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CanmetENERGY's Integrated Community Energy Mapping & Building Energy Modelling

Webinar for the Clean Air Partnership

Thursday April 26th, 2018

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CanmetENERGY Ottawa, NRCan



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Overview

- CanmetENERGY Ottawa's Buildings and Renewables Group
- Need to accelerate CEP implementation
- **Past research** - Integrated Community Energy Mapping (ICEM)
 - TaNDM method for energy and emissions inventories
 - SCEC³ model
- **Current research** - HTAP/BTAP Housing and building modelling
- Stakeholder consultation to inform **future research**

CanmetENERGY Ottawa

Buildings and Renewables Group (BRG)

Built Environment & Renewable Electricity and Heating/Cooling

- Application of computational tools (e.g. HTAP, BTAP) to advance the Pan Canadian Framework, Canada's Building Strategy and other building-oriented policies.
- De-risking innovative mechanical systems (e.g. heat pumps)
- Improve performance of building envelope systems (e.g., PEER project)
- Assessment of District Energy Systems
- Solar thermal and storage systems for communities and buildings



Current Need

- **To accelerate implementation of cost-effective energy and emissions actions in the built environment**
- In a recent QUEST study* 63% of respondents identified “Energy Data Collection” as the primary need for advancing smart energy communities
- **Reduce costs**
 - Municipalities spending \$20,000 to \$70,000 on data acquisition for energy and emissions inventories and modelling
 - Modelling services in the 100’s of thousands.
- **Achieve consistency**
 - Access to consistent, authoritative, fit for purpose buildings and energy data
 - To level the playing field for municipalities and utilities of all sizes
- **Build capacity**
 - Energy literacy around buildings and energy data and its highest and best use

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** Reference: Our Impact: Advancing Smart Energy Communities in 2016, Quality Urban Energy Systems of Tomorrow (QUEST), 2017.*

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Energy Benchmarking Data Sources

StatCan / NRCan Survey Data:



NRCan / US DOE
Benchmarking Data

More Data Coming:

E.g. Ontario Bill 135, Energy Statute Law Amendment Act
→ Move toward mandatory energy data reporting and disclosure requirements

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- ❖ Generally report **TOTAL ANNUAL** energy use intensity
- ❖ Heating/Cooling/Elec EUI not always directly provided
- ❖ Building types not always consistent in datasets
- ❖ Values represent fuel energy not thermal energy
- ❖ Unable to provide temporal profile or peak estimation

- Data on specific building types not always valid at the community scale.

- Can be difficult to apply to a district energy network analysis where hourly data is ideal.

NRCan Comprehensive Energy Use Databases



Other Sources:
BOMA, REALpac, etc:



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Past CanmetENERGY ICEM Research (2006 – 2012)

- Urban Archetypes Project, 2006-08
- **Tract and Neighbourhood Data Modelling (TaNDM), 2010-12**
 - **Objective: Improve energy and emissions inventories for buildings**
- **Spatial Energy Carbon and Cost Characterization Model (SCEC³), 2008–12**
 - **Objective: Develop and demonstrate a map-based model of the building stock in support of community energy and emissions planning**
- Integrated Energy Mapping for Ontario Communities (IEMOC), 2010-11
- Strait-Highlands Energy Asset Mapping, 2010-11
- The Value of Energy Mapping Symposium, 2009
- Putting Energy and Emissions on the Map – workshop package



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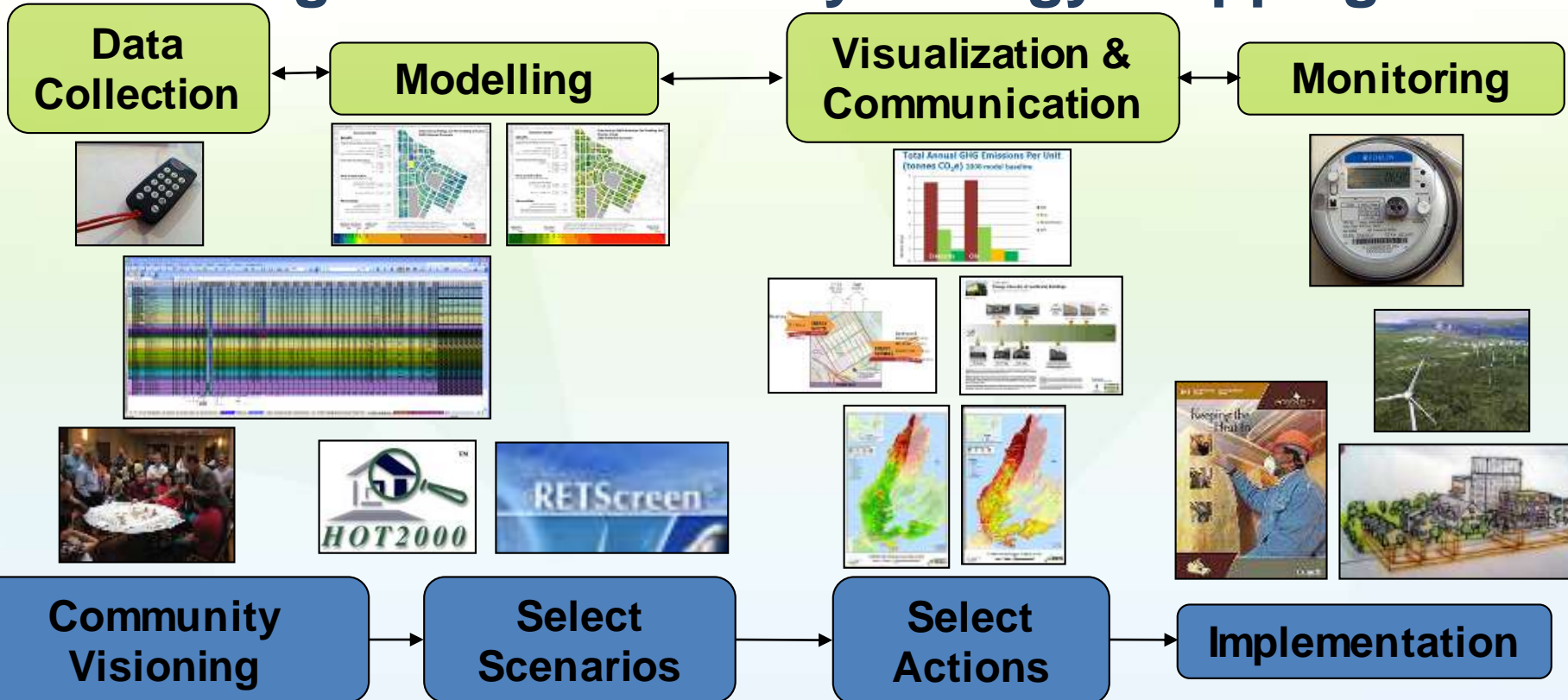


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Integrated Community Energy Mapping



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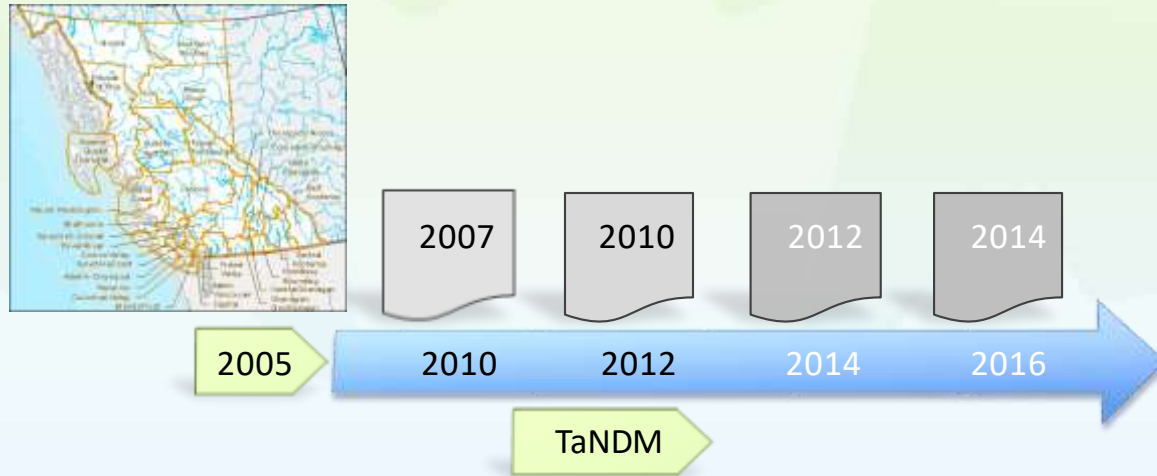
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CEEI: Community Energy and Emissions Inventory

PURPOSE: to provide a provincial solution for tracking and reporting energy and greenhouse gas (GHG) emission indicators at a community (municipal or regional district) level.



CEEI GOAL: continuous improvement

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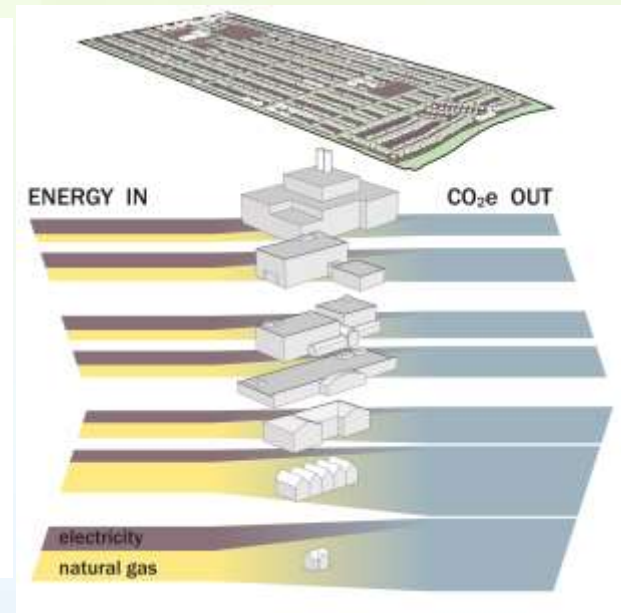
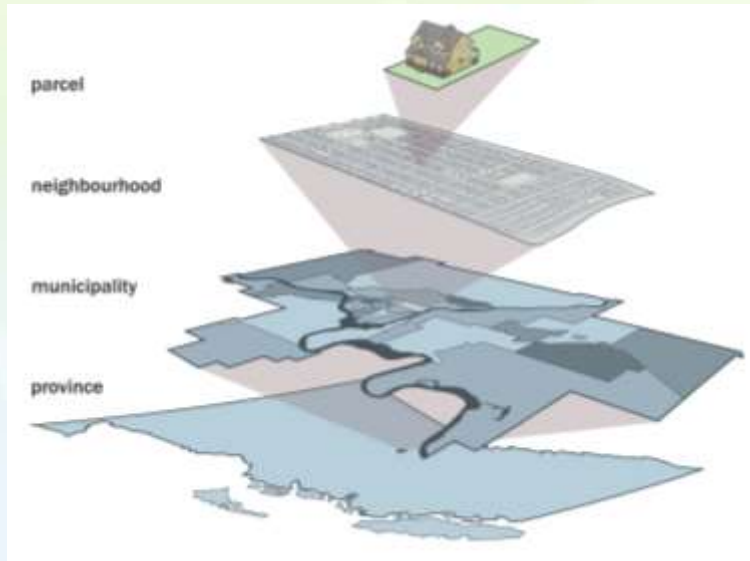
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TaNDM: Tract and Neighbourhood Data Modelling

PURPOSE: explore opportunities and challenges for mapping CEEI at the neighbourhood (census tract) scale, focusing on building indicators.



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Key Method: Requirements Gathering Workshop

Win-win
opportunities

Consensus
building

Collaborative
spirit

Strengthen new and
old relationships

Learn who's
doing what



Use case
identification

Scope
definition

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Key Method: Standard Building Categories

- Cross-walk table aligning building categories from a general to detailed level, as maintained by utilities, governments, property assessment corporations etc..

