



# QUEST

**in 2017**

Canada's leader in developing  
Smart Energy Communities

## **Ontario Cost-Benefit Analysis Tool**

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CEKAP - 13 September 2017

# BACKGROUND

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- Originally developed by the Canadian Urban Institute (CUI) under the Integrated Energy Mapping for Ontario Communities (IEMOC) project in 2011
- Used to predict **energy reduction, GHG and ROI of various building and transportation scenarios, and distributed energy resources (DERs)** compared to Business-As-Usual
- QUEST Ontario Municipal Working Group to assess the scope of a potential update and assessing level of effort needed

# THE COST-BENEFIT ANALYSIS TOOL

## Fuel Inputs

Existing Population (2008)	359,000	Growth rate	1%	2021 Population	429,473
Existing Jobs (2008)	201,091	Project populat	70,473	2021 Jobs	229,886

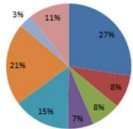
## Existing Buildings

Fuel	2006
Natural Gas	
Gasoline	
Diesel	
Biodiesel	
Biomass	
Fuel Type - Electricity	
Nuclear	
Coal	
Renewable	
Gas Combined Cycle	
Gas Single Cycle	
Electricity - Blended	
Electricity - Day Time	
Electricity - Night Time	

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\*EIFs based on add  
\*\* Due to data aggrt

Electricity Consumption Breakdown (%)



Baseline Buildings

Start input fuel Baseline Buildings

## Electricity

Existing Buildings	Projected Development
Res Low	63
Res Med	41
Res High	25
Comm Office	5
Comm Retail	8
Industrial	19
Institutional Low	6
Institutional High	9
<b>TOTAL</b>	<b>38,625,945</b>

## Projected Development

City-Wide Total: Building Space (m<sup>2</sup>) \* 2009

Existing Buildings	Projected Development
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<b>TOTAL</b>	<b>38,625,945</b>

\*Developed in collaboration with City of

City Wide Project Building Space (m<sup>2</sup>) - Phases



## Existing Building Retrofits

m <sup>2</sup>	Electricity					Natural Gas						
	Simulated EF (GJ/m <sup>2</sup> )	Adjusted EF (GJ/m <sup>2</sup> )	% of Building Space Treated	Consumption (GJ)	Emissions (tonnes CO <sub>2</sub> )	Simulated EF (GJ/m <sup>2</sup> )	Adjusted EF (GJ/m <sup>2</sup> )	% of Building Space Treated	% DHV of Natural Gas	DHV Consumption (GJ)	Consumption (GJ)	Emissions (tonnes CO <sub>2</sub> )
Res Low	0.28	0.18	100%	3,203,065	23,418	0.44	0.38	100%	41%	1,089,998	7,535,604	412
Res Medium	0.27	0.18	100%	989,680	7,220	0.37	0.24	100%	46%	590,986	1,284,752	71
Res High	0.32	0.22	100%	889,314	6,501	0.97	0.17	100%	17%	81,367	478,632	2
Comm Office	0.77	0.60	100%	791,111	5,710	0.53	141	100%	0%	-	18,349,503	80
Comm Retail	0.97	0.78	100%	1,786,952	12,501	1.31	130	100%	0%	-	2,862,884	84
Industrial	0.54	0.54	100%	2,477,504	18,303	0.73	142	100%	0%	-	6,566,070	26
Institutional Low	0.40	0.40	100%	381,624	2,863	0.84	156	100%	8%	120,994	1,512,425	84
Institutional High	0.89	0.89	100%	1,223,620	8,945	0.87	143	100%	22%	430,481	1,956,731	101
<b>TOTAL</b>	<b>38,625,945</b>			<b>11,664,464</b>	<b>85,273</b>					<b>4,313,426</b>	<b>24,032,381</b>	<b>1,348</b>

