Residential Energy Use in Older Neighbourhoods: findings from the Urban Archetypes Project

Jessica Webster BA, MSLS
Natural Resources Canada

Sustainable Communities:
Do Older Neighbourhoods Make the Grade?

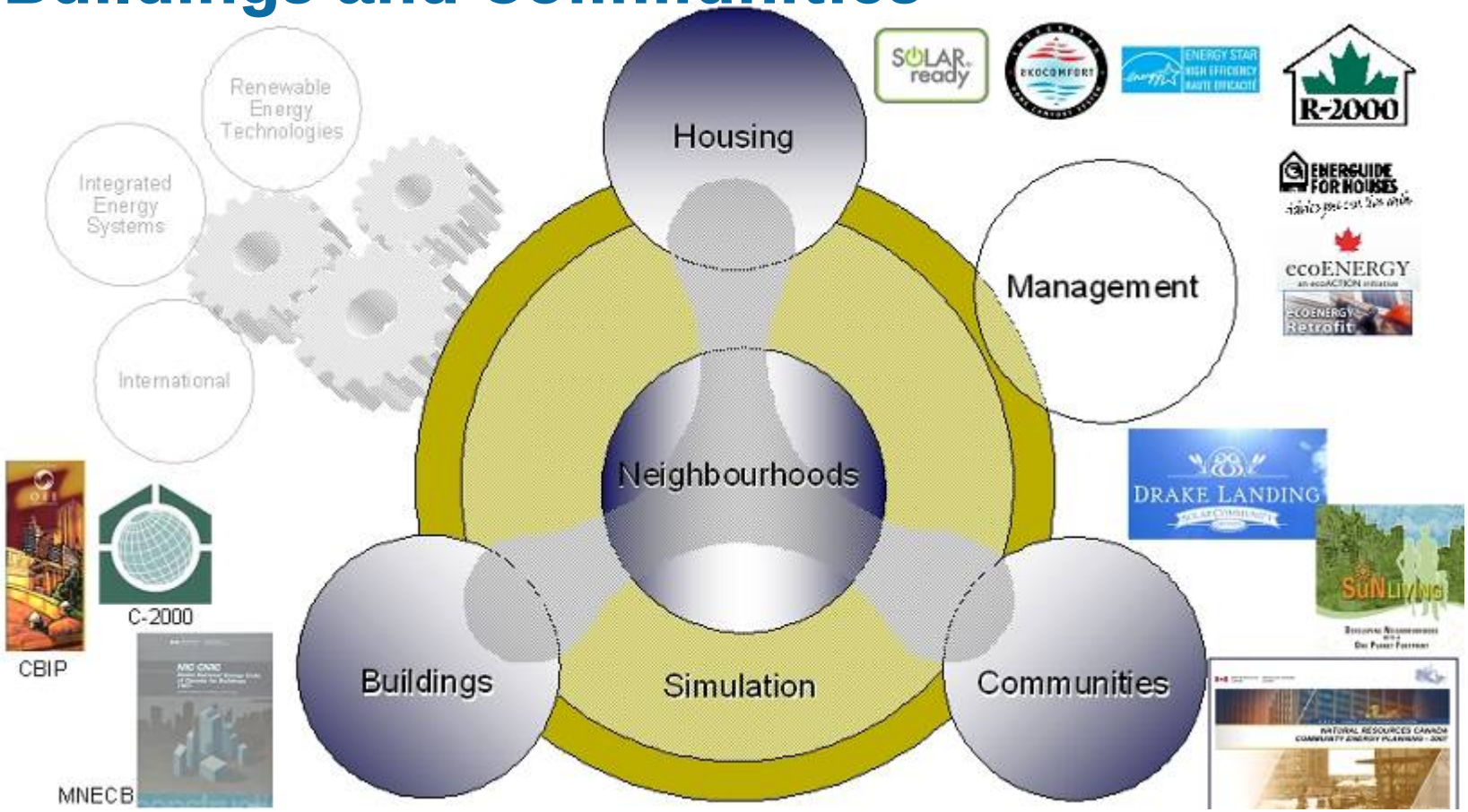
The Heritage Imperative: Old Buildings in an Age of Environmental Crisis

Toronto, September 25th, 2009

Overview

- Natural Resources Canada (NRCan)
  - CanmetENERGY
    - Housing, Simulation, Buildings and Communities
- The Urban Archetypes Project
  - Objectives
  - Results
    - Transportation
    - Housing
  - Some conclusions
- Recommendations for older houses
  - EcoENERGY Retrofit Homes program
- Addressing the energy ingenuity gap in communities

CanmetENERGY: Housing, Simulation, Buildings and Communities



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The Urban Archetypes Project