Sector	Major Categories	Sub Categories
Residential	<i>Single family</i>	<i>Single detached</i>
	<i>Multi-family</i>	<i>Single attached - duplex, row, townhouse</i>
		<i>Low-rise apartment</i>
		<i>Hi-rise apartment</i>
		<i>Other residential</i>
Commercial/Institutional	<i>Office</i>	<i>Office - large</i>
		<i>Office - medium</i>
		<i>Office - small</i>
	<i>Healthcare</i>	<i>Hospital</i>
		<i>Care facilities</i>
	<i>Education</i>	<i>Elementary school</i>
		<i>Secondary school</i>
		<i>University/college</i>
	<i>Retail</i>	<i>Shopping centre</i>
		<i>Retail strip</i>
		<i>Big box</i>
		<i>Retail - other</i>
		<i>Food-retail</i>
	<i>Accommodation</i>	<i>Hotel</i>
		<i>Medium hotel/motel</i>
		<i>Accommodation - other</i>
	<i>Restaurant/Pub</i>	<i>Restaurant/Pub</i>
<i>Fast food</i>		

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Key Method: Standard Building Information Report

- Authoritative dataset of building attribute information, vetted for energy modelling, consistency, privacy
- In TaNDM, report was produced by BC Assessment

Attribute grouping	Attribute
Locational	Area/Jur/Roll
	PID
	Civic address
	Legal description
Use	Actual Use Code
	Building Type
	Manual Class
	Occupancy
	Unit of measure
Floor Area	Total Area
	Foundation Area
	Number of Units
	Strata Unit Area
	Gross Building Area (GBA)
	Gross Leasable Area (GLA)
	Net Leasable Area (NLA)

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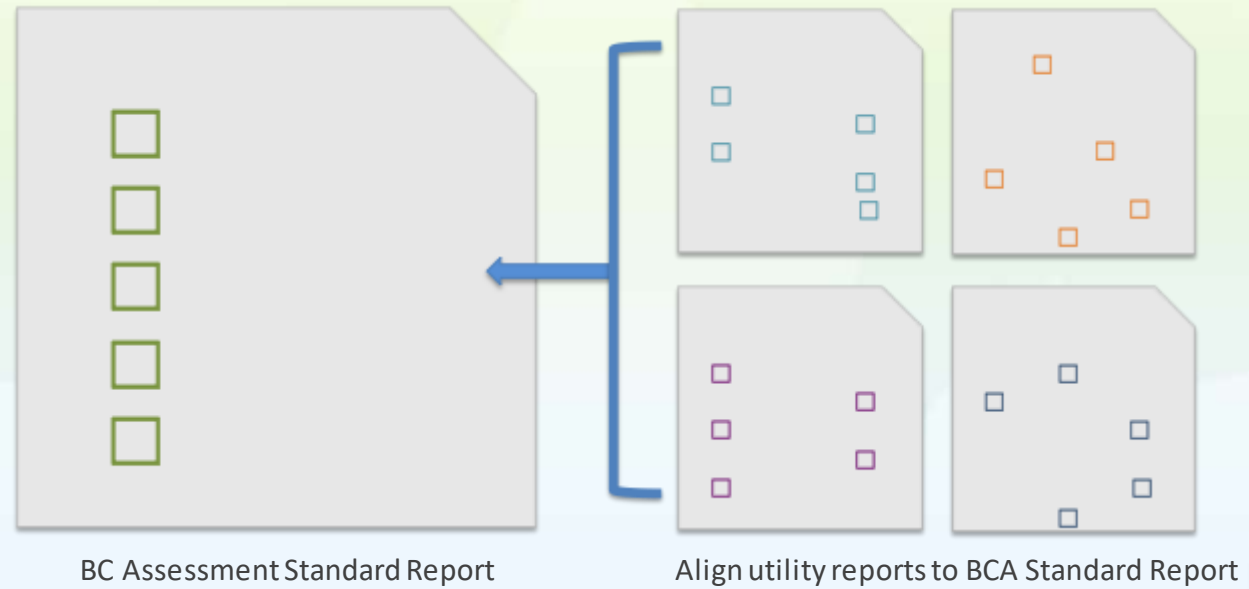
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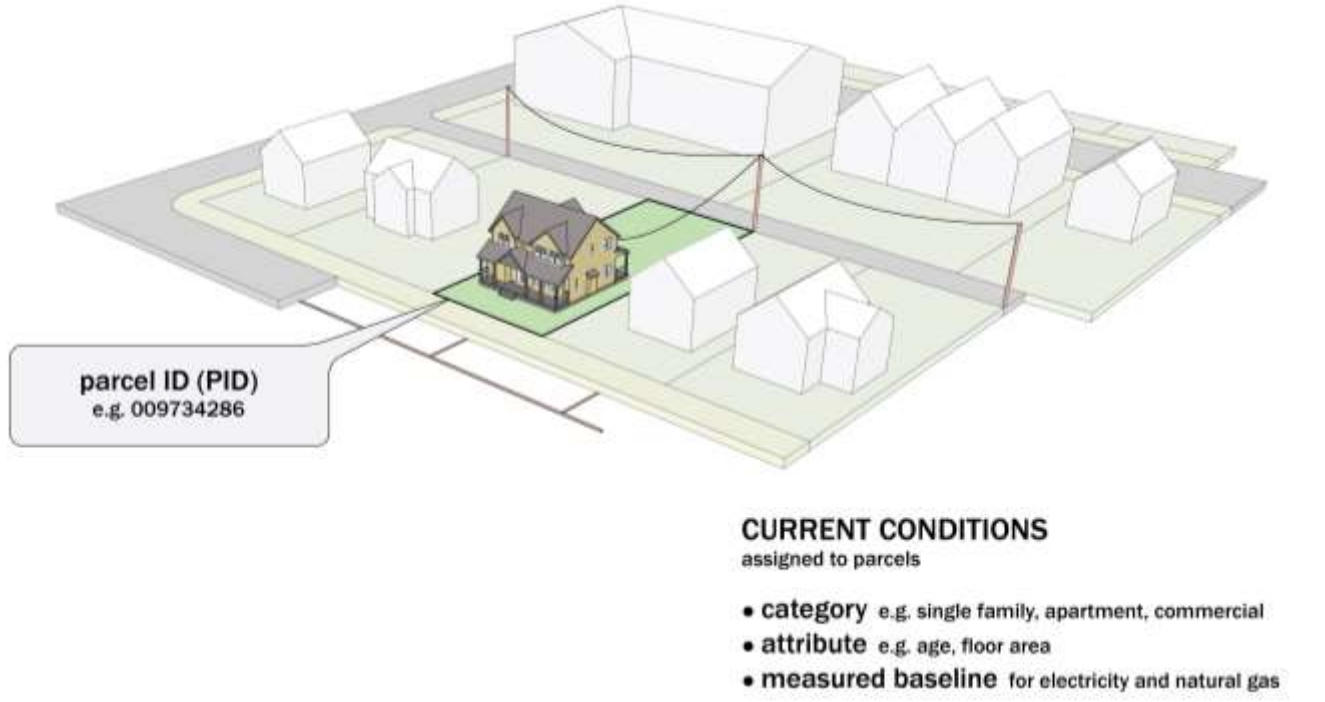


Key Method: Share building attribute information with utilities



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Key Method: Parcel Data Method



parcel ID (PID)
e.g. 009734286

CURRENT CONDITIONS

assigned to parcels

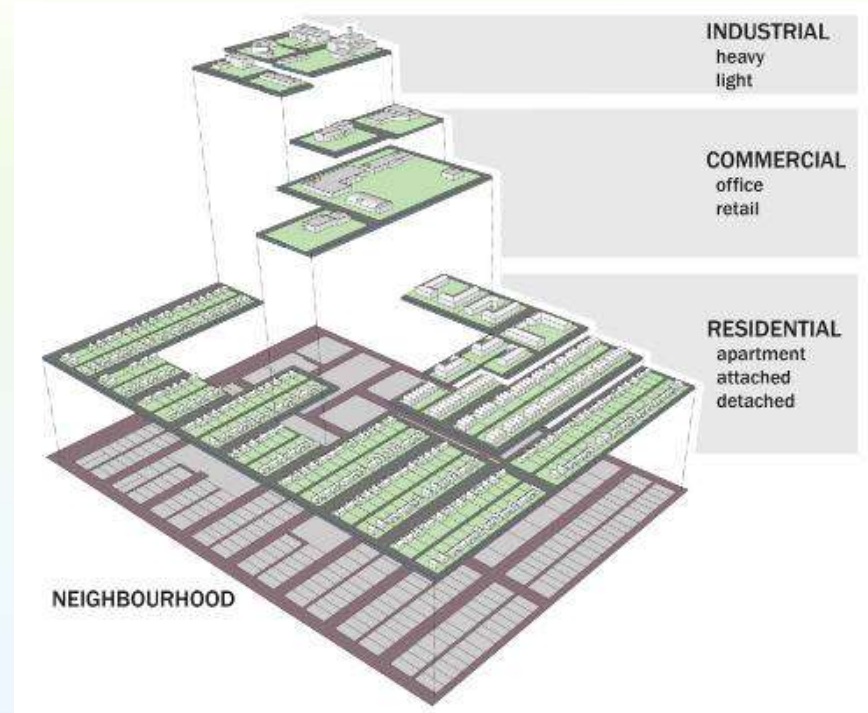
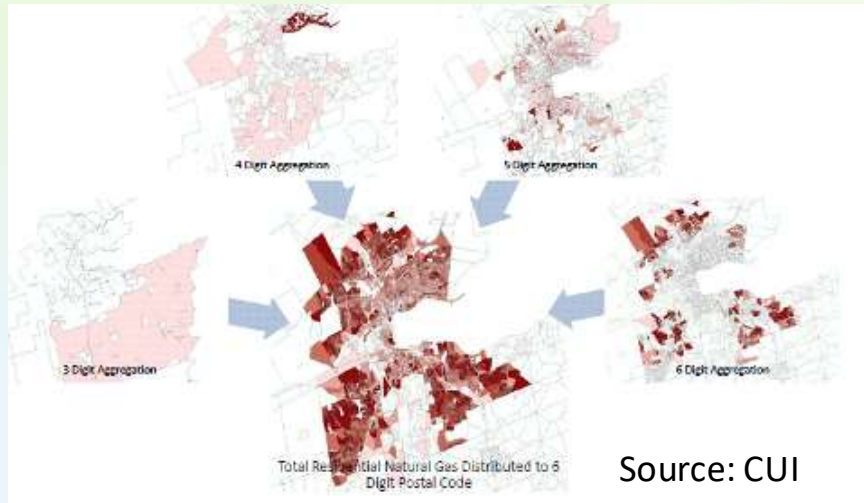
- **category** e.g. single family, apartment, commercial
- **attribute** e.g. age, floor area
- **measured baseline** for electricity and natural gas