## High Efficiency Energy Intensities

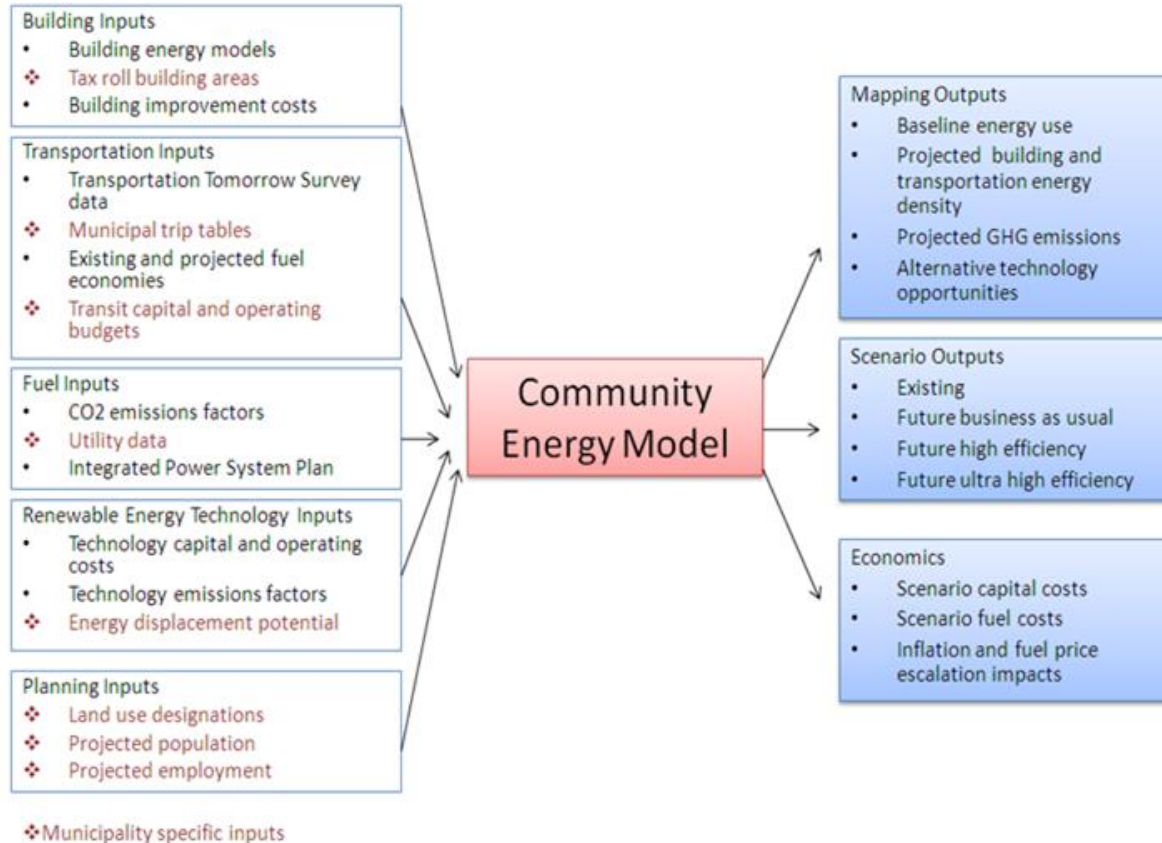
m <sup>2</sup>	Electricity					Natural Gas						
	Simulated EF (GJ/m <sup>2</sup> )	Adjusted EF (GJ/m <sup>2</sup> )	% of Building Space Treated	Consumption (GJ)	Emissions (tonnes CO <sub>2</sub> )	Simulated EF (GJ/m <sup>2</sup> )	Adjusted EF (GJ/m <sup>2</sup> )	% of Building Space Treated	% DHV of Natural Gas	DHV Consumption (GJ)	Consumption (GJ)	Emissions (tonnes CO <sub>2</sub> )
Res Low	0.25	0.15	100%	3,101,764	22,875	0.39	0.33	100%	29%	1,900,283	6,952,899	361
Res Medium	0.26	0.18	100%	961,807	7,045	0.32	0.21	100%	40%	450,061	1,037,852	8
Res High	0.37	0.23	100%	869,495	6,356	0.64	0.11	100%	20%	63,269	316,345	5
Comm Office	0.43	0.43	100%	559,133	4,080	0.53	157	100%	0%	-	2,044,637	104
Comm Retail	0.56	0.45	100%	994,350	7,269	1.54	152	100%	0%	-	3,347,625	181
Industrial	0.22	0.22	100%	1,504,422	10,980	0.75	145	100%	8%	67,061	6,706,106	27
Institutional Low	0.50	0.26	100%	295,576	1,861	0.86	179	100%	8%	86,824	1,738,473	91
Institutional High	0.76	0.76	100%	1,043,774	7,630	0.90	148	100%	10%	384,529	2,025,901	118
<b>TOTAL</b>	<b>38,625,945</b>			<b>9,292,929</b>	<b>67,331</b>					<b>2,921,126</b>	<b>23,820,116</b>	<b>1,336</b>

