Net-Zero Energy Emissions Study and Pilot

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Sustainability & Asset Management
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Agenda

- **Part 1: Introduction to Net-Zero Energy Emissions (NZEE)**
  - Canadian environmental landscape scan
  - Relationship between energy and GHG emissions
  - Types of Green Buildings and how to retrofit to lower-carbon

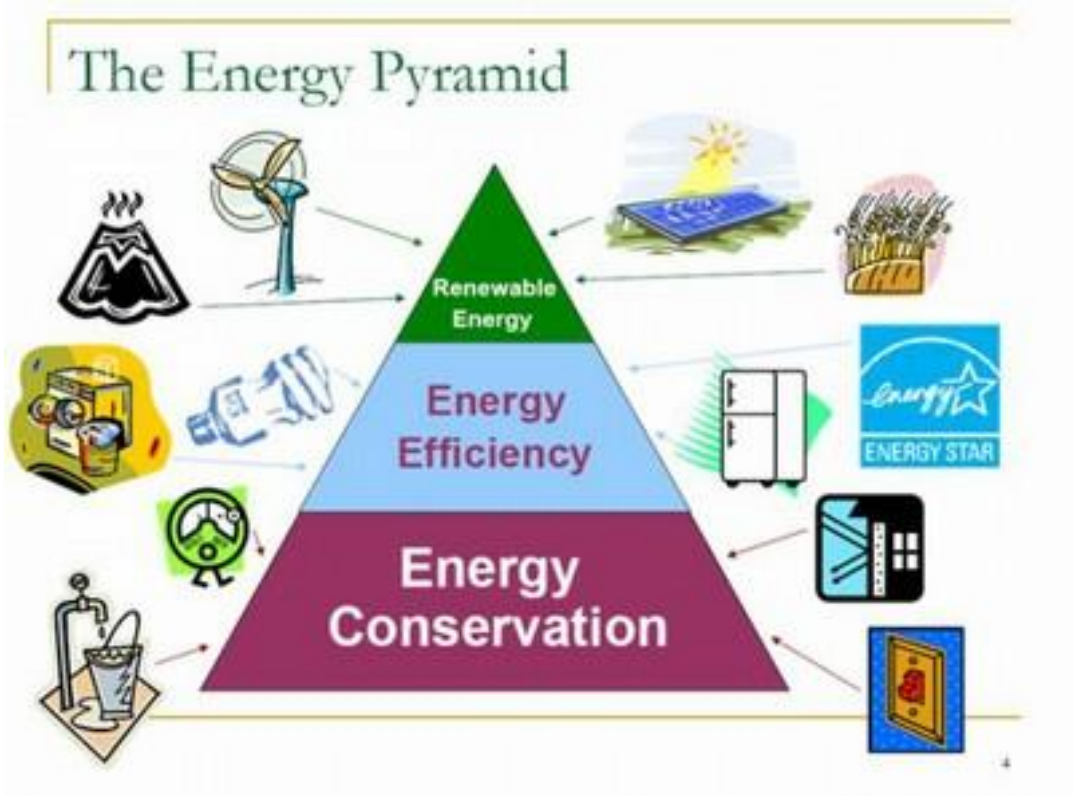
- **Part 2: Markham's NZEE Study and Pilot**
  - Pilot purpose, goals and objectives
  - How property type and specific buildings were selected
  - Major milestone timeline

Markham's NZEE Study & Pilot Project

Pilot Purpose

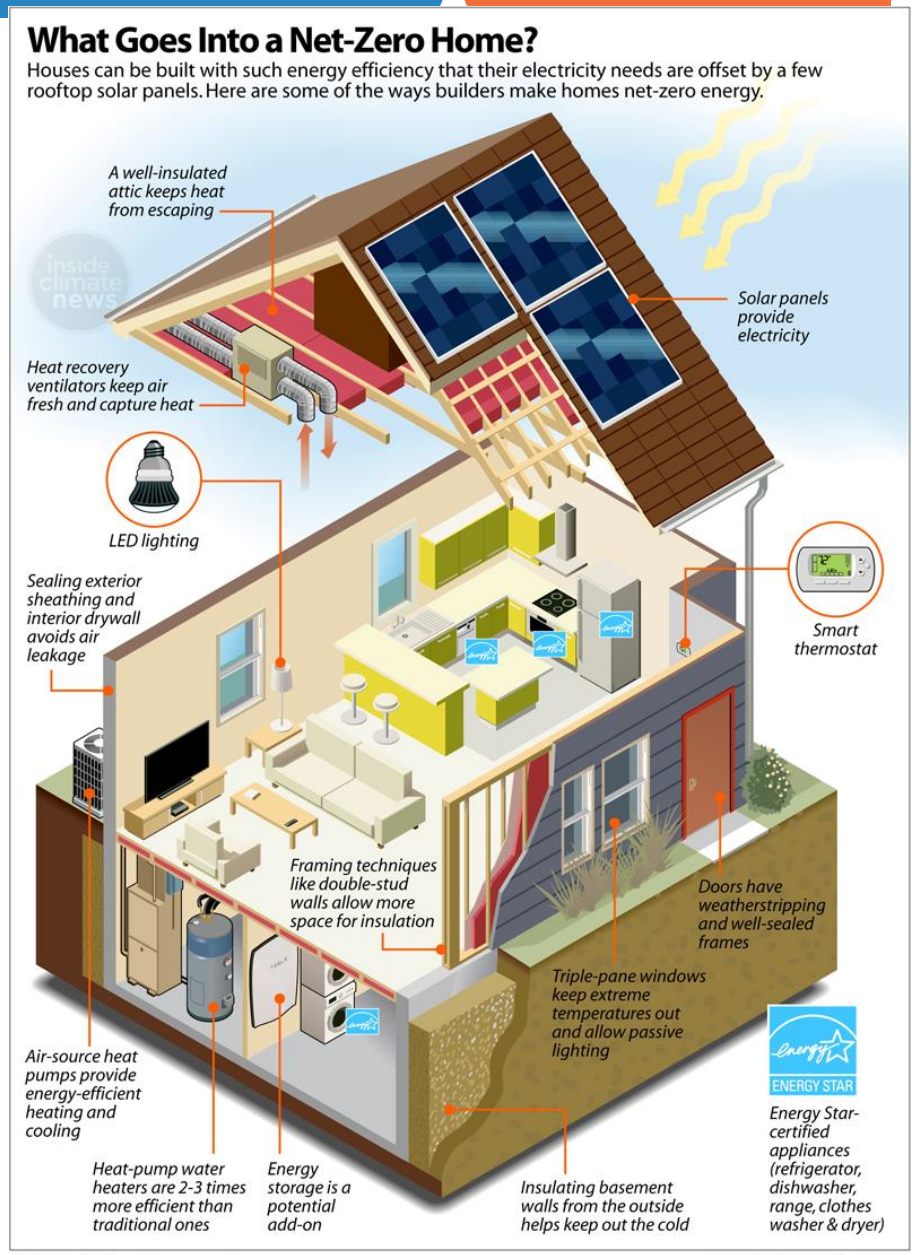
Study, research, and design an archetypal model and retrofit framework that will create pathways for facilities to achieve Net-Zero Energy Emissions (NZEE) via:

