Summary report on renewable energy resource data in Alberta: Focus on wind, solar, and biomass resources

Abstract

Theoretical resources are typically presented as a map that indicates the measured or modeled energy potential across a geographic area (e.g., wind speed; solar irradiance; biomass productivity). This is assessed using some combination of in situ data collection and geophysical modeling. This report assesses the availability and quality of such data in Alberta.

Contents

1.0 Introduction

This report assesses the availability and quality of resource data and resource maps for primary land-based renewable energy resources in New Brunswick: wind, solar, and biomass. These maps do not serve as an assessment of any project site, but rather outline areas with relatively high or relatively low energy potential based on the nature of the resource alone. In other words, these maps are a starting point, but by themselves insufficient, as a basis upon which to assess actual, realizable renewable energy development prospects in an area. The maps and data considered within this report have been created at provincial, national, or international scales, and are therefore suitable for use in renewable energy assessment across New Brunswick.

2.0 Wind Energy Resource Maps

Wind energy maps are typically created by joining atmospheric circulation models with local topographic data to create a model of wind speed, power, and direction at varying heights above Earth's surface. In most cases, geophysical models are used to spatially interpolate measured data collected at weather stations. Typically, this work is undertaken by government agencies, often working with consulting firms, although more detailed and localized data are produced by and for wind energy developers. Wind maps can be created at a regional level (mesoscale) with a spatial resolution ranging from 1.5 to 2 km, or at a local level (microscale) with a typical spatial resolution ranging from 100 - 200 m. For the purposes of informing municipal planning, working with microscale data is ideal. For the purpose of communications and planning, resource data are classified according to the International Electrotechnical Commission (IEC), per table 1 below.

Table 1: IEC Standardized Classification System for Wind Resources. For more information about the IEC wind classification system visit: https://www.lmwindpower.com/en/stories-and-press/stories/learn-about-wind/what-is-a-wind-class

	Class 1 (High)	**Class 2 (Medium)**	**Class 3 (Low)**	**Class 4 Very Low)**
Reference Wind Speed	50 m/s	42.5 m/s	37.5 m/s	30 m/s
Annual Average Wind Speed	**10 m/s**	**8.5 m/s**	**7.5 m/s**	**6 m/s**
50-year Return Gust	70 m/s	59.5 m/s	52.5 m/s	42 m/s
1-year Return Gust	52.5 m/s	44.6 m/s	39.4 m/s	31.5 m/s

2.1 Preferred Data Source: The Global Wind Atlas

This atlas was created in partnership between the Technical University of Denmark and the World Bank Group. The main concern with the Global Wind Atlas is accuracy. When compared to local wind maps for other regions in Canada, the Global Wind Atlas seems to overestimate wind speed. These data provide mean wind speed and mean power density at a 200m spatial resolution. Data can be downloaded here: https://globalwindatlas.info/downloads/gis-files. Detailed information about data creation, validation, and other key features can be found here: https://globalwindatlas.info/about/dataset

3.0 Solar Energy Resources

Maps of incident solar models are typically created using data from satellite imagery or environmental reanalyses that are then calibrated with irradiance measurements taken at weather stations. Factors that affect the irradiance at a specific location include longitude (angle of incidence), surface albedo (how reflective the ground is), typical atmospheric profile (absorption and reflectivity of incoming radiation), slope, aerosols, and shading. Typically, irradiance maps are created at coarse spatial resolutions, as variation in irradiance is minimal over short distances and varies meaningfully only over relatively large geographic areas. For this reason, when siting solar energy production facilities, the intensity of solar radiation is not as strongly considered as other variables such as the availability of land or distance to transmission lines.

3.1 Preferred Data Source: National Solar Resource Database Physical Solar Model v.3.0.1

The Physical Solar Model v.3.0.1 is the latest iteration of the National Renewable Energy Laboratory's (NREL) National Solar Resource Database (NSRDB). For over 25 years, the NREL has been maintaining the NSRDB, updating irradiance maps yearly. While not specifically developed for use within New Brunswick, the NSRDB PSM is an excellent resource that is readily available for use.

Table 2. Summary of the National Solar Radiation Database's Physical Solar Model

Name of Dataset	National Solar Radiation Database Physical Solar Model v.3.0.1
Creation Date	March, 2016
Model Distributor	National Renewable Energy Laboratory (NREL) - https://maps.nrel.gov/nsrdb-viewer/
File Format	ESRI Shapefile
Spatial Resolution	4 km (Nominally)
Map Categories	Annual average ground horizontal irradiance (kWh m^{-2} day^{-1}) within +/- 5% accuracy
Model Creation	The Fast All-Sky Radiation Model for Solar applications (FARMS) was used to calculate ground horizontal irradiance for the PSM using numerous inputs.
Data Sources	Data from numerous earth observation satellites and affiliated projects are used to create the PSM. Data sources include satellites, projects, and sensors such as GOES, MERRA2, MODIS, and IMS.
Ease of use and Accessibility	The Physical Solar Model can be viewed on the NSRDB Data Viewer, and can be downloaded in the ESRI Shapefile format from the NSRDB website.

4.0 Biomass Energy Resources

Biomass energy is broadly defined as organic matter that is used as a fuel source in the production of energy (heat, transport/motor power, electricity). The focus of this project is on cellulosic biomass potential (crop residues and forestry residues). The study is not considering the use of whole crops (i.e., we are not considering corn-to-ethanol and other 'first generation' sources of biomass for energy/fuel).

Mapping theoretical biomass resources requires a combination of land-use maps and agricultural / forestry census statistics, as described below.

4.1 Spatial data to map crop residues and forestry residues

Table 3. AAFC Annual Crop Inventory Map

Name of the Dataset	Agriculture and Agri-Food Canada Annual Crop Inventory
Map Distributor	Agriculture and Agri-Food Canada https://open.canada.ca/data/en/dataset/ba2645d5-4458-414d-b196-6303ac06c1c9
File Format	GeoTIFF
Spatial Resolution	30 metre grid
Map Categories (Thematic Description)	The AAFC Annual Crop Inventory maps feature over 40 distinct class of agricultural activity, including field crops, horticultural crops, and pasture land. Since the first the first crop inventory was published in 2009, the thematic precision of the inventory has increased over the years, with more crops being included in each revision.
Map Creation and Data Sources	The map was created using a decision-tree based classification approach upon optical and infrared satellite imagery, and the map was validated using field measurements taken by insurance companies and provincial ministries. Satellite Imagery from the Landsat-8, Sentinel-2, Gaofen-1, and RADARSAT-2 satellites
Ease of use and Accessibility	The AAFC Annual Crop Inventory Map for 2016 is available for download from the Canada Open Data portal. Additional Crop Inventory Maps from 2011-2017 are also available for download.

4.2 Statistical Data to estimate crop yield and residue production factors.

Residue yields to estimate recoverable biomass came from multiple sources, including the following:

- Crops:
  - https://www1.agriculture.alberta.ca/$department/deptdocs.nsf/ba3468a2a8681f69872569d60073fde1/65bba93dbfbf7b6087256f5400649bf8/$FILE/100_25-1_chapter3.pdf and http://reap-canada.com/online_library/agri_fibres_forestry/Assessing%20the%20Agri-Fibre%20Biomass%20Residue....%20(Bailey-Stamler%20et%20al.,%202007).pdf
- Grasslands:
  - https://www.tandfonline.com/doi/full/10.5589/m12-056

4.3 Statistical data to estimate forestry residue production

https://dspace.library.uu.nl/handle/1874/279518