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ECONOMIC IMPACT ASSESSMENT OF A 100 MW WIND FARM PROJECT IN NEW BRUNSWICK

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EXECUTIVE SUMMARY

A case study of the economic impact assessment of a generic 100 megawatt (100 MW) wind farm project constructed and operated in New Brunswick is presented. Financial information was obtained by comparing publicly available data from a sample group of wind farms recently constructed or being constructed in Eastern Canada.

Using the best representative financial information for projects in Eastern Canada, the research group estimates that a 100 MW wind farm represents a $200 million investment. The direct provincial expenditures during the construction phase amounts to $34 million, representing 17% of the total project investment. Data from the sample wind farms indicate that 81 person-years of direct labor are created during the construction phase of similar wind farm projects in the region. In total, including the direct, indirect and induced jobs, the construction phase could create a total of 225 person-years of labour in the province. The New Brunswick government could receive approximately $2 million in income tax, sales taxes and other taxes resulting from the construction of the project. It is important to note that the jobs created and the tax revenues for the province of New Brunswick during the construction phase of the project are independent of the type of ownership of the wind farm.

Data from the sample show that the operations and maintenance of a 100 MW wind farm requires the equivalent of 9 employees on a yearly basis. When counting the direct, indirect and induced jobs, the research group estimates that the operation and maintenance phase of a 100 MW wind farm would create a total of 17 jobs in the province, expressed in person-years, and permanent for as long as the wind farm stays in operation. The operation and maintenance phase of the 100 MW wind farm would produce in the order of $935,000 in total annual tax revenues for the New Brunswick government. Again, it is important to note that the employment created and the tax revenues for the province of New Brunswick during the operation and maintenance phase of the project are independent of the type of ownership of the wind farm.

Based on the current financial costs to build, finance and operate a 100 MW wind farm in Eastern Canada, it is estimated that the owners of the 100 MW wind farm accumulate profits of over $200 over the 25 year life of the project. Furthermore, since these estimates do not take into consideration eventual revenues from the trading of carbon credits, these profits could be much higher once carbon markets are introduced in the economy. While it is difficult to quantify the economic impact of such revenues, it is clear that the main economic impact of a 100 MW wind farm is through the ownership of a wind farm. Case studies presented in the report show the importance of retaining those profits in the region if economic prosperity is desired.

Summary Table

Provincial economic impact assessment of a generic 100 MW wind farm in New Brunswick.

	Economic Impact Assessment
Project Location & Details	
Location	NB
Total installed capacity	100 MW
Investment	
Total project investment	$200,000,000.
Cost per MW	2.0 M$/MW
Construction Phase	
Construction year	2009
Provincial expenditures	$34,000,000.
% of Provincial expenditures / Total project investment	17.0%
Duration	14 months
Direct Labour (Person-years)	81
Total employment - Direct, indirect & induced (Person-years)	225
Total provincial revenues	$2,034,475.
Operation & Maintenance Phase (Annual)	
Direct wind farm O&M employment	9 jobs
Total employment (Direct, indirect & induced)	17 jobs
Total annual provincial tax revenues	$934,852
Profits from the Wind Farm	
Total profits generated from the wind farm	$200,000,000.
Profits retained in NB – 0% NB ownership	0.
Profits retained in NB – 30% NB ownership	$60,000,000.
Profits retained in NB – 100% NB ownership	$200,000,000.

Note: The profits indicated in this Table do not account for the additional revenues from the sale of carbon credits.

SOMMAIRE EXÉCUTIF

Ce rapport présente une analyse des impacts économiques d'un projet de parc éolien générique de 100 MW construit et opéré au Nouveau-Brunswick. L'information financière fut obtenue en comparant des données publiques disponibles de plusieurs parcs éoliens récemment construits ou présentement en construction dans la région de l'Est du Canada.

