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Community Energy Explorer beyond Metro Vancouver

A Developers Guide

1.0 INTRODUCTION

While this website is based in the Metro Vancouver area, low carbon community energy is a province-wide concern. This guide provides communities outside of Metro Vancouver with information and resources to create a localized platform for exploring community energy.

1.1 STRUCTURE AND GUIDANCE

The website is divided into 5 key sections:

1. **Energy 101**: A basic guide to energy concepts
2. **Hot Topics**: Guided pathways through the website for relevant issues facing many communities throughout British Columbia
3. **Maps**: Energy demand and potential supply maps for the Metro Vancouver area
4. **Scenarios**: Modelled scenario case studies to show potential impacts of different community energy options
5. **Tools and Resources**: A set of links to relevant case studies, tools, and websites focusing on community energy.

Much of the website has relevance for all communities in the province. The 'Energy 101' and 'Tools and Resources' sections are ready to be used by anyone interested in furthering the concept of community energy in their town, though they can (and should) also be added to or tailored with more local examples. The 'Hot Topics' section focuses on issues most relevant to larger towns and cities, and more rural regions may want to tailor the pathways for non-expert decision-makers to navigate the site, according to locally important energy issues. We recommend that communities consider undertaking their own case study scenario(s) to localize the context and parameters of energy outcomes for scenarios, but the scenarios featured on our website will have relevance throughout British Columbia.

The mapping section of the website is the most location specific. Most of this guide will focus on the methodologies and data used to create the maps.

2.0 MAP METHODOLOGIES

The Community Energy Explorer maps are based on work by Dr. Rory Tooke. More detailed explanation can be found at: energyexplorer.ca/blog. The section below gives a basic description of how the maps were created, the data sources used, and links to the blog. Communities across British Columbia should have access to the same data sources to create local energy demand and supply maps for their region or city. For a more in-depth report of our map methodology, please view it here.

2.1 ENERGY DEMAND

Building energy use is was measured by utilities, but there are privacy and liability concerns which usually restrict data access. The spatial demand map by 1.4 can be assembled from the following sources:

- Energy audit information was taken from over 7000 houses from the Natural Resource Canada EcoEnergy Program. The data was used to establish the relation between building energy use and its' age. The trend shows that new homes perform better than old ones as a general estimate.
- BC Assessment data can be used to identify the year most homes are built and their size (floor area) for single family homes and duplexes only. This information was used in relation to the building's energy use and age to predict energy performances of these buildings for all homes in

the region. The assessment data also gives the number of units in townhouses, and apartment buildings, allowing us to normalize data so that energy use can be represented for individual dwelling units or for multi-unit buildings as a whole.

- Energy use intensity can be calculated by dividing the total amount of energy estimated by area of building coverage.
- Greenhouse gas intensity can be calculated by factoring in the average GHG emissions per m2 of building coverage, aggregating both homes heated by fossil fuels (mostly natural gas).

2.2 SOLAR ENERGY & CLOUD COVER

1) Solar energy capacity mapping. There are three components of sunlight:
    a. Atmosphere (including cloud cover),
    b. Solar Position, and
    c. Urban Form

Local governments can use zoning bylaws to help dictate the building and urban design, including the roof geometry. For example, the direction by which sloped roofs are orientated or the placement of trees on property are ways that can utilize solar potential.

LiDAR (Light Detection and Ranging) datasets are used for looking at solar energy potentials. Four steps were considered based on the publications in the Solar Energy and Applied Energy Journals:

a. Determine the outline of building,
b. Calculate the slope and orientation of each square meter of roof,
c. for each square meter of roof, locate surrounding buildings and trees that could occlude the sun, and
d. model the trajectory of the sun at regular time intervals to determine how much solar energy reaches the roofs over a period of time (accounting atmospheric effects).

Since LiDAR datasets are not available in all municipalities across the Metro Vancouver region, the calculation was extrapolated across regions of known radiation by land use type from LiDAR to non-available LiDAR sites. If LiDAR is not available, there are other potential sources of mapping for solar potential, for example Google Earth, Coolkit, or DIY mapping exercises.

2) Cloud Cover

Cloud cover and aerosols were included in assessment of overall solar energy levels but did not account for any geographic variation in cloud cover across Metro Vancouver (i.e. cloud cover was assumed to be the same in all of the Metro Vancouver municipalities).

MODIS is a sensor that is mounted to two satellites (Terra and Aqua) and scans the entire Earth every 1-2 days. MODIS measures light reflected from Earth’s surface and the atmosphere at various wavelengths. Data from the Aqua satellite was used to assess cloud cover extent over time, since the time of the image acquisition more closely coincides with highest sun angles (meaning strongest solar energy hitting local earth surface).

In this map, the data spanned over an 11-year period from July 2002 to 2013. By using the MODIS Reprojection Tool Swatch, the image files were geographically referenced and gridded to an area around Metro Vancouver.

2.3 WIND ENERGY CAPACITY MAPPING

Wind turbines provide some of the most iconic imagery when it to comes to renewable energy, but while wind energy technologies are often a low-cost option for energy generation, in metropolitan areas wind resources are often not reliable or economically viable.

There are four types of area sites that could be represented:

a. Offshore,
b. Urban,
c. Rural, and
d. Mountain.

Each has a different capacity for wind development.

There are variations in wind speed across Metro Vancouver. Environment Canada's Canadian Wind Energy Atlas is the primary source of data, where wind assessments are calculated at 80m above surface. There has been statisticaly analyses of atmospheric observation and models provided by US National Centers for Environmental Prediction and National Center for Atmospheric Research at 6 hour intervals, between 1958-2000, which provides a general systematic estimate of wind speed across large areas (i.e. all of Canada) at low spatial resolution.