## Ultra High Efficiency Energy Intensities

m <sup>2</sup>	Electricity					Natural Gas						
	Simulated EF (GJ/m <sup>2</sup> )	Adjusted EF (GJ/m <sup>2</sup> )	% of Building Space Treated	Consumption (GJ)	Emissions (tonnes CO <sub>2</sub> )	Simulated EF (GJ/m <sup>2</sup> )	Adjusted EF (GJ/m <sup>2</sup> )	% of Building Space Treated	% DHV of Natural Gas	DHV Consumption (GJ)	Consumption (GJ)	Emissions (tonnes CO <sub>2</sub> )
Res Low	0.24	0.15	100%	2,906,367	21,247	0.29	0.24	100%	29%	1,377,705	4,750,707	20
<b>TOTAL</b>	<b>38,625,945</b>			<b>2,906,367</b>	<b>21,247</b>					<b>1,377,705</b>	<b>4,750,707</b>	<b>20</b>

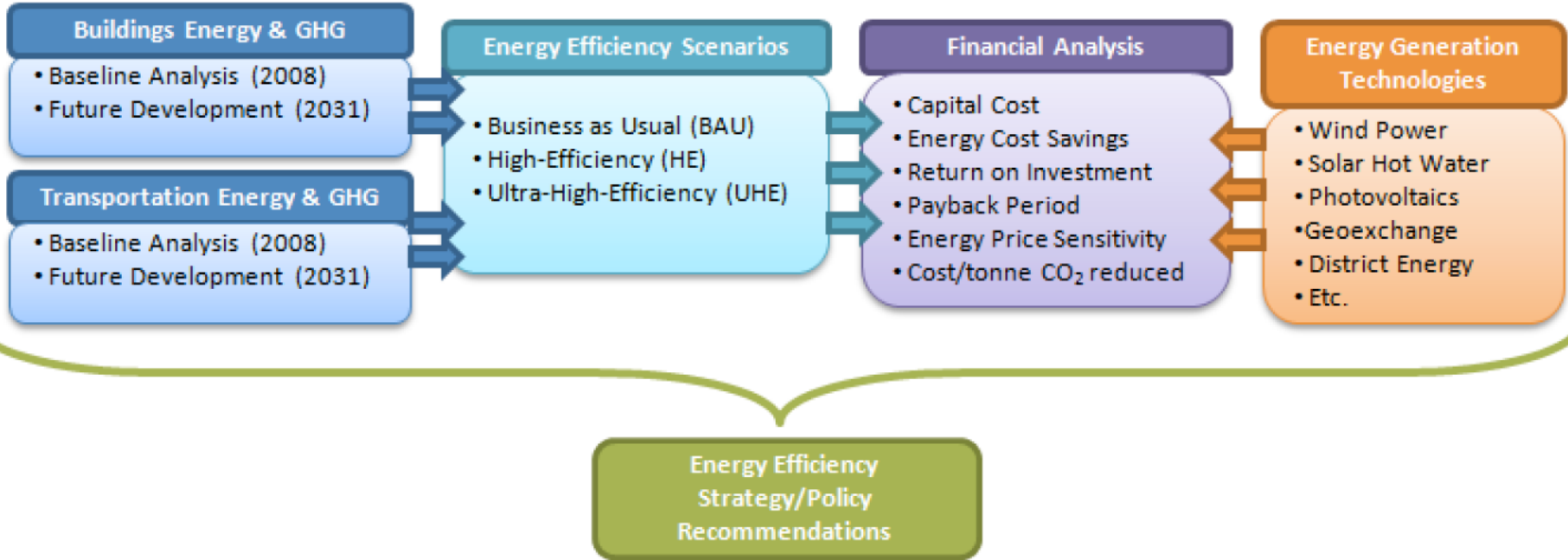
Start input fuel Baseline Buildings