En utilisant l'information financière la plus représentative, le groupe de recherche estime qu'un parc éolien de 100 MW représente un investissement total de 200 millions $ avec des dépenses provinciales directes lors de la phase de construction qui s'élèvent à 34 millions $, représentant ainsi 17% de l'investissement total du projet. Les données des parcs éoliens échantillonnés indiquent que la phase de construction des projets de parcs éoliens similaires dans la région va créer environ 81 année-personnes d'emplois directs et au total, 225 année-personnes d'emplois directs, indirects et induits seront généralement créés dans la province lors de cette phase. Approximativement 2 millions $ en impôts sur le revenu, taxes de vente et autres taxes seront remis au gouvernement du Nouveau-Brunswick durant la construction du projet.

Les données des parcs éoliens échantillonnés démontrent que 9 emplois peuvent être générés, sur une base annuelle, lors de la phase d'opération et d'entretien d'un parc éolien de 100 MW. Le groupe de recherche estime qu'au total, 17 emplois directs, indirects et induits seront générés dans la province lors de cette phase; ces emplois seront permanents tant que le parc éolien demeure en exploitation. Finalement, la phase d'opération et d'entretien d'un parc éolien de 100 MW produira plus de 935 000$ annuellement en recettes fiscales pour le gouvernement du Nouveau-Brunswick.

En se basant sur les données financières actuelles, en ce qui concerne les coûts de construction, de financement et d'opération d'un parc éolien de 100 MW dans la région de l'Est du Canada, le groupe de recherche estime que les propriétaires du projet accumuleront plus de 200 millions $ en profits nets sur la durée de vie de 25 ans du projet. Par ailleurs, étant donné que ces estimés ne prennent pas en considération les revenus éventuels des échanges de carbone, ces profits pourraient être encore plus élevés lorsque les marchés de carbone seront intégrés à l'économie. Même s'il est difficile d'estimer les impacts économiques de ces revenus, il est clair que la majorité des ces impacts sont directement reliés à la propriété du parc éolien. Les études de cas présentées dans ce rapport démontrent l'importance de retenir les profits dans la région si l'on désire générer de la richesse et atteindre une prospérité économique.

Tableau sommaire

Impacts économiques provinciaux d'un parc éolien générique de 100 MW au Nouveau-Brunswick.

	Analyse impacts économiques
Localisation du projet	
Localisation	NB
Capacité totale installée	100 MW
Investissement	
Investissement total	200 000 000$
Coût par MW	2.0 M$/MW
Phase de construction	
Année de construction	2009
Dépenses provinciales	34 000 000$
% dépenses provinciales / investissement total	17.0%
Durée	14 mois
Emplois directs (année-personnes)	81
Total des emplois directs, indirects et induits (année-personnes)	225
Total des revenus provinciaux	2 034 475$
Phase d'opération et d'entretien	
Emplois directs du parc éolien	9 emplois
Total des emplois directs, indirects et induits	17 emplois
Total des revenus annuels provinciaux	934 852$
Profits nets du parc éolien	
Total des profits nets générés par le parc éolien	200 000 000$
Profits retenus au N.-B. – 0% d'appartenance	0
Profits retenus au N.-B. – 30% d'appartenance	60 000 000$
Profits retenus au N.-B. – 100% d'appartenance	200 000 000$

Note : Les profits indiqués dans ce tableau ne prennent pas compte des revenus additionnels que peuvent engendrer la vente des crédits de carbone.

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... - 1 -
SOMMAIRE EXÉCUTIF ..... - 3 -
CONTEXT ..... - 6 -
METHODOLOGY ..... - 7 -
PROFILE OF INVESTMENT OF A GENERIC 100 MW WIND FARM ..... - 8 -
ECONOMIC IMPACT ASSESSMENT ..... - 11 -
OWNERSHIP AND LONG TERM INVESTMENTS ..... - 14 -
REFERENCES ..... - 16 -
APPENDIX A: WIND FARM CASE STUDIES IN EASTERN CANADA ..... - 19 -
APPENDIX B: ANNUAL PROVINCIAL DIRECT TAX REVENUES ..... - 22 -
APPENDIX C: PEI ENERGY CORPORATION CASE STUDY ..... - 23 -
APPENDIX D: EDMUNDSTON ENERGY CASE STUDY ..... - 26 -
APPENDIX E: CASH FLOW ANALYSIS OF A GENERIC 100 MW WIND FARM ..... - 27 -

