CITY OF VANCOUVER

ADMINISTRATIVE REPORT

Report Date: April 12, 2019
Contact: Sean Pander
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RTS No.: 12985
VanRIMS No.: 08-2000-20
Meeting Date: April 24, 2019

TO: Standing Committee on City Finance and Services

FROM: General Manager of Planning, Urban Design and Sustainability

SUBJECT: Building Retrofits for Deep Carbon Reductions

RECOMMENDATION

A. THAT Council approve the Deep Emission Building Retrofits Program to support deep carbon reductions in non-City owned buildings as described in this report;

FURTHER THAT Council approve an initial multi-year capital project budget and annual expenditure budget of $1.5 million for the Deep Emission Building Retrofits Program to be added to the 2019-2022 Capital Plan as a new program under Renewable Energy; and

FURTHER THAT Council direct staff to develop an implementation and funding strategy for the overall program including the remaining $3.5 million for future years in advance of the 2020 Capital Budget.

B. THAT Council approve a $2.2 million increase to the existing $1.2 million multi-year capital project budget and existing annual expenditure budget for the 2019 Energy Optimization Program for City-owned building from the 2019-2022 Capital Plan for Facility sustainability and resilience programs.

C. THAT Council approve a grant of $200,000 to the Vancouver Heritage Foundation to renew for the second time the Heritage Energy Retrofit Grant program for owners of heritage and character homes to complete energy efficiency upgrades. The source of funding is the 2019 Planning, Urban Design and Sustainability operating budget.

D. THAT staff develop and report back in 2020 on a Deep Emission Retrofit Strategy for existing buildings to achieve the City's 2030 and 2050 carbon reduction targets.

E. THAT Council renews its request to the Province of British Columbia for amendments to the Vancouver Charter to allow the City to implement a building energy benchmarking program.

Recommendation C requires two-thirds affirmative votes of all Council members per section 206(1) of the Vancouver Charter.

REPORT SUMMARY

The City of Vancouver has declared a Climate Emergency in recognition of the need to take rapid and decisive action to reduce greenhouse gas emissions if we are going to avert runaway climate change. Council via a motion in December 2018 has directed staff to report back with recommendations on how to leverage additional city funding of $5 million on reducing GHG emissions from existing buildings and to accelerate retrofits to achieve the City's 2030 GHG targets. The recommendations in this report are complementary to those in the Climate Emergency Response report (RTS No. 12978).

Currently, the majority of building retrofits are incremental and piecemeal, which results in technology lock-in that does not lead to deep emission reductions. This needs to change to a holistic and long-term approach to achieve the City's targets. 95% of building emissions come from the use of natural gas for space heating and hot water systems. Eliminating these emissions is essential to meeting our 100% renewable energy target and heat pumps powered by low/zero-carbon electricity will be the primary enabling technology. In the short term we need early adopters to replace their furnaces, boilers and hot water tanks with heat pumps through a variety of supportive actions in the next five years, which will build industry capacity, daylight barriers and prepare the market for widespread adoption.

To this end, this report recommends a $5 million program to advance building retrofits in the following areas:

1	**$3.7M**	**Incentives + Pilots**	Targeted Incentives and Heat Pumps Pilot Projects for Detached Homes, Multi-Family and Commercial/Institutional Buildings
2	**$0.6M**	**Implementation Support**	Planning and Implementation Support for Multi-Family Buildings
3	**$0.4M**	**Staffing**	Staffing to Manage and Implement the Program
4	**$0.3M**	**Research**	Research on Barriers and Emerging Solutions

In addition, this report recommends the use of $200,000 from the Sustainability Reserve, within the PDS operating budget, to continue the Heritage Energy Retrofit Grant program with funding to complete energy efficiency upgrades to put heritage and character homes on the path to zero emissions

The report also identifies critical short term actions that will be necessary to meet the City's 2030 and 2050 emission reduction targets for buildings, including implementing an energy benchmarking program, and exploring additional funding mechanisms and financial tools for retrofits.

It is estimated that this total investment of $5 million will leverage another $5 million from the Provincial government and utilities and catalyze greater than $10 million in private sector

investments in deep emission reduction projects for a total of $20 million. By the end of 2022 these projects are targeted to result in 300-500 buildings being retrofitted with heat pumps resulting in approximately 4,500 tCO2e in annual emission reductions and 67,500 tCO2e over the lifetime of the projects. While these initial reductions are modest compared to the magnitude of change required by 2030, they are critical for catalyzing the transition of existing buildings away from fossil fuel based heating and for removing barriers for widespread adoption of new technologies such as heat pumps.

In order to ensure we can achieve our 2030 and 2050 targets in a way that minimizes disruptions while creating economic opportunities, staff have begun to develop a Zero Emission Buildings Retrofit Strategy and will bring it forward for Council approval in 2020. The Strategy will include recommendations regarding continued use of incentives and investments in industry capacity-building to catalyze voluntary adoption of zero emissions space and water heating over the next six years. Further, it will need to include a jobs just-transition roadmap. Ultimately, there will need to be a regulatory structure that requires high efficiency windows, improved insulation, and the installation of zero emissions heating equipment when old inefficient building elements or fossil fuel based heating equipment needs replacing (in the same way higher efficiency furnaces are already required when an old one is replaced).

COUNCIL AUTHORITY/PREVIOUS DECISIONS

March 2005: Council endorsed the Community Climate Change Action Plan to reduce GHG emissions in the community to 6% below 1990 levels by 2012 which included a number of actions aimed at reducing emissions from existing buildings.

July 2011: Council adopted the Greenest City 2020 Action Plan which included the target to reduce energy use and greenhouse gas emissions in existing buildings by 20% below 2007 levels by 2020 and emissions from all sources in Vancouver by 33% over the same time period.

September 2013: Council approved updates to the Vancouver Building By-Law which required energy efficiency improvements as a permit condition for building renovations and directed staff to develop recommendations for Council consideration on energy reporting requirements for larger buildings as part of a Building Retrofit Strategy.

March 2014: Council resolved to seek amendments to the Vancouver Charter to empower the City to require annual reporting of building energy use data for the purpose of benchmarking energy performance.

