consistent workload. This can introduce inefficiencies resulting in added costs. Bulk procurement initiatives with sufficient planning can ensure product availability and shortened lead times, enabling projects to get done in a timely and efficient manner.

RECOMMENDATION 7: Focus the first initiatives on market segments where split incentive does not exist

Bulk procurement does not offer a pathway to eliminating the split incentive between tenants and building owners. To reasonably avoid this barrier, the pilot or the first initiatives should concentrate on market segments where one owner retains responsibility for both HVAC equipment and energy bills to get the model right, and then expand to other more challenging segments.

The split-incentive barrier continues to pose a significant challenge in rental buildings where the building owner may not benefit from the energy savings resulting from heat pump installations. Unfortunately, the interviews did not uncover any bulk procurement strategies that can address this barrier, and instead it was suggested that other policy levers would be more appropriate to encourage heat pump adoption in market rate rental properties. This bulk procurement initiative may be best served by focusing first on market segments where the end customers have both the authority and incentive to adopt a heat pump. An exception to this may be affordable housing providers, who have the specific objective of ensuring affordable access to housing, both in terms of rent and energy costs. Moreover, efforts that can help transform the heat pump market at large, may have spillover benefits for rental housing, or other hard-to-reach market segments, by lowering costs and increasing demand for rental units that are equipped with heat pumps.

RECOMMENDATION 8: Convene a working group of building operators and relevant industry organizations

Building owners/operators are often siloed and forming working groups across various housing market actors can help open dialogue to coordinate actions and identify solutions.

Interviewees generally expressed a willingness to explore market-wide bulk procurement opportunities. Market-wide initiatives can offer the opportunity to bring together a diverse set of actors, explore more expansive bulk procurement, and address other market barriers. For example, affordable housing and condominium corporations across the GTHA may have similar needs which would prove complementary to bulk procurement. However, there are systemic hurdles that exist which limit the opportunity for these organizations to collaborate. Differing governing bodies, funding streams, and mandates serve as a barrier to exploring opportunities related to joint bulk procurement projects.

Additionally, across the board there appear to be some internal hurdles faced by those who are looking to promote or adopt heat pump retrofits. Housing organizations, who own some of the largest building portfolios in the country are often resource constrained, retain 100% occupancy rates, and must always maintain reliability of HVAC equipment. Condominium corporations and utilities which have access to large groups of potential customers may not be able to take title of assets required in a bulk procurement program.

While these challenges are independent of heat pumps, they can affect adoption rates and the viability of bulk procurement initiatives. Working groups offer an opportunity to bring together building owners/operators and key industry representatives with the primary goal of strategizing, designing, and coordinating solutions to alleviate these barriers. Relevant parties can include but are not limited to:

- **The Housing Services Corporation (HSC):** an Ontario based non-profit organization committed to ensuring that residents have access to safe and affordable housing. HSC supports individual housing provider needs and leverages group purchasing to secure competitive rates for services.[13]
- **Low Carbon Cities Canada (LC3):** a partnership between seven local urban centres and the Federation of Canadian Municipalities to help cities achieve emissions reductions goals.[14]
- **Advanced Heat Pump Coalition:** a group of utility and energy efficiency interested parties that share knowledge and align efforts on HVAC industry efforts that help utilities accelerate market adoption of residential heat pumps.[15]
- **Transition Accelerator:** The Transition Accelerator is a pan-Canadian charity that works with groups across the country to direct these disruptions to solve business and social challenges while building viable transition pathways to a net zero future.[16]
- **Provincial and Municipal Governments:** Governments are often a primary source of funding and resources and are responsible for facilitating economic development. Governments can also act as conveners and bring together necessary parties to facilitate communication and progress.

[13] Housing Services Corporation (HSC). Accessed February 21, 2023.
[14] Low Carbon Cities Canada (LC3). Accessed February 21, 2023.
[15] Midwest Energy Efficient Alliance. "Advanced Heat Pump Coalition". Accessed February 21, 2023.
[16] The Transition Accelerator. Accessed February 21, 2023.

6. Conclusion

Findings from this project indicate that upfront cost savings stemming from bulk procurement are modest and primarily associated with shipping discounts associated with securing larger orders. However, beyond monetary savings, bulk procurement offers a range of other benefits which may be beneficial for accelerating heat pump adoption (Table 6).