CONTEXT

The K.C. Irving Chair in Sustainable Development and the Chaire des caisses populaires acadiennes en gestion des coopératives of the Université de Moncton present this study on the economic impact assessment of a generic 100 MW wind farm project constructed and operated in the province of New Brunswick, Canada. In addition, this report compares the economic impacts of three proposed ownership models of wind farms: no provincial ownership, 30% provincial ownership, and 100% provincial ownership.

In terms of methodology, this study compares publicly available financial data of utility scale wind farms recently constructed or currently being constructed in Eastern Canada. From these global expenditures, a profile of investment and expenditures is constructed for both the construction and operations phases of a generic 100 MW wind farm in New Brunswick. Finally, the economic impact assessment of a 100 MW wind farm is performed by using Canadian based methodologies and data.

It should be noted that the accuracy of the economic impact assessment presented in this report is limited to the accuracy of the data published by various sources and to the economic Input-Output tables for the province of New Brunswick and the national Input-Output tables for Canada.

The economic impact assessment presented in this report is based solely from the perspective of capital costs associated with the planning and construction phases of the generic wind farm as well as the typical annual operations and maintenance costs for this type of wind farm. No attempt has been made to estimate the possible impacts attributed to energy prices in the province of New Brunswick. However, the research team evaluates that the economic projections and results published in the report are representative of the current reality of wind energy development in Eastern Canada.

This independent study has been done within the research programs of the K.C. Irving Chair in Sustainable Development and the Chaire des caisses populaires acadiennes en gestion des coopératives of the Université de Moncton; this study has not been sponsored by government and has not been funded by industry.

METHODOLOGY

The capital costs and operating costs breakdowns for the generic 100 megawatt (100 MW) wind farm project were estimated by evaluating a sample of wind farms recently constructed or in construction in Eastern Canada. These estimates were then reviewed and checked against the research group's reference costs.

In order to estimate the amount of provincial spending, the expenditure categories were assigned a percentage of direct provincial spending based on the average direct provincial spending from the sample wind farms. The provincial zone was defined as the entire province of New Brunswick, and all other expenditures that were not assigned in the provincial zone were allocated to the national or international zones.

The research group assumed that the wind turbine expenditures would be entirely allocated outside the province of New Brunswick, such that no major components (towers, blades, nacelle covers, etc.) would be manufactured provincially. This assumption is based on the current trend in North America in general, and in Atlantic Canada in particular, for large scale wind turbine generators.

Estimates were done in regards to the provincial and municipal taxes resulting from the construction of the generic 100 MW wind farm. The assessment values were based on the New Brunswick Assessment Act (O.C. 2008-155) in regards to a 99 MW wind farm consisting of 33 wind turbines of 3 MW of installed capacity each. Furthermore, the research group assumed the generic wind farm would be located entirely in a Local Service District in which the non-residential tax rate is representative of the average non-residential tax rate for Local Service Districts in New Brunswick. Given that the provincial and municipal taxes are dependent on the wind turbine models and the number of generators, the research group opted to choose the standard wind turbine model currently installed in Atlantic Canada. This explains the discrepancies between the generic 100 MW wind farm and the 99 MW wind farm used to estimate the provincial and municipal taxes.

In order to estimate the revenues to the landowner resulting from the land lease agreements, the research group used the average capacity factor for wind farms in Canada, as published by Natural Resources Canada (NRCan), i.e. a 36% capacity factor [1]. By assuming that the developer receives the equivalent of 80$/MWh (0.08$/kWh) on a fixed price basis, with a full annual indexation of 2%, for the life of the project from the provincial utility for the wind farm's electricity generation, the annual project revenues were estimated. These estimates were necessary since developers do not release specific details related to energy generation or the power purchase agreements with local utilities. Nonetheless, the research group evaluates that the assumption on the purchase price of electricity is representative of the actual negotiated value in the region.