June 2014: Council approved the Energy Retrofit Strategy for Existing Buildings, with 17 key actions aimed at reducing GHG emissions from existing detached and multifamily housing and also approved a building energy benchmarking program.

June 2015: Launched first Vancouver Heritage Foundation energy retrofit pilot program to provide grants to owners of character homes to complete energy efficiency upgrades.

November 2017: Council approved the Renewable City Action Plan, establishing interim targets of 50% reduction in GHGs and 55% renewable energy by 2030 as a part of the overall strategy to achieve 100% renewable energy before 2050.

December 18, 2018: Council voted unanimously to direct up to $5 million from emerging priorities capital funding as well as utilize existing capital budgets and seek matching senior government funding to pursue building retrofits for deep carbon reductions, including solar hot water and water conservation measures, and that staff report back as early as possible in 2019 and on an ongoing basis with information on building retrofit options, potential funding sources including a local carbon trust, and current capital and operating budgets to improve outcomes in reducing Vancouver's greenhouse gas emissions..

This report provides the staff response to the December 18, 2018, $5 million funding direction.

January 16, 2019: Council approved a motion recognizing climate change as an emergency and directed staff to recommend new actions to further accelerate the reduction of carbon pollution.

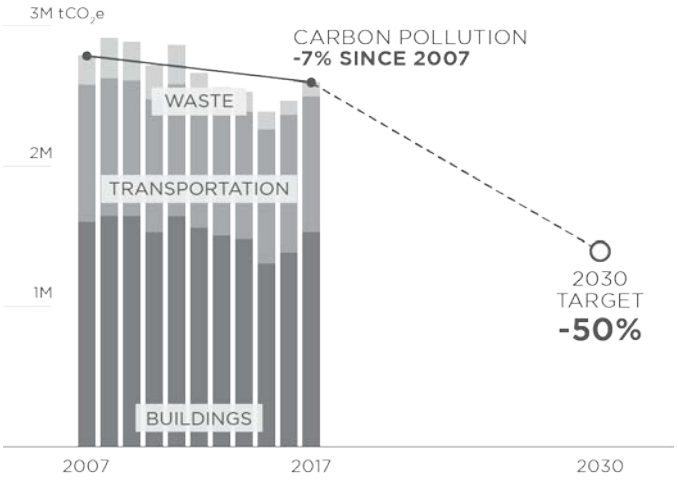
CITY MANAGER'S/GENERAL MANAGER'S COMMENTS

The City Manager recommends approval of the foregoing.

REPORT

Background/Context

In December 2018, as a part of the 2019 Budget approval process, Council directed staff to allocate up to $5 million from emerging priorities capital funding, existing capital budgets and seek matching senior government funding to pursue building retrofits for deep carbon reductions. One month later, Council formally declared a Climate Emergency, which included the direction for staff to report back on new actions to reduce carbon pollution, in particular the need to reduce emissions 50% below 2007 levels by 2030. In 2017 the City had achieved a 7% reduction.



59% of community-wide emissions come from buildings

95% of GHG emissions in buildings come from the combustion of natural gas for space heat and hot water.

46% of 2030 reductions are targeted to come from buildings = 552,000 tCO_2e

In recent years, the City has made significant progress on reducing the emission intensity of new buildings through the Zero Emission Building Plan and associated updates to the Rezoning

Policy and Vancouver Building Bylaw. New buildings built today produce on average 43% less GHGs than those built in 2007.

Since Council approved the Administrative Report, dated June 2, 2014, entitled “Energy Retrofit Strategy for Existing Building” (RTS No. 9983), there have been steady, incremental reductions in emissions from existing buildings through changes to the Vancouver Building Bylaw regarding energy upgrades at time of building permit through City-led as well as energy utility and industry association energy conservation programs. (See the February 7, 2017, Council Report Reference: Update on Energy Retrofits to Existing Buildings, RTS No. 10673). The 2014 Retrofit Strategy focused on collaboration with industry partners to enhance outcomes from energy efficiency programs. This has included the City-led Thermal Imaging and Smart Thermostat pilots, the Green Landlord program in partnership with Landlord BC, supporting the BC Non-Profit Housing Association’s energy retrofit program, the Strata Energy Advisor Program in partnership with Metro Vancouver and the Heritage Energy Retrofit Grant program with Vancouver Heritage Foundation. Despite a population growth of 5% since 2007, buildings emissions have decreased 7% over that same time period. This number has varied yearly depending on the severity of winter conditions and heating demand, highlighting the need for more resilient buildings.

While efforts are proving to be positive, the pace of reductions is clearly not fast enough to meet our 2020 or 2030 reduction targets. In addition, past emission reduction efforts have focused expressly on modest and uncoordinated efficiency improvements to building envelopes or fossil fuel burning equipment such as furnaces and boilers. Achieving deep emission reductions and eventual success in meeting our 100% renewable energy targets requires a more strategic approach to envelope upgrades and the initiation of efforts to transition equipment to renewable energy technologies. Further efforts to replace existing fossil fuel burning heating equipment with slightly more efficient gas technologies only extends our dependence on fossil fuels and pushes the opportunity to transition to renewable energy further into the future. An example that illustrates a typical scenario:

> *The owner of rental apartment building takes advantage of a utility rebate program to replace their old, inefficient gas boiler with a new efficient model. Two years later the owners hire contractors to replace the aging siding, repair the balconies and replace the balcony doors. In the process they do not add insulation and only modestly reduce air leakage. The two projects are carried out independent from one another without consideration of potential synergies. While the new boiler resulted in a reduction in GHG emissions of 20%, there will be no further economic opportunities to reduce emissions for the next 20-25 years (the life of the equipment). Ideally the owner would have planned the projects jointly, scheduling the siding repair first and taking the opportunity to add insulation to reduce the heating demand of the building. With a reduced heating load, the replacement boiler could be downsized and the savings invested in the most efficient model available.*

Funding Context

In 2018, the BC government conducted a soft-launch of the EfficiencyBC program that included, for the first time, incentives to switch from natural gas space heating and hot water equipment to high efficiency electricity (heat pumps).