- energy conservation,
- energy efficiency (including electrification and heat recovery),
- on-site renewable energy, and
- purchasing local renewable energy credits



Pilot Objectives

- **Retrofit (and construct) buildings to NZEE** (environmental)
- **Reduce utility bills, maintenance costs, and mitigate capital costs** (economic)
- **Improve building quality, comfort, health and resilience** (social)
- **Increase internal communication, awareness, and capacity**
- **Support sector transformation**



Project Scope

Phase I (Completed in November – February 2021)

1. Review, analyze, and benchmark historic energy and GHG data for each property type
2. Select one type of building to prototype
3. Identify and recommend building candidates
4. Present results, build awareness, and generate buy-in and support for this project

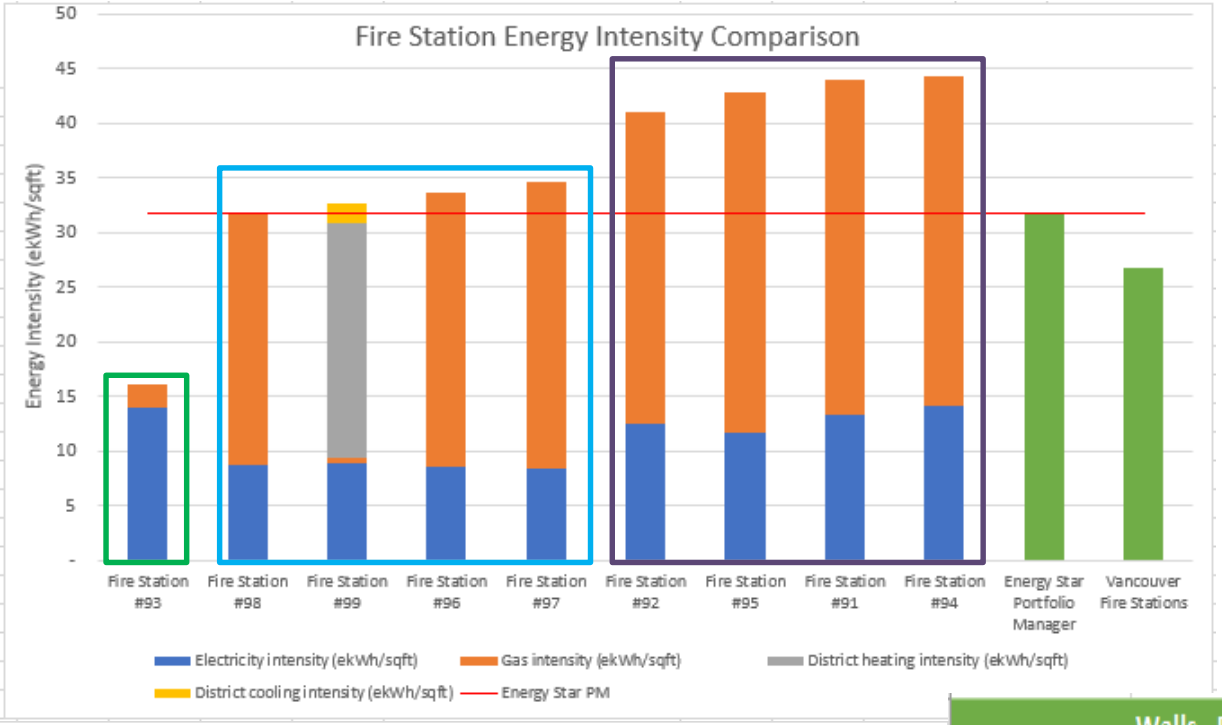
Overview of Facility Selection Criteria

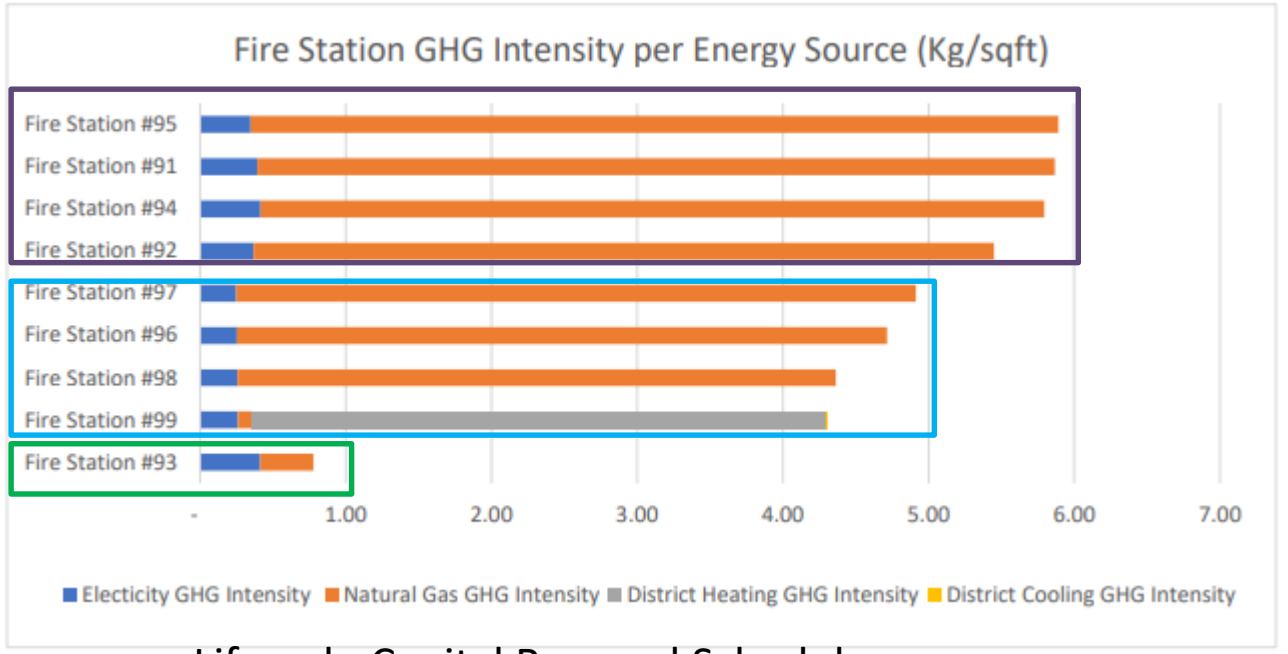
Criteria	Sub-Criteria	Description
Baseline energy-efficiency and GHGs	Baseline energy-efficiency	Relatively similar energy end-use breakdown, load profiles, and narrow energy-efficiency performance range (energy intensity in ekWh/sqft)
	Baseline GHG-efficiency	Relatively similar energy end-use breakdowns, GHG profiles, and narrow GHG-efficiency performance range (GHG intensity in Kg/sqft)
Operational & Implementation considerations	Within budget	Energy & GHG audit costs typically increase as building size increases. Smaller facilities are typically less expensive to audit relative to larger facilities
	Unique Property Type	Study and model how to migrate a class of properties and systems towards NZE
	Operational during study period	Is (or will) the facility be operational during the study period
	Staff availability	Are staff available to participate in a site visit and answer study questions
	Impact to service	Impacts to level of service during energy improvement renovations
	Ability to modify facility	Heritage facilities pose additional challenges due to limitations with modifying the characteristics (aesthetics) of the facility and property.
Data Availability	Hourly interval data	At least 3 years of hourly electricity and/or natural gas data
	3 years of utility data	Separately metered facility with at least 3 years of complete utility bill data
	Complete drawing set and LC	Complete drawing set available and capital planning in Lifecycle database
Capital renewal schedule	Major capital projects	Major equipment renewals with less than 1/3rd equipment life remaining
	Capital renewals that could incorporate heat-recovery	Is there an existing heat recovery system or could we add one via Lifecycle within next 5 to 10 years (geothermal, heat pumps, HRVs, ERVs)
	Type of space heating systems	Electric, natural gas fired, hydronic or radiant heating
Renewable energy	Existing systems installed or feasibility studies completed	Renewable energy generating potential