Finally, while carbon markets will most probably be implemented in the near future, the financial projections and the economic impact assessment presented in this report do not account for eventual revenues from the trading of carbon credits.

PROFILE OF INVESTMENT OF A GENERIC 100 MW WIND FARM

In this section, a profile of investment for the construction (which includes the development of the project) of a generic 100 MW wind farm is presented, along with the annual costs for the operations and maintenance of the wind farm over a 25 year period.

Appendix A presents a compilation of publicly available financial data from sample utility scale wind farms constructed or currently in construction in Eastern Canada. Based on this data, the total project investment of the 100 MW wind farm is estimated at $200 million, while Table 1 shows the breakdown of the profile of investment for the construction phase of the 100 MW wind farm.

Table 1

Profile of investment for the **construction phase** of a generic 100 MW wind farm in New Brunswick[a].

	Data Used in Economic Impact Assessment
Project Location & Details	
Location	NB
Total Installed Capacity	100 MW
Number of Turbines	33
Investment	
Total Project Investment	$200,000,000.
Cost per MW	2.0 M$/MW
Construction Phase	
Construction Year	2009
Provincial Expenditures	$34,000,000.
% of Provincial Expenditures / Total Project Investment	17.0%
Duration	14 months
Wind Farm Employment (Average During Construction)	70 jobs
Total Number of Jobs (Person-years)	81
Number of Jobs per MW (Person-years)	0.81

[a] *All data are available in Appendix A, column "Data used in Economic Impact Assessment".*

As can be seen from Table 1, in the sample wind farms, 17% of the total project investments were direct provincial expenditures. If this average is applied to the generic 100 MW wind farm, the research groups estimates that $34 million of expenditures can be directly invested in the

province during the wind farm's construction phase. This number is relatively high in comparison to direct provincial expenditures associated with the recently completed Kent Hills wind farm near Moncton, New Brunswick, because the average takes into account the data from the Eastern Kings wind farm built in Prince Edward Island which was not built as an EPC (Engineer, Procure and Construct) project, but was built on the principle of maximizing the involvement of local businesses and entrepreneurs, from the project manager to the laborers. Secondly, since the research group assumed that the wind turbines will be manufactured outside the province of New Brunswick, and since the wind turbine components are worth approximately 75% of the total project investment [23], the direct provincial expenditures during the construction phase will necessarily be less than 25% for such projects. However, the research group notes that data from the sample wind farms located in Quebec show that when efficient legislation is used to stimulate the economic impacts, the results are real; the direct provincial expenditures for those projects in Quebec were 40% to 60% of the total project investments. Unfortunately, because of the relatively small capacity of the electricity grid to integrate wind energy, New Brunswick is not in a position to influence the wind energy manufacturing sector as it was done in Quebec to maximize provincial expenditures; this situation could however be different if a bold initiative to develop the wind energy sector to supply the New England market is undertaken by the province.

Given the general land cover in New Brunswick, the research group estimates the duration of the construction phase of the generic 100 MW wind farm to be 14 months. This number was derived with the assumption that the first six (6) months of the construction phase would consist of the development of the wind farm, tree clearing and construction of access roads. These activities would be followed by an eight (8) months installation phase of the wind turbines, electrical components, and to commission the wind farm.

Finally, data from the sample wind farms showed that 100 MW wind farm projects generally produce a total of 81 person-years of direct employment during the construction phase of the wind farm. This leads to an average of 70 direct jobs during the 14 months construction phase of such projects. It is important to note that the jobs created in the province of New Brunswick during the construction phase of the project are independent of the type of ownership of the wind farm

Table 2 shows the profile of investment for the operation and maintenance (O&M) phase of the generic 100 MW wind farm. As can be seen from Table 2, in the sample wind farms, the annual provincial O&M provincial expenditures represent 46% of the total annual O&M expenditures. This value for the annual provincial O&M expenditures translates to approximately $1,450,656 annually for the generic 100 MW wind farm.