In December 2018, the BC government released its new climate plan, CleanBC, which includes $58 million for building energy retrofits in addition to the previously announced $1.1B for capital renewal of non-market housing over 10 years. However, our experience indicates that the

provincial incentives will not be adequate to move the market quick enough to achieve our goals – hence our need to top up these incentives.

In March 2019, the federal government released its 2019 budget, which included an investment of $1.01 billion to increase energy efficiency in residential, commercial and multi-unit buildings. These investments will be delivered by the Federation of Canadian Municipalities (FCM) through the Green Municipal Fund and include grants and financing for retrofits and pilot projects, though the details of this funding have not been established yet.

Strategic Analysis

This section of the report includes:
a) an overview of heat pumps and why they are strategically important to meeting the City's targets;
b) global context of heat pump adoption;
c) funding recommendations, including details on incentive programs, pilot projects, implementation support and research needs,
d) accelerated action on energy retrofits for City facilities;
e) a recommendation to extend the Heritage Energy Retrofit Program;
f) the need to develop a Zero Emission Building Retrofit Strategy; and
g) the importance of building energy benchmarking.

a. Heat Pumps are Key to Meeting GHG Targets and Increasing Resilience

Governmental and non-governmental organizations around the world, including the BC government and dozens of other cities with ambitious climate pollution reduction commitments, have recognized that there needs to be a significant shift to electric heat pumps for space heat and hot water. In BC the 95% carbon-free electricity is more expensive than gas, but because heat pumps operate at 200%-800% efficiency – depending on the model, application and outdoor temperature – they use much less energy resulting in comparable overall energy bills.

What is a Heat Pump?
Heat pumps extract heat energy from the air, ground, or even the sewer system (as is the case in the City's Neighbourhood Energy Utility) and use small amounts of electricity to boost its temperature and push it inside to heat a building or the water needed for showers, washing dishes, etc. There are *cold-climate-certified* heat pumps that operate efficiently down to -15C.

In the summer, they work in reverse to provide cooling by moving heat from inside your home to the outside.

Because heat pumps move heat directly, rather than converting energy into heat, they're more efficient than baseboard heaters or furnaces.

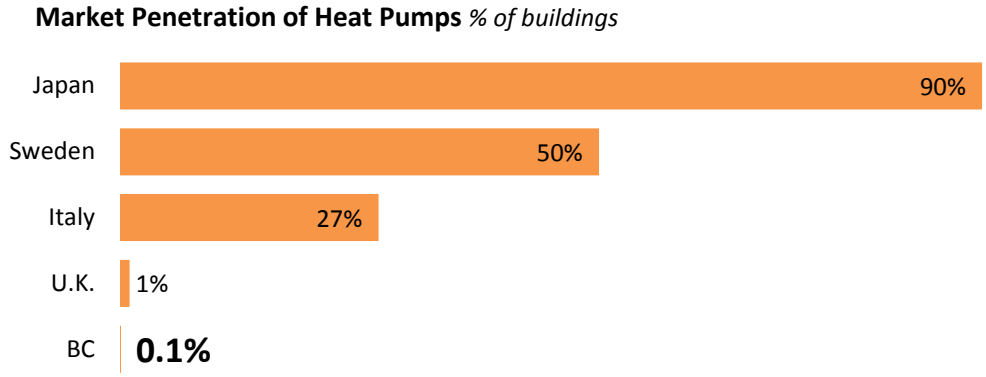
Switching from gas space heating and hot water to heat pumps powered by renewable electricity will achieve a 90%+ reduction in the emissions of a building.
In addition, there are significant co-benefits to heat pumps that make them important for achieving other City objectives, including resilience:

1. Reducing indoor gas combustion improves air quality
2. Removing gas from a building reduces neighbourhood fire risks in the event of earthquake
3. Heat pumps can also provide cooling in the summer which will become increasingly important as summer heatwaves increase with climate change

b. Heat Pump Global Context – Market Penetration, Cost and Enabling Conditions

High energy prices, energy infrastructure costs, stricter efficiency standards, large financial incentives and a greater need for cooling are some of the factors that have led to high penetration of heat pumps in the southeastern US, a number of European countries (e.g.

Sweden, Norway, Finland, France, Austria, Spain, Italy), and in China and Japan. With higher demand for heat pumps and greater competition among manufactures, these markets see equipment costs 10-20% less and installation costs 30-50% less than in countries where heat pumps have low market share, like Canada. The primary reason for lower equipment costs is manufactures and distributors decrease their mark-up to remain competitive. Installation costs decrease significantly as contractors become familiar and skilled with the technology and there is competition. Increasing market share of heat pumps is key for reducing their cost premium. In the U.S., states and utilities that have run the largest incentive programs have seen the lowest average installation costs.



c. Funding Recommendations – Recommendation A

Given this context, staff have developed recommendations for a funding program with four categories of work, described below in more detail.

1	**$3.7M**	**Incentives + Pilots**	Targeted Incentives and Heat Pumps Pilot Projects for Detached Homes, Multi-Family and Commercial Buildings
2	**$0.6M**	**Implementation Support**	Planning and Implementation Support for Multi-Family Buildings
3	**$0.4M**	**Staffing**	Staffing to Manage and Implement the Program
4	**$0.3M**	**Research**	Research on Barriers and Emerging Solutions

1. Targeted Incentives & Pilot Projects: $3.7M

Proposed Action: Staff recommends that the bulk of the funding be allocated to targeted incentives and to pilot projects that will result in improved understanding of the challenges of introducing renewable energy technologies in some building types.

Background:

The Province and energy utilities have considerable experience in energy efficiency incentives and continue to offer these in BC. That said, government incentives for technologies such heat pumps are very new and City funds to complement recently launched provincial and utility offers will help inform optimal incentive levels and strategies. These insights will be critical to increasing the scale of voluntary adoption of these technologies which in turn will lower costs and identify additional barriers to widespread adoption.

EfficiencyBC was expanded to $58 million over three years in the most recent Provincial government budget. With this funding there will be significant expansions of the program in

2019. The City played a significant role in shaping the design of the EfficiencyBC program and incentive areas. The City will leverage the extensive administrative capacity that is being built by the BC government, including BC Hydro and other EfficiencyBC contractors.