Table 6. Opportunities and limitations to bulk procurement and aggregation of heat pumps

Opportunities	Limitations
• Some reduced costs, primarily associated with shipping savings • Standardized administrative logistics and costs • Streamlined supply chains and minimized disruptions and supply delays • Increased customer awareness and knowledge • Increased market penetration and attract emerging technologies • Improved local heat pump supplies/inventories by demonstrating demand and market size • Increased demand for local contractor/installer services • Improved local knowledge and skillsets with technology	• Highly variable capital costs on a case-by-case basis, make it hard to determine savings potential • Even in the optimal case, upfront cost savings from bulk procurement appear to be minimal • There is no economy of scale on labour and installers already purchase required materials in bulk, likely eliminating any installation cost savings. • Aggregation does not eliminate peripheral cost barriers associated with retrofits (e.g., electrical panel and control system upgrades)

To maximize success, this report has identified these opportunities and proposes eight practical recommendations which may be used as guidelines for structuring future bulk procurement initiatives. The extent to which bulk procurement can successfully address various barriers and capture the full suite of benefits is likely to depend on the approach, as well as a range of external factors. Organizations looking to facilitate or participate in product aggregation and bulk procurement initiatives should assess their needs early to determine if these initiatives provide enough benefits beyond the counterfactual.

Other Considerations on Bulk Procurement

While this study's findings indicate that there are minimal cost savings associated with heat pump bulk procurement initiatives, it is also important to recognize that there are limited case-studies and examples to draw from. Moreover, the manufacturers interviewed would logically be expected to avoid making promises of cost reductions based on theoretical purchase orders. Considering the other potential benefits offered by bulk procurement, there remains a strong rationale for energy transition leaders to experiment further with bulk procurement of heat pumps to expand the body of evidence and work in more concrete terms with manufacturers to find cost reduction opportunities.

Further testing of bulk procurement strategies could yield the following:

- More solid evidence of the potential cost savings;
- Explore how bulk procurement could address barriers in a specific market (i.e. affordable housing providers);
- Identify opportunities to avoid possible supply chain delays in heat pump provision;
- Establish a relationship with one or more suppliers, and work iteratively to improve the cost savings and efficiency of future bulk procurements;
- Drive demand in the market that can contribute to broader heat pump market transformation, thereby lowering prices across the board.

Thus, while this study can help set reasonable expectations for the potential cost and barrier reducing impacts from bulk procurement of heat pumps, it should be recognized that this is a quickly evolving market, and that bulk procurement models themselves are still being innovated on and refined, which could lead help support deeper cost savings impacts in future initiatives.

Appendix A: Studied Bulk Procurement Initiative Details

Initiative	Description	Progress/Outcomes	Projected Benefits & Learnings
Clean Heat for All Challenge **Who:** Collaboration between 3 NY State Organizations • New York City Housing Authority (NYCHA) • New York State Energy Research and Development Authority (NYSERDA) • New York Power Authority (NYPA)	**What:** The challenge calls upon manufacturers to *develop a packaged cold climate heat pump that can be installed through an existing window opening* to provide heating and cooling on a room-by-room basis. **Level:** Market Segment **Specifics:** • RFP identifies a list of product specifications that manufacturers will be challenged to meet • NYCHA will purchase the first 24,000 units from the awarded vendor(s) to be installed at six developments • NYPA is providing upfront financing and supporting the implementation of the challenge • NYSERDA is providing $13 million for the demonstration phase, including initial purchase, monitoring and performance assessment • NYSERDA will aid drafting the product specifications and performing commissioning as well as measurement & verification for the demonstration units • NYCHA will invest $250 million, to purchase and install the new equipment as well as provide additional improvements to the building envelopes and hot water systems	**Status:** Ongoing • In August 2022, initiative committed $70 million initial investment in the development and production of 30,000 new heat pump units • Midea America was awarded a contract for 20,000 units, Gradient was awarded a contract to manufacture 10,000 units • NYPA awarded the funding through two seven-year contracts to Midea America and Gradient • Over the next year, NYPA will coordinate with Midea and Gradient to develop the proposed heat pump technology for testing and demonstration • NYPA will collaborate with NYCHA to install 60 of the developed units in designated public housing to be monitored and assessed over the course of a winter season • Following testing, they will begin widespread installation of 30,000 units in the following years	• Reduce GHG emissions from its portfolio of public housing to meet state level targets • Development of replicable procurement mechanism for the multifamily sector across the Northeast • Generates interest from housing organizations. Other State level organizations have already confirmed their interest in utilizing the new product for their preservation and new construction pipelines • Increasing perceived market size by regional collaboration. NYCHA and NYSERDA are working with other public housing authorities and housing agencies to generate demand • Increased product availability for niche use cases and fills gap. Small window-unit heat pumps can easily be placed in MURBs • Increases affordability for low-income and other hard to reach demographics • Improved operation and installation from early performance monitoring and optimization

