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North American Renewable Energy Database: NARED

Technical Project Report

By Patrick HENN

326, Saint-Joseph Blvd. East, suite 100
Montreal (Quebec) Canada H2T 1J2

Phone : (514) 849 7900

Fax : (514) 849 6357

sec@helioscentre.org

www.helioscentre.org

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Introduction

As part of its mandate with respect to energy, the Commission on Environmental Cooperation (CEC) has been studying market-based approaches to encourage carbon sequestration, renewable energy and energy efficiency.

In order to increase awareness and provide background information for the development of market based approaches, the CEC, in collaboration with Environment Canada, has requested the collaboration of external consultants to develop a database of existing and planned renewable electricity generating capacity in the three countries of North America.

This report is provided as an accompaniment to the North American Renewable Energy Database (NARED), developed by the Helios Centre, for the CEC and Environment Canada. It presents a brief overview of the database's contents, the methodological approach, as well as some general results.

The project aimed at developing a database of currently installed and planned renewable energy capacity in Canada, the United States and Mexico, disaggregated by state, province or territory, and also by renewable energy type. The renewable energy sources covered were to be biomass, geothermal, solar, water and wind. For planned capacity, the database was to divide capacity between three main stages of development, i.e. proposed, planned, and under construction, on a horizon of 10 years or so.

NARED was developed according to those guidelines, to the extent made possible by readily available data. As such, the complete database comes from the joining of three databases, one for each country. The Mexican segment was prepared by Energy Matters; the National Renewable Energy Laboratory (NREL) used the Renewable Energy Plant Information System (REPiS) as the basis for the United States section. The Helios Centre was responsible for the development of the Canadian segment, as well as for the overall coordination of the project.

This report is structured as follows. Section 1 provides information on the database contents and its organisation. The second section discusses the methodological approach used to collect the data; this section is divided by country, as approaches differ from one country to another. The report concludes with some general comments and recommendations.

Database Contents and Organisation

The North American Renewable Energy Database presents summary data on a state, province or territory level, disaggregated by type of renewable energy source and technology, and by development status.

a) Coverage

The database covers the three North American countries, Canada, Mexico and the United States and presents total renewable energy capacity (per type of renewable energy) at the province, state or territory level. Information at the individual power plant level that underlies these aggregate data is available from the individual country databases. The three Canadian territories (Northwest Territories, Yukon and Nunavut) were considered under one category called "Territories".

b) Renewable Energy Categories

The renewable energy types included in NARED are biomass, geothermal, solar, hydro and wind. When considered appropriate, sub-categories are used within each type. Thus in total, the database reports eight different renewable energy categories (see table 1).

Table 1. Renewable Energy Categories in NARED

Renewable energy category	Type of unit/technology
<i>Biomass – Biogas</i>	Units that produce electricity from a biomass-derived gas, such as landfill gas or methane from anaerobic digestion.
<i>Biomass – Direct-firing</i>	Units that produce electricity directly from burning biomass residue, such as wood and wood waste, agricultural residues and crops, spent pulping liquor, municipal solid waste. ¹
<i>Geothermal</i>	Units that produce electricity from geothermal energy.
<i>Hydro – Large</i>	Hydropower units (including storage and run-of-river projects) exceeding 30 MW in capacity.
<i>Hydro – Small</i>	Hydropower units (including storage and run-of-river projects) of 30 MW or less. ²
<i>Solar – Photovoltaic (PV)</i>	Installations that produce electricity using photovoltaic solar cell technology.
<i>Solar – Thermal</i>	Units that produce electricity using solar thermal technology.
<i>Wind</i>	Units that produce electricity from wind turbines.

¹ Because of ambiguities in the available information, this category may include some gasification units using wood or agricultural waste. When a gasification process was known to be used, the unit was placed in the "Biomass – Biogas" category.

² United States hydropower capacity in NARED is reported under one category called "Hydro".

c) Development Categories

Renewable energy projects that serve as the basis for NARED are classified within four main development categories. This is done to provide information on current generated capacity and planned capacity for the short and long term.

The **“installed” category** relates to all projects that have been built and commissioned to generate electricity. We note, however, that some such units may not be actively producing electricity; there are still considered under the “installed” category in NARED.

The three other categories pertain to projects that are proposed or under development over the next 10 years or so. These are broken down into three categories: “under construction”, “planned” and “proposed”.

The **“under construction” category** includes projects for which construction has begun as well as those practically at this development stage, because all conditions have been met (financing, power purchase agreement, environmental and building permits, purchase order, etc.).