Details:
Incentives will be targeted at specific technologies, building sectors and stakeholder groups in order to lower first-costs of deep emission retrofits, raise awareness about heat pumps, build the capacity of industry, pilot technologies in sectors where there are no local examples and leverage senior government and utility investments.

In detached homes, the City will top-up incentives for multiple heat pump space heating technologies, including a bulk purchasing pilot program that will be piloted and a new Certified Heat Pump Installer program will be rolled out by the Province and BC Hydro.

In multi-family buildings, the City will top-up incentives for central heat pumps for space heat and hot water, heat-pump make-up-air units (for corridor ventilation), and heat pumps for individual suites.

In partnership with the Province and industry associations, including the BC Non-Profit Housing Association and Landlord BC, the City will co-fund pilot projects focused on commercially ready technologies with very low or no local adoption in these sectors. Coaching and implementation support will be provided to participating buildings to ensure best practices are followed with regards to tenant engagement and project management and to ensure there is no displacement of tenants. The performance of the installed systems will be monitored and commissioned for one year following installation. The results and lessons learned will be documented through written case studies and used to adjust future incentives and build the capacity of building owners and industry professionals.

For the Commercial/Institutional sector, the City will top-up heat pump incentives for both small and large commercial buildings via the EfficiencyBC Custom and Custom-lite programs and future prescriptive incentives. Large commercial buildings represent the largest GHG emission reduction opportunity in the near-term because of the frequent positive business case associated with capturing and re-using large internal waste-heat loads.

Other renewable energy technologies such as solar photovoltaic and solar hot water may play a complementary role in a transition to electricity based heating systems. Staff will research applications and opportunities for these additional technologies and develop pilot programs to better understand their role in ensuring a cost effective transition away from fossil fuels.

A breakdown of the initial envisioned funding contributions and targeted number of buildings and GHG emission reductions are detailed in Appendix C. These allocations will be adjusted based on update and response.

2. <u>Implementation Support for Multi-Family Buildings:</u> Up to $600k
Proposed Actions:
A) The City provides funding to the BC Non-Profit Housing Association for energy coaches to assist buildings in Vancouver assess, plan and implement heat pump retrofit projects.
B) The City provides funding to Metro Vancouver to Expand the Strata Energy Adviser Program for condos and co-ops in Vancouver.

Background:
Across building tenures in the multi-family sector, owners, managers and residents lack the capacity and technical understand to identify and navigate building energy retrofit options. Without the provision of support, the retrofit incentive dollars will go unspent. The provision of coaching, expert advice and implementation support will be critical to short term adoption of heat pumps.

Details:
The BC Non-Profit Housing Association has a small team of energy advisers funded through the utilities that support non-profit housing societies across BC with walk-though energy audits, energy benchmarking, capital planning, and identifying and implementing energy retrofit projects. The City would co-fund two additional energy adviser positions for three years terms dedicated to buildings located in Vancouver. These positions will be critical to ensuring incentives and capital replacement grants focused on energy will get utilized and for supporting the retrofit pilot projects.

Through the Strata Energy Adviser Pilot Program, 50 condo and co-op buildings in Vancouver are receiving energy audits, coaching and mini-grants for building tune-ups, advanced controls and detailed energy studies. This support is important for building the capacity of owners and strata councils in understanding and implementing energy upgrades in their buildings. The City funding will be used to expand the program beyond its current pilot phase to serve more buildings in the City of Vancouver, specifically focused on accessing the EfficiencyBC and City top-up incentives for heat pumps.

3. Staffing: Up to $400k
Proposed Action: The City funds one new 3-year temporary full-time staff position in Sustainability focused on conducting research to address heat pump technical barriers, working internally to address regulatory and process barriers, and supporting the implementation of the incentive programs and pilot projects.

Background:
The program described in this report represents a significant additional work load for staff. Given the momentum and critical juncture in the implementation of the Zero Emission Building Plan, it would be undesirable to divert Green Buildings staff time from new construction policy development and implementation, thus the request for a new temporary staff position.

4. Research: Up to $300k
Proposed Action: The City co-funds research on retrofit technologies and barriers that are important to inform widespread adoption of heat pumps.

Details:
Over the next three years it will be critical to commission research in the following areas:
- Analysing technologies and retrofit approaches;
- Approaches and opportunities for effective envelope improvements to support the switch from fossil fuels;
- Understanding electrical grid impacts and solutions;
- Collaborating with industry and trade schools to create a skills and jobs transition plan to ensure a just-transition for workers currently trained on fossil fuel based equipment.

d. Civic Facilities – Recommendation B

The City is already demonstrating significant leadership through retrofitting civic buildings to achieve deep reductions in emissions. In 2018, two years in advance of the 2020 target of 20% reduction, the City achieved a 24% reduction in emissions below 2007 levels. This is a 42% reduction from 1990, when the City began tracking emissions from City facilities. This leadership includes creation of the Renewable Energy Strategy for City Owned Buildings and implementation of projects such as retrofitting City Hall with an air-source heat pump to provide space heating and cooling (see Appendix B for case study), ice-rink heat recovery and gas to heat pump retrofits at Kitsilano and Hillcrest community centers, and energy retrofits and control system optimization projects at over 40 other city large owned buildings, that has resulted in the reduction of 7,000 tonnes/yr. CO2e. These upgrades also respond in part to growth pressures on civic facilities.

These retrofit projects set an important example for the private sector and serve as an educational opportunity for the public about low carbon and renewable energy technologies. The City has an opportunity to accelerate the implementation of the Renewable Energy Strategy for City Owned Buildings by advancing the planned 2019-2022 funding for the Energy Optimization Program for City-owned buildings in 2019. In response to the climate emergency declaration and Council direction to increase funding to deliver additional deep carbon building retrofit projects, staff will undertake additional deep emission retrofit reduction projects for City owned buildings in value of $2.2m in 2019, which increases our 2019 budget to $3.4m.