The data from the sample wind farms show that an average of 0.09 direct jobs per MW of installed capacity is created during the operation and maintenance phase, which translates to a direct O&M employment of 9 jobs for the generic 100 MW wind farm. Again, it is important to note that the employment created in the province of New Brunswick during the operation and maintenance phase of the project are independent of the type of ownership of the wind farm

Because of the lack of publicly available data due to Non-Disclosure Agreements between the wind farm developers and landowners, the research group had to estimate the annual landowner royalties. Based on landowner royalties of 2.5% of the annual revenues, which is representative of the highest unofficial landowner royalties in the region, the annual landowner royalty payments are estimated to be approximately $500,000.

The research group estimates the annual provincial tax revenues from a generic 100 MW wind farm to be $934,852. Details pertaining to the annual provincial tax revenues are presented in Appendix B.

Table 2

Profile of investment for the **operation and maintenance (O&M) phase** of a generic 100 MW wind farm in New Brunswick[a].

	Data Used in Economic Impact Assessment
Operation & Maintenance Phase	
Estimated annual revenues	$25,228,800.
Estimated annual O&M expenditures	$3,153,600.
Annual O&M provincial expenditures	$1,450,656.
% of O&M provincial / O&M total	46.0%
Direct wind farm O&M employment	9 jobs
Direct wind farm O&M employment per MW (Jobs/MW)	0.09
Annual landowner royalties	$500,000.
Annual provincial direct tax revenues	$934,852.

[a] *All data are available in Appendix A, column "Data used in Economic Impact Assessment".*

ECONOMIC IMPACT ASSESSMENT

The evaluation of the provincial economic impacts of a wind farm project is usually based on Input-Output techniques. The *Input-Output Structure of the Canadian Economy* produced by Statistics Canada is part of the *System of National Accounts* [24]. This integrated system tracks all the economic transactions between economic actors in a province or country. Since the Input-Output model primarily deals with the methodology of analysing interdependence among the different sectors of the economy, it is a good tool to analyze business linkages between the different industries of an economy.

In the case of wind farm investments made in the province of New Brunswick, two issues limit the use of this approach at the provincial level. First, the provincial Input-Output table integrates only 25 sectors, whereas there is no specific information on direct jobs created by on-shore wind projects. Second, since there is presently only one wind farm operating in the province, it is thus not possible to estimate a specific model for the wind energy sector in New Brunswick. To overcome these limitations, the research group has adopted a mixed approach, for each type of impact, as indicated in the following.

When considering a new project or activity, three types of economic impacts are measured, with application to the wind energy sector in New Brunswick:

1- Direct impacts

   Economic impacts of the activities of the businesses directly involved in the construction and the operation and maintenance of the wind farm (e.g. employment and income on the construction site). These businesses would receive the capital expenditures or operating revenues for the wind farm project. The evaluation of the direct impacts of a generic 100 MW wind farm during the construction and the operation and maintenance phases is based on the estimated project data summarized in Tables 1 and 2. Therefore, the construction phase of the generic 100 MW wind farm could generate 81 person-years of direct employment in the province and 9 direct job employments for the O&M phase of the project on a yearly basis in the province.

2- Indirect impacts

   Economic impacts of the activities of the businesses which supply commodities and services to the wind farm project during the construction and the operation and maintenance phases (e.g. employment and income in the wind turbine manufacturing plants). The evaluation of the indirect economic impact of a generic 100 MW wind farm during the construction phase is based on the multiplier for the construction industry from the New Brunswick Input-Output table. According to Statistics Canada estimates, for each $1 million of expenditures in this industry, 2.7 indirect jobs are created in the provincial economy. Therefore, the $34 million of provincial expenditures in the construction phase could generate 92 person-years of indirect employment in the province, while the $1.45 million annual expenditures for O&M could generate 4 indirect jobs on a yearly basis in the province.