- 2005-2009
- 8 communities
- 31 neighbourhood study areas
  - Distinct urban form
  - Being of interest from an energy perspective
  - Approximately 300 dwelling units in size

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Older neighbourhoods

From east to west:

- Hydrostone, Halifax NS
- **Sandy Hill and New Edinburgh, Ottawa ON**
- Newcastle, Clarington ON
- Centre Square, Regina SK
- London Road, Lethbridge AB
- **Mission, Calgary AB**

Objectives

- ***To explore the linkages between urban form, lifestyle patterns of area residents and energy use on the neighbourhood scale***

- Develop neighbourhood energy profiles
- Build a library of case studies
- Make a general case for or against certain development patterns or aspects of development patterns
- Provide data to project participants
- Effectively communicate energy information
- Work towards a methodology for community energy characterization

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The Urban Archetypes Project

Is:

- Snapshot of ***annual energy end-use, cost and GHG emissions*** of ***residents in existing neighbourhoods*** *for* ***housing and vehicle transportation***, taking urban form and demographic variables into account

Is not:

- Building lifecycle analysis
  - Does not consider embodied energy
  - Does not consider energy for water, waste or food
- Recommendations for energy efficiency
- Renewable energy technology assessment

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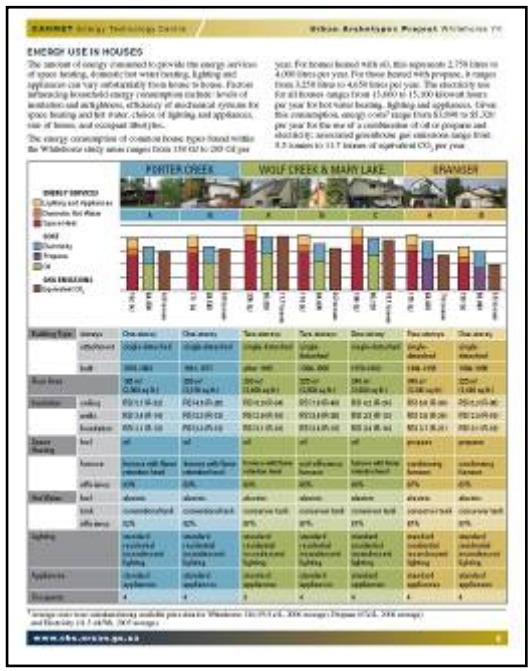
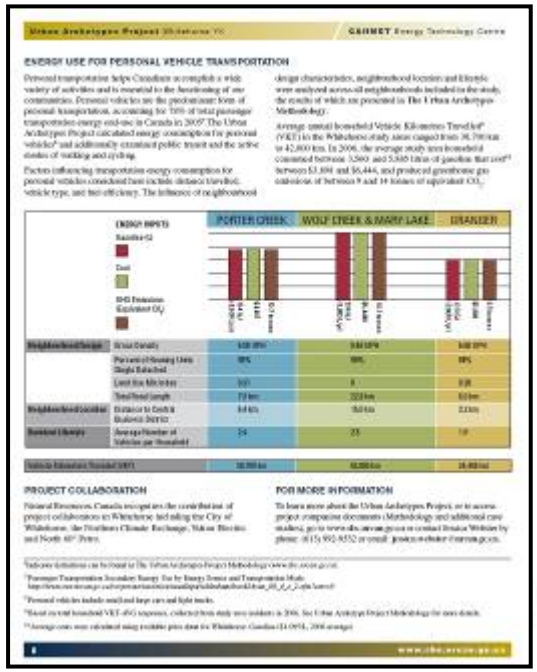
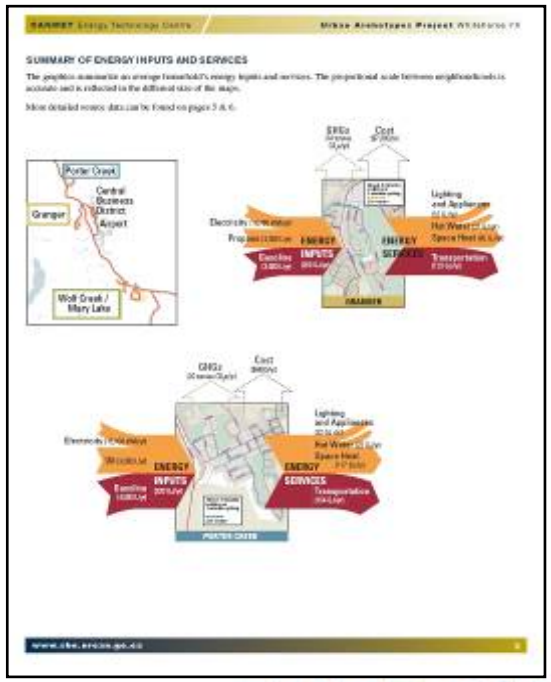
Urban Archetypes Community Case Studies