Key Method: Aggregate by Building Category

Utility data aggregation by postal codes causes errors in energy inventories



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Deliverable: methodology



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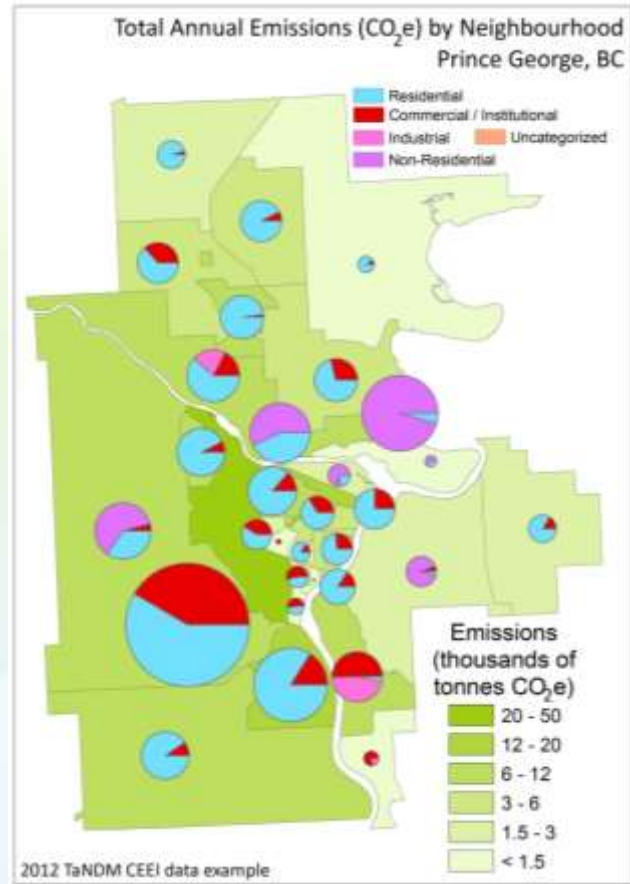
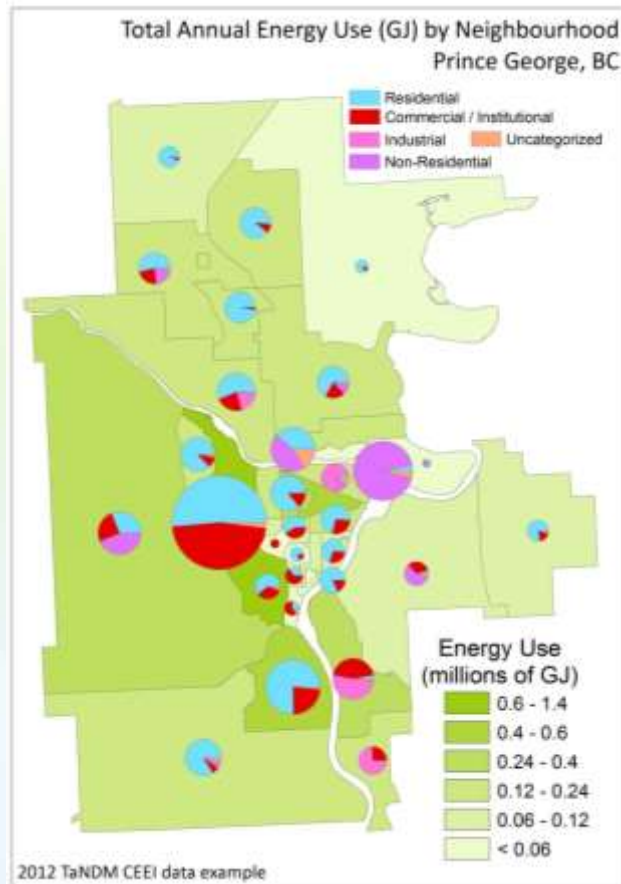
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Sample outputs

- Annual energy use (GJ) by neighbourhood, by sector
- Annual emissions, by neighbourhood, by sector



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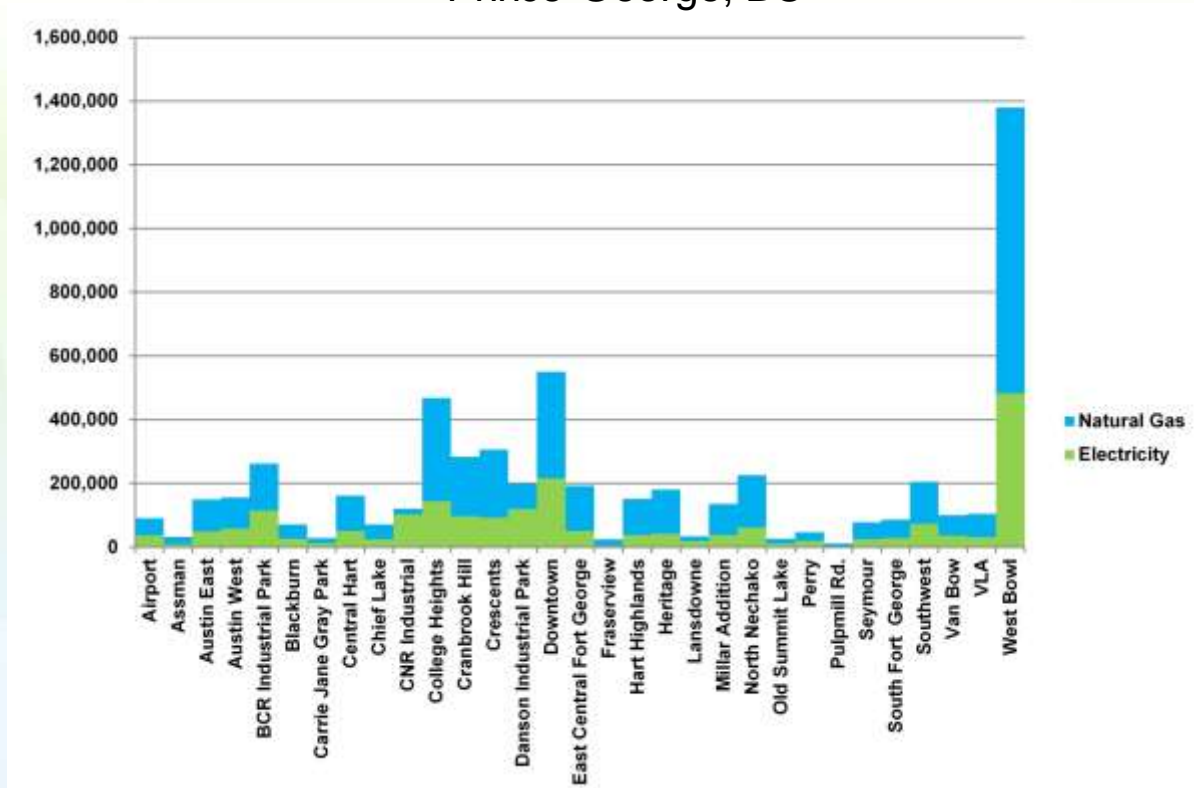
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Sample outputs

Energy Use by Source by Neighbourhood, Prince George, BC

- Annual energy use (GJ) by energy source (natural gas, electricity), by neighbourhood



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Spatial Community Energy Carbon and Cost Characterization (SCEC³) model

- Model of the City of Prince George's housing stock to assess energy efficiency, district and renewable energy technology integration towards its PCP targets
- Developed from 2008- 2012 in conjunction with City planning processes (ICSP, OCP update)
- Four scenarios developed

Location of Retrofits, New Construction and Renewables
2040 Preferred Scenario



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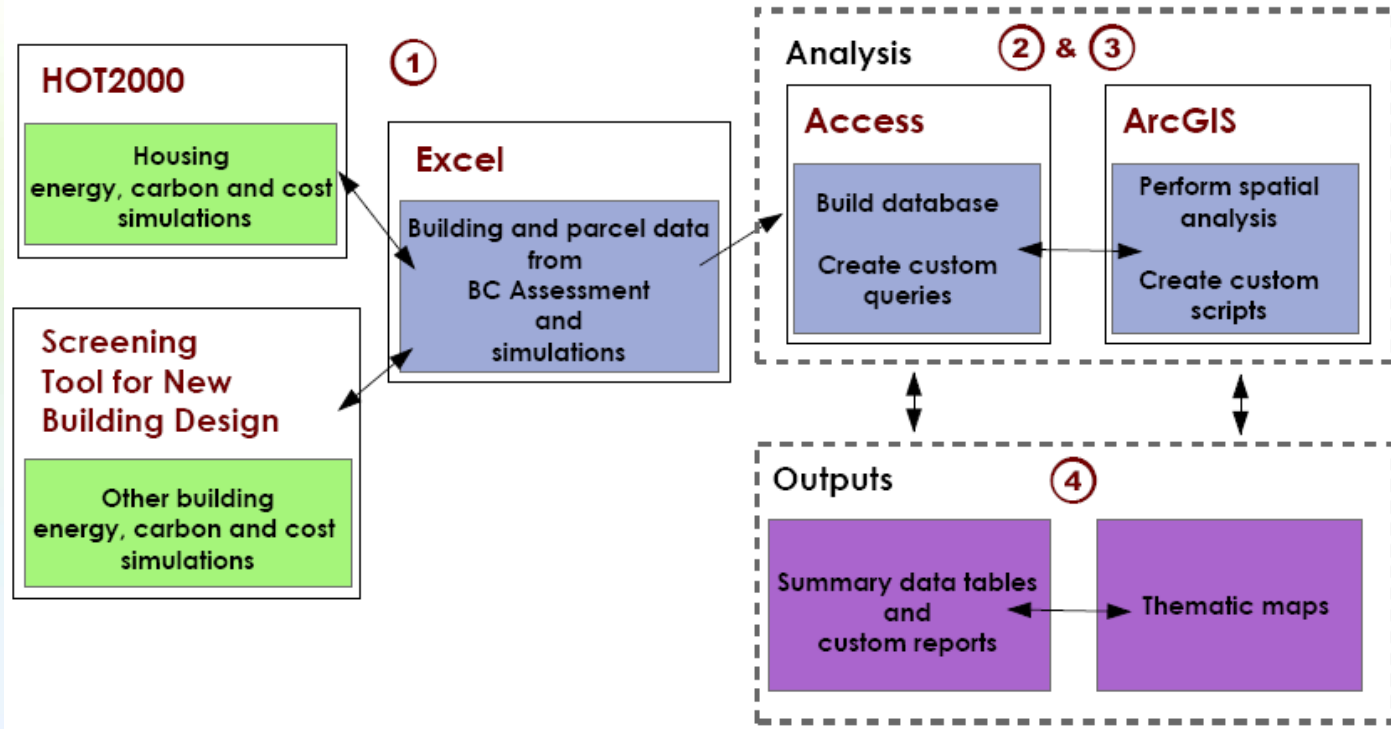


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SCEC³ Software Building Blocks, circa 2012

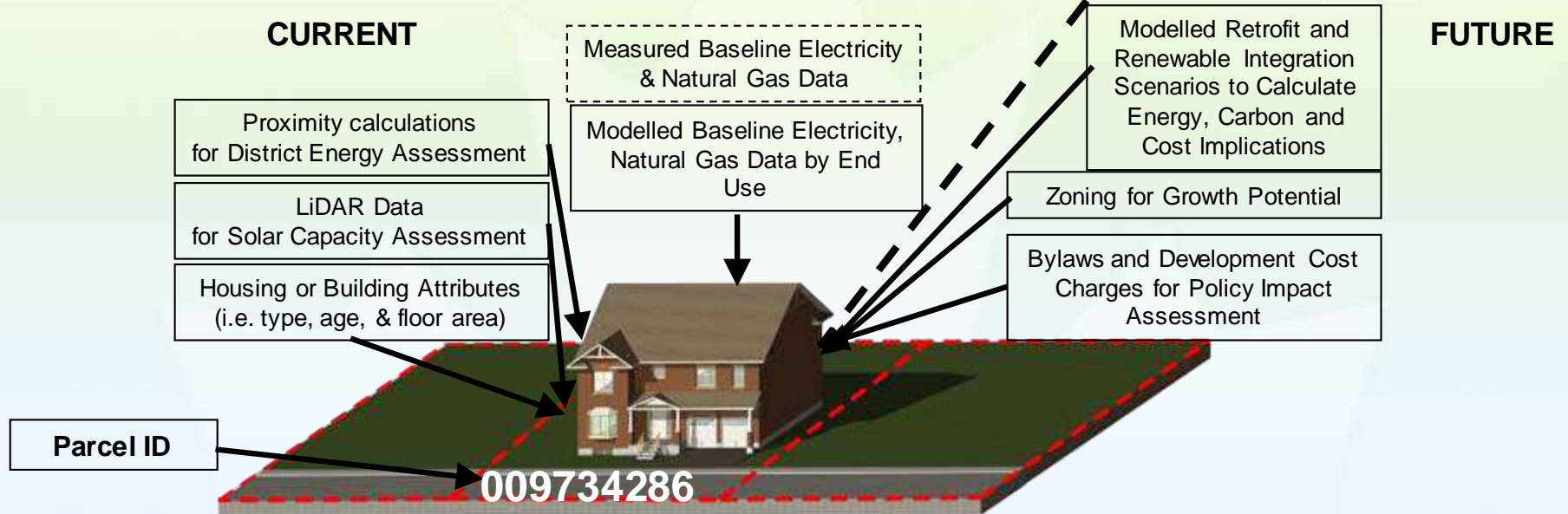


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Key Method: Parcel Data method

A flexible decision support approach.