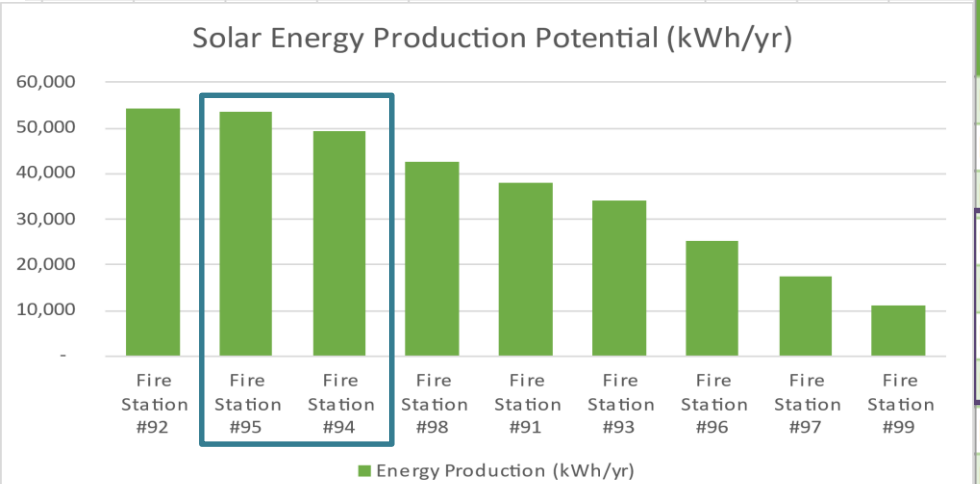
Fire Stations are the best type of building for NZEE Pilot!

- Largest portfolio of closely related buildings with most comparable building characteristics, and energy & GHG data (will produce the most accurate and reliable models)
- Highest portfolio percentage of Level 1 energy audits completed (55%) for that property type within the last 5 years
- Best budget choice due to size and common and overlapping building characteristics
- Service considered "essential" and is the only property type with all buildings occupied and fully operational during COVID-19 pandemic
- Only property type where all facilities have benefited from preliminary solar PV studies
- Leading by example with a fire station NZEE retrofit roadmap will strongly support sector transformation and increased building resilience in Markham's community

Fire Stations were selected based on energy/GHG intensity, Capital renewal schedule, and renewable energy potential







Lifecycle Capital Renewal Schedule

Building Name	Walls - Brick (< 17 yr)	Walls - Siding (<10 yr)	Windows (< 10 yr)	Doors (<9 yr)	Space heating (<7 yr)	Space cooling (<7yr)	Water heating (<7 yr)	Roof (<9 yr)	Total
Fire Station #91	!		✓	✗	✓	✗	!	✓	4
Fire Station #92	✗	✗	!	✓	✓	✓	✓	✓	5.5
Fire Station #93	✗		✗	✗	✓	!	!	✗	2
Fire Station #94	✓	✓	✓	!	✓	✓	✓	✗	6.5
Fire Station #95	✓	✓	✓	✓	✓	✓	✓	!	7.5
Fire Station #96	✗	✓	✓	!	!	✓	✓	✓	6
Fire Station #97	✓		✓	✓	✓	✓	✗	!	5.5
Fire Station #98	✗	✗	✗	✓	✓	✓	✓	!	4.5
Fire Station #99	✗		✗	✗	✓	✗	✗	✗	1

Best fire station candidates to participate in pilot study

- Fire Station 93 – most energy & GHG efficient, GSHP
- Fire Station 94 – "typical" inefficient fire station, major equipment due for replacement, high solar potential
- Fire Station 95– "typical" inefficient fire station, major equipment due for replacement, high solar potential
- Fire Station 97 – "typical" median efficient fire station, moderate equipment replacement

Project Scope

Phase II

1. Solicit services from a consultant to complete the recommendations from the report per RFP Scope:
    a. Create a baseline and NZEE archetypal models
    b. Contrast and recommend design standards/certifications
    c. Set performance metrics
    d. Complete energy audits and net-zero studies at each pilot facility
    e. Identify cost-effective solutions
    f. Develop a modular net-zero retrofit framework, design, tender spec/language, and analysis tools (financial, energy, GHG)
    g. Create customized net-zero retrofit roadmaps
    h. Facilitate stakeholder engagement and capacity building including a report & presentation to Council
2. Review retrofit options and select preferred roadmap to achieve NZEE for each facility
3. Discussion and/or policy on how to address the incremental capital cost
    a. Review potential to apply for grant funds to offset the incremental cost

Next Steps

Action Item	Timeline
Present and verify content, assumptions, and recommendations in this report	December 2020
Select facilities to participate in pilot study	December 2020 – February 2021
RFP Scope Research & Development Present and receive consensus from team on scope and approach	January – February 2021
Solicit and award services for an external consultant to complete the recommendations in the report per RFP Scope	March– April 2021
Study Period - complete deliverables outlined in RFP Scope	May – November 2021
Review retrofit options and select preferred pathways to NZEE	December 2021 – January 2022
Discussion and/or policy on how to address the incremental capital cost - Review and apply for grant funding (if available)	January - May 2022
Design & retrofit pilot facilities to NZEE	2023-2031


THANK YOU FOR LISTENING
QUESTIONS?
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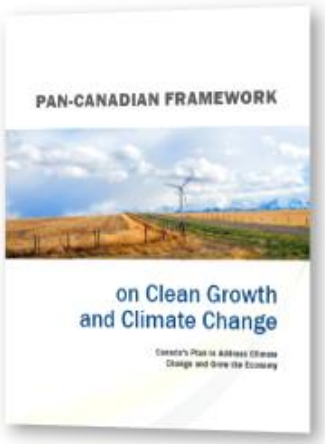
Support Slides