- Comparative summary of neighbourhood results on a community basis
- Available online: Google ‘Urban Archetypes Project’
- www.canmetenergy.nrcan.gc.ca







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Transportation analysis I

- **Transportation: energy, cost, GHGs**
  - ***Estimated annual household Vehicle Kilometres Travelled***
  - Make, model & year of vehicles
  - Provided by area residents in interviews
- **Urban Form**
  - ***Measured through spatial analysis***
  - Using Geographical Information Systems (GIS)
- **Demographics**
  - Household size, income
  - Provided in interviews

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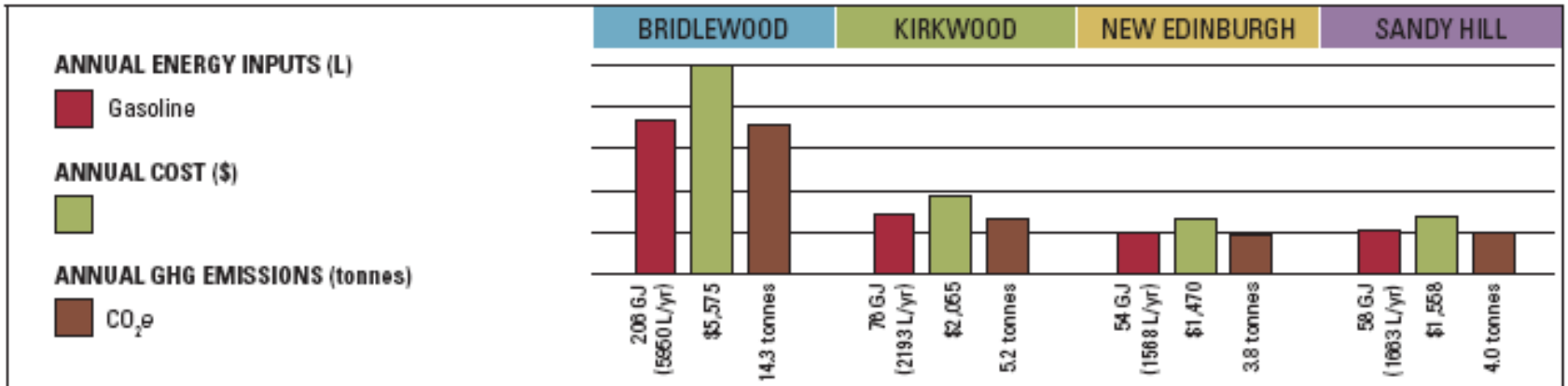
Transportation results: Ottawa



		BRIDLEWOOD	KIRKWOOD	NEW EDINBURGH	SANDY HILL
Resident Lifestyle	Vehicle Kilometres Travelled (VKT-AVG)	44 000 km/yr	16 900 km/yr	12 000 km/yr	12 700 km/yr
	Average number of vehicles per household	2.2	0.8	0.8	0.8
Neighbourhood Design	Gross density (units per hectare)	15.0	29.7	42.2	47.6
	Percent of housing units single detached	96.5%	0.8%	20%	18.5%
	Land-use mix index*	0.3	2.0	3.6	0.3
	Total road length	4.2 km	0.6 km	4.4 km	5.9 km
Neighbourhood Location	Distance to central business district	19.9 km	5.7 km	2.4 km	1.3 km

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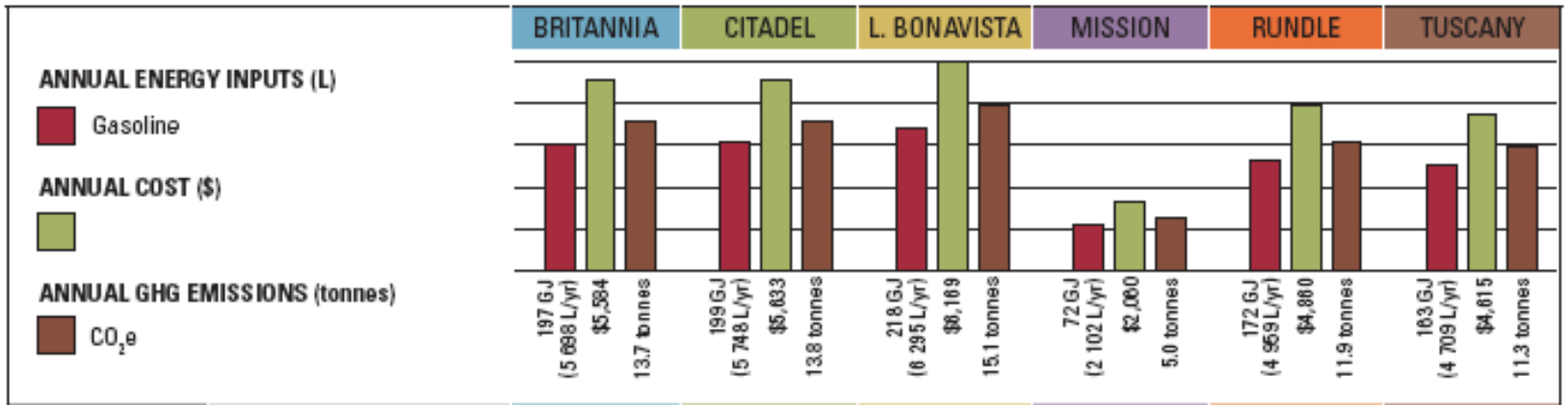
Transportation results: Calgary