To turn wind into electricity, institutions suggest the best sites for wind energy have consistent high winds. But there is a place for medium and low wind sites that represent 90% of locations where financing is available. It all depends on design, and local and/or site condition.

2.4 BIOENERGY CAPACITY MAPPING

The two main types of bioenergy mapped in CEE come from biofuel sources and biomass sources. Biofuel can be bioethanol (fermentation of starch crops), biodiesel (vegetable oils and animal fats), and biogas (methane from anaerobic digestion of organic waste or syngas from wood). Biomass sources can come from forestry waste, construction wood waste, fuel crops (dried manure and stemwood from plantations or natural forest), garbage, charcoal or biochar.

1) The CEE forest biomass capacity mapping focuses on stemwood from natural forest areas. The BC Vegetation Resource Inventory (VRI) was used to prove information where vegetation resources are located and how much resource exists within inventory unit. The site index* and tree species was used from VRI to establish background conditions for estimates of biomass in Metro Vancouver. These information were entered into a FORECAST ecosystem model, where the model simulates initial soil conditions and ecosystem dynamics (calibrated to conditions relative to Metro Vancouver region). Categorizing vegetation inventory units into classes can be done to represent the distribution of the site indices for each species. One of the main outputs of the model is running simulations of accumulation of biomass over time. The analysis identified 4.5 million metric tons of annual sustainable forest biomass in Metro Vancouver, but the question comes down to "what portion of biomass can be realistically harvested?"

*Site index –standard indicator of potential for trees to grow at a particular location (estimate site productivity)

2) Biogas. Agriculture contributes up to 30% of all GHG emissions, where methane is released into the atmosphere from livestock manure. Methane is also a primary chemical component of biogas and natural gas. When captured and combusted, the fuel can be used to generate electricity and/or heat. The CEE mapping focuses on livestock type and numbers as an indicator for biogas potential.Livestock head counts were used from the 2006 Agriculture Census. The conversion for manure and energy yield by livestock grouping were selected from American and European studies. Assuming that manure is available for energy producing purposes, Metro Vancouver region could produce a total of ~675TJ of livestock biogas energy per year (this is equivalent to the total thermal and electricity energy used in approximately 3000 single family homes) .

2.5 INDUSTRIAL HEAT RECOVERY

There are two basic applications of capturing waste hear:

1) Recycling waste heat back into the processes at the same facility and;
2) Transferring the waste heat for use by another process off-site, perhaps some distance away.

The data used for this analysis was the industrial point source data from 148 locations that Metro Vancouver tracks for air quality. Each of the industries is attributed with a NAICS (North American Industry Classification Standard) code that indicates the industry type. A total of 22 industrial subsectors are observed within the Metro Vancouver data.

The recoverable energy for unique industry types has been examined in the UK. However, the industry classification in the UK does not direct match that of North America. As a result, the NAICS codes were re-categorized to match as best possible those from the UK system. The table at the URL below lists how the industry classification was reorganized and also provides the range of recovery factors that are applied to the energy use from each industry, to provide an estimate of potential recoverable energy.

2.6 SEWAGE HEAT RECOVERY

The maps on sewage heat recovery were taken directly from a report prepared in 2005 for Metro Vancouver (then the GVRD) by Compass Resource Management Ltd. and MK Jaccard and Associates.
A more recent study conducted for the City of Surrey can be found here.

2.7 GEOEXCHANGE

The maps on sewage heat recovery were taken directly from a report prepared in 2005 for Metro Vancouver (then the GVRD) by Compass Resource Management Ltd. and MK Jaccard and Associates.

2.6 DATA SOURCES USED

National	Provincial	Other
Environment Canada's Canadian Wind Energy Atlas http://www.windatlas.ca/index-en.php	BC Assessment data http://bcassessment.ca/services-and-products/Pages/Data-for-Public-Sector-Organizations.aspx	the MODIS Reprojection Tool Swatch https://lpdaac.usgs.gov/tools/modis_reprojection_tool_swath
2006 Agriculture Census http://www.statcan.gc.ca/ca-ra2006/index-eng.htm	BC Vegetation Resource Inventory https://catalogue.data.gov.bc.ca/dataset/vri-forest-vegetation-composite-polygons-and-rank-1-layer	FORECAST model http://web.forestry.ubc.ca/ecomodels//moddev/forecast/forecast.htm

3.0 TIPS ON WEBSITE ASSEMBLY

Our website was developed using Node.js, which requires an experienced web developer. This makes the website more difficult to update and modify for non-technical staff. Technical staff are needed for sophisticated interactive mapping with spatial data. We have also had issues finding inexpensive hosting servers for node-js. A community-driven website should consider these issues. Other web platforms might have less functionality, but could be easier to update and share with neighbouring communities. Regional districts would be a logical scale for hosting a web platform on community energy.

4.0 IMPORTANT RESOURCES

Communities interested in exploring community energy projects should also be aware of important resources available to British Columbians.

The Community Energy Association (CEA) has a program to assist smaller communities with their Community Energy and Emissions Plans (CEEPs). For more information, visit: http://communityenergy.bc.ca/about/join-cea/ceep-quickstart-community-of-practice/
Members of the CEA also teach courses at BCIT: https://www.bcit.ca/study/courses/cesa5210

BC Hydro provides support for community energy managers. Larger communities interested in employing a community energy manager should visit:
https://www.bchydro.com/powersmart/business/programs/sustainable-communities/cemp.html