Strong climate change commitment across Canada

Federal

Municipal

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE



>500 municipalities declared a Climate Emergency

Strong climate change commitment across Canada

Federal

2030

Goal: Reduce GHGs by 30% below 2005 levels by 2030

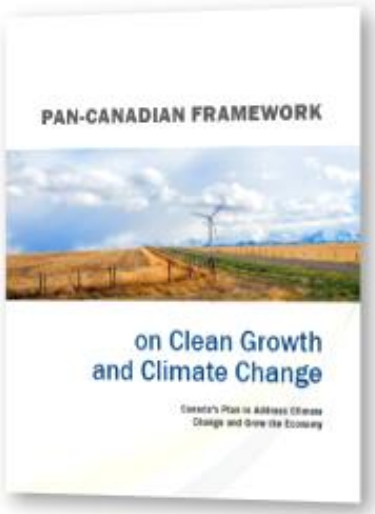
- Phase out coal-fired electricity generation
- Add more stringent regulations to natural gas-fired electricity generation
- $15B toward climate initiatives
- “Net-Zero Energy Ready” model building codes
- Model energy building codes for existing buildings (by 2022)

2050

Goal: Net-Zero GHG emissions by 2050

- 100% of electricity generated by low-carbon sources

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE

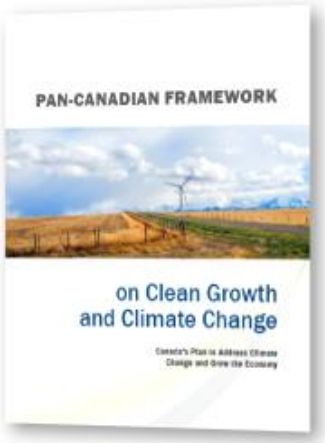


Strong climate change commitment across Canada

2050
Goal: Net-Zero Energy Emissions across all sectors in Markham's community by 2050

Municipal

COP21 · CMP11
PARIS 2015
UN CLIMATE CHANGE CONFERENCE



>500 municipalities declared a Climate Emergency

Federal Carbon Pricing – Increasing to $170/tonne by 2030

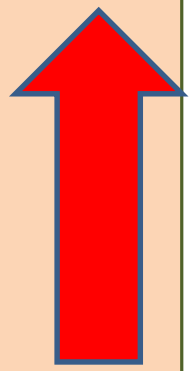
Year	Carbon Pricing $/tonne	Natural Gas $/m3 Effective	Electricity $/kWh Effective	Gasoline $/L Effective
2017	$ -	$ 0.26	$ 0.140	$ 1.00
2018	$ 10.00	$ 0.28	$ 0.140	$ 1.02
2019	$ 20.00	$ 0.30	$ 0.141	$ 1.05
2020	$ 30.00	$ 0.32	$ 0.141	$ 1.07
2021	$ 40.00	$ 0.34	$ 0.142	$ 1.09
2022	$ 50.00	$ 0.35	$ 0.142	$ 1.12
2023	$ 65.00	$ 0.38	$ 0.143	$ 1.15
2024	$ 80.00	$ 0.41	$ 0.143	$ 1.19
2025	$ 95.00	$ 0.44	$ 0.144	$ 1.22
2026	$ 110.00	$ 0.47	$ 0.145	$ 1.25
2027	$ 125.00	$ 0.50	$ 0.145	$ 1.29
2028	$ 140.00	$ 0.53	$ 0.146	$ 1.32
2029	$ 155.00	$ 0.55	$ 0.147	$ 1.36
2030	**$ 170.00**	**$ 0.58**	**$ 0.147**	**$ 1.39**