# THE COST-BENEFIT ANALYSIS TOOL

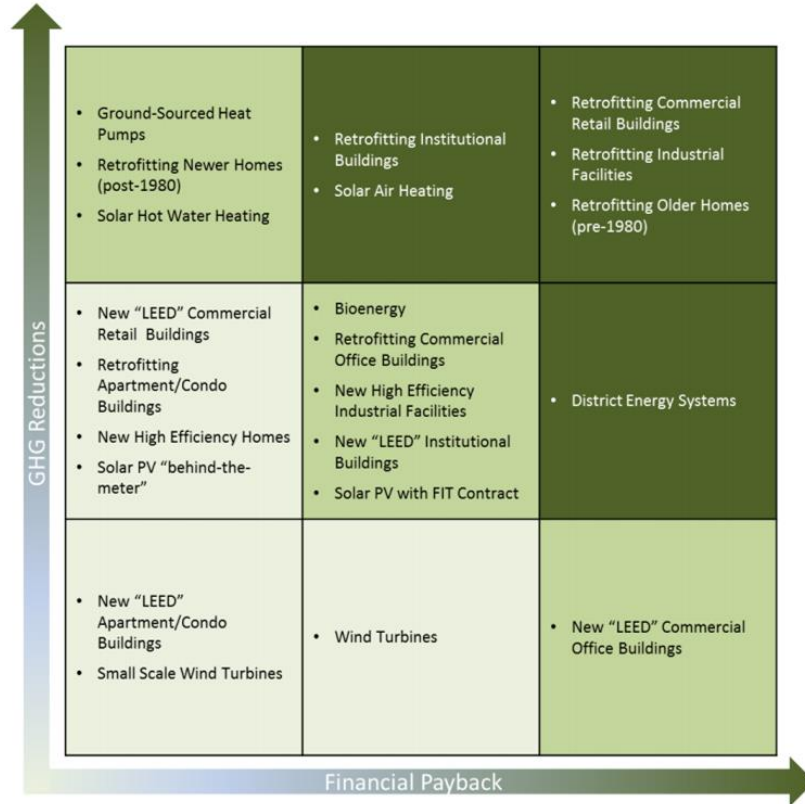


# THE COST-BENEFIT ANALYSIS TOOL

## ENERGY MAPPING PROCESS



# APPLICATIONS



# APPLICATIONS

## Office - New

E Cost BAU			12.44	13.32	13.56	13.76	14.08	14.36
E Cost HE			7.89	8.38	8.53	8.67	8.86	9.04
E Cost UHE			7.26	7.68	7.82	7.95	8.12	8.29
	CAP	E - Save						
HE vs BAU	\$	(26.11)	4.55	4.94	5.03	5.10	5.22	5.32
UHE vs BAU	\$	(52.09)	5.18	5.64	5.74	5.82	5.96	6.08
UHE vs HE	\$	(25.98)	0.63	0.70	0.71	0.72	0.74	0.76
	IRR	Payback (Yrs)						
HE vs BAU		20%	4					
UHE vs BAU		11%	8					
UHE vs HE		-3%	-					

## Office - Retro Existing

E Cost BAU			17.60	18.83	19.16	19.45	19.90	20.30
E Cost HE			14.97	16.25	16.53	16.76	17.16	17.50
E Cost UHE			13.85	14.76	14.88	14.94	15.14	15.29