		BRITANNIA	CITADEL	L. BONAVISTA	MISSION	RUNDLE	TUSCANY
Resident Lifestyle	Vehicle kilometres travelled (VKT-AVG)	40 400 km/yr	42 300 km/yr	45 600 km/yr	16 200 km/yr	36 200 km/yr	36 500 km/yr
	Average number of vehicles per household	2.3	2.1	2.4	0.9	2.6	–
Neighbourhood Design	Gross density (units per hectare)	6.43	14.87	7.02	55.5	11.61	14.9
	Percent of housing units Single detached	79%	93%	98%	4%	68%	91%
	Land-use mix index*	0.28	0.00	0.20	4.00	2.00	1.10
	Total road length	6.3 km	5.3 km	5.3 km	0.9 km	4.4 km	3.9 km
Neighbourhood Location	Distance to central business district	4.1 km	13.2 km	12.2 km	1.6 km	7.2 km	16.0 km

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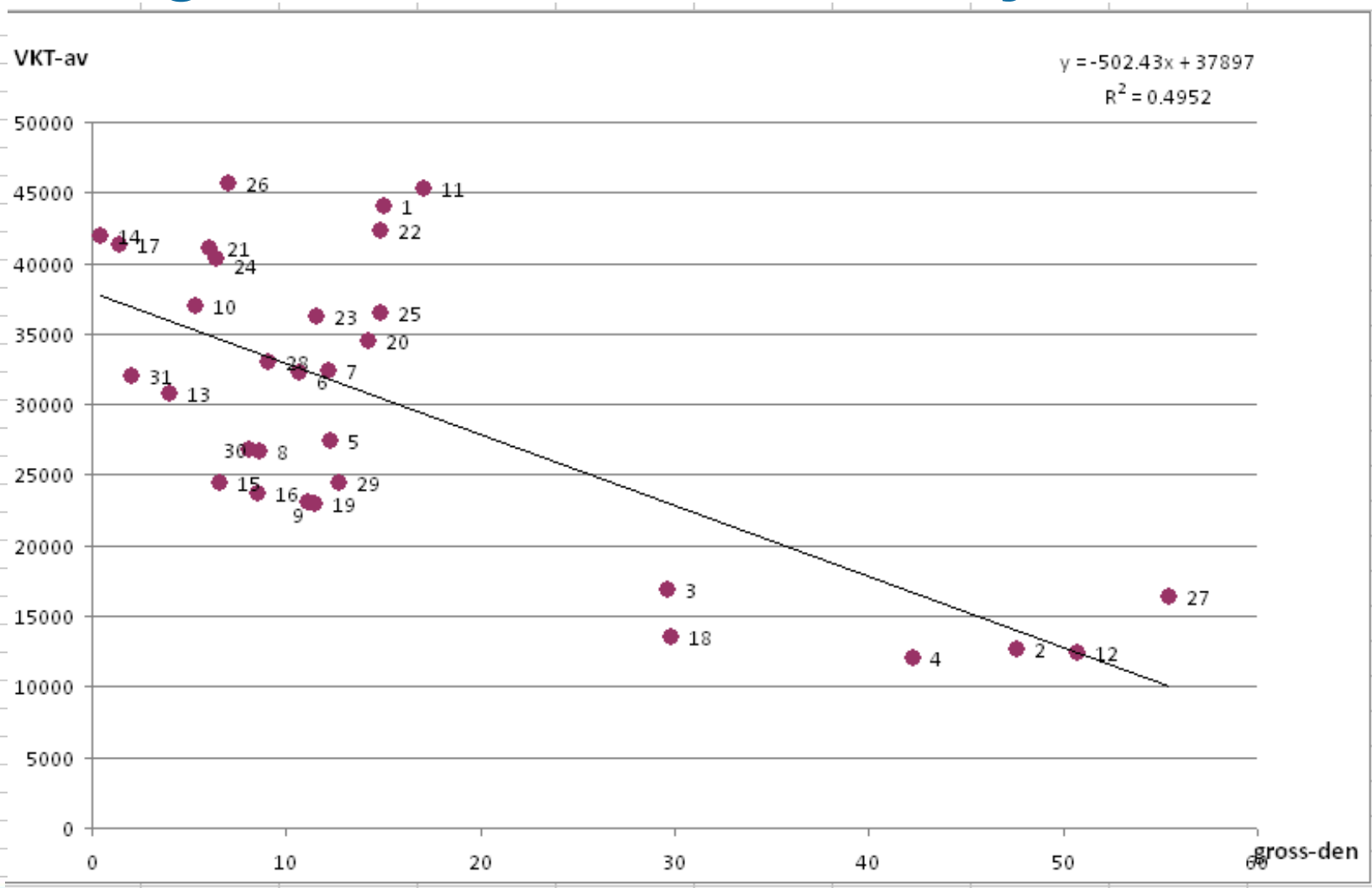
Transportation analysis II