The **“planned” category** refers to projects that have accomplished some but not all of the milestones leading to actual development. For example, projects selected following an RFP process would be considered under this category.

Finally, in order to provide a sense of the degree of activity in the renewable energy industries in North America, we have also chosen to include projects which have been identified for possible development, without any assurance that they will actually see the light of day. The **“proposed” category** includes projects that have been submitted in an RFP process, those for which a feasibility study has been initiated, and those for which an announcement of intent has been made.

It is important to note that there is considerable uncertainty as to whether or not a project listed in this category will actually be developed. At the same time, there is no guarantee that we have identified all such projects, as many developers keep their plans confidential until a later stage in the development process. Thus, it is not possible to draw firm conclusions from the information in this category with respect to the amounts of renewable energy capacity that will actually be developed over the next 10 years. We chose nevertheless to present this information, in order to give an idea of the growing interest in renewable energy projects.

We should note that an additional category, called “unknown” has been used for certain units in the United States, as no information was available to assess their status.

A more detailed explanation of the framework underlying these development categories is found in Appendix 1.

Methodological Approach by Country

NARED was developed from the joining of three separate databases, each pertaining to one country. To the extent possible, the Helios Centre has coordinated the efforts as to provide a full database with uniform content, from one country to the other. The following presents the methodological approaches behind each of the three database segments.

Canada

The Canadian segment of NARED was produced by the Helios Centre, based on information provided by a large number of organisations operating at the federal and provincial level. It includes both grid-connected and, to a certain extent, off-grid installations.

Data were collected by two means: (1) an extensive literature review of all publicly available reports and data of relevant organisations, such as federal and provincial governmental departments, NGOs, electric utilities, independent market operators and independent power producer associations; and (2) personal communications with officials of these organisations.

A complete list of all Canadian organisations reviewed or contacted is found in Appendix 2.

As expected, not all organisations had information that was relevant to the database. The following describes the main information sources for each renewable energy category.

Biomass (biogas and direct-firing)

For installed capacity, the main information source was Statistics Canada's (StatsCan) survey of electric power plants. The last available survey reported on total installed capacity in 2001. Sources including electric utilities, independent market operators and independent power producers were helpful in providing updates for projects that have come on line since 2001.

For proposed, planned and under construction capacity, electric utilities provided most of the information, by way of their publicly announced projects and RFP process results.

Geothermal

Canada does not have large geothermal resources suitable for electricity production. At the present time, there is no electricity generated from geothermal resources in Canada³ and only one project, located in British Columbia, is at the planned stage. The estimated capacity of this project is 200 MW.

Hydro (large and small)

For installed capacity, we used StatsCan's 2001 survey of electric power plants, supplemented by information from electric utilities, independent market operators and independent power producers for projects that came on line more recently.

For proposed, planned and under construction capacity, electric utilities provided most of the information, by way of their publicly announced projects and RFP process results. Additional information was provided by the Canadian Electric Association and the Canadian Hydropower Association, independent market operators (Alberta and Ontario) and provincial governments.

³ Canada does, however, have significant *thermal* energy produced from geothermal heat pumps.

Solar – PV

Information on installed PV capacity was taken from Natural Resources Canada's "PV Technology Status and Prospects — Canadian Annual Report 2002", which includes results from a PV market survey. According to this survey, installed PV capacity had reached 10 MW in 2002. This capacity is derived from the amount of sales reported by the surveyed companies.

Unfortunately, it was not possible from the survey data to "distribute" this capacity among the provinces and territories. Indeed, the survey did not ask questions related to the location of sales.

In order to attempt a "distribution" of the total capacity, we contacted several solar PV experts from NGOs, industry and federal and provincial departments, but we were unable to develop reliable estimates.

In absence of readily available (and defensible) information, installed solar PV capacity in NARED is only reported at the national level, and is evaluated at 10 MW (of which an estimated 95 % are off-grid applications and 5 % is grid-connected).

Accordingly, there was no information available on proposed, planned or under construction capacity. However, NRCan's market survey results indicated that there has been a 23 % average annual increase in installed solar PV in Canada, over the last 10 years. Following NRCan's recommendation, we have applied this average growth rate for future years and reported this projection – estimated at 65 MW for 2010 -- as "planned" solar PV capacity for Canada. We stress the fact that this figure is not based on the indicators used for this category elsewhere in the database.

There is no installed, planned or proposed *solar thermal* electricity production in Canada.