## District Energy - Existing DT

### Income

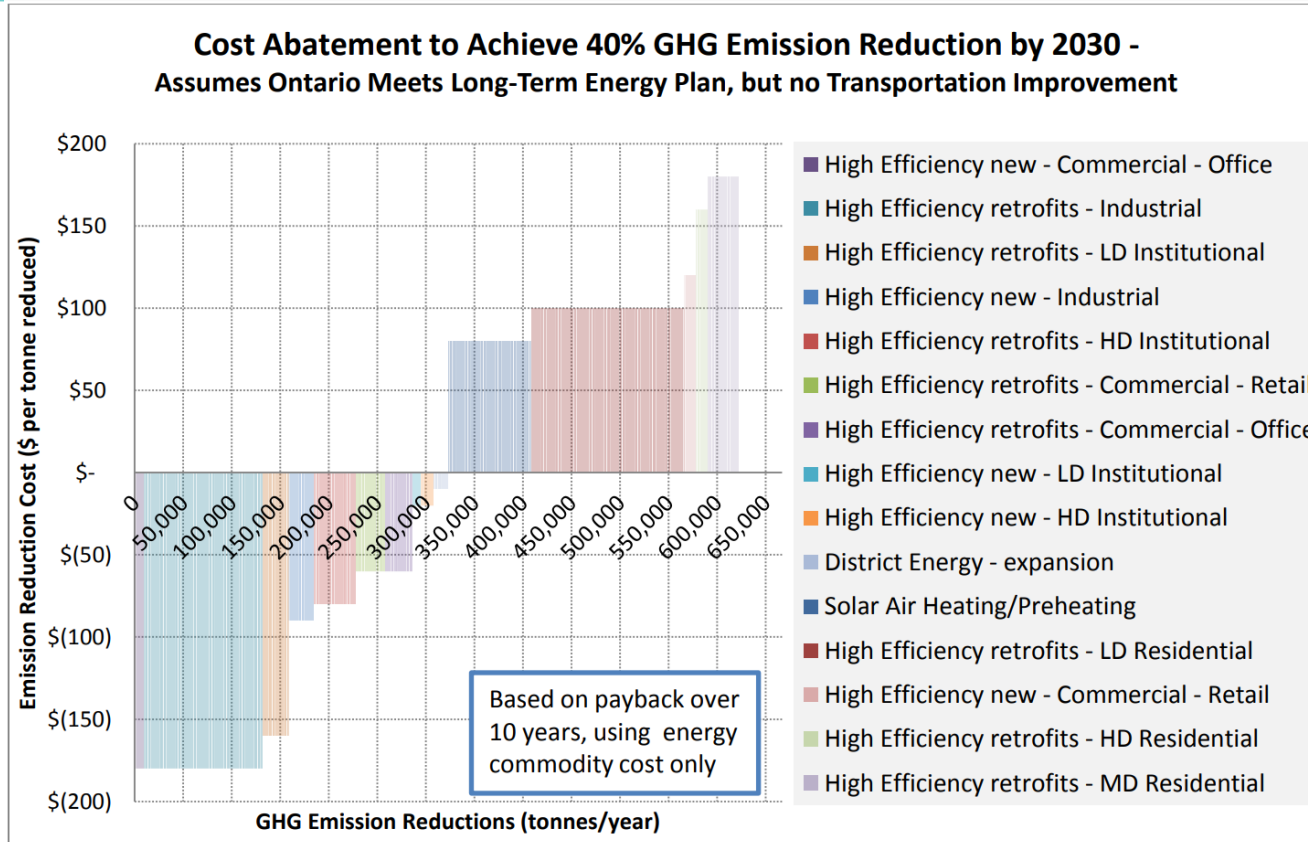
<b>Elec Displaced</b>	\$	4,442,268	\$	4,531,113	\$	4,621,735	\$	4,714,170	\$	4,808,453	\$	4,904,622	\$	5,002,715	\$	5,102,715		
<b>NG Displaced</b>	\$	1,872,928	\$	2,185,083	\$	2,216,298	\$	2,231,906	\$	2,294,337	\$	2,341,160	\$	2,419,199	\$	2,575,199		
<b>Elec to Grid</b>	\$	6,225,635	\$	6,350,148	\$	6,477,151	\$	6,606,694	\$	6,738,828	\$	6,873,605	\$	7,011,077	\$	7,151,077		
<b>Capital Cost</b>	\$	97,794,376	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-		
<b>Annual Costs</b>																		
<b>O&amp;M</b>	\$	1,635,726	\$	1,668,441	\$	1,701,809	\$	1,735,846	\$	1,770,562	\$	1,805,974	\$	1,842,093	\$	1,878,974		
<b>Fuel - Elec</b>	\$	305,907	\$	312,025	\$	318,265	\$	324,631	\$	331,123	\$	337,746	\$	344,501	\$	351,501		
<b>Fuel - NG</b>	\$	4,367,085	\$	5,094,932	\$	5,167,717	\$	5,204,109	\$	5,349,679	\$	5,458,856	\$	5,640,818	\$	6,004,199		
<b>Net</b>	\$	(97,794,376.15)	\$	6,232,114	\$	5,990,947	\$	6,127,393	\$	6,288,185	\$	6,390,254	\$	6,516,812	\$	6,605,579	\$	6,594,268
<b>IRR</b>																	3.83%	