3- Induced impacts

The households of the various workers involved in the direct and indirect activities will probably spend their money the same way as average households do. Hence, these new expenditures will create jobs and incomes, counted as induced impacts. Induced economic impact is thus generated by spending wages, salaries, and other incomes from direct and indirect economic activities. Because of the lack of economic data for the wind energy sector, the induced economic impacts are not calculated by the Input-Output model. Rather, the approach proposed by Pollin & Garrett-Peltier [25] is used, where it is supposed that the induced effect of a wind farm project "will add 30 percent to the overall level of job creation generated by the direct and indirect effects".

Table 3 shows the provincial results for the construction phase of a generic 100 MW wind farm project in New Brunswick. This phase could create a total of 225 person-years of labour in the province. The New Brunswick government could receive approximately $2 million in income tax, sales taxes and other taxes resulting from the construction of the project.

From Table 3, it can be seen that for each year of the operation and maintenance phase, the project will create a total of 17 jobs in the province, expressed in person-years. As usual in this type of investment, these impacts are not as important as those of the construction phase, but they are permanent for as long as the wind farm stays in operation. For the provincial government, total annual taxes revenues could be in the order of $935,000.

It is important to note that the direct, indirect and induced employment created in the province of New Brunswick, along with the tax revenues for the Government of New Brunswick, during the construction phase and the operation and maintenance phase of a wind farm project are independent of the type of ownership of the wind farm

Table 3

Direct, indirect and induced provincial economic impacts of a generic 100MW wind farm in New Brunswick.

Items	**Direct**	**Indirect**	**Induced**	**Total**
		Construction Phase		
Jobs[1]	81	92	52	225
Value added	$6,980,884.	$7,183,441.	$4,249,297.	$18,413,622.
Salaries and wages	$4,347,593.	$3,960,637.	$2,492,469.	$10,800,698.
Other revenues	$2,633,291.	$3,222,804.	$1,756,829.	$7,612,924.
Income taxes	$419,034.	$431,193.	$255,068.	$1,105,294.
Sales taxes		$356,484.	$210,875.	$567,358.
WorkSafeNB	$145,644.	$132,681.	$83,498.	$361,823.
Total provincial tax revenues				$2,034,475.
		Operation and Maintenance Phase		
Jobs[1]	9	4	4	17
Value added[2]	$1,125,197.	$297,732.	$426,879.	$1,849,808.
Salaries and wages	$336,441.	$172,577.	$152,705.	$661,723.
Other revenues and royalties	$788,756.	$125,156.	$274,174.	$1,188,085.
Income taxes	$67,541.	$17,872.	$25,624.	$111,036.
Sales taxes		$14,775.	$21,184.	$35,959.
Provincial property taxes	$755,081.	$4,361.	$6,252.	$765,694.
WorkSafeNB	$11,271.	$5,781.	$5,116.	$22,168.
Total provincial tax revenues				$934,852.

[1] *Number of jobs expressed in person-years.*
[2] *Depending on the degree of provincial ownership, value added in New Brunswick may become higher in time as the profits generated by the project increase, as can be seen in Appendix E.*

OWNERSHIP AND LONG TERM INVESTMENTS

It is clear that wind farm ownership has an impact on the probability that the profits generated by the project will be reinvested in the province. The two case studies presented in Appendix C and D show examples of locally owned energy corporations that reinvest a large part of their income in the community.

To illustrate this argument, as it applies to the wind energy sector, three scenarios are examined. In the first scenario, the degree of provincial ownership of the wind farm is 0%. In the second scenario, provincial investors own 30% of the wind farm assets. Finally, in the third scenario, provincial ownership is at 100%.

The cash flow analysis of a generic 100 MW wind farm presented, in Appendix E, shows that the total investment for such a project is $200 million and the down payment required for this investment is typically 20% of the total costs of the project, i.e. $40 million. The cash flow analysis assumes that the initial down payment is interest-free such as an interest-free loan or a cash investment. Furthermore, for simplicity, the research group has neglected the reinvestments of the net profits from year to year since the net revenues will most probably be reinvested in the local economy in the case of community-based ownership or the provincial economy in the case of a Crown corporation ownership.

