Appendix C: Surrey CEEP Power Conservation Analysis

Community Wide Overview

On a community-wide basis, across all sectors, and in the absence of significant action by local and senior governments and utilities, electricity consumption would double by 2040 relative to the base year, 2007. GHGs, under this Business as Usual future, would grow 28% relative to 2007.

Conservation strategies in new building construction and existing buildings reduce electricity consumption by 8% relative to the Business as Usual (BAU). Building electricity consumption, nevertheless, still grows primarily due to rapid population and employment growth of 65% and 105% respectively, which leads to increases in residential and commercial floor space (see Figure 1).

The vast majority of electricity consumed in Surrey today and out past the year 2020 is in the buildings sector (99% in 2020). In 2020, electricity consumption in the transportation sector is only 1% but then rises steadily to approximately 10% of total community electricity consumption by 2040. Building electricity conservation and displacement by biomass-driven district energy is approximately equal to the growth in electricity demand in transportation.

As well as reducing GHGs, transportation electrification results in significant energy efficiency gains due to higher energy utilization rates, i.e., converting electricity to the drive train rather than to heat or braking friction. A typical electric vehicle (EV) uses 0.0828 gigajoules (GJ) per 100 km traveled in contrast to an average passenger vehicle on the road today, which uses 0.348 GJ per 100 km traveled or roughly 25% of the energy. In British Columbia, a typical EV emits 6 grams CO_2e per km, while the average internal combustion engine passenger vehicle emits 288 grams CO_2e per km.[1]

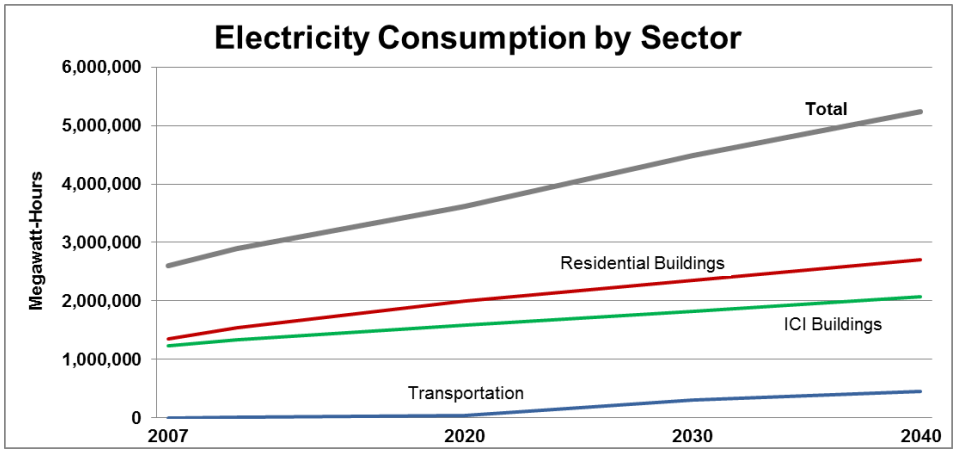

Figure 1: Electricity Consumption by Sector with CEEP Implementation

Table 1: Total Electricity Consumption by Sector with CEEP Implementation

	2007	2020	2040
Residential Buildings	1,358,287	1,994,509	2,708,433
ICI Buildings	1,234,000	1,590,253	2,072,352
Transportation	6,396	40,445	453,504
Total	2,598,683	3,625,207	5,234,289

[1] Sources: US Department of Energy, 2013; According to the United States Environmental Protection Agency (US EPA), the 2011 Nissan Leaf (full electric vehicle) uses 0.23 kW-h of electricity per kilometre traveled. 1 kW-h is equivalent to 0.0036 GJ.

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Building Sector Electricity Demand Analysis

Total building electricity consumption increases from 2007 to 2040, primarily due a substantial increase in residential and commercial floor area driven by rapid population and employment growth (65% and 102% respectively by 2040 relative to 2007).