- Average household Vehicle Kilometres Travelled (VKT) used as the dependent variable in multivariate regression analysis
- Spatial variables of urban form quantified included:
  - **Neighbourhood design**
    - Density
    - % of single family dwellings
    - Land use mix index
    - Street connectivity
  - **Neighbourhood location**
    - Distance to CBD
    - Distance to rail
    - Distance to highway interchange
- Subsequent bi-variate analysis took household size and income into account

Transportation results: correlation of VKT to gross residential density

1	Bridlewood Park
2	Sandy Hill
3	Kirkwood
4	New Edinburgh
5	Eagle Ridge
6	Westwood Plateau
7	Ranch Park
8	Burquitlam
9	Cathedral
10	Twin Lakes Southeast
11	Twin Lakes Northwest
12	Centre Sqaure
13	Porter Creek
14	Wolf Creek/ Mary Lake
15	Granger
16	Clayton Park
17	Kingswood
18	Hydrostone
19	Lucasville
20	Hobbs
21	Newcastle
22	Citadel
23	Rundell
24	Britannia
25	Tuscany
26	Lake Bonavista
27	Mission
28	Tudor Estates
29	London Road
30	Park Meadows
31	Paradise Canyon



Transportation results: correlation of VKT to distance to CBD

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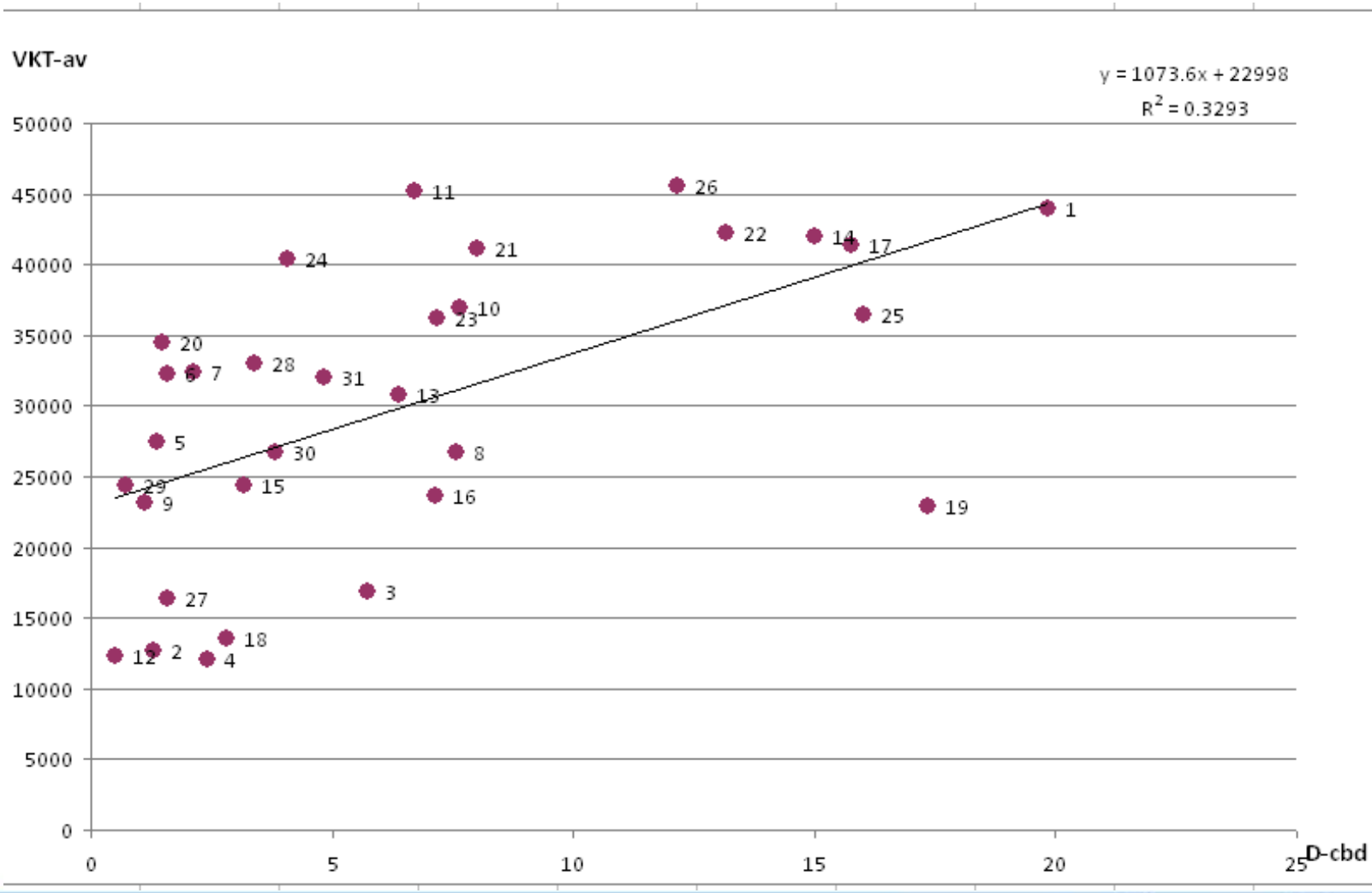