Based on the cash flow analysis of a generic 100 MW wind farm, the annual average profit of the first 20 years of the project can be approximated to the order of $5 million per year while for the last five years of the life cycle of the project, the annual profits are in the order of $20 million per year.

Table 4 summarizes the potential total net profit (without revenues from the eventual trading of carbon credits) for a generic 100 MW wind farm constructed, operated and maintained according to the financial conditions currently seen in Eastern Canada. Essentially, it is clear that the larger the provincial ownership stake in the project, the larger the percentage of profits that are retained in New Brunswick. These most probable profits can reach in excess of $200 million over the 25 year life of a generic 100 MW wind farm in New Brunswick. In the context of the Self-Sufficiency objective of the Government of New Brunswick, it is fundamental that the Government of New Brunswick adopts public policies that will maximize the retention, in New Brunswick, of revenues generated from the exploitation of wind, a renewable natural resource, to generate electricity.

Table 4

Distribution of the profits generated by a generic 100 MW wind farm in New Brunswick ($).

	Degree of Provincial Ownership		
	0%	**30%**	**100%**
Total profits	200,000,000	200,000,000	200,000,000
Profits retained in New Brunswick	0	60,000,000	200,000,000
Profits flowing outside of New Brunswick	200,000,000	140,000,000	0

Note: The total profits indicated in this Table does not account for the eventual revenues from the sale of carbon credits.

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APPENDIX A: WIND FARM CASE STUDIES IN EASTERN CANADA

Table A1: Wind farm case studies in Eastern Canada (1 of 3).

	Prince Wind Energy Project[3]	**Baie-des-Sables Wind Farm**[4,5]	**Eastern Kings Wind Farm**[6,7,8]	**Anse-à-Valleau Wind Farm**[9,10,11]
Project Location & Details				
Location	Sault Ste Marie, On	Baie-des-Sables, Qc	Eastern Kings, PEI	Anse-à-Valleau, Qc
Total Installed Capacity	189 MW	109.5 MW	30 MW	100.5 MW
Number of Turbines	126	73	10	67
Turbine Model	GE sle	GE sle	Vestas V90	GE sle
Turbine Nameplate Capacity	1.5 MW	1.5 MW	3 MW	1.5 MW
Investment				
Total Project Investment	$400,000,000.	$164,000,000.	$47,000,000.	$164,000,000.
Cost per MW	2.12 M$/MW	1.50 M$/MW	1.57 M$/MW	1.63 M$/MW
Construction Phase				
Construction Year	2005	2006	2006	2007
Provincial Expenditures	NA	$65,600,000.[e]	$10,000,000.	$65,600,000.[e]
% of DPE / TPI [a]	NA	40%[e]	21.3%	40%[e]
Duration[b]	14 months	8 months	6 months	8 months
Employment (Average During Construction)[b]	242 employees	100 employees	25 employees	100 employees
Total Number of Jobs (Person-years)	282	66.7	12.5	66.7
Number of Jobs per MW (Person-years)	1.49	0.61	0.42	0.67
Operation & Maintenance Phase				
Estimated Annual Revenues[c]	$47,682,432.	$27,625,536.	$7,568,640.	$25,354,944.
Estimated Annual O&M Expenditures[d]	$5,960,304.	$3,453,192.	$946,080.	$3,169,368.
Annual O&M Provincial Expenditures	$1,600,000.	NA	$473,040.	NA
% of O&M Provincial / O&M Total	26.8%	NA	50%	NA
Direct O&M Employment	17 jobs	10 jobs	3 jobs	10 jobs
Direct O&M Employment per MW	0.09 jobs/MW	0.09 jobs/MW	0.1 jobs/MW	0.1 jobs/MW
Annual Landowner Royalties	NA	$139,500.	$214,216.	$153,000.

Table A1: Wind farm case studies in Eastern Canada (2 of 3).