To amplify the impact these projects, the City's Sustainability Department will undertake programmed public education in the buildings that have been retrofitted to highlight the technologies and their benefits to visitors and the community.

e. Heritage Energy Retrofit Grant – Recommendation C

There are approximately 17,000 homes in Vancouver that were constructed prior to 1940. Of these, approximately 10,000 are believed to be owner-occupied and could see significant gains in sustainability made through energy efficiency upgrades. Many of these homes may be considered character homes contributing to the character of their streetscapes and neighborhoods and subject of efforts to encourage retention rather than replacement.

The Heritage Energy Retrofit Grant in its previous pilot and first renewal were quite successful with 49 homes participating or completed to date. The average annual reduction was 3.3 tons of greenhouse gases, with an average expected life of 29 years, for a total reduction per home of 94 tons over the 29 years. Through this program we have learned that the one-on-one guidance is needed to help homeowners reduce greenhouse gases through upgrades that make the most difference and respect recognize the character of the home. We have learned that large reductions are possible with an envelope focus while pointing to the potential of heat pumps. The program has shown, if incentivizing heat pumps, more incentive dollars are needed to address the capital cost difference.

The second renewal of the program would:

- Focus on carbon reduction as well as energy efficiency through the use of heat pumps and envelope upgrades;
- Augment the existing rebates for the highest priority upgrades;
- Encourage measures that are heritage and character sensitive, appropriate for older construction and sympathetic to retaining historic elements in the home; and

- Offer a limited number of homes a full offset of the incremental cost of upgrading to a heat pump and transitioning off of fossil fuel combustion in the home.

(See Appendix A for more details).

f. Zero Emission Building Retrofit Strategy - Recommendation D

Staff has begun work on a deep emission reduction strategy for existing buildings and will bring a report to Council in 2020. This strategy is envisioned to include a description of the barriers and recommendations on:

- Short term actions to address barriers and prepare for mainstream adoption:
  - Incentives, training programs, standards development, partnerships, advocacy
- Industry Skills and Jobs Roadmap:
  - The City will work with industry to co-develop a roadmap focused on addressing barriers and capitalizing on opportunities to transition to low-carbon mechanical equipment in existing buildings, including addressing skills and training needs and coordination between sectors. The Roadmap will be developed as an integrated component of the Retrofit Strategy.
- Grid Infrastructure Analysis
  - The City will work with BC Hydro and the Province to undertake a study to identify options for addressing in-building and grid electrical constraints to heat pump adoption and electrification of transportation. This is important to avoid costly future building and infrastructure upgrades and to ensure smooth adoption of low-carbon technologies. The study will connect research on retrofit pathways for different building types, quantification of grid pressures and identification of potential solutions. It will inform electricity demand management programs, building codes, financial and incentive program structure for different building types.
- Future regulatory structure
  - The regulatory mechanisms and timing by which buildings will upgrade major systems to achieve deep reductions in emissions.

g. Building Data – Recommendation E

A major limitation to the City's efforts to reduce GHG emissions from buildings is the lack of data on building energy use and emissions. Utilities collect data on metered energy use but cannot associate it to detailed building characteristics and do not provide this data to the City. Over a dozen local governments in the United States as well as the Province of Ontario have introduced mandatory building energy benchmarking and reporting for large buildings (typically over 50,000 square feet in size) to address this limitation. Energy benchmarking is the compilation of building characteristics, energy and water use data in a consistent format that enables comparison of performance among similar buildings.

The City already requires that new buildings that are approved through the Green Buildings Policy for Rezonings report on their energy and water use annually, but the City lacks the authority to require reporting and public disclosure of this information for existing buildings. This data is a powerful tool for building managers to optimize performance and reduce energy costs, for government to refine and improve the effectiveness of energy conservation regulations for new building, and to identify existing buildings that would likely benefit the most from energy efficiency improvements and support efforts to engage the owners of these buildings in considering and undertaking voluntary efficiency upgrades.

City staff is currently working with staff from BC Hydro and other local governments in the region to develop a common approach for building energy benchmarking and reporting requirements,

with the goal of launching a voluntary program in the short term. Staff recommend that Council direct staff to renew the City's request to the Provincial government for a change to the Vancouver Charter that will allow the City to transition the voluntary program into a mandatory reporting and disclosure bylaw.

Financial Implications

Deep Emission Building Retrofit Program for non-City owned buildings:
The 2019-2022 Capital Plan did not contemplate the proposed $5 million Building Retrofit Program. The Deep Emission Retrofit Program budget included in this report will provide $1.5 million of initial funding for the program in 2019 using property tax funded pay-as-you-go City contributions re-allocated from the 2019-2022 Capital Plan for Facility sustainability and resilience programs. Funding requests for the remaining years of the program will be brought forward as part of the annual budget process after development of an implementation and funding strategy for the overall program.

The contemplated breakdown of the program and 2019 funding is summarized as follows:

Category	Committed in 2019	Remaining for 2020-2022	Program Total
Targeted Incentives	$700,000	$3,000,000	$3,700,000
Implementation Support	$300,000	$300,000	$600,000
Staffing	$400,000	$0	$400,000
Research	$100,000	$200,000	$300,000
TOTAL	***$1,500,000***	***$3,500,000***	***$5,000,000***

Energy Optimization Program for City-owned buildings:
The proposed $2.2 million acceleration of the planned $3.4m Energy Optimization Program for City-owned buildings included in the 2019-2022 Capital Plan for Facility sustainability and resilience programs will be funded by $700,000 of debenture funding for Renovations of Community and Civic Facilities and $1.5 million of cash community amenity contributions previously received from rezonings with Metro core to be added to the 2019-2022 Capital Plan.

Combined with the initial $1.2 million approved for the Energy Optimization Program as part of the 2019 Capital Budget this will allow the City to advance work on $3.4 million of upgrades to City-owned building during 2019.

Heritage Retrofit Grant Program:
The proposed $200,000 grant to Vancouver Heritage Foundation to support energy efficiency upgrades in heritage buildings will be funded from the 2019 operating budget for Sustainability.

Human Resources/Labour Relations

The proposed funding program includes the creation of one new 3-year temporary full-time staff position in Sustainability.