<u>Rate Increase</u>

Natural Gas – 124%

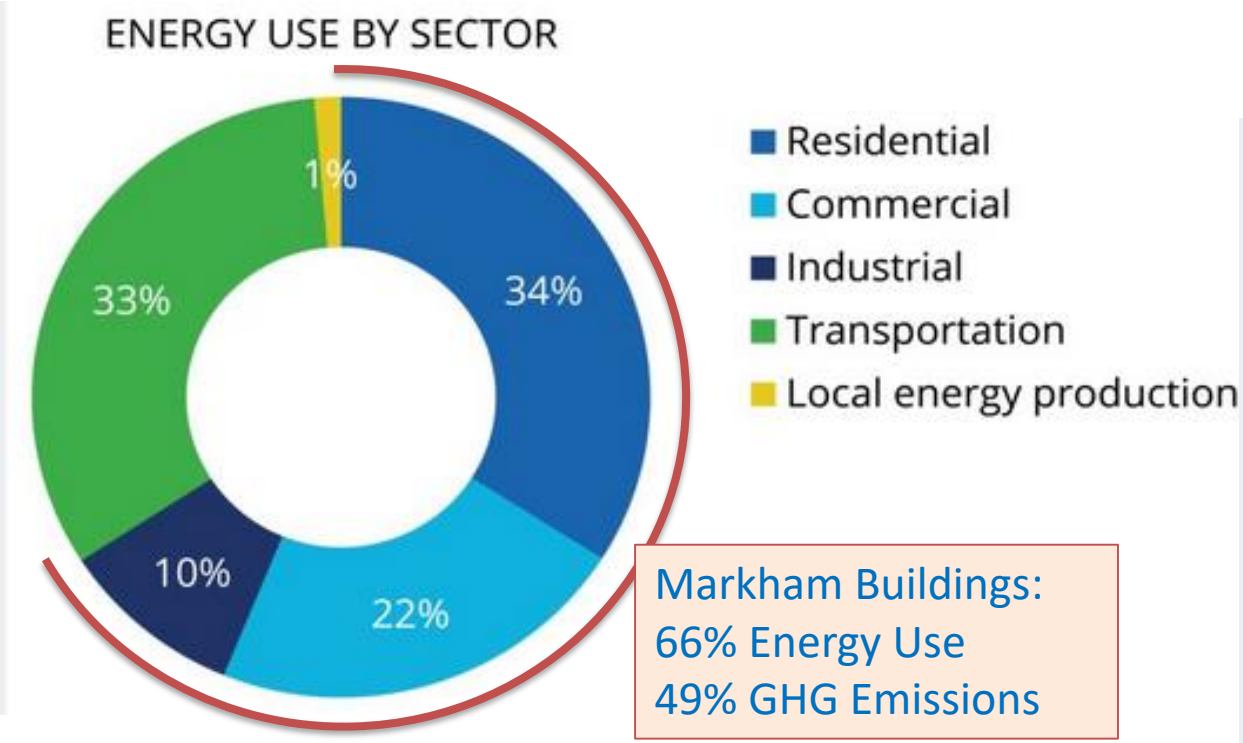
Electricity – 5%

Gasoline – 39%



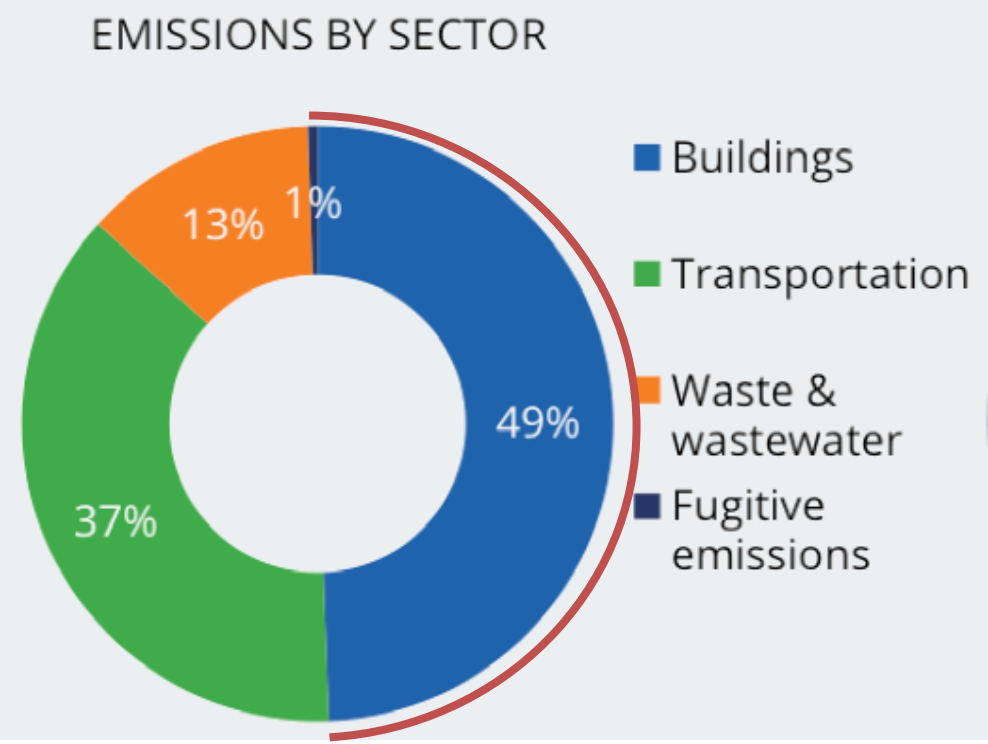
Buildings represent a significant portion of local and national GHG emissions

Markham's Community Energy & GHG Emissions by Sector



Markham Buildings:
66% Energy Use
49% GHG Emissions

Source: Markham's MEP "Getting to Zero"

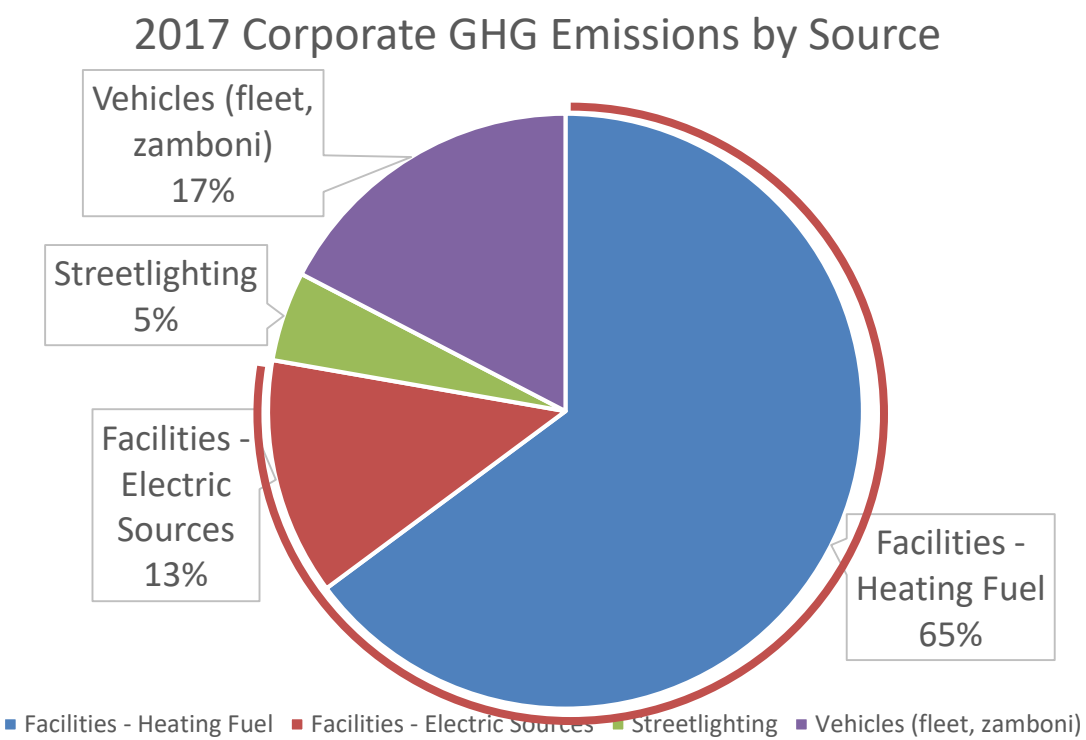


Source: Markham's MEP "Getting to Zero"

"Over 50% of existing buildings will still be in operation in 2050"

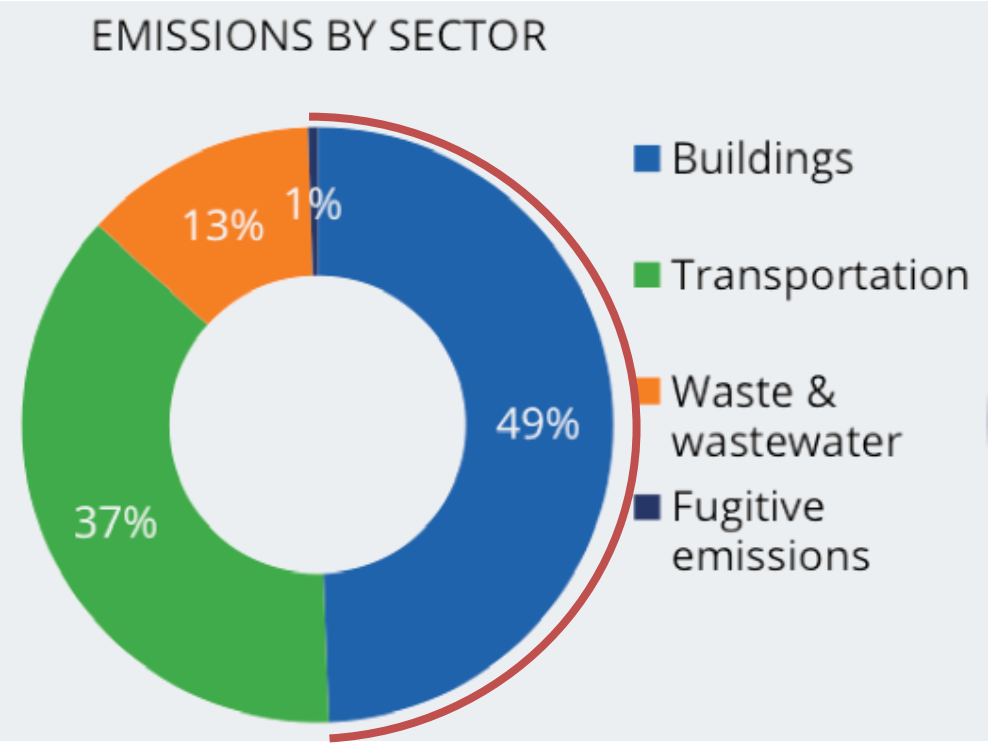
Buildings represent a significant portion of local and national GHG emissions