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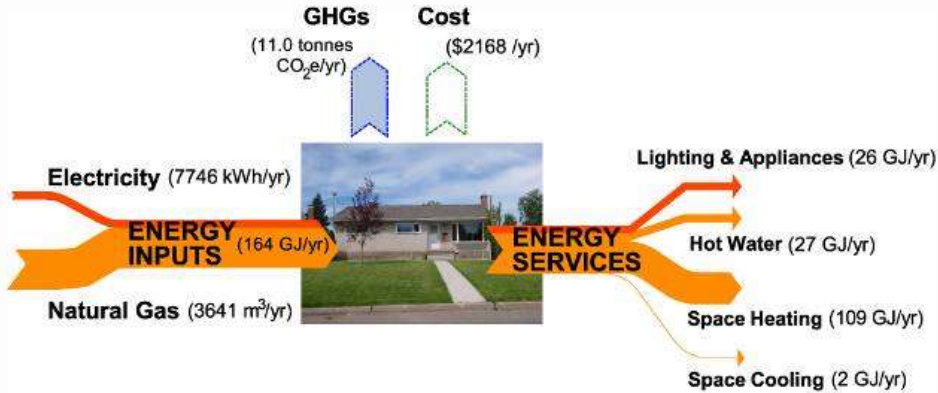


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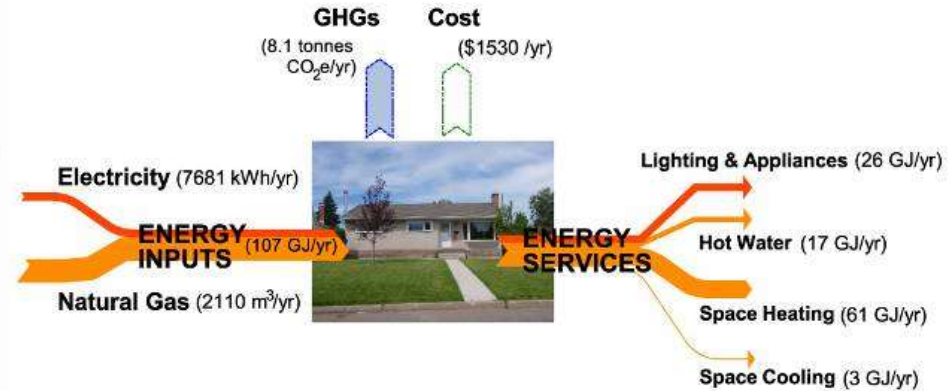
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Key Method: Building Energy Modelling



Single Family Dwelling 1 Base Case

Prince George, BC



SFD1 Retrofit - Furnace, DHW & closed chimney upgrade

Prince George, BC

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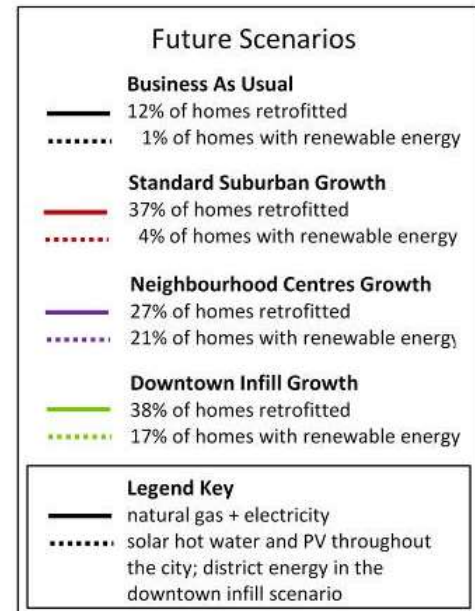
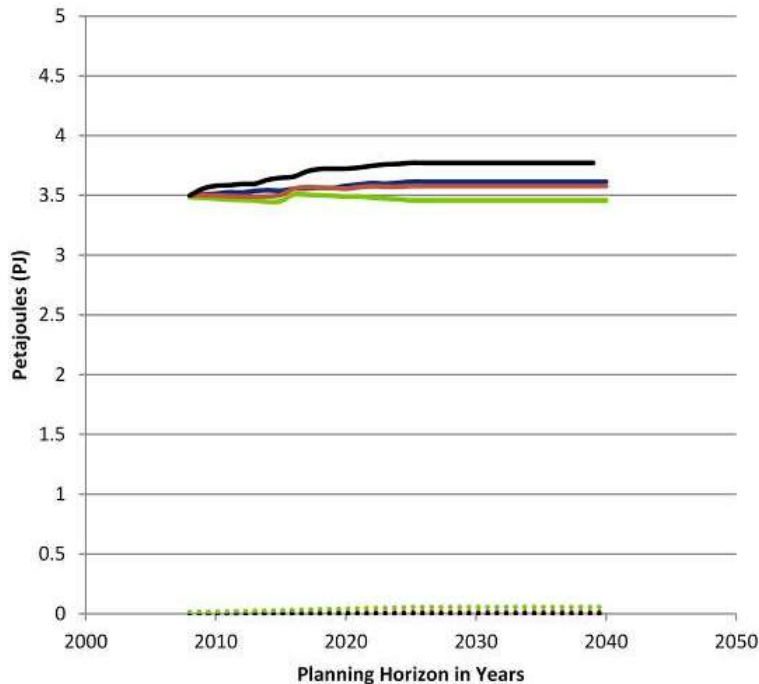
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SCEC³ Output: the gap to net zero energy

- The gap to net zero energy in Prince George, BC
- Slow growth community

Total Annual Residential Energy Use City of Prince George, BC



Source: NRCan, Vive le Monde Mapping; results derived from the Spatial Community Energy Carbon and Cost Characterization Model (SCEC³).

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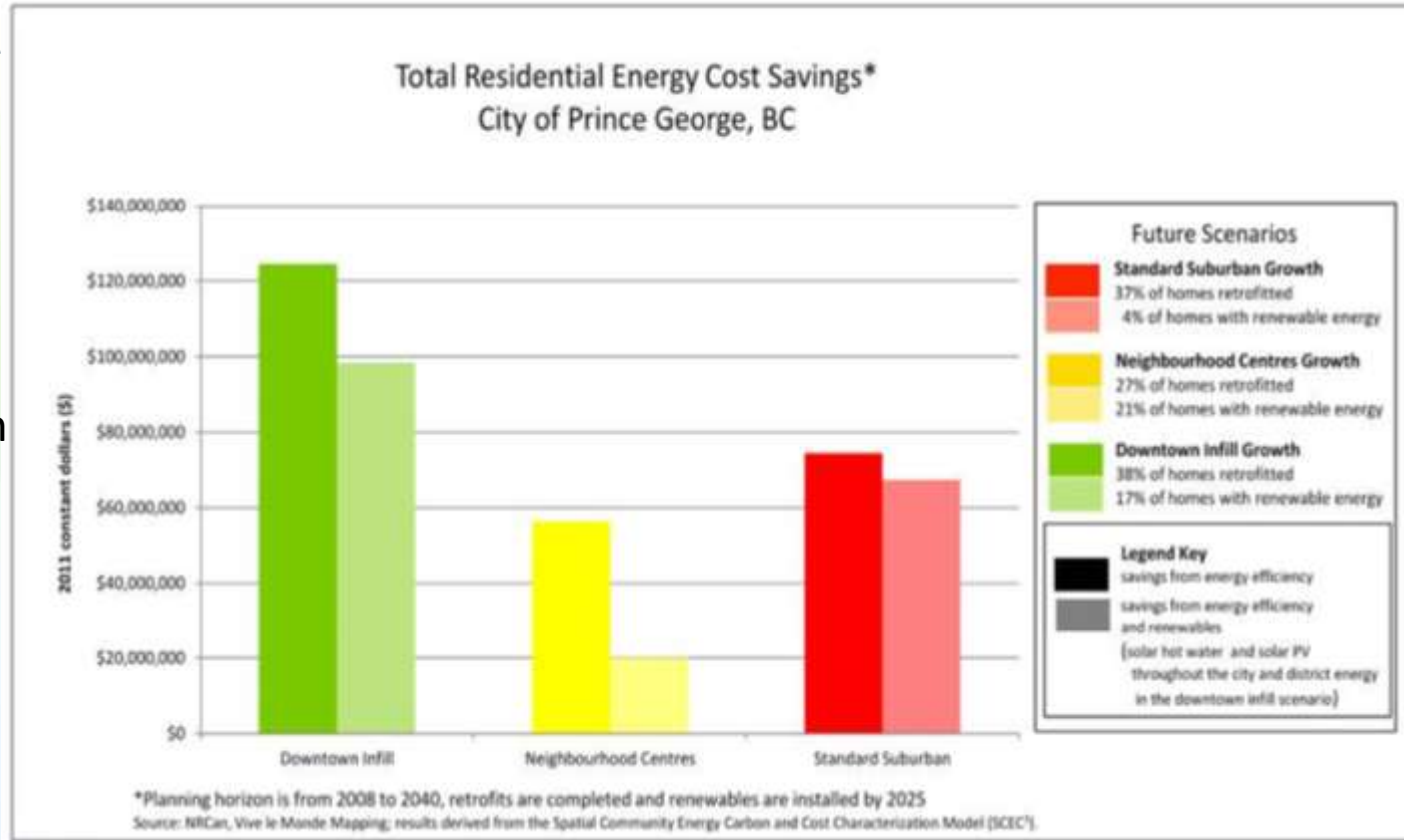
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SCEC³ output: Cumulative cost savings

- A surprising finding was that the economic opportunity may be more of a driver than energy or environmental objectives



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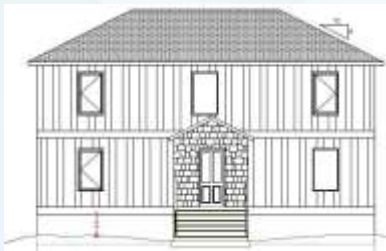
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Current Research

- Smart Archetypes
- Housing Technology Assessment Platform (HTAP)
- Building Technology Assessment Platform (BTAP)



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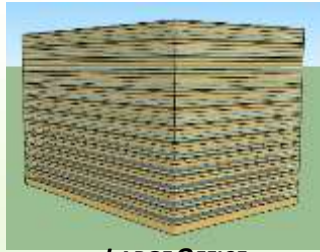


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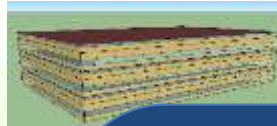
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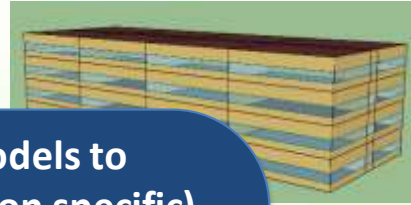
NRCan CanmetENERGY Smart Archetypes



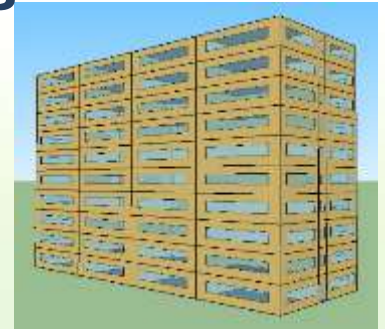
LARGE OFFICE



ME



SM



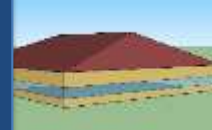
HIGHRISE APARTMENT



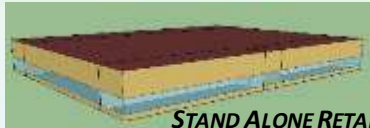
WAREHOUSE



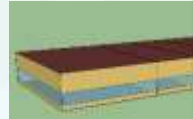
SM



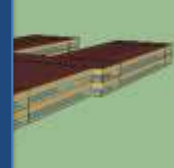
FULL SERVICE RESTAURANT



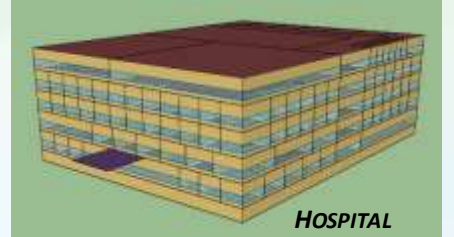
STAND ALONE RETAIL



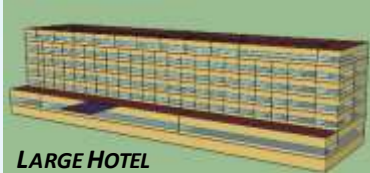
SM



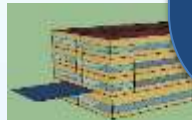
SCHOOL



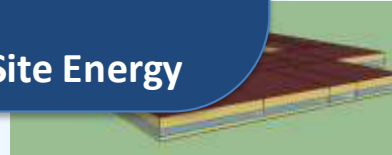
HOSPITAL



LARGE HOTEL



SMALL HOTEL



PRIMARY SCHOOL

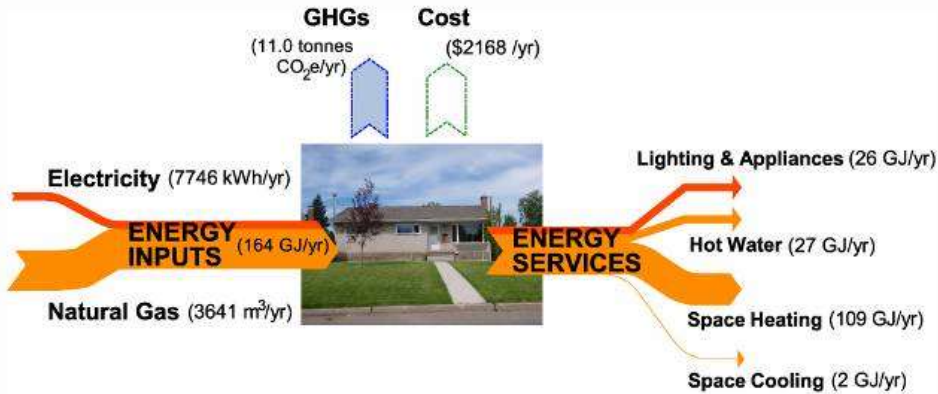


OUTPATIENT CARE

Use generic models to develop (location specific) energy use and demand profiles for each archetype:

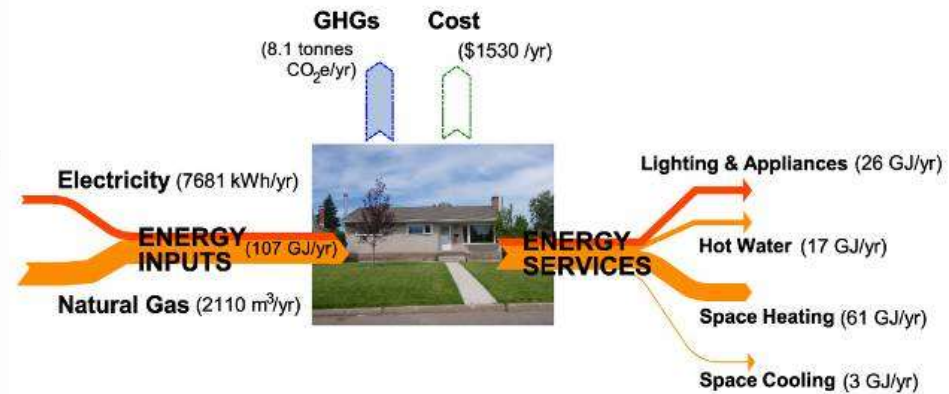
- DHW
- Space Heating
- Total Heating
- Space Cooling
- Electricity
- Gas
- Total Site Energy

Old method: single simulation for base case and a limited number of prescribed scenarios



Single Family Dwelling 1 Base Case

Prince George, BC



SFD1 Retrofit - Furnace, DHW & closed chimney upgrade

Prince George, BC

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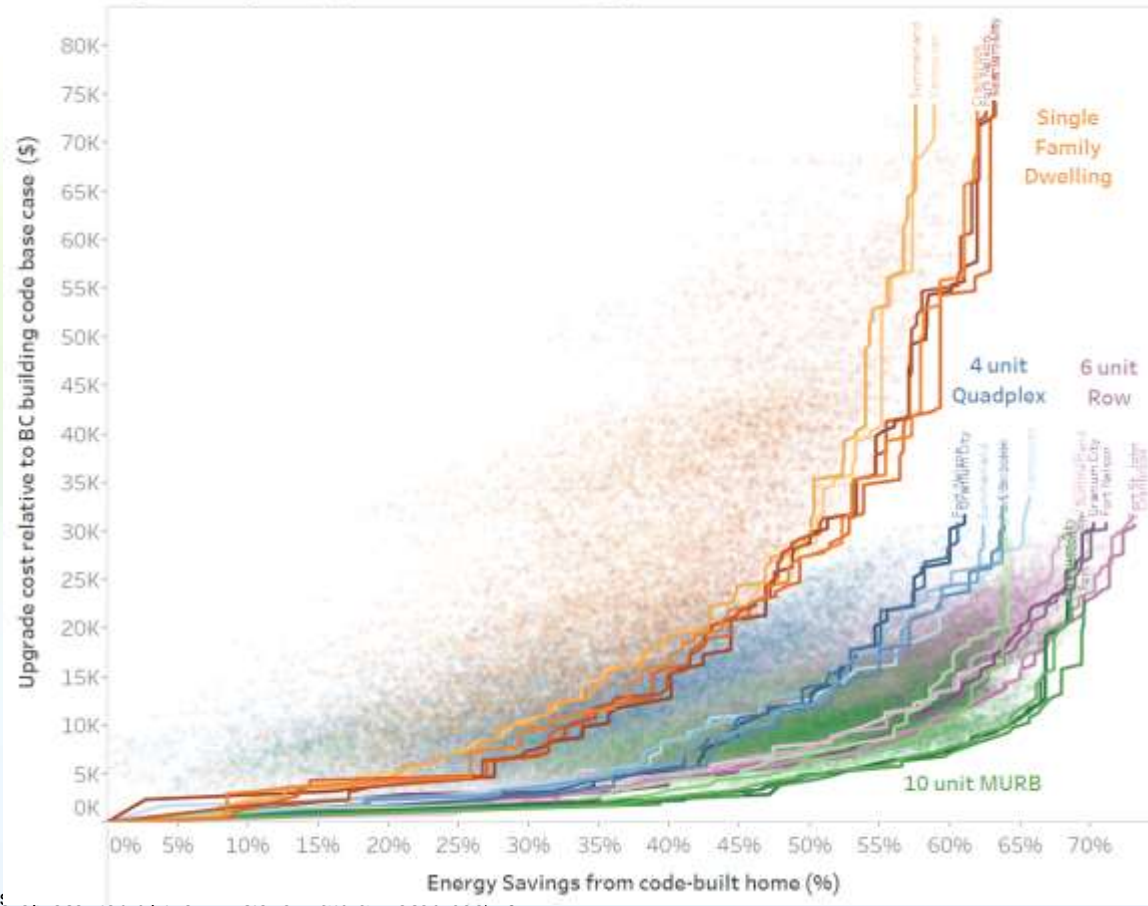


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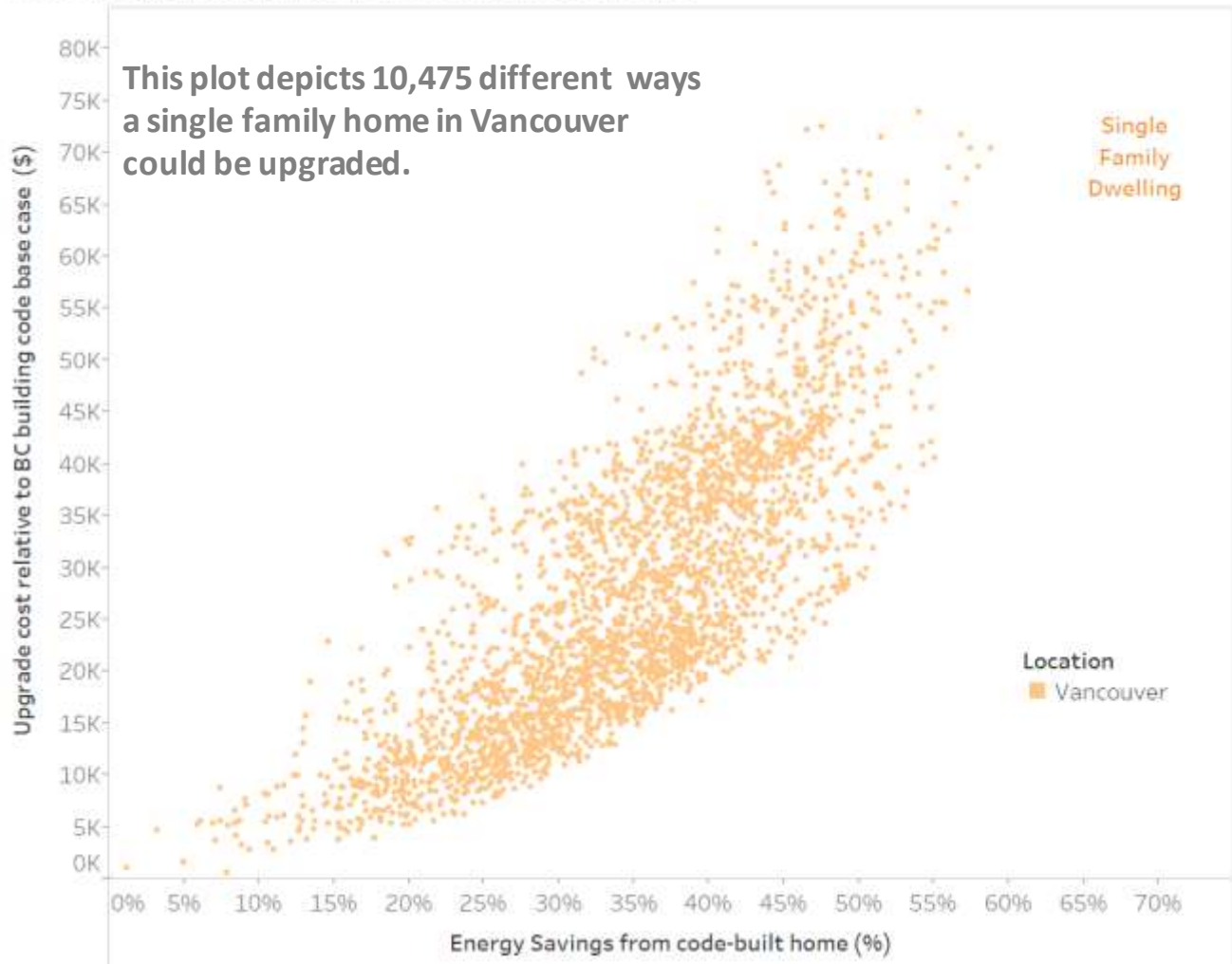
New method:
leveraging cloud computing to run 10,000 + simulations per archetype



Cost of Energy Efficiency in BC, by climate zone and housing type

HTAP:
supports
identification of
cost-optimal
technology
pathways to net
zero energy in
new and existing
housing

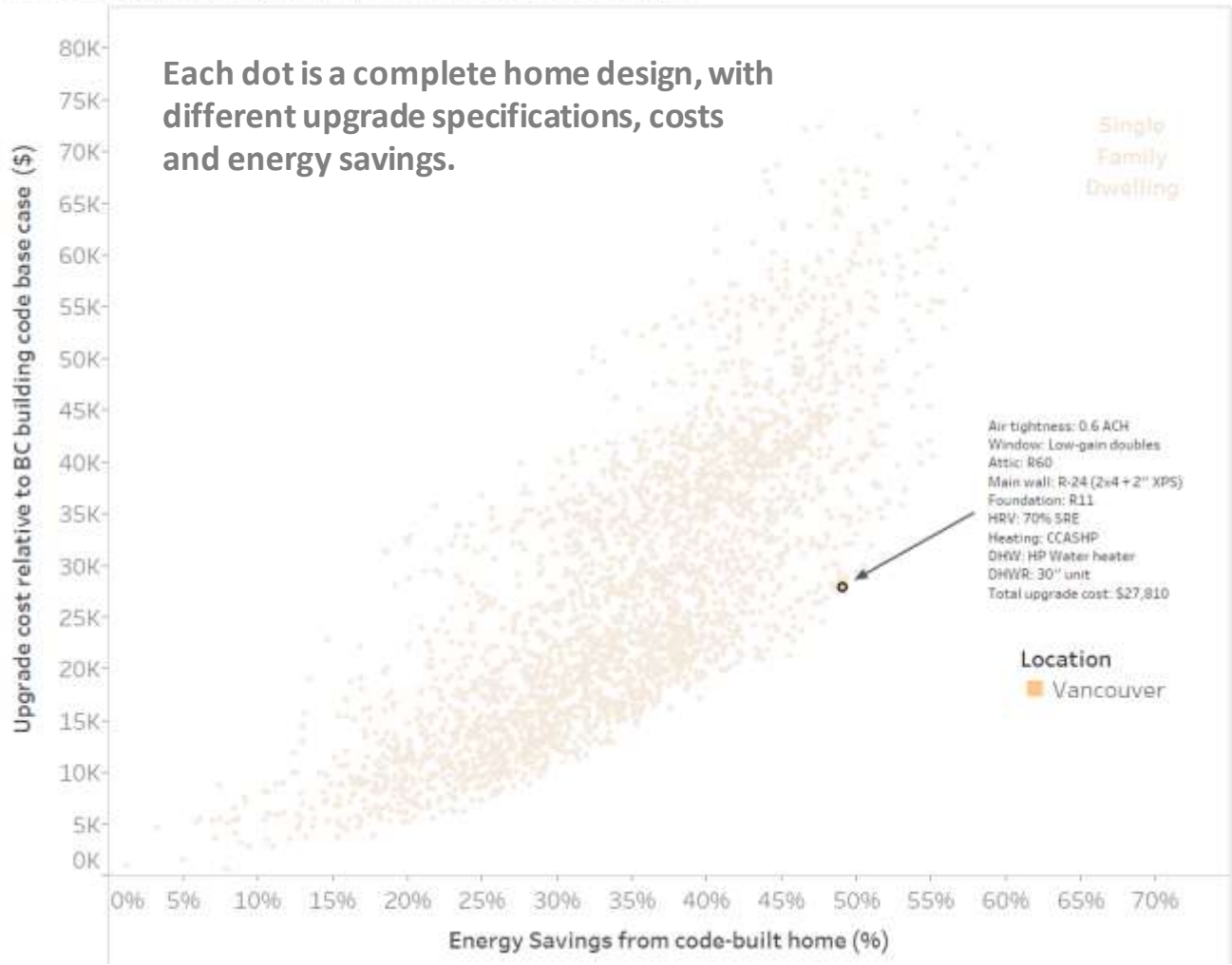
This plot depicts 10,475 different ways
a single family home in Vancouver
could be upgraded.