A Business as Usual (BAU) scenario represents a future in which no further action is taken by the City or by senior-level governments to manage energy and GHGs beyond current City plans and policies, and currently legislated senior government commitments up to 2015 (notably BC Building Code updates scheduled to take effect between 2012 and 2015). In the absence of such actions, electricity demand in buildings would almost double by 2040 relative to the base year, 2007. Relative to this Business As Usual future, local and senior government strategies outlined by Surrey's *Community Energy & Emissions Plan* are expected to produce significant electricity savings - reducing annual power consumption by 41,000 Megawatt-Hours (1%) by 2020 and 433,000 Megawatt-Hours (8%) by 2040 (see Table 2).

Electricity savings relative to BAU are equally divided between residential and industrial, commercial, and institutional (ICI) buildings in 2020. However, residential buildings account for over 70% of savings by 2040 (see Table 3).

Table 2: Total Building Electricity Consumption to 2040 – BAU vs. Surrey CEEP Path (Megawatt-Hours)

	2007	2020 [2]	2040
Business As Usual (No Further Action)	2,593,300	3,625,800	5,214,400
Surrey CEEP Path	-	3,584,800	4,780,800
Electricity Savings	-	41,000 (1%)	433,600 (8%)

Table 3: Building Electricity Consumption by Sector to 2040 – BAU vs. Surrey CEEP Path (Megawatt-Hours)

	2007	2020 [x]	2040
BAU Electricity Consumption (MWh)			
Residential Buildings	1,358,287	2,015,038	3,023,888
ICI Buildings	1,234,000	1,610,808	2,190,512
Total	2,593,287	3,625,846	5,214,100
Surrey CEEP Path Electricity Consumption (MWh)			
Residential Buildings	1,358,287	1,994,509	2,708,433
ICI Buildings	1,234,000	1,590,253	2,072,352
Total	2,593,287	3,584,762	4,780,785
Electricity Savings			
Residential Buildings	-	20,259	315,455
ICI Buildings	-	20,554	118,160
Total	-	41,083	433,615

[2] Some factors reduce the apparent magnitude of electricity savings by 2020: firstly, actions taken since 2007 and committed to by senior governments (e.g. the BC Building Code update in 2012) are excluded; secondly, it is assumed most local actions do not begin to have an impact until close to 2015.

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Table 4 shows electricity savings from specific CEEP strategies. District energy strategies produce the most savings (69%), followed by land use strategies (31%), existing building strategies (8%), and new construction strategies (3%). The large savings from district energy result from switching electricity used for space heating and hot water, to power generated from biomass combustion.

Table 4: Local Action Building Electricity Savings by Sector and Sub-Sector (2040)

Sector/Sub Sector & Strategy	Electrical Savings by Policy (Megawatt-Hours)	Share of Local Electricity Conservation
Existing Building Strategies	**25,100**	**8%**
▪ Third Party Retrofit Program Integration	7,530	2%
▪ Affordable Housing Energy Retrofit Strategy	17,570	6%
New Construction Strategies	**7,600**	**3%**
▪ Third Party Incentive Promotion	1,140	1%
▪ Local Incentive Program Development	1,140	1%
▪ Basic Building Standards Strategy	5,320	2%
District Energy Strategies	**177,900**	**59%**
▪ City Centre District Energy Network	124,530	41%
▪ District Energy Beyond City Centre	53,370	18%
Land Use Strategies[3]	**93,200**	**31%**
Total	**303,800**	**100%**

Total electricity and natural gas savings for buildings are given in Table 5. Local government actions are responsible for two-thirds of these savings. The remaining one-third in savings is from senior government actions on building codes and energy conservation.