Some conclusions on transportation

- Older neighbourhoods in Urban Archetypes Project:
  - Centrally located
  - Higher densities
  - More mixed-use
- Lower Vehicle Kilometres Travelled
  - Less fuel consumed, lower costs, fewer GHG emissions
- Anecdotally, residents of these neighbourhoods also took more walking, cycling and transit trips
- ***The older neighbourhoods studied in the urban archetypes project were more inherently efficient from a transportation energy perspective***
- Urban form variables became less significant when household size taken into account

Housing analysis

- **Total annual energy, cost and GHGs**
  - Space heating, hot water and lighting/appliances
- **Initial approach: utilities data**
  - Inconsistencies in data
  - Inability to link energy use to dwelling type
- **Simulation of *representative dwelling types***
  - Houses: NRCan EnerGuide for Houses audits and *HOT2XP/HOT2000* software
    - Pre-retrofit audits
  - Apartments: Building geometry from site visits, and '*Screening Tool for New Building Design*'
    - http://screen.nrcan.gc.ca

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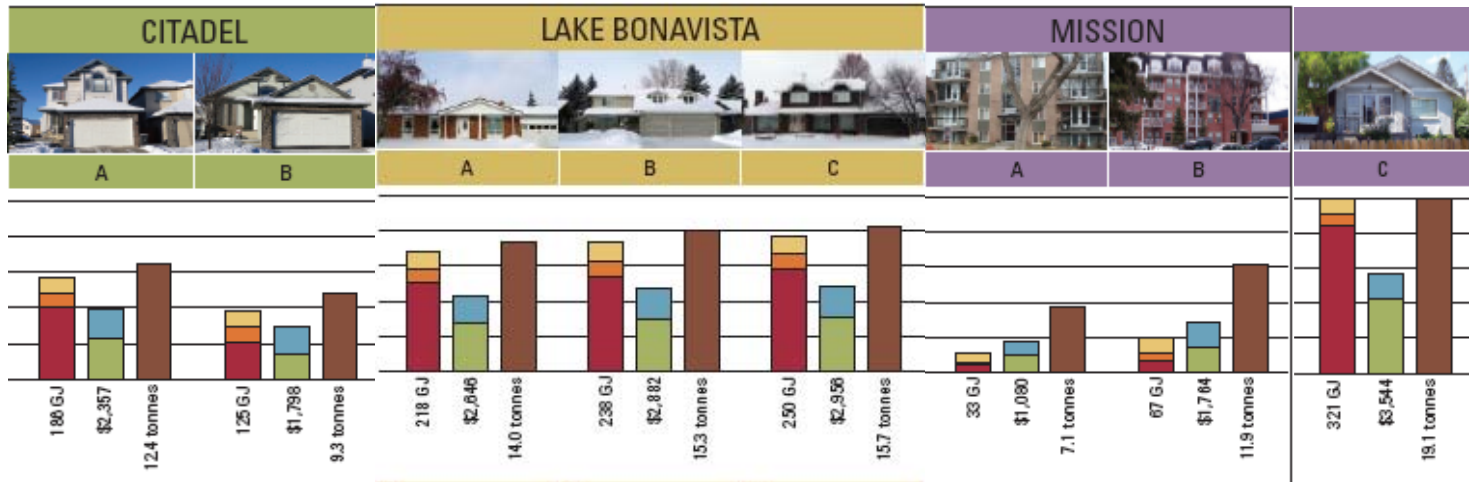
Housing results: Ottawa