Wind

For installed capacity, NARED benefited from CanWEA's database of grid-connected wind projects, which is updated frequently. Installed capacity on the CanWEA site is presented by project name, owner and location.

For proposed and planned capacity, the main source of information was NRCan's Wind Power Production Incentive (WPPI) program. WPPI is the federal government's program to promote wind energy and offers a production incentive to selected projects. WPPI's objective is to increase wind power in Canada by 1000 MW within the next 4 years or so⁴.

As virtually all proposed grid-connected wind projects in Canada are seeking to benefit from the program, we considered that the information from this site would be accurate. Discussions were also held with program officials, in order to accurately place the different projects registered in WPPI in the proper status categories. As a result, all projects that have registered to WPPI, by sending a letter of intent, were reported in the "proposed" category of NARED. From this list of proposed projects, a certain number of projects, more advanced in the process, were rather included in the "planned" category.

There were no known wind projects under construction at the time of this writing.

Staff from provincial governments and electric utilities were also contacted and documents reviewed to validate the information and ensure that no significant capacity was left out.

⁴ This objective will possibly be increased.

Only grid-connected wind capacity is presented in NARED.

United States

The US portion of the NARED database was prepared by NREL and used NREL's latest version of the REPiS database⁵. As REPiS reports individual electric plants or units, an effort was made by the program officials to aggregate the information and present it by state, renewable energy category and development status (as defined in NARED).

REPiS provides detailed information on grid-connected, renewable electricity plants, installed and planned in all states and for all renewable sources and technologies. The data in REPiS comes from publicly available sources, such as federal and state government publications and reports; trade association data sources; trade press literature such as weekly newsletters; and personal communications with industry and government officials. No surveys were conducted to collect data.

NREL notes that 7 states are not included in REPiS (2002): Alaska, Delaware, Illinois, Maine, Maryland, New Jersey and South Dakota.

The 2002 version of REPiS contains information on nearly 150,000 MW of grid-connected, renewable energy generation capacity. It also includes 7,500 MW of capacity additions being planned for 2003 and beyond. Data sources for planned units are incomplete, and the data in REPiS probably does not capture the universe of planned grid-connected renewable energy units. Therefore, the planned data in REPiS should be viewed as illustrative, not comprehensive.

More specific sources of data and methodology is discussed below by type of renewable energy source⁶.

Biomass

REPiS includes data on wood and agricultural waste, as well as waste-to-energy (WTE) and biogas facilities. The primary reference for wood and agricultural waste was an inventory of these facilities prepared by the California Biomass Energy Alliance. The data in this report consisted mostly of plant location, plant capacity, and how much of the plant capacity was consumed at the plant site or delivered to the electric grid.

Co-firing of wood and/or refuse with fossil fuel, primarily coal, is also represented in REPiS. Only facilities that regularly co-fire biomass with fossil fuels were included. Facilities that co-fired biomass with fossil fuels on a testing or experimental basis were not included. Data sources included EIA, and a list of biomass co-firing at fossil electric plants provided by the Antares Corporation. Two directories by Governmental Advisory Associates provided the bulk of information used to update the solid waste and landfill methane facilities in REPiS.

Geothermal

The U.S. Department of Energy's Geothermal Office and the Interagency Geothermal Coordinating Council (IGCC) provided most of the information through their annual update of geothermal activities. The report included a list of geothermal electric plants in the United States.

⁵ The REPiS database (2002) can be downloaded at <http://www.eere.energy.gov/repis/>.

⁶ This information is provided in the 1999 technical report for REPiS. No report has been issued with the 2002 version. Thus the information on sources and methodology is provided as indicative only.

Hydro

REPiS includes conventional, run-of-the-river and pumped storage hydro projects. The Federal Energy Regulatory Commission (FERC) provided a list of operating hydro projects. NREL also used EIA publications.

Solar

The Utility Photovoltaic Group (UPVG), a trade association of electric utilities involved in photovoltaics R&D and deployment, provided a database of US PV installations. DOE's Photovoltaics Program provided an electronic spreadsheet of known PV installations in the U.S., using REPiS, the UPVG database, the Million Solar Roofs database, and other databases as sources.

Wind

Many sources were used for utility-scale wind facilities, including the American Wind Energy Association's Web site of wind projects; the California Energy Commission; and a database of wind electric installations provided by Princeton Economic Research. For wind facilities in California, these data sources were crosschecked with data and ownership provided in biennial qualifying facility reports provided by the three California investor-owned utilities to the California Public Utilities Commission (Pacific Gas & Electric; San Diego Gas & Electric; Southern California Edison).