Initiative	Description	Progress/Outcomes	Projected Benefits & Learnings
Clean Heating and Cooling Community Campaigns and HeatSmart (USA) **Who:** Collaboration between New York State Energy Research and Development Authority (NYSERDA) and local community-based organizations and utilities	**What:** Non-profit campaign run by a community-based organization and facilitated by NYSERDA that offers free, expert guidance on installing heat pumps at scale and benefitting from bulk discount prices **Level:** Community Level **Specifics:** • Eases the process of replacing current heating or cooling system by connecting customers with pre-qualified contractors and detailing potential incentives, tax breaks, financing, and payment options • NYSERDA supports community-based organizations across the State to help homeowners and small businesses learn about clean heating and cooling systems • Campaigns are supported by local governments and utilities, and comprised of friends, neighbours, environmental advocates, and technical experts • Work to help understand your goals, navigate incentives and financing programs, and pair you with a prequalified, certified contractor • Campaigns issue an RFP to select a qualified installer. An installer is then selected based on qualifications and experience	**Status:** Ongoing • Participation different for each campaign • 18 different ongoing programs in New York State	• Generates product awareness at the grassroots level by providing no- or low-cost support from experienced, qualified professionals • Maximize uptake by leveraging existing community networks. E.g., early clean energy technology adopters, and active community groups • Develop local network of skilled professionals. E.g., contractors and installers by using an RFP process to procure their services • Reduce costs by capitalizing on wholesale prices as more members of the community participate • Customers received average price reductions of around 20%
Solarize (USA) and Solar Together London **Who:** Solar CrowdSource	**What:** Non-profit, community-based solar PV group-purchasing program for building and homeowners **Level:** Community Level **Specifics:**	**Status:** Ongoing • Participation different for each campaign • 5 ongoing Solarize campaigns • 12 Solarize campaigns total	• Established ease of implementation. Solar CrowdSource has a well-established model and provides guidance on how to run local

Initiative	Description	Progress/Outcomes	Projected Benefits & Learnings
	• Community-led campaign to leverage knowledge, information sharing, and bulk purchasing of rooftop PV • Campaigns are supported by local governments and utilities, and comprised of friends, neighbours, environmental advocates, and technical experts • Opportunity is available for both residential and commercial applications • Campaigns have a limited run to encourage participation. Typical length of a campaign is 3 - 5 months • Campaigns issue an RFP to select a qualified installer. An installer is then selected based on qualifications and experience. Solar CrowdSource helps facilitate the RFP process as part of its services • Once selected, the installer will conduct free site evaluations and quotes for each community member's home or business • Rates and terms are pre-negotiated to provide certainty and incent participation. Tiered pricing (prices go down as more community members sign up)	Summary of impact from all campaigns includes: • 1000+ installations • 7.22MW added solar capacity • 2.71MWh added battery storage • 182,100 tons avoided CO^2e	solarize campaigns, eliminating guesswork • Develop local network of skilled professionals. E.g., contractors and installers by using an RFP process to procure their services • Provides guidance and streamlines administrative burdens associated with applying for tax credits and incentives • Reduce costs by capitalizing on both wholesale product prices and energy rates as more members of the community participate
Project Greenlight **Who:** Vancouver Economic Commission	**What:** An alternative to traditional procurement processes, which uses calls for innovation to solicit proposals from small- and medium-sized businesses that may not regularly track traditional procurement channels. *(Does not include explicit pathway for procurement, but successful projects may lead to large-scale deployment)* **Level:** Market Wide	**Status:** Ongoing • Individual challenges launched in 2021 • There are currently six open/targeted calls	• Expedites technology adoption and innovation by rapidly sourcing, screening, and onboarding solutions • Provides avenue for rapid growth wherein successful campaigns have the potential opportunity to scale across their asset portfolios • Clean tech companies struggle with first client and companies