### Biomass

#### Income

<b>Elec Displaced</b>	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-
<b>NG Displaced</b>	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-
<b>Elec to Grid</b>	\$	19.40	\$	19.79	\$	20.18	\$	20.59	\$	21.00	\$	21.42	\$	21.85	\$	22.29

# APPLICATIONS





# PROPOSED UPDATES

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- **Updating assumptions**
- Update & add new technologies
- Updating user interface for user friendliness
- Re-piloting and updating municipal inputs

# NEXT STEPS

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## 1. Stakeholder and consultant outreach

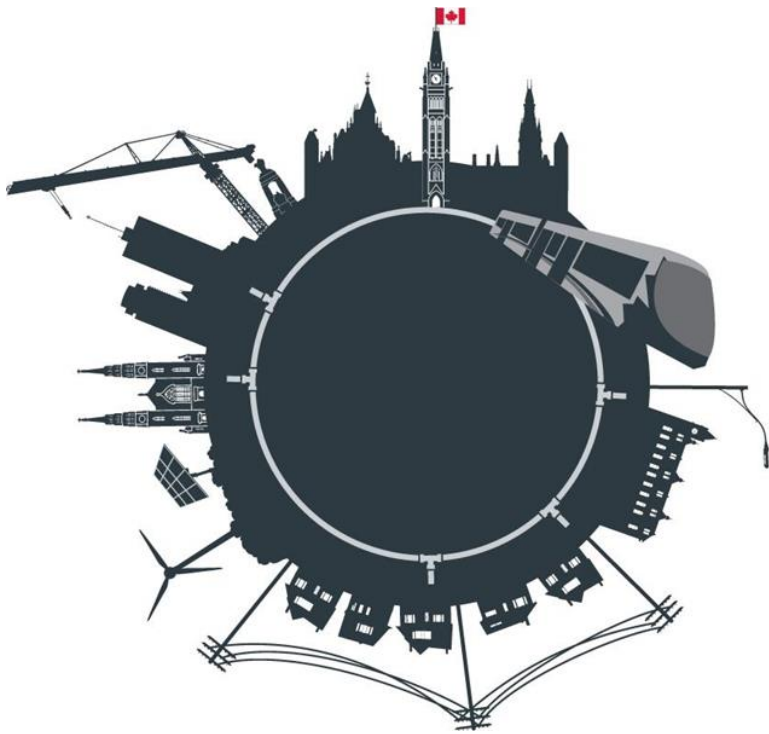
1. Funding opportunity exploration

1. Detailed work plan

# DISCUSSION QUESTIONS

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1. Are there any similar tools being used in your jurisdiction?
1. Is an open-source approach viable for keeping assumptions relevant?
1. Is a broadly applicable, publicly available model necessary?



# QUEST2017

## Smart Energy Communities on the Hill

NOVEMBER 6-8 DELTA OTTAWA



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