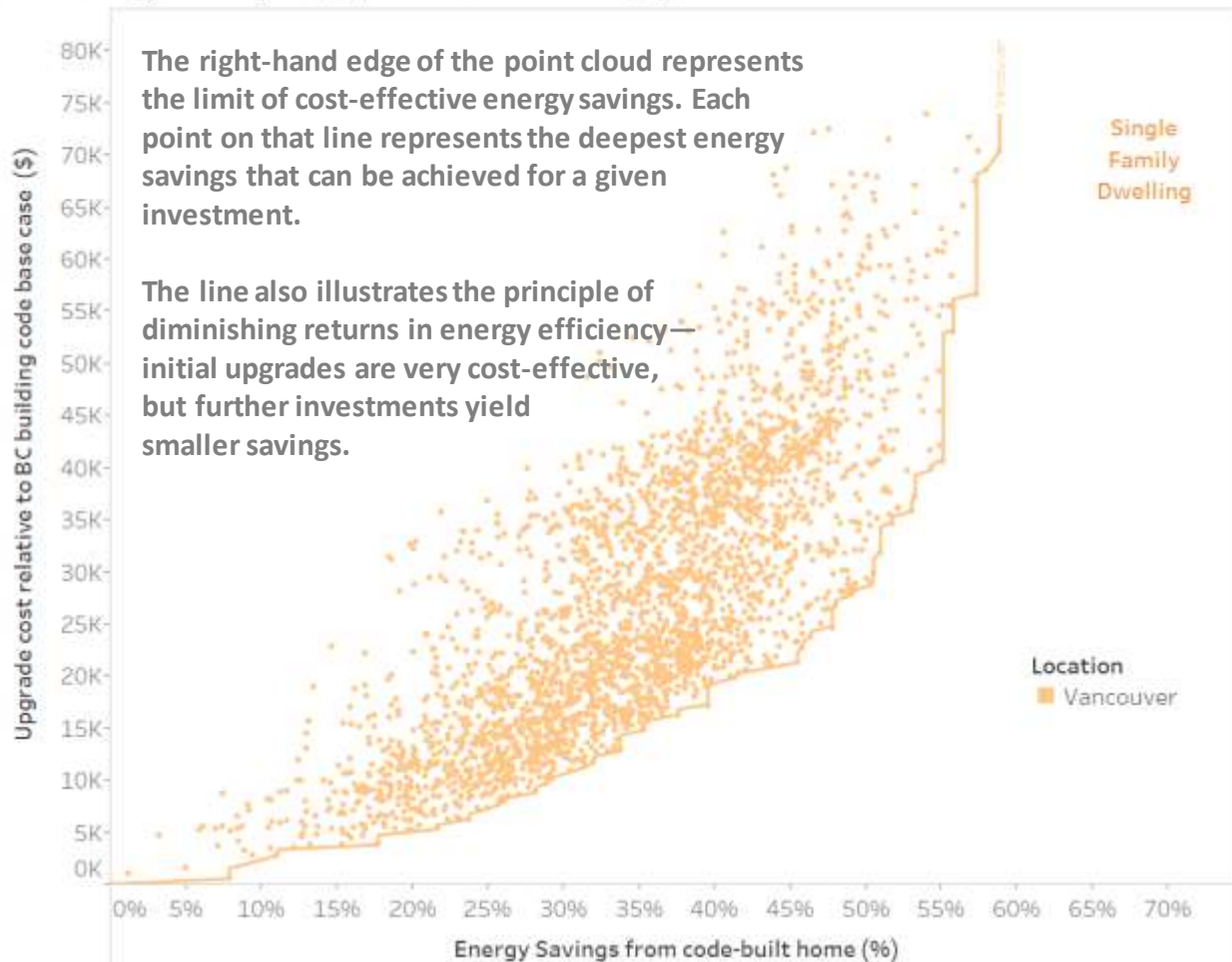
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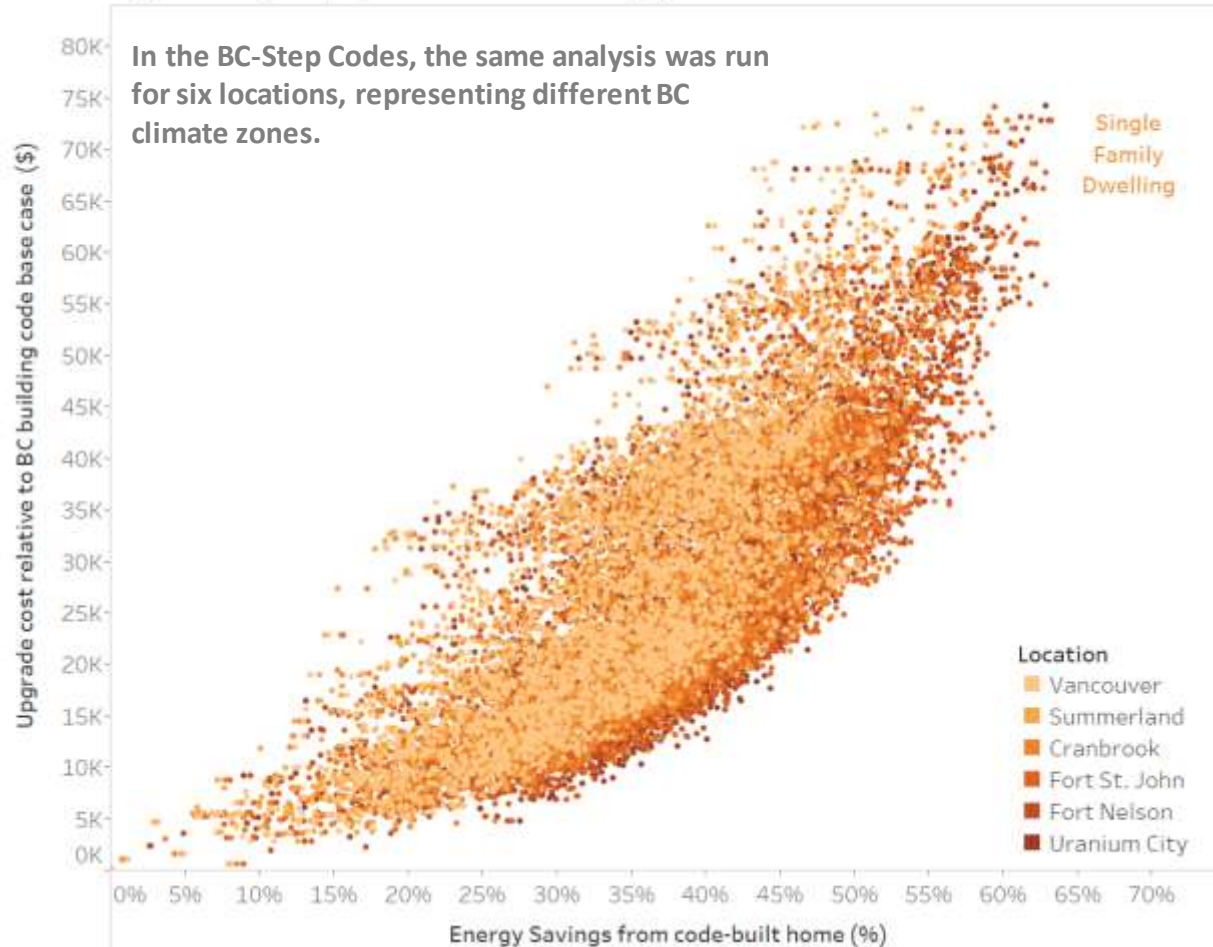
Cost of Energy Efficiency in BC, by climate zone and housing type