CONCLUSION

The recent Intergovernmental Panel on Climate Change (IPCC) report and Vancouver's declaration of a Climate Emergency necessitates a significant increase in actions by cities. The allocation of the $5 million will enable the City to accelerate action on reducing city-wide emissions while advancing the key priorities of reducing barriers to heat pumps and deep retrofits, leveraging public and private sector investments, and identifying and implementing retrofit solutions for existing affordable housing. The recommended actions in this report are important first steps the City can take in partnership with senior government, utilities and industry in support of critical near-term voluntary action on deep emission retrofits in buildings, laying the foundation for big shifts in building energy over the next decade.

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ADDITIONAL DETAILS ON HERITAGE ENERGY RETROFIT PROGRAM

If renewed, the Heritage Energy Retrofit Grant program would start in mid-2019 and be open for applications for 24 months or until the target number (likely 40, but may be higher) homes has been achieved. The program will then operate for two to four years while renovations to homes are completed. Grants will be based on energy efficiency improvements identified through an energy audit and implemented by the homeowner payable at a value of up to $150/tonne of the modelled GHG reductions resulting from their interventions to a maximum value of $10,000 for a single grant. These grants would be incremental and co-ordinated with provincial and utility rebates.

Eligibility criteria for the pilot program will be established but key assumptions include:

- The goal is to achieve the most significant reduction possible putting the home on the path to 100% renewable);
- Participating homes will have heritage character value or are listed on the Vancouver Heritage Register;
- Agreement by the homeowner that the test results and utility data, achieved through evaluations by the Certified Energy Advisor before and after the completion of upgrades, will be shared with the City;
- Most upgrades will be subject to the use of a simple calculator tool to make sure the energy upgrade reduces carbon within the cost threshold that the City has deemed acceptable. In addition some upgrades like storm windows and pre- evaluation costs may get a direct incentive.
- Most, if not all homes, which use natural gas or oil for heating will be eligible, however electrically heated homes would not be eligible.

The program has been developed through a partnership of the Sustainability Group with the Heritage Conservation Program and Vancouver Heritage Foundation (VHF). The program takes into consideration complexities associated with the heritage character of many of the buildings participating through the Program. The intent is to improve energy efficiency and climate protection while not unnecessarily diminishing the existing heritage character wherever possible. The VHF has considerable experience in managing and administering grant programs targeted to homeowners through their True Colours and Restore It grants for the past 20 years.

CITY OF VANCOUVER | GREENEST CITY

Phased Heat Pump retrofit as part of City's long term capital planning to achieve zero emissions in all buildings

Vancouver has the goal to derive 100% of its energy from renewable sources by mid-century. As part of this strategy, the City of Vancouver is committed to show leadership and green its own operations and facilities. Accordingly, the City plans to achieve 100% renewable energy and zero emissions in its own facilities by 2040.

Address	453 West 12th, Vancouver
Ownership	City of Vancouver self-managed
Type of building	Institutional
Year of construction	1936
Number of floors	12
Height	323 ft (98 m)
Floor area	152,000 sq ft

CASE STUDY - VANCOUVER

VANCOUVER CITY HALL

RETROFIT MOTIVATIONS

The City plans to achieve 100% renewable energy and zero emissions in its own facilities by 2040. The chosen approach focuses on 3 pillars:

1. build new City-owned facilities to zero emission standards from 2018 onwards
2. upgrade existing facilities to make them more energy efficient and converting natural gas to high-efficiency electric heating
3. connect close-by civic facilities to low carbon Neighbourhood Renewable Energy systems

The City Hall campus is in need of development and expansion due to seismic safety issues and growing service requirements.

The East Wing demolition catalyzed the replacement of the old chiller and cooling tower system with an Air Source Heat Pump. Retrofit projects can sometimes take multiple years. This is also the case here since the City is working on a long-term plan to redevelop a large part of the City Hall grounds.

Aeriel view of the East Wing that was demolished.

PHASED RETROFIT OVERVIEW

Phase	Description	Purpose	Timeline
1	• Planning for East Wing demolition. • Choice of heating & cooling equipment. • Demolition East Wing & construction work. • Heat Pump installation & high-level commissioning. The Heat Pump currently heats the entire building but only in the shoulder season. It was turned off during the winter months.	• High risk of East Wing collapsing in an earthquake. • Existing chiller plant housed in East Wing had to be relocated and replaced. • Opportunity to convert to zero emissions equipment.	2014 – 2017 (completed)
2	• Finish commissioning and adjust temperature set points throughout 2018. • Modify the building piping system on the first four floors to redirect the lower temperature heat from the heat pump to existing low temperature fan coils.	• City Hall building has some high-temperature hydronic distribution equipment that the heat pump cannot supply in very cold weather. • Modify so that heat pump can provide space heating to the lower building part all winter. • Take advantage of full heat pump capacity & further reduce GHG emissions.	2018 – 2019 (planned and budgeted)
3	• Complement the heat pump heating and cooling system with a ventilation strategy customized for each building section. • Install Dedicated Outdoor Air Systems throughout the building. • Install additional heat pump supply and distribution systems in the upper portions of the building.	• By separating ventilation from heating and cooling, ventilation can be optimally controlled and energy use reduced. • Improve temperature and humidity control, enhance comfort. • Maximise energy & GHG emissions savings.	By 2030

PHASE 1 | PROJECT PROCESS

1. 2014-15

The larger East Wing demolition project necessitated building studies, as well as funds from the capital plan and approval from senior management and Council.

Two services, the heating and chilled water systems, were interconnected between the East Wing Annex and the main City Hall Building. The Annex housed a 270 ton chiller plant in the basement and cooling towers on the roof that provided chilled water to both building fan coils. The existing chiller plant was over 13 years old and near the end of its lifecycle and had to be either relocated or replaced in a new location.

2. 2015

Heating & Cooling system option evaluation:

- A helical rotary chiller with a fluid based cooling tower (a like-for-like replacement)
- An air cooled chiller
- An air cooled chiller with a desuperheater
- A heat recovery air source heat pump (ASHP)

3. 2016

The opportunity was identified to take advantage of equipment replacements and renovation for converting to zero emissions equipment. The ASHP option had the same incremental capital cost as adding a desuperheater. Rather than replacing the cooling system with a similar system that would provide cooling only, the decision was made to move to a more energy efficient solution.