An unpublished NREL survey was used for small wind turbine facilities.

Mexico

The Mexico segment of NARED was prepared in September 2003 by the consulting firm Energy Matters, of Mexico City.

The database reports on currently installed projects and those under construction. Information is provided at the plant level, with information on the project owner/proponent, capacity, renewable energy category and provincial location. Renewable energy sources covered are biomass, geothermal, hydro and wind. No information was provided on "planned" or "proposed" projects.

The biomass projects include co-fired units that use bagasse for sugar cane and fuel oil. On average, power generated at the sugar cane facilities is 77 % bagasse and 23 % fuel oil. NARED only reports on the bagasse-generated capacity of these co-fired units, in the category Biomass – Direct-firing.

Other biogas facilities reported for Mexico include landfill gas electric power stations. We note however that these stations are supplemented (20 %) with natural gas. NARED only reports on the biogas-generated capacity of these co-fired units, in the category Biomass – Biogas.

The Mexican database was not accompanied by a technical report.

Country Summary Tables

The following tables present total renewable energy capacity by country and by development status.

Table 1. Canada Summary Table

Renewable Energy	Status	Total Capacity (MW)
Biomass - Biogas	Installed	113.90
Biomass - Biogas	Planned	7.85
Biomass - Biogas	Proposed	27.00
Biomass - Biogas	Under construction	0.62
Biomass - Direct-firing	Installed	1779.05
Biomass - Direct-firing	Planned	51.00
Biomass - Direct-firing	Proposed	125.45
Biomass - Direct-firing	Under construction	25.60
Geothermal	Proposed	200.00
Hydro - Large	Installed	65223.63
Hydro - Large	Planned	1862.00
Hydro - Large	Proposed	7066.90
Hydro - Large	Under construction	2260.00
Hydro - Small	Installed	2206.35
Hydro - Small	Planned	185.10
Hydro - Small	Proposed	1204.30
Hydro - Small	Under construction	103.80
Solar - PV	Installed	10.00
Solar - PV	Planned	64.00
Wind	Installed	322.21
Wind	Planned	904.30
Wind	Proposed	3298.06
TOTAL INSTALLED CAPACITY – all sources (excluding large hydro)		4431.51
TOTAL INSTALLED CAPACITY – all sources		69,655.14

Table 2. United States Summary Table

Renewable Energy	Status	Total Capacity (MW)
Biomass - Biogas	Installed	1150.74
Biomass - Biogas	Planned	40.20
Biomass - Biogas	Proposed	196.62
Biomass - Biogas	Under Construction	17.10
Biomass - Biogas	Unknown	13.53
Biomass - Direct-firing	Installed	11833.48
Biomass - Direct-firing	Proposed	531.90
Biomass - Direct-firing	Unknown	371.44
Geothermal	Installed	2779.40
Geothermal	Planned	155.00
Geothermal	Proposed	542.90
Geothermal	Under Construction	12.00
Geothermal	Unknown	248.00
Hydro	Installed	95209.86
Hydro	Proposed	747.50
Hydro	Under Construction	27.00
Hydro	Unknown	387.51
Solar - PV	Installed	71.11
Solar - PV	Planned	0.01
Solar - PV	Proposed	187.73
Solar - PV	Under Construction	0.01
Solar - PV	Unknown	0.02
Solar Thermal	Installed	353.93
Solar Thermal	Planned	50.00
Solar Thermal	Proposed	3.00
Solar Thermal	Unknown	0.01
Wind	Installed	5137.55
Wind	Planned	270.06
Wind	Proposed	13585.33
Wind	Unknown	133.53
TOTAL INSTALLED CAPACITY – all sources		116,536.07

Table 3. Mexico Summary Table

Renewable Energy	Status	Total Capacity (MW)
Biomass - Biogas	Installed	8.64
Biomass - Biogas	Under construction	5.94
Biomass - Direct-firing	Installed	172.94
Geothermal	Installed	837.90
Geothermal	Under construction	107.00
Hydro - Large	Installed	9299.80
Hydro - Large	Under construction	2387.00
Hydro - Small	Installed	292.36
Hydro - Small	Under construction	160.36
Wind	Installed	2.73
Wind	Under construction	843.00
TOTAL INSTALLED CAPACITY – all sources (excluding large hydro)		1314.57
TOTAL INSTALLED CAPACITY – all sources		10,614.37

Concluding Comments

Apart from the United States initiative, very little effort has been made in North America to produce a comprehensive, multi-source inventory of renewable energy capacity. But according to several Canadian officials and energy experts consulted during this project, such a database is an essential piece of information for developing renewable energy policies.