EnerGuide Rating System		69		49	52	58	53	41	64
Energy Use Intensity		648.0 MJ/m² floor area	94.1 MJ/m² floor area	1 272.0 MJ/m² floor area	1 580.0 MJ/m² floor area	1 253 MJ/m² floor area	1 308 MJ/m² floor area	1 126 MJ/m² floor area	1 006 MJ/m² floor area
Building Type	Storeys	two storeys	three-and-a-half storeys	two storeys	two storeys	two storeys	two storeys	three storeys	two storeys
	Attachment	single detached	low-rise apartment building	single detached	single detached	duplex	single detached	four-plex	single detached
	Built	1984–95	1955	pre-1945	pre-1945	pre-1945	pre-1945	pre-1945	1945–60
Heated Floor Area		278 m² (2996 sq. ft.)	108 m²/suite (1162 sq. ft./suite)	217 m² (2 339 sq. ft.)	137 m² (1 472 sq. ft.)	143 m² (1 543 sq. ft.)	168 m² (1 802 sq. ft.)	90 m² (968 sq. ft.)	177 m² (1905 sq. ft.)
Insulation	Ceiling	5.7 RSI (R-32)	3.6 RSI (R-20)	2.8 (R-16)	2.4 RSI (R-13)	2.3 RSI (R-13)	2.2 RSI (R-12)	2.5 RSI (R-14)	3.9 RSI (R-22)
	Walls	2.6 RSI (R-14)	1.5 RSI (R-9)	1.3 RSI (R-7)	0.9 (R-5)	1.0 RSI (R-5)	1.1 RSI (R-6)	1.2 RSI (R-7)	1.4 RSI (R-8)
	Foundation	1.8 RSI (R-10)	0.8 RSI (R-5)	0.5 RSI (R-3)	0.2 (R-1)	0.6 RSI (R-3)	0.1 RSI (R-1)	0.7 RSI (R-4)	0.8 RSI (R-4)
Space Heating	Fuel	natural gas	natural gas	natural gas	oil	natural gas	oil	natural gas	natural gas
	Furnace	with continuous pilot	with continuous pilot	with continuous pilot	with flame-retention head	induced draft fan	with flame-retention head	with spark ignition	induced draft fan
	Efficiency	78%	70%	78%	83%	80%	83%	78%	80%
	Ventilation	none	none	none	none	none	none	none	none
Hot Water	Fuel	natural gas	natural gas	natural gas	electricity	natural gas	electricity	natural gas	natural gas
	Tank	conventional (pilot)	conventional (pilot)	conventional (pilot)	conventional	conventional (pilot)	conventional	induced draft fan	conventional
	Efficiency	55%	70%	55%	82%	55%	82%	57%	55%
Lighting		incandescent	incandescent	incandescent	incandescent	incandescent	incandescent	incandescent	incandescent
Appliances		conventional	conventional	conventional	conventional	conventional	conventional	conventional	conventional
Occupants		4	3	5	5	2	3	2	4