Markham's Corporate GHG Emissions by Sector



Source: Markham's 2019 Corporate Energy Management Plan (CEMP)

Markham's Community GHG Emissions by Sector

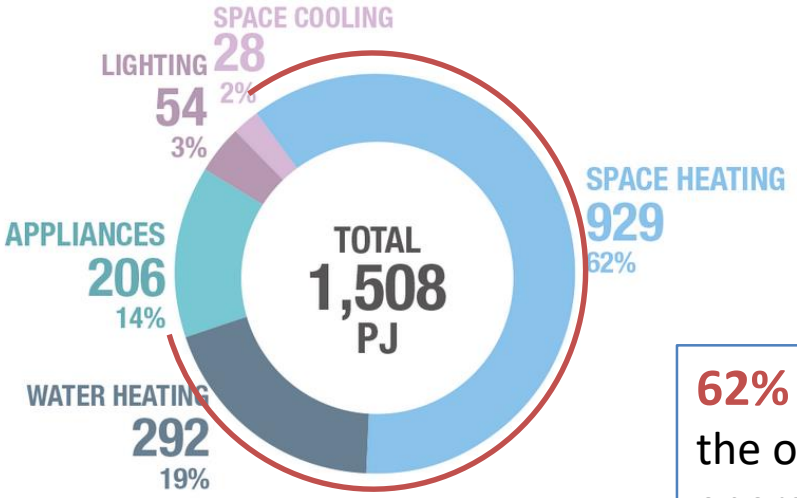


Source: Markham's MEP "Getting to Zero"

"Over 50% of existing buildings will still be in operation in 2050"

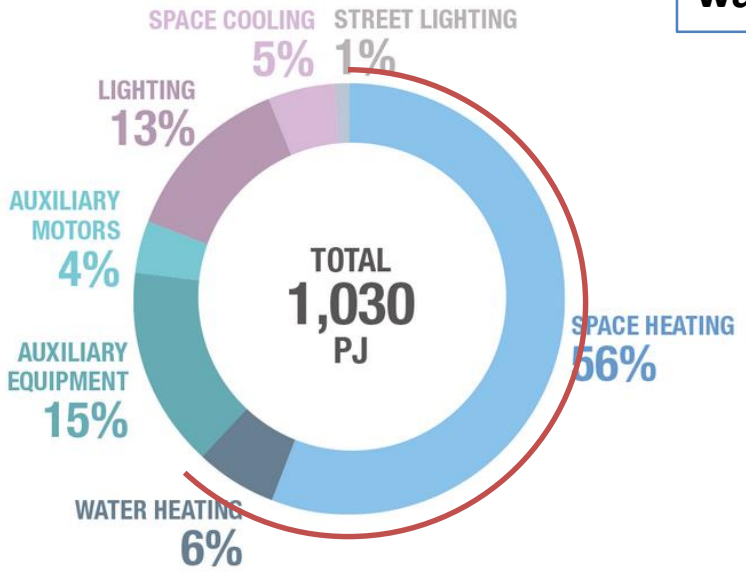
Focusing on space and water heating will improve energy-efficiency and reduce GHGs