Initiative	Description	Progress/Outcomes	Projected Benefits & Learnings
	Specifics: • Exists to provide a small, contained space for innovators to showcase a single product at a time. • There is no explicit pathway to procurement in the program • Provides an avenue to for members (enterprises) to advertise their own challenges on one platform which brings innovators to one place • Members currently include municipal governments, transit agencies, and utilities • Opportunity is available for both small- and medium-sized businesses. Applicants must be public or private enterprises located in the Metro Vancouver region • A network which aims to provide the opportunity to pilot and fast-track technological solution with public and private enterprises seeking to solve specific challenges • All calls for innovation are promoted across the network, with the goal of scouting, shortlisting, and connecting members with candidates		were approaching city with unsolicited proposals • Serves as a method to funnel opportunities into one place • Able to meet very niche needs since format allows for targeted requests tailored to specific problem(s) faced by certain businesses/enterprises • Opportunity to test real-world readiness of innovative technologies by working with enterprises with existing problems and needs
EuroAccess – LIFE Clean Energy Transition sub-programme (LIFE-2022-CET-HEATPUMPS) **Who:** LIFE Programme (EU)	**What:** Open call for a proposal to "Accelerate deployment and affordability of heat pumps through collective purchase actions and procurement" **Level:** Market Segment **Specifics:** • €6,000,000 grant for a proposal which will set up and support collective purchase and procurement actions	**Status:** Ongoing • At the closure of the RFP process in November 2022, five proposals were submitted	• This RFP is extremely comprehensive as it requires that proposals tackle many or all of the barriers to widespread heat pump adoption • If successful, this initiative will increase affordability by minimizing up-front equipment costs by capitalizing on wholesale pricing

Initiative	Description	Progress/Outcomes	Projected Benefits & Learnings
	aiming at reducing the product and/or installation prices heat pump products • Focus should be on space and water heating for households but does not preclude non-residential buildings • Outcomes should include the increased deployment of heat pumps through bulk purchase/procurement, and demonstrate effectiveness and replicability for accelerating their deployment and affordability • The proposal must also coordinate calls for interest on the purchase and installation of heat pumps • Other requirements include: • - Ensure building suitability and readiness prior to purchase • - Proper building heating needs and size evaluation • - Quantify the impacts of the project using key performance indicators • - Identify, simplify access to, and seek synergies with relevant financing opportunities • - Undertake other initiatives along the value chain that would lead to lowering the installation price • - Engage in promotional and awareness raising activities		• The campaign also aims to ensure adequate workforce capacity by securing contractor and installation services to support mass adoption • The successful applicant is required to ensure compatibility with and streamline processes for consumers to receive applicable financing opportunities at the national, regional, and local levels- further reducing costs • Additionally, this campaign should heighten awareness and knowledge of heat pump technologies by requiring that the applicant conduct promotional activities
Energy Efficiency Service Limited India – Super-Efficient AC Program (ESEAP) **Who:** Energy Efficiency Services Limited (EESL)	**What:** A 2017 government-led bulk procurement of 100,000 efficient air conditioners from global manufacturers, sold to distribution utilities via an online marketplace **Level:** Market Wide **Specifics:**	**Status:** Closed • The contract for the program was awarded to Panasonic and Godrej for a total of 100,000 units of air conditioners • Panasonic was awarded 60,000 units	• Successfully reduced capital costs associated with efficient AC products as the bulk order and competitive sealed bidding brought down the price of the products • By mandating applicants include the installation and O&M of units, this provided certainty of

Initiative	Description	Progress/Outcomes	Projected Benefits & Learnings
under the Government of India	• ESEAP was launched to collaborate with leaders in the AC industry and to increase the penetration of Super Efficient Air Conditioners (SEACs) in India • The RFP listed several design and performance requirements including AC units of 1.5 TR with a minimum Indian Seasonal Energy Efficiency Ratio (ISEER) of 5.2 primarily for residential and institutional use • The RFP also included requirements which mandated that manufacturers design, manufacture, supply, install, and provide after-sales O&M • Other requirements include: • - Window or split style units • - 1 (+2) year warranty with additional component warranty	• Godrej was awarded 40,000 units and additionally utilized a low-GWP refrigerant (not required by RFP) • In 2019, EESL started to deploy units in retail sector. To do this, EESL developed a dedicated online marketplace website	adequate workforce and skillsets required to service the units in the short-mid term • Despite successful procurement, the lack of public engagement meant that inputs from stakeholders were not properly received and demand for product was adversely affected • Modelled after their successful LED program, the initiative neglected to consider that AC equipment has higher upfront costs, annual maintenance requirement, and increased liability leading to hesitancy in consumer adoption • The RFP was based on mature technology rather than innovative tech. This meant that other bids with more emerging, clean tech such as low GWP refrigerants lost due to higher costs. Future RFPs should include metrics for climate impact to ensure climate goals are met

Appendix B: Interview Guide

A preliminary list of questions was developed and was used as a guide during the semi-structured interviews. It is important to note that these questions are a template/guide but that each interview was tailored to the specific actor and their respective role within the market.