Housing results: Calgary, selected



EnerGuide Rating System		69	76	66	65	65	n/a	n/a	44
Energy Use Intensity		703 MJ/m²	605 MJ/m²	624 MJ/m²	720 MJ/m²	719 MJ/m²	462 MJ/m²	475 MJ/m²	1 378 MJ/m²
Building Type	Storeys	two storeys	one storey	one storey	two storeys	two storeys	four storeys / 16 suites	six storeys / 38 suites	two storeys
	Attachment	single detached	single detached	single detached	single detached	single detached	MURB	MURB	single detached
	Built	1984–95	post-1995	1961-77	1961-77	1978-83	1966	1998	pre-1945
Heated Floor Area		265 m² (2 846 sq.ft.)	207 m² (2 226 sq.ft.)	348 m² (3 749 sq.ft.)	330 m² (3 554 sq.ft.)	348 m² (3 746 sq.ft.)	73 m² (785 sq.ft.)	140 m² (1 506 sq.ft.)	233 m² (2 509 sq.ft.)
Insulation	Ceiling	5 RSI (R-28)	6.0 RSI (R-34)	4.6 RSI (R-26)	4.3 RSI (R-24)	3.6 RSI (R-20)	2.6 RSI (R-15)	4.3 RSI (R-24)	2.1 RSI (R-12)
	Walls	2.6 RSI (R-15)	2.8 RSI (R-16)	1.9 RSI (R-11)	1.9 RSI (R-11)	1.9 RSI (R-11)	1.8 RSI (R-10)	2.9 RSI (R-16)	1.0 RSI (R-6)
	Foundation	2.4 RSI (R-14)	2.2 RSI (R-12)	1.0 RSI (R-6)	1.2 RSI (R-7)	1.2 RSI (R-7)	none	none	0.6 RSI (R-3)
Space Heating	Fuel	natural gas	natural gas	natural gas	natural gas	natural gas	natural gas	natural gas	natural gas
	Furnace	with continuous pilot	boiler with spark ignition	with continuous pilot	with continuous pilot	with continuous pilot	boiler, natural draft, on-off	boiler, natural draft, on-off	with continuous pilot
	Efficiency	78%	80%	78%	78%	78%	80%	80%	78%
	Ventilation	none	none	none	none	none	none	mechanical outdoor air supply	none
Hot Water	Fuel	natural gas	natural gas	natural gas	natural gas	natural gas	natural gas	natural gas	natural gas
	Tank	conventional	conventional	conventional	conventional	conventional	conventional	conventional	conventional
	Efficiency	55%	55%	55%	55%	55%	80%	80%	55%
Lighting		incandescent	incandescent	incandescent	incandescent	incandescent	incandescent	incandescent	incandescent
Appliances		conventional	conventional	conventional	conventional	conventional	conventional	conventional	conventional
Occupants		3	3	3	4	4	1	2	2

Some conclusions on housing

- Greater variation in housing stock in older neighbourhoods
  - Dwelling type, age, retrofit, tenure
- Housing energy performance varies accordingly
  - Old large houses can be among the most inefficient
    - Can be retrofit to be highly efficient
  - Low-rise apartments studied in archetypes project were found to be more efficient
    - Less access to data on apartments overall
    - Tenure can be a disincentive to efficiency and retrofits
- Variety of housing stock makes for more complete communities
  - Subdivided older homes appear to use less energy on a household basis

Recommendations for older houses

- **Air sealing**
  - Caulking & weatherstripping
- **Heating system tune-up**
- **Insulation**
  - Vapour and air barriers
  - Basements and attics
  - Blowing nsulation into wood-frame walls
  - If original exterior finish has been replaced previously the opportunity exists to copy the original finish when retrofitting the exterior
- **Windows**
  - Weatherstripping of older, single-pane, wood-frame windows
  - Possible to have custom wood storms made to order if original wood storm windows are not salvagable
  - Select interior storms; avoid metal storms or storm-and-screen combinations
- **Doors**
  - Weatherstripping
  - Avoid aluminum storms
  - Restore enclosed vestibule

ecoENERGY Retrofit Homes

- Program from the Office of Energy Efficiency (OEE) at NRCan
- Formerly known as EnerGuide for Houses
  - Still uses EnerGuide Rating System (ERS)
- 427,924 pre-retrofit evaluation completed since April 1, 2007
- 183.7M paid in incentives
- Average grant $1,423
- Average energy savings 23%
- Average GHG reductions 3.3 tonnes
- 1,570 certified energy advisors across Canada
  - Audit must be completed by a licensed contract prior to commencing retrofits
- 25% in additional incentives through March 31, 2010
- www.ecoaction.gc.ca/ecoenergy

Addressing the energy ingenuity gap in communities

- Canada needs a methodology for community energy and GHG characterization
  - Best practice guidelines or standards
- Energy and emissions inventories
  - Benchmarking
  - Target setting
  - Scenario-based modelling ‘what if’
- Integration of energy information into community decision making
  - Linking energy to the land use planning process
- Different levels of detail required for energy decisions at different scales in the urban environment
  - Mapping energy demand and supply using GIS

Current projects

- Community Energy Solutions Roadmap
  - Approved by the demand Side Management Committee of the Council of Energy Ministers
- Minister's roundtable on Integrated Community Energy Solutions
- Federal Technical Committee on Urban Energy Characterization
  - Scan of federal energy data sources
  - Scan of energy and GHG characterization methodologies (CSA)
- Energy mapping research
  - Prototype developed for City of Prince George BC
  - Energy mapping symposium

Thank you!

Contact:
Jessica Webster
Jessica.Webster@nrcan.gc.ca
613 992 9532
www.canmetenergy.nrcan.gc.ca

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