Table 5: Total Building Electricity & Natural Gas Savings by 2040 in MWh

Senior Government Building Codes & Energy Conservation	474,914
Local Government Building & District Energy Strategies	461,224
Local Government Smart Land Use Strategies	445,562
Total Savings	1,381,700

[3] Through the CEEP and the City's OCP Update, multi-family projections have risen significantly. 75% of new construction is expected to be multi-family by 2040 relative to 23% in 2007. Half of all residential buildings in Surrey will be multi-family in 2040 vs 33% in 2007. This shift reduces per capita/per household energy demand through smaller building footprints and shared walls (decreasing floor space per household and improving thermal performance).

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Transportation Sector Electricity Demand Analysis

In the transportation sector, electricity use is expected to grow significantly, reaching over 450,000 MWh annually by 2040, roughly the equivalent of the building conservation savings outlined in the CEEP. Electric vehicles are expected to become increasingly popular. Electricity use by these vehicles is projected to account for 9% of total electricity consumption by 2040 (see Figure 2).

Personal transportation is expected to be responsible for the largest share of electricity consumption - more than 75% by 2040. Electricity demand by public transportation and commercial vehicles is expected to be much lower, at 18% and 7% respectively. While electricity demand rises, the widespread adoption of electric vehicles is expected to reduce GHGs by roughly 40% relative to BAU, due to the replacement of carbon-intensive liquid fossil fuels currently used in internal combustion vehicles, with relatively low-carbon electricity.

Figure 2: Total Transportation Electricity Demand

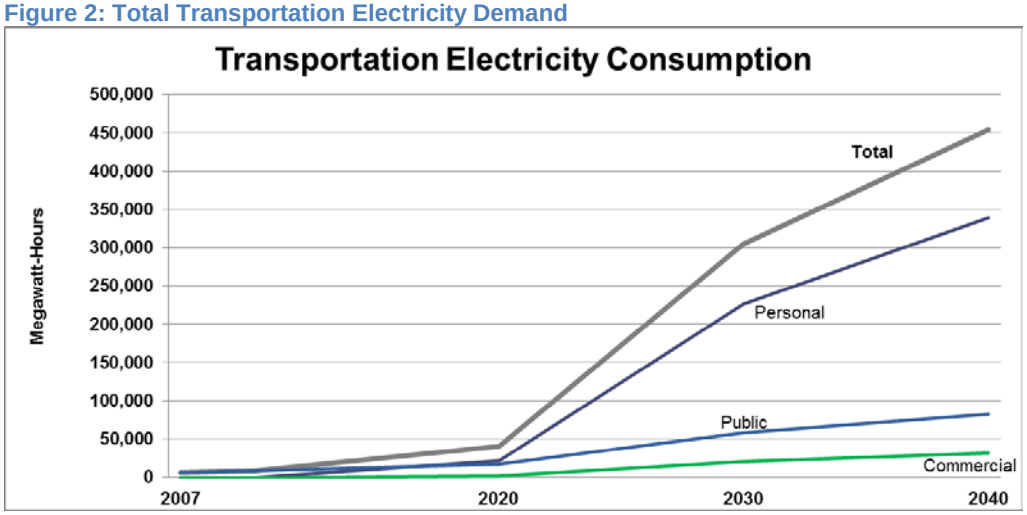

Table 6: Transportation Electricity Consumption by Sector (Megawatt-Hours)

	2007	2020	2040
Personal	<1	22,000	339,000
Public	6,000	17,000	83,000
Commercial	<1	2,000	32,000
Total	6,000	41,000	454,000

The shift toward electric vehicles will drive electricity demand in the transportation sector. The proportion of all personal passenger vehicles that are electrical vehicles is projected to increase slightly between 2007 and 2020. After 2020, it is expected that electric vehicles will be more commercially mature and that electric vehicle charging infrastructure will be broadly available. Beyond 2020, the proportion of electric vehicles is assumed to increase much more rapidly and reach 36% of all passenger vehicles by 2040 (see Table 7).

Table 7: Share of Passenger Vehicle Fleet that is Electric (Plug-In and Hybrid) under the CEEP

	2007	2020	2040
Passenger Vehicles	211,279	268,200	275,246
Share Electric Vehicles	0%	3%	36%