The North American Renewable Energy Database presents, in our view, a useful — but not complete — portrait of installed and projected renewable energy capacity in North America, by province/state/territory and by energy type. Indeed, much data could be gathered from several different sources in Canada, and the US benefits from a large inventory within REPiS. However, much of the available information relates to grid-connected capacity, and there was no data on future energy project developments — proposed or planned capacity — in Mexico.

For the Canadian segment, we consider that the extent of available information has made possible the development of a fairly complete database. However this project cannot pretend to include all existing and planned renewable energy for the country. Indeed, as the database relied on readily available information, we assume that this approach could not have captured all projects and future developments for the next 10 years or so. This is particularly true, as explained in this report, for off-grid installations such as solar PV panels and biomass plants. It is also true for hydropower (and, to a lesser extent, wind power), where the scale of development in many cases depends on policy decisions not yet made by the various provincial and territorial governments. The use of a survey questionnaire and more communications with key officials across the country would have been useful, but exceeded the scope of this project.

Finally we end this report with three recommendations considered important for future developments. Firstly, as for all databases and inventories, NARED should be regularly updated to provide accurate and timely data. This is particularly true for the fast-moving and dynamic renewable energy sector. Secondly, as stated above, a more focused attention should be placed on off-grid applications, in all three countries, to complete the inventory of renewable electricity production. And thirdly, we would suggest that this database extend its scope to include *thermal* energy generation, which forms a significant part of total energy produced by renewables, namely geothermal, solar and biomass.

APPENDIX 1: Development Categories – Framework for Assessment

Status	General indicators
PROPOSED	<p>Feasibility study (completed or undergoing)</p> <p>Or</p> <p>Application to an RFP</p> <p>Or</p> <p>In the case of greenfield projects: announcement of intent, but without confirmation of financing, permits, etc.</p>
PLANNED	<p>Project is selected from RFP process, has more detailed description of project, submitted environmental assessment, letter of <i>intent</i> of financial partners, confirmation of PPA, etc.</p> <p>And / or</p> <p>In the case of greenfield projects: announcement of project + financing intent by partners, permit applications underway, etc.</p>
UNDER CONSTRUCTION	<p>A project can be considered in this category if it is either being built (field work has started), or even if it is <i>virtually</i> under construction because <u>all</u> the following elements are in place:</p> <ul style="list-style-type: none"> - confirmation of financing, PPA, - environmental assessment accepted, all building permits + authorizations received; - confirmation of equipment supplier + issuance of purchase order <p>If only some elements are confirmed, the project should be considered planned and not under construction</p>

APPENDIX 2: Organisations reviewed and/or contacted (Canada)

National organisations

Federal departments

- ✓ Natural Resources Canada
- ✓ Statistics Canada

Industry associations and NGOs

- ✓ Canadian Electric Association
- ✓ Canadian Renewable Energy Association
- ✓ Canadian Wind Energy Association (CanWEA)
- ✓ Earth Energy Society of Canada
- ✓ Canadian Geo-exchange Coalition
- ✓ Canadian Hydropower Association
- ✓ Canadian Solar Industry of Canada
- ✓ Canadian Solar Society of Canada
- ✓ Énergie solaire-Québec

Provincial organisations

- ✓ Ministries related to energy and natural resources
- ✓ Independent power producer societies in Canada:
 - ✓ IPPSA (Alberta)
 - ✓ IPPSO (Ontario)
 - ✓ IPPBC (British Columbia)
 - ✓ AQPER (Quebec)
- ✓ Independent market operators in Canada:
 - ✓ Independent electric market operator of Ontario
 - ✓ Independent market operator of Alberta

Electric utilities and power producers:

- | | |
|----------------------------|--|
| ✓ BC Hydro | ✓ Newfoundland and Labrador Hydro |
| ✓ Transalta | ✓ Geopower |
| ✓ Saskpower | ✓ Arise Technologies |
| ✓ Manitoba hydro | ✓ Soltech |
| ✓ Ontario Power Generation | ✓ Matrix Energy Visionquest Windelectric |
| ✓ Hydro-Québec | ✓ Irrican |
| ✓ New Brunswick Power | ✓ Edper Brascan Hydro |
| ✓ Nova Scotia Power | |
| ✓ Maritime Electric | |