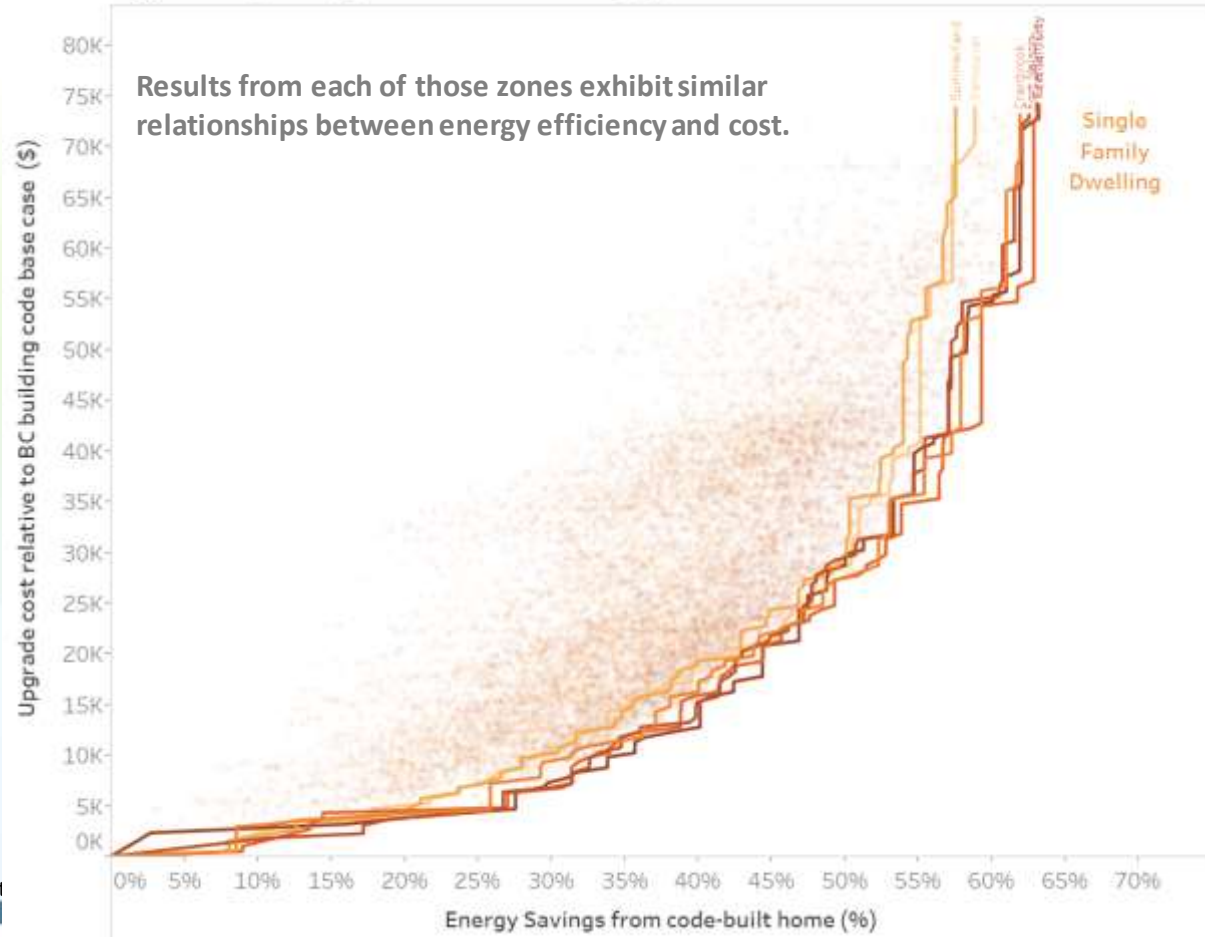


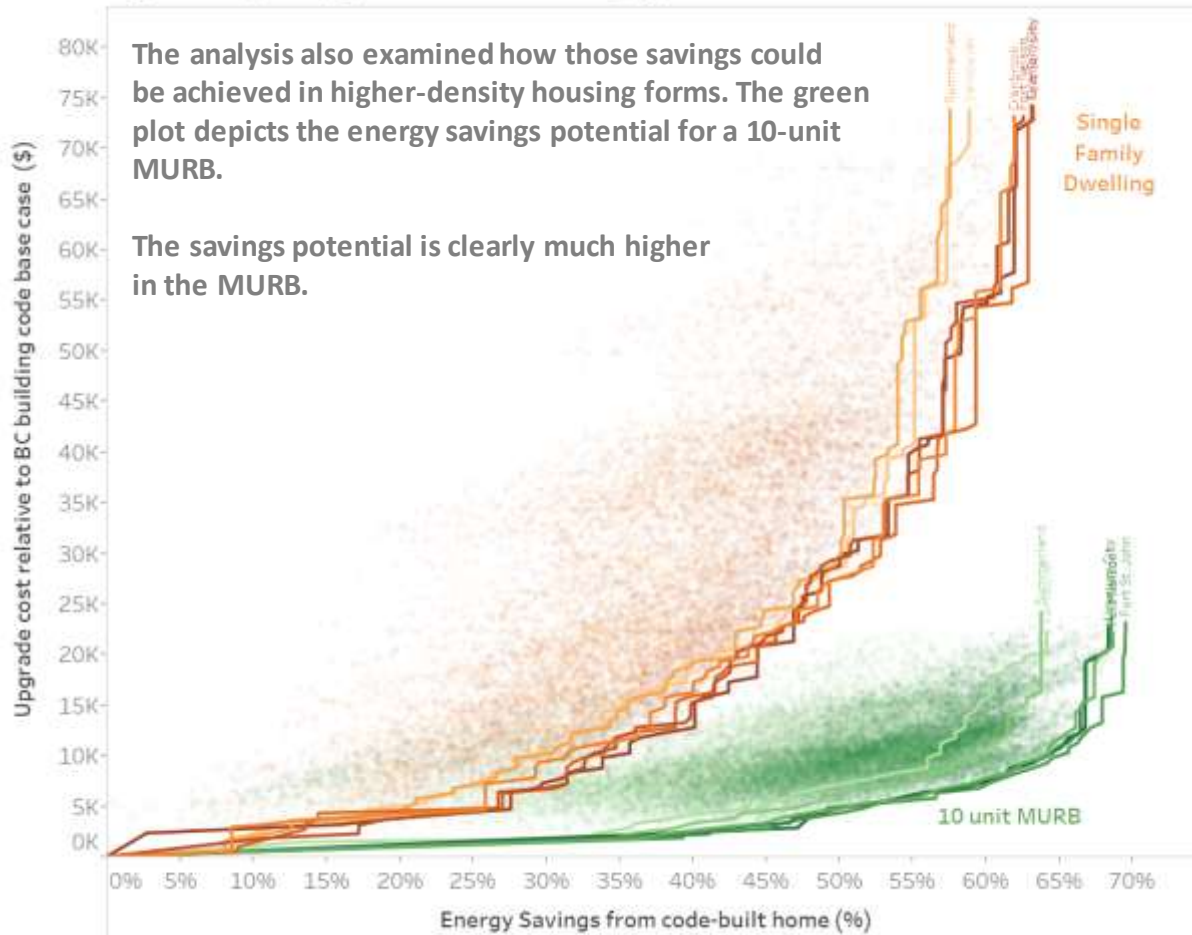
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In the BC-Step Codes, the same analysis was run for six locations, representing different BC climate zones.







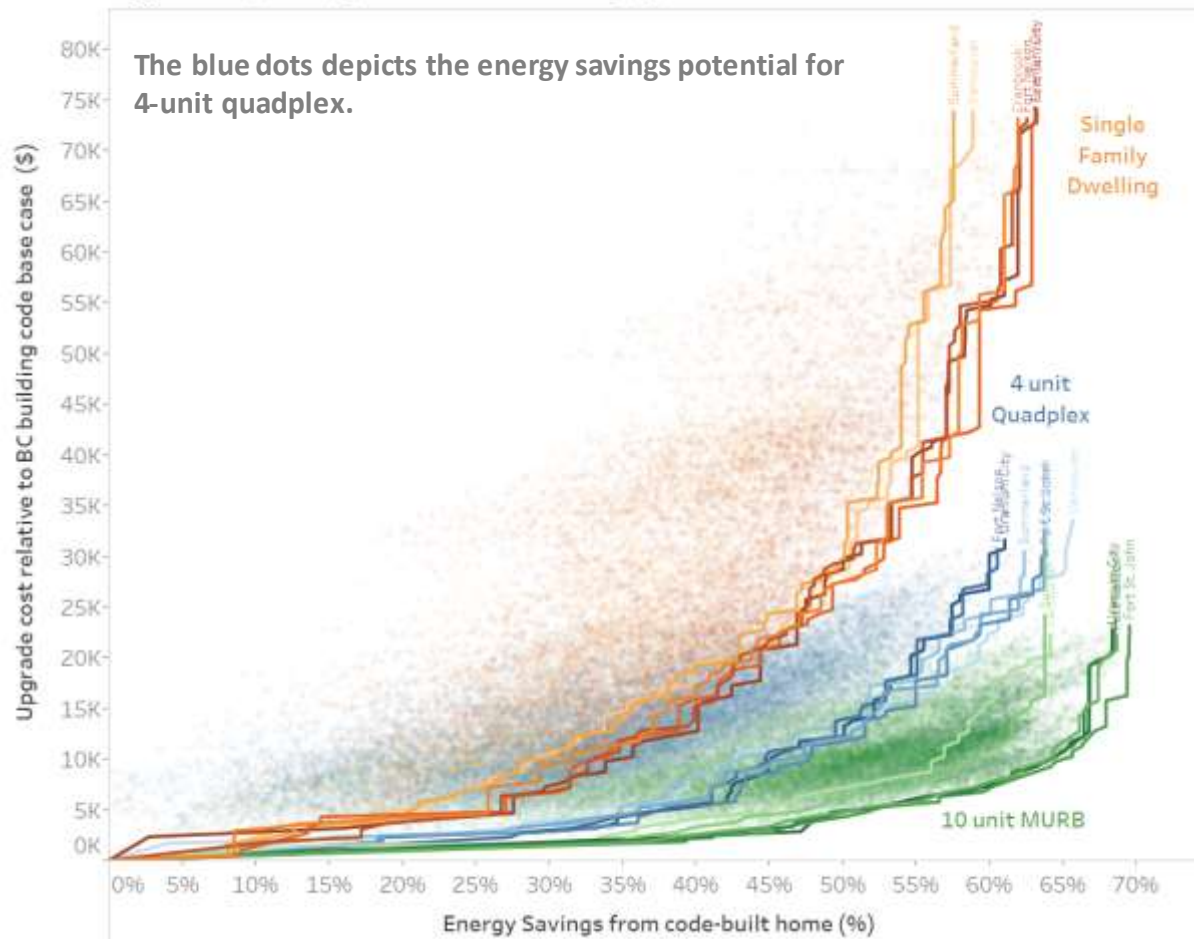
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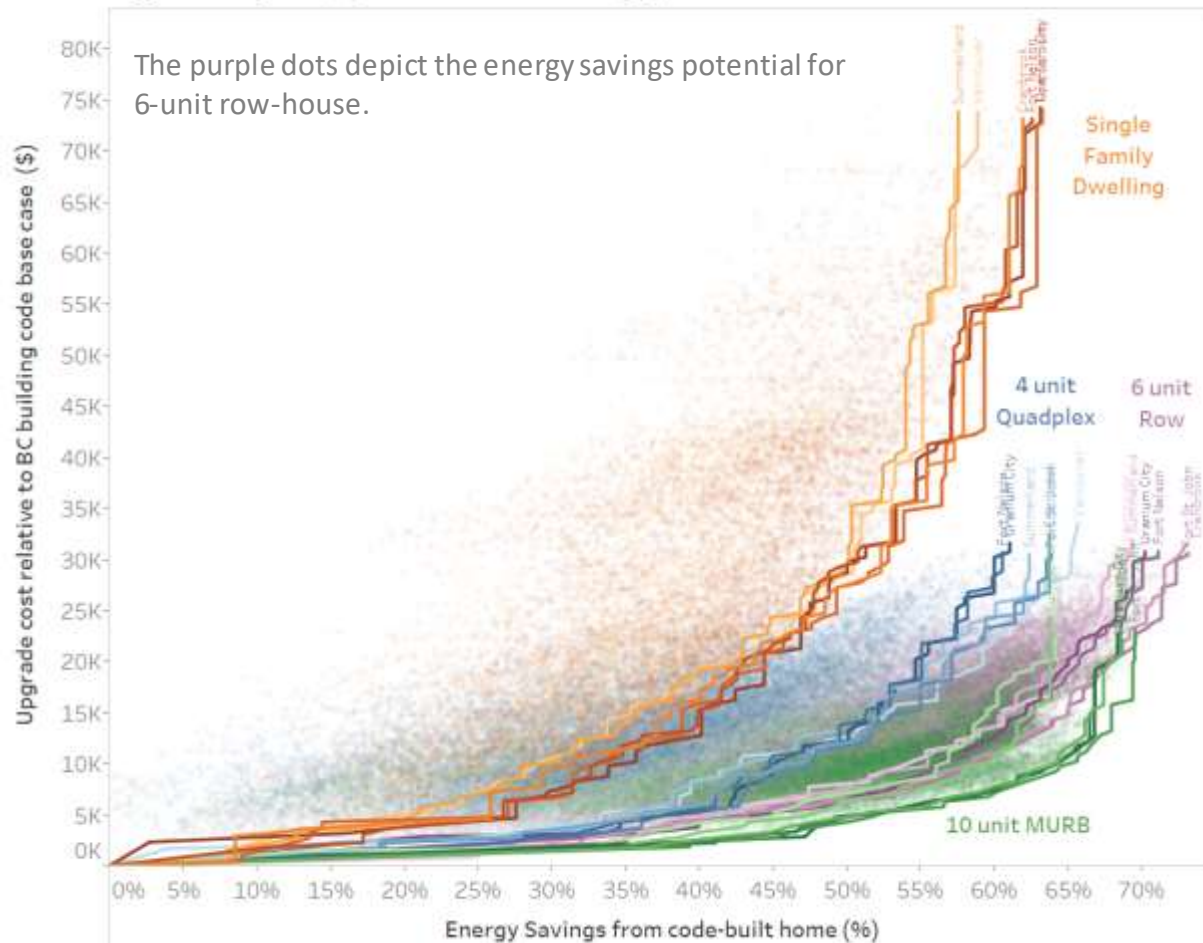


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The purple dots depict the energy savings potential for 6-unit row-house.



Building Technology Assessment Platform (BTAP)

- Commercial building simulation platform that evaluates sets of technologies to assess building code changes, incremental costs of code compliance, and cost effective net zero energy solutions.
- 16 building archetypes (NECB 2011) x 70 locations in all climate zones = < 1000 reference models
- Built on the OpenStudio/ EnergyPlus building simulation platform, developed by the U.S. DOE and NREL.
- Uses OpenStudio's Amazon Cloud computing, allowing tens of thousands of simulations to be run in a single hour.
- Project is open source, allowing transparency and public inspection of the implementation and assumptions. Ruby source code, archetypes and data for BTAP is available on GitHub under an open data license.