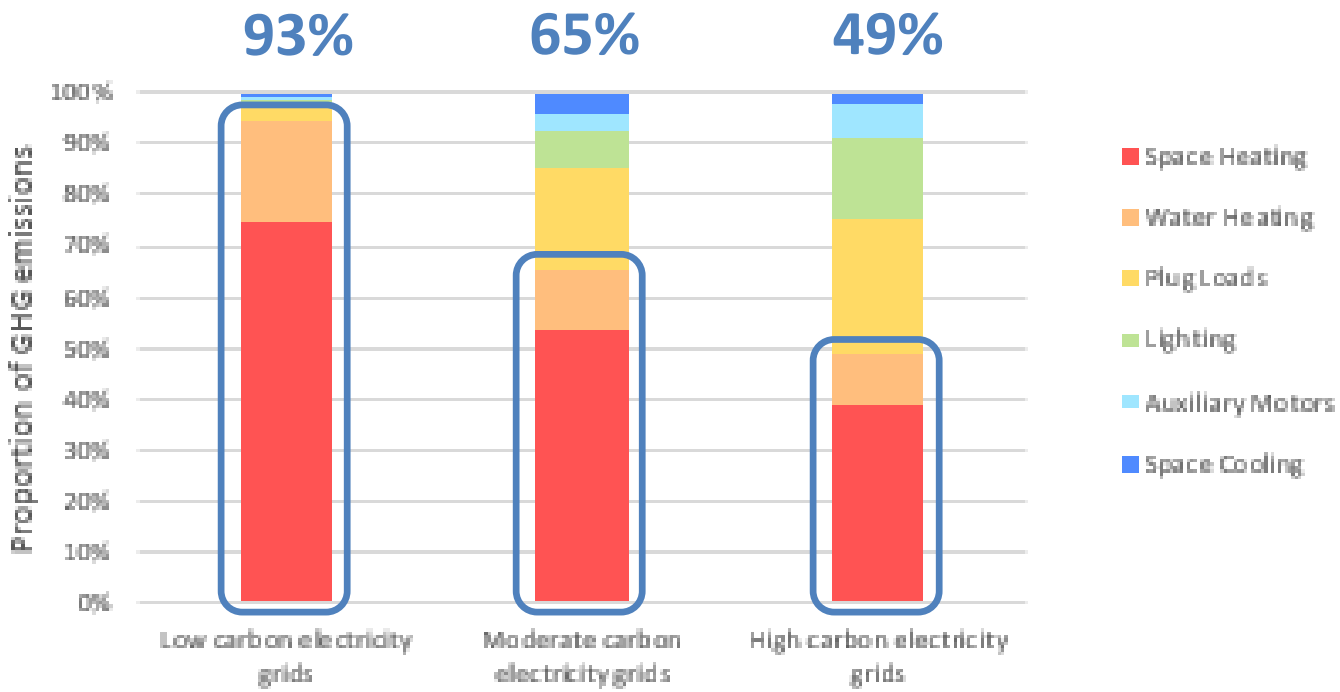
Residential Energy Use by End Use, 2017



62% - 81% of the overall energy is used for **space and water heating**

Commercial Energy Use by End Use, 2017



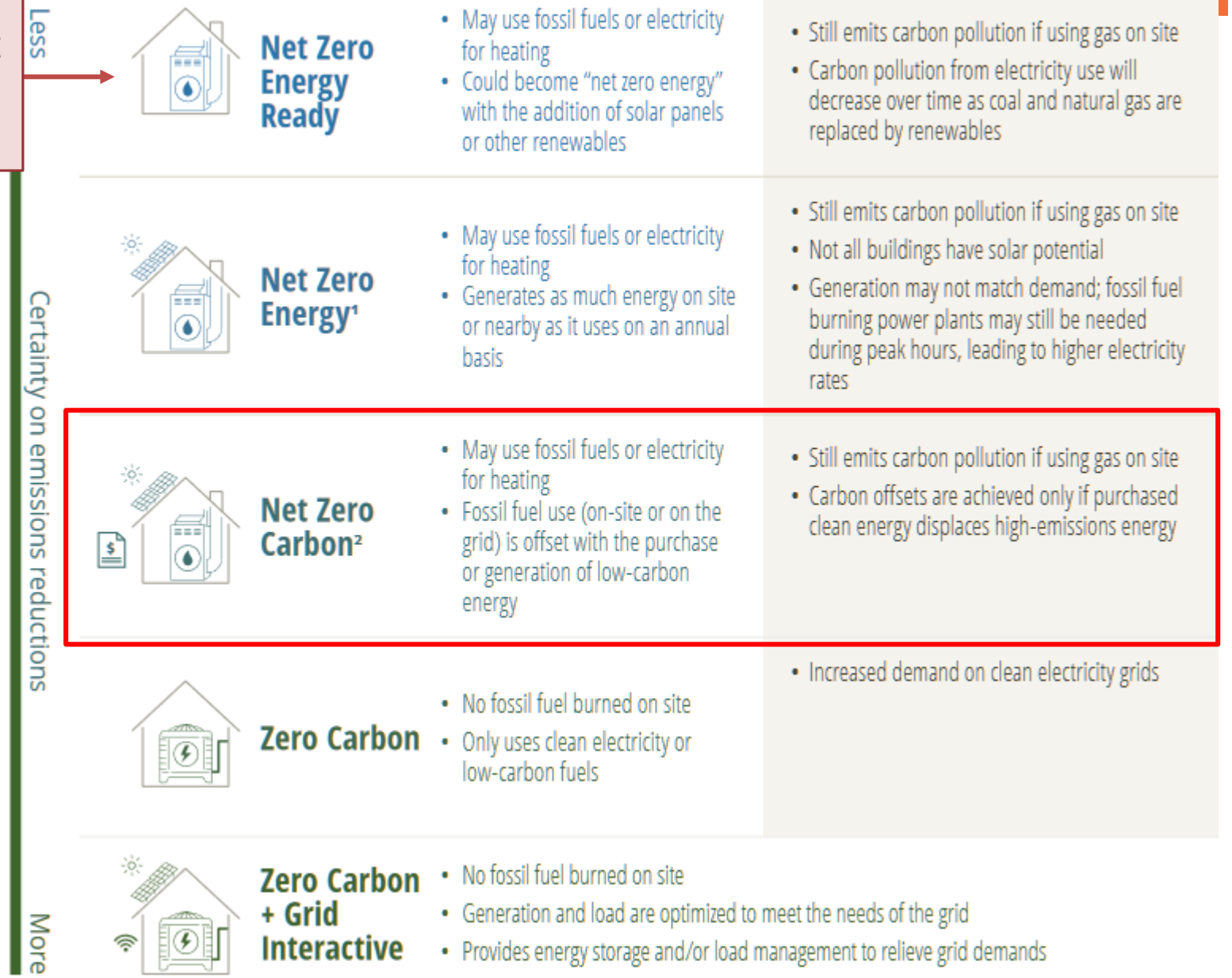


Source: Dunsky Study and FCM's Municipal Energy Roadmap

Types of Green Buildings

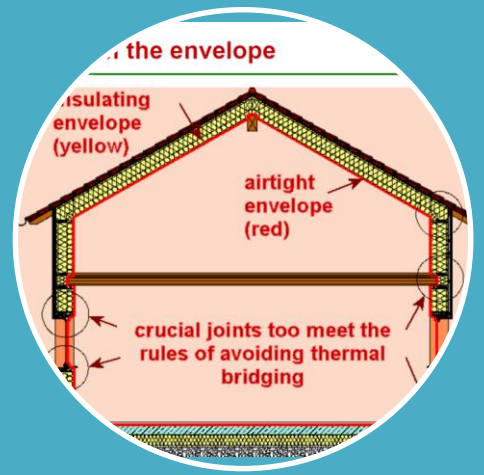
"Net-Zero Carbon" offers the best compromise of aggressively and affordably reducing building energy & GHG emissions

Federal Model NBC target (2030)



Source: Pembina Institutes Five Types of Green Buildings Explained

NZEE Buildings are Super Energy-Efficient!



Super-airtight and insulated building envelope

- Highly insulated building structure and components
- Air-tight and reduced thermal bridging

Operated efficiently with super energy efficiency equipment

- Ventilation with heat recovery
- Rightsized heating and cooling systems
- Water heating
- Electrical loads (appliances, lighting)