4. 2016 – 2017

Demolition of the East Wing building was accomplished at the end of 2016. Construction of a new public plaza and City Hall mechanical room took place in 2017.

5. Fall 2017

Phase 1 of the phased retrofit project was finalized with the installation of the new ASHP equipment. The new heating & cooling ASHP system recycles the waste heat that is generated from cooling, or extracts the heat from the air directly, using it to heat the building and hot water instead of gas boilers.

PHASE 1 | PROJECT STAKEHOLDERS

The collaboration between multiple stakeholders during the consultation, design, and implementation of the first project phase was essential.

Role	Who	Description
Project Manager	City staff	Project oversight; hired and coordinated the consultants and general contractor.
Architect	DA Architects & Planners	Architectural design and co-ordination of other professionals.
Structural Consultant	RJC	Structural design and construction consulting services.
Mechanical Consultant	AME Group	Mechanical design and construction consulting services.
Mechanical Contractor	Alpha Mechanical	Mechanical construction.
General Contractor	Heatherbrae Builders	Project construction and co-ordination of sub trades.
Electrical Consultant	AES Electrical Engineering	Electrical design and construction consulting services.
Commissioning Agent	Western Mechanical Services	Commissioning of mechanical systems.
City Energy Manager	City staff	Set objectives for the project in terms of energy efficiency and GHG reductions; review design to ensure that objectives and budget are met; identify financial sources to cover the incremental cost of the ASHP.
City Facility Mechanical Supervisor	City staff	Design review and commissioning assistance to ensure that systems are easy to maintain.

TECHNICAL DETAILS

The Air Source Heat Recovery unit was chosen for multiple reasons:

1. Thanks to its heat recovery, the high efficiency that the unit provides is even greater compared to a traditional HP. The Total Efficiency Ratio (TER) – the ratio between the total capacity produced simultaneously (heating and cooling) and the electrical power input to the unit – is a maximum of 6.3.

2. The NRP multipurpose unit offers flexibility: It satisfies simultaneously and independently requirements for cooling, heating, and domestic hot water (DHW). It is available in several models with different noise and temperature ratings.

3. The Italian equipment had been successfully implemented in other buildings in the Lower Mainland. The City's energy management team was keen to test the chosen model with a building that they have good control over before implementing it in other City-owned facilities.

Technology	Air Source Heat Pump (ASHP)
Make & Model	Aermec, Model NRP Air Source Heat Recovery Unit
Service provided	Medium temperature space heating & cooling; DHW preheat
Installation Date	October 2017
Refrigerant	Two R410A refrigerant circuits
Operating Limit: max. leaving water temperature	55°C
Operating Limit: external air temperature	-10°C to 42°C
Total Efficiency Ratio (TER)	6.3
Available models	4 pipe system (simultaneous demands for heating & cooling)
	2 pipe system (simultaneous cooling & DHW production)

SYSTEM DESIGN

The unit chosen for the Vancouver City Hall is the four pipe system for simultaneous heating and cooling. The equipment has four different operating modes: it pulls heat from the air or from the cooling loop and sends heat to either the space heating or DHW system; excess heat can be rejected to the air. A DHW preheat tank was installed as part of the retrofit to use waste heat for DHW preheating.

The limitation of the current system design is that the City Hall building has some high-temperature hydronic distribution equipment. During very cold weather, the supply water temperature delivered by the ASHP is too low for the building's high temperature hot water distribution system and gas boilers need to provide back-up heat. This means that the ASHP can currently only provide heating to the building during shoulder season, when temperatures are above freezing.

Aermec ASHP installed at City Hall

ANNUAL SAVINGS (PHASE 1 & 2)

45% GAS

34% GREENHOUSE GASES

PHASE 1 | PROJECT IMPLEMENTATION & INSTALLATION CONSIDERATIONS

Integrating the ASHP with the rest of the building's older mechanical systems was a challenge and careful commissioning was crucial. The commissioning consultant, with the assistance of City facility operations staff, was successful in right-sizing the pumps and commissioning the flow rates to match the design of the existing building. Having the right stakeholders work together effectively was paramount for successfully integrating the new energy efficient system with the existing building.

The ASHP commissioning started in late October 2017. This only allowed a few weeks of operation before the weather turned cold and the boilers had to be started. Commissioning will continue in the spring of 2018 and temperature set points will be adjusted throughout the year as the building systems are modified in the second phase of the project to use the ASHP for heating throughout all seasons.

ASHP installation outside City Hall

ECONOMIC ANALYSIS

Total Installation Costs	**$534,000**
Including additional costs for ASHP (vs. like-for-like replacement)	$138,000

Estimated Annual Savings (Phase I & II)	
$	$20,000*
Gas (GJ)	2,000
Electricity (kWh)	(110,000)
Phase 1 GHG (t CO_2e)	25
Phase 2 GHG (t CO_2e)	75
Phase 3 GHG (t CO_2e)	210

Estimated Annual Savings (Phase I & II)	
Gas (%)	45%
Electricity (%)	(-6%)
GHG (%)	34%

The tender price for the installation of an air cooled chiller, which would have constituted a regular like-for-like replacement, was $396K. An additional $138K was paid for the ASHP equipment and installation, adding DHW preheat, piping, and controls. The equipment's service life is expected to be 15 to 20 years. Maintenance and operating costs are insignificant because the manufacturer will perform important equipment maintenance during the first years. Other routine maintenance will be carried out by City staff.

The first and second phases of the project are estimated to reduce City Hall's annual natural gas consumption by 45% (2,000 GJ). Electricity use is expected to slightly increase by 6% (110,000 kWh).

Combined, this leads to annual energy cost savings of $20,000*. Important drivers of the project were the GHG emission reductions: they are expected to drop by 34% (75t CO_2e annually) after the second phase of the project with much higher reductions being achieved after the final project phase is completed.

Helen Gutteridge Plaza (former East Wing) in front of ASHP

*The City has been purchasing Renewable Natural Gas (RNG) for the City Hall building. Energy cost savings are based on RNG prices. GHG savings are based on natural gas since RNG purchases will be transferred to other City-owned buildings where they will displace natural gas.