Initiatives Questions

1. Initiative Overview/What is the ongoing or completed initiative for? Product, segment, sector, etc.
2. If the initiative is complete, would you consider it successful?

   Metrics of success: cost savings, mass deployment of technology, consumer satisfaction/support, increased awareness of HPs, GHG reductions?
3. If the initiative is ongoing, how is it progressing? Are you on track to meet your targets?
4. What were the challenges faced throughout the process?

   Probe for: Not enough submissions/proposals? Timelines? Budget? Contractor availability/skillset? Low interest/participation from the community?
5. If any, to what extent did the challenges faced complicate your efforts to successfully complete the project?

   Probe for: How did the outcomes/impacts differ from your expectations at the onset (positively or negatively)
6. What would you do differently (or the same) next time?

Manufacturer Questions

1. How closely is the pricing of a product linked to purchase/market size, if at all?
2. Do you currently have wholesale pricing for suppliers/distributors who place bulk purchases?
   a. Is there a minimum purchase size to take advantage of (or where you would consider offering) wholesale pricing?
   b. What is the typical number of units a distributor would purchase of your product in the GTHA?
3. Have you ever participated in bulk procurement/aggregation initiatives?
   a. If yes, how was the experience?
   b. What were the benefits/challenges if any?
   c. What would you do differently if you were to do it again?
4. If not, would you be willing to participate in a bulk procurement initiative?
   a. What would attract you to participate?

b. What benefits do you think this could offer to you/purchaser?

   Probe for: ideal scale and specific segment (residential/commercial)

5. What are you looking for in potential future bulk procurement opportunities/RFPs? E.g., testing, compliance, certification support? Guaranteed number of purchases? Training or installation support? Guaranteed contracting?
6. What are the barriers/challenges to heat pump bulk procurement initiatives?
   a. Supply chains (COVID notwithstanding), market size, one-size fits all approach/building-specific needs, retrofits (electrical upgrades etc.), safety/performance regulations? Available workforce capacity, market size, one-size fits all approach/building-specific needs?

Installer Questions

1. Can you provide a high-level overview of how you quote pricing?
   a. Are you able to provide firm quotes for your services or do you need to visit each building/home in advance?
2. How closely is the pricing of your services linked to quantity/bulk purchase of installations, if at all?
   a. What are the main metrics for pricing of installation?
   b. Have you ever offered wholesale pricing for large groups/building owners making bulk purchases?
3. Have you ever participated in bulk procurement/aggregation initiatives?
   a. If yes, how was the experience?
   b. What were the benefits/challenges if any?
   c. What would you do differently if you were to do it again?
4. If not, would you be willing to participate in a bulk procurement initiative?
   a. What would attract you to participate?
   b. What benefits do you think this could offer to you/purchaser?

      Probe for: ideal scale and specific segment (residential/commercial)
5. What are you looking for in potential future bulk procurement opportunities/RFPs? E.g., testing, compliance, certification support? Guaranteed number of purchases? Training or installation support? Guaranteed contracting?
6. What are the barriers/challenges to heat pump bulk procurement initiatives?
   a. Supply chains (covid notwithstanding), market size, one-size fits all approach/building-specific needs, retrofits (electrical upgrades etc.), safety/performance regulations? Available workforce capacity, market size, one-size fits all approach/building-specific needs?
7. Do you have any recommendations for structuring or participating in bulk procurement?

Market/Alliance Questions

1. How would you describe the role of your organization?
2. Specifically, to heating and cooling technologies?
3. If you manage buildings (e.g., community housing), do you have authority over heating/cooling equipment?
4. Who supports the costs of maintaining and upgrading equipment at end of life?
5. Have you ever participated/facilitated bulk procurement/aggregation initiatives?
    a. If yes, how was the experience?
    b. What were the benefits/challenges if any?
    c. What would you do differently if you were to do it again?
6. If not, would you be willing to participate in a bulk procurement initiative? Why or why not?
7. What are the barriers/challenges to heat pump bulk procurement initiatives?
    a. Demographics (e.g., renters/low-income), awareness of heat pump technologies, variety of building-specific needs, retrofit costs (electrical upgrades etc.), coordinating with different building owners, coordinating across jurisdictions, regulations etc.
8. Are you aware of other organizations who have undertaken bulk procurement/aggregation initiatives?

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This report was prepared by Dunsky Energy + Climate Advisors, an independent firm focused on the clean energy transition and committed to quality, integrity and unbiased analysis and counsel. Our findings and recommendations are based on the best information available at the time the work was conducted as well as our experts' professional judgment. **Dunsky is proud to stand by our work.**