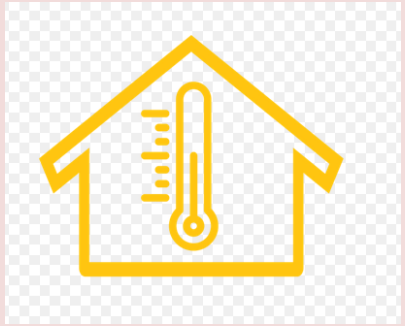
Renewable Energy

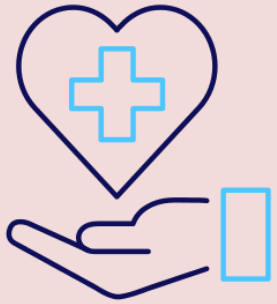
- Low-carbon energy sources

NZEE Benefits

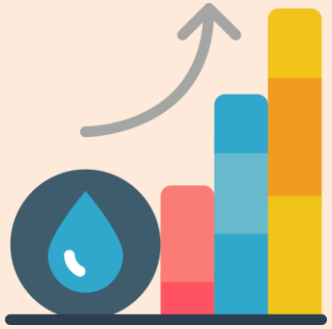
Environmental

Social





Economic



Heat Pumping Supporting Data

ETHER

MARKHAM

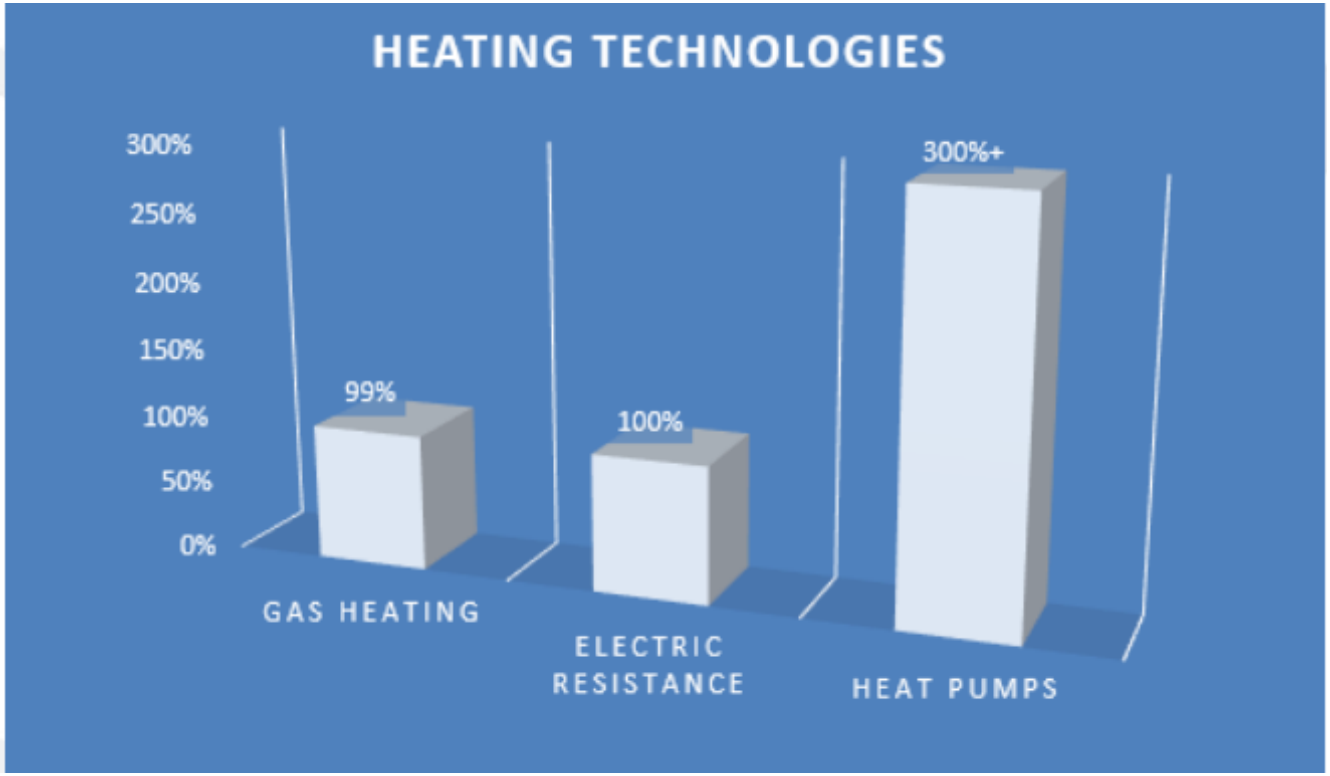
Heat Pumps vs. Gas?

Air Source Heat Pump

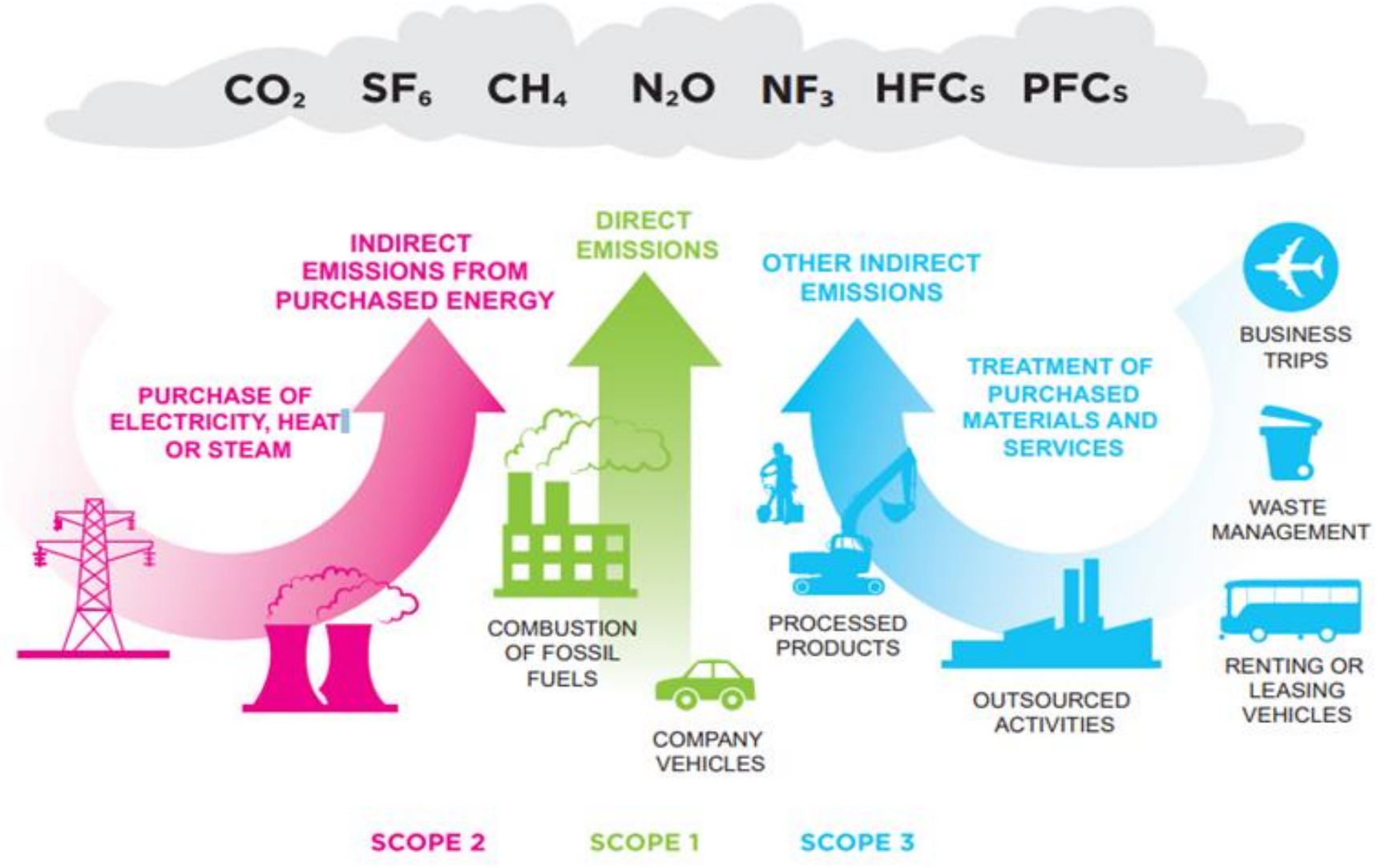
- Domestic water Heat Pumps – very attractive
- By 2030 many applications of ASHP will be comparable in operating cost to gas

Water Source or Geothermal Heat Pump

- Heat Pump beats free cooling HX by 2023
- Geothermal systems 30-40% savings vs. gas in 2030



Carbon Budgeting – Measuring an Organization's GHG Emissions



City of Markham's GHG Profile

2017 Corporate Greenhouse Gas Emissions by Source		
Source Category	**Total CO_2e(Kg)**	**GHG Emissions by Source (%)**
Facilities - Natural Gas	5,700,000	50
Facilities – District Hot Water	1,660,000	15
Facilities - Electricity	1,410,000	12
Fleet - Unleaded Fuel	1,060,000	9
Fleet - Biodiesel B5	560,000	5
Traffic & Street Lights	550,000	5
Fleet - Biodiesel B20	280,000	2
Propane (Zamboni)	70,000	1
Facilities – District Chilled Water	60,000	1
Total	**11,360,000**	**100**

Source: Markham's 2019 Corporate Energy Management Plan