NEXT PROJECT PHASES

The end goal of the project is for ASHPs to provide space heating and DHW preheat for the entire building all year long. Only then will the equipment's full GHG emissions reduction potential be reached. Accordingly, two more project phases are planned.

Phase 2: Modify the building piping systems to redirect the lower temperature heat from the ASHP to existing low temperature fan coils so that the equipment can provide heating throughout the winter. The lower four floors of the building will be targeted in this phase. The ASHP's capacity should be able to serve this area. The second phase is expected to be implemented in 2018 – 2019.

Phase 3: Complement the ASHP heating and cooling strategy with a ventilation strategy for the City Hall building, customized for each building section. The building was originally designed for cross-flow ventilation and operable windows but over the years interior walls were put up and spaces subdivided. A mismatch of ventilation and cooling systems were installed which now need to be redesigned.

Outside the new building that houses the ASHP.

The third phase will involve installing Dedicated Outdoor Air Systems (DOAS) throughout the entire building using high-efficiency heat recovery ventilators (HRVs), which will separate the ventilation from the heating system. New ASHP supply and distribution systems will be installed in the upper portions of the building that are not already served by the work completed in the second phase. Either additional ASHPs or variable refrigerant flow systems will be chosen. This phase will require the building to be vacated and for the staff to move to a different location. It will therefore likely only be completed by 2030 during implementation of the broader City Hall campus redevelopment. Final GHG emission reductions are expected to reach 91% (210t CO_2e annually).

USER EXPERIENCE & RECOMMENDATIONS

It is too early for the City's energy and maintenance departments to confirm the equipment's performance until phase II work is completed. The City of Vancouver is leading this project as a pilot for testing the technology before implementing it more widely.

Since the HP retrofit project was part of a larger City Hall demolition and construction project, the energy aspect was not a priority at the beginning. Once the City's energy management department became involved, the opportunity for energy and GHG savings was identified and it became an energy retrofit project.

"It is really important for organisations to make sustainability objectives a priority; otherwise you will never step out of the like-for-like replacement cycles. The more efficient option will usually involve higher capital costs and be more complicated to implement. But projects like this will pay off financially in the long run, and help the City achieve its aggressive GHG reduction targets."

–Craig Edwards, City Energy Manager

APPLICABILITY

- Systems like the Aermec NRP multipurpose ASHP can be a good choice for applications that have simultaneous and independent requirements for heating and cooling. Many buildings in the commercial, hotel, and health care sectors have heating and cooling demands not directly linked with seasonal variations. This creates the need to provide simultaneous and independent chilled water for space cooling and dehumidification and hot water for space heating and/or for the production of DHW.

- ASHPs can be widely applied to different building types to provide space heating and cooling. At 10°C, the Total Efficiency Ratio (TER) of the Aermec NRP series is a maximum of 6.3. This means that 6.3 kilowatt hours (kWh) of heat and cooling are transferred for every kWh of electricity supplied to the heat pump. The TER decreases with temperature because it is more difficult to extract heat from cooler air. The local mild climate makes the Lower Mainland an ideal geographic area for ASHP application.

LIMITATIONS

This type of equipment has a number of limitations that need to be considered depending on site and building specificities:

- Sufficient outdoor space is required which can sometimes be difficult in retrofit applications. In particular, ASHPs require outside air to operate and should not be completely enclosed.
- The colder it gets outside the less efficient ASHPs get, declining rapidly from 1°C. ASHP technologies differ in minimum outdoor air temperatures at which they can operate, but generally fall in the range of -10°C to -20°C, so specific equipment selection is important. Depending on building envelope and HVAC equipment design, partial or full backup heating systems may be required for the coldest days of the year.
- Equipment and installation costs for ASHPs are higher than for natural gas boilers. Due to current low gas prices and comparably higher electricity prices, paybacks can be long, especially in comparison to gas-fired chillers or boilers. To mitigate this, heat pump retrofits should be planned when the existing heating equipment has reached the end of its lifetime and needs replacement, so that only incremental costs need to be taken into consideration.
- In buildings that do not have cooling systems prior to the retrofit, the introduction of summer cooling loads will reduce energy savings, but can be a highly desirable co-benefit for occupants – and in some cases could be the primary motivation for installing an ASHP.
- Although today's ASHPs are significantly quieter than previous generations, the noise generated by the fans can still be an issue and the placement of the heat pump therefore needs to be carefully considered.

FOR MORE INFORMATION, PLEASE CONTACT:

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PROPOSED INCENTIVE DETAILS

A breakdown of the initial envisioned funding contributions and targeted number of buildings and GHG emission reductions are detailed in the table below. These allocations will be adjusted based on incentive uptake and response.

Incentive Details

					Targets		
	Measure	BC/Utility $	+ City $	+ Private $	2019-2022 Vancouver Buildings	GHGs Reduced per Building (Annual tCO2e)	Total GHGs (Annual tCO2e)
Detached Homes	Space Heat – Heat Pumps (ductless + ducted)	$1,200-$3,000	$4,000	$5,000	50-350	5	250-1750
	Hot Water – Heat Pumps	$1,000	$2,000	$3,000	60-250	1	60-250
Multi-Family	Make-up-Air – Heat Pumps	$10,000	$20,000	$110,000	10-40	15	150-600
	Hot Water – Heat Pumps	$30,000	$30,000	$80,000	5-25	50	250-1250
	Space Heat –Heat Pumps (ductless *per suite)	$1,000	$2,000	$3,000	100-500*	1	100-500
	Demonstration Projects	$100,000	$100,000	$0	6	60	360
Commercial Institutional	Large Buildings (Heat Pumps + efficiency)	$80,000	$25,000	$400,000	4-25	100	400-2500
	Small Buildings (Heat Pumps + efficiency)	$15,000	$15,000	$80,000	5-30	20	100-600
	Implementation Support, Research, Staffing		$1.3 M				
	TOTAL:	**$3-5 M**	**$5 M**	**$10 M**	**300-500**		**~4,500**