<https://github.com/NREL/openstudio-standards/tree/nrcan>

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Archetype Development

Define Geometry

Assign Space Types

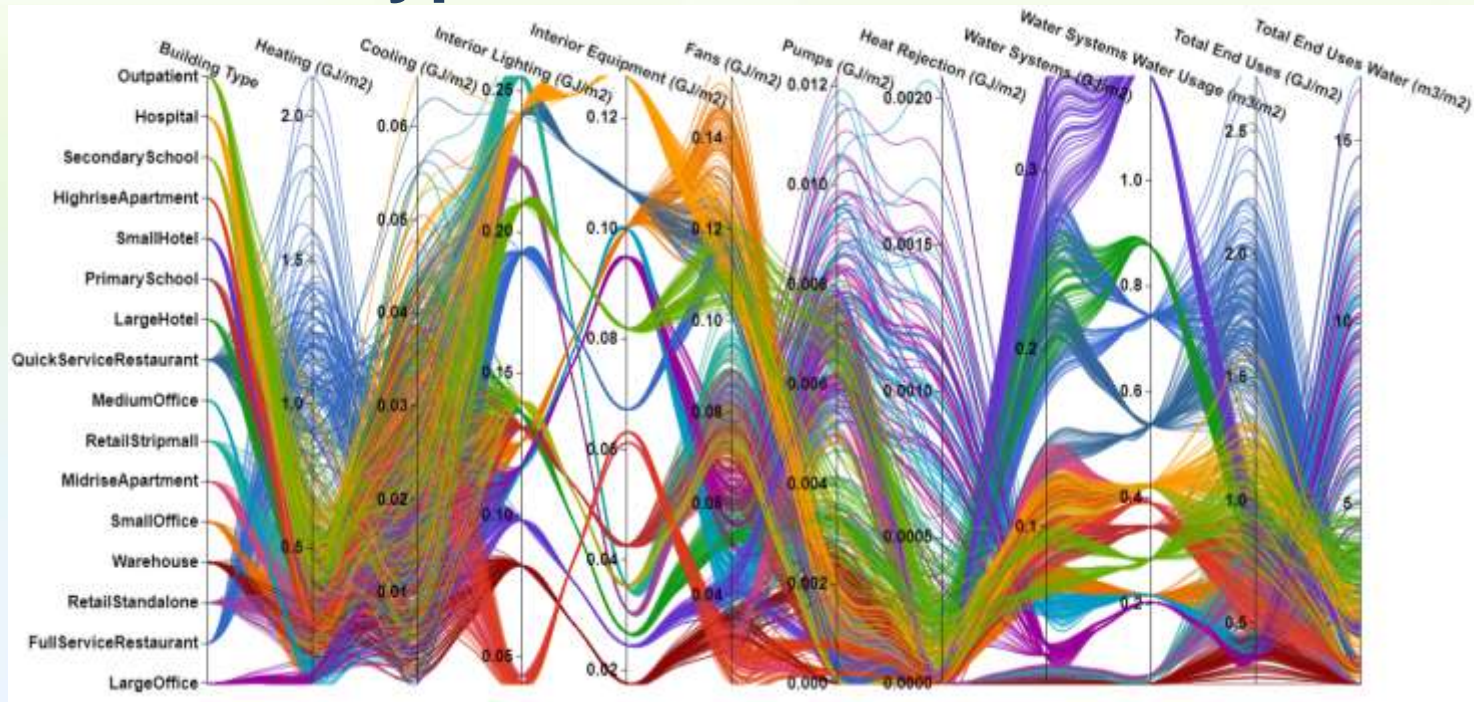
Define Zones/ Loops

Define Envelope / FDWR

Define HVAC Based on Sizing



Plot of baseline energy use in 16 NECB archetypes in 69 Canadian cities



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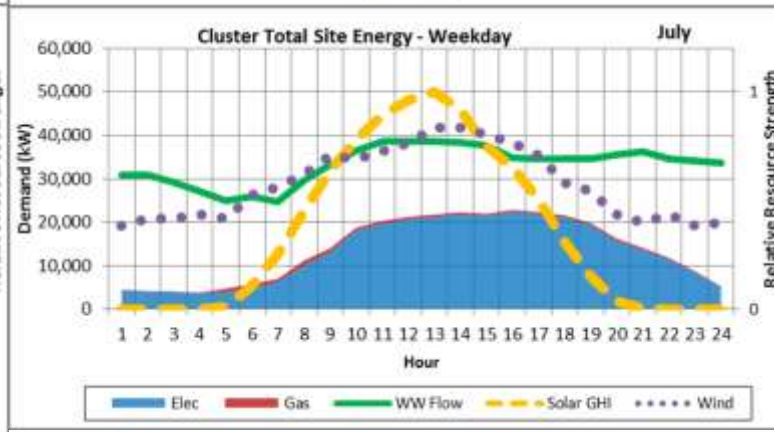
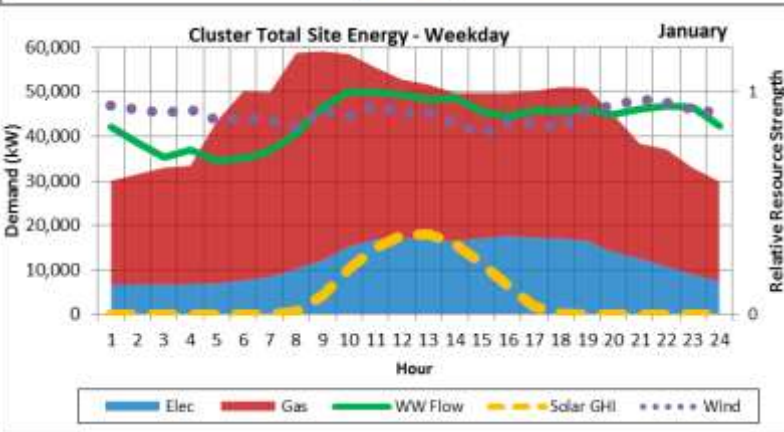
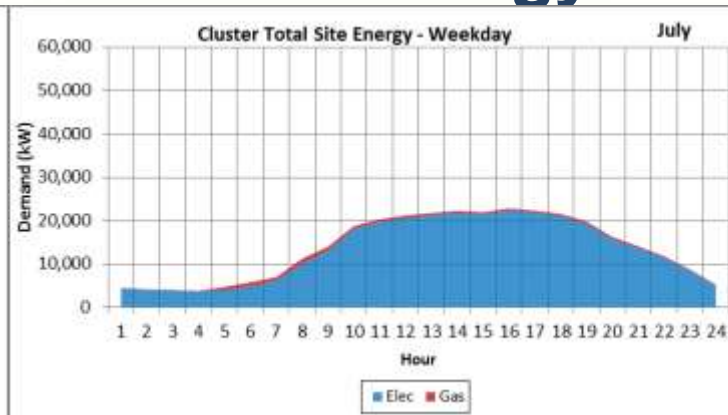
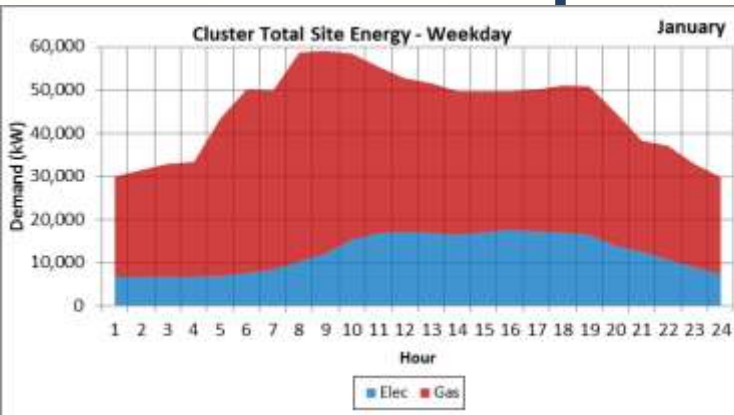


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BTAP outputs for District Energy Analysis

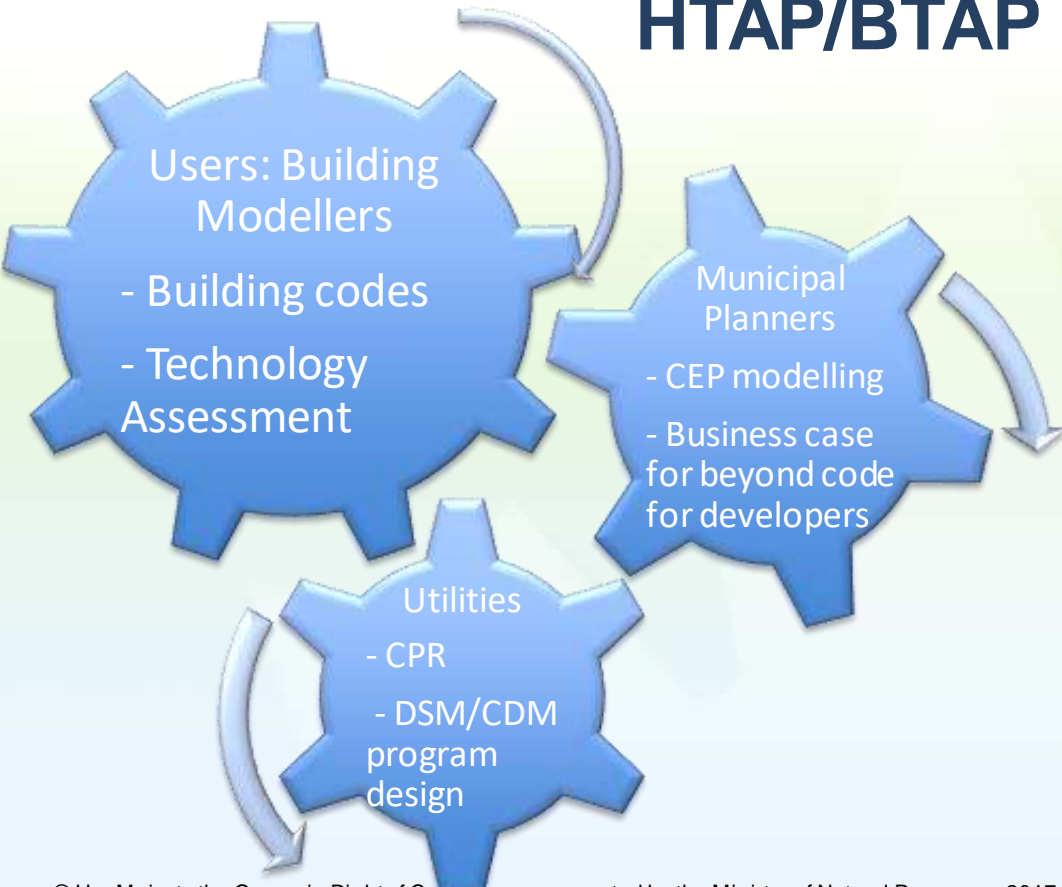


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HTAP/BTAP Data



Funded Projects:

- ***Addressing Barriers to High Performance Building Design***
- PERD funded, large project
- ***Better Evidence for Better Building Codes***
- 8 years of modest funding through Green Infrastructure (2018/19 through 2024/25)
- Preparing archetype datasets and models for application to building code development, for use by modellers

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What CanmetENERGY-Ottawa brings

- IP from ICEM, Smart Archetypes, HTAP/BTAP
- Expert analysis using other modelling platforms
 - e.g. RETscreen, Trnysys
- Leverage district and renewable energy expertise
- Leverage mapping expertise within NRCan
 - e.g. Canada Centre for Mapping and Earth Observation (CCMEO), GeoConnections
- Leverage existing federal data
 - e.g., EnerGuide for Houses, Canadian Housing Statistics Program



Recommended Reading

Data Issues and Promising Practices for ICEM

- Research paper developed based on review of three energy mapping projects: IEMOC, SCEC³ & TaNDM
- Identifies and analyzes key data issues observed across projects and proposes promising practices for their resolution
- Available online: <http://www.nrcan.gc.ca/energy/offices-labs/canmet/publications/19118>



We'd Like to Hear from You!

- Participate in an upcoming International Energy Association (IEA) Survey on Buildings and Energy Data Users and Data Needs
- Contribute your perspectives on your data needs and use cases to our research proposal development process
- Collaborate on a data interoperability test bed demonstration to identify cost-optimal pathways to a net zero built environment

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Thank you! Questions?

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