	Port Alma Wind Farm[12,13,14]	**Carleton Wind Farm**[15,16,17,18]	**Kent Hills Wind Farm**[19]	**Caribou Mountain Wind Farm**[20,21,22]	**Data Used in Economic Impact Assessment**
Project Location & Details					
Location	Chatham-Kent, On	Carleton, Qc	Albert County, NB	Caribou Montain, NB	NB
Total Installed Capacity	101.2 MW	109.5 MW	96 MW	99 MW	100 MW
Number of Turbines	44	73	32	33	-
Turbine Model	Siemens 2.3 MW MkII	GE sle	Vestas V90	Vestas V90	-
Turbine Nameplate Capacity	2.3 MW	1.5 MW	3 MW	3 MW	-
Investment					
Total Project Investment	$200,000,000.	$170,000,000.	$170,000,000.	$200,000,000.	$200,000,000.
Cost per MW	1.98 M$/MW	1.55 M$/MW	1.77 M$/MW	2.02 M$/MW	2.0 M$/MW[i]
Construction Phase					
Construction Year	2007	2008	2008	2009	2009
Provincial Expenditures	$35,000,000.	$104,000,000.[e]	$20,000,000.	NA	$34,000,000.
% of DPE / TPI [a]	17.5%	61.2%[e]	11.7%	NA	17.0%[j]
Duration[b]	12 months	6 months	14 months[f]	NA[g]	14 months[k]
Employment (Average During Construction)[b]	100 employees	200 employees	60 employees	125 employees	70 employees
Number of Person-years (Total)	100	100	70	NA[g]	81[l]
Number of Person-years per MW	0.99	0.91	0.73	NA[g]	0.81
Operation & Maintenance Phase					
Estimated Annual Revenues[c]	$25,531,546.	$27,625,536.	$24,219,648.	$24,976,512.	$25,228,800.
Estimated Annual O&M Expenditures[d]	$3,191,443.	$3,453,192.	$3,027,456.	$3,122,064.	$3,153,600.
Annual O&M Provincial Expenditures	NA	$2,555,000.	$1,000,000.	NA	$1,450,656.
% of O&M Provincial / O&M Total	NA	74.0%	33.0%	NA	46.0%
Direct O&M Employment	6 jobs	10 jobs	7 jobs	12 jobs	9 jobs
Direct O&M Employment per MW	0.06 jobs/MW	0.09 jobs/MW	0.07 jobs/MW	0.12 jobs/MW	0.09 jobs/MW
Annual Landowner Royalties	$500,000.	$320,700.	NA	$350,000.[h]	$500,000.[m]

[a] *DPE / TPI : Direct Provincial Expenditures / Total Project Investment.*
[b] *Estimates taken from data in case studies and press releases.*
[c] *Capacity Factor = 36%[1] ; 0.08$/kWh.*
[d] *Capacity Factor = 36%; 0.01$/kWh[2].*
[e] *Numbers include development phase.*
[f] *Estimate value.*
[g] *Wind farm currently in construction.*
[h] *Value representative of a 100 MW wind farm located on Crown Land in New Brunswick.*
[i] *Value representative of the highest cost per MW in the sample wind farms rather than the average of 1.77 M$/MW; highest cost is more representative of current total project investment to build a 100 MW wind farm in the region.*
[j] *Because of legislated minimum local expenditures in Quebec, data from this province are not used to calculate the most probable average for New Brunswick.*
[k] *Value representative of a 100 MW wind farm located on wooden land in New Brunswick.*
[l] *Average for the wind farms of approximately 100 MW in the sample.*
[m] *Value corresponds to 2% of estimated annual revenues; representative of highest unofficial value in the region.*
NA: *Data not available.*

Table A1: Wind farm case studies in Eastern Canada (3 of 3).

APPENDIX B: ANNUAL PROVINCIAL DIRECT TAX REVENUES

Table B1 presents the estimated annual provincial direct tax revenues that a 99 MW wind farm would produce if currently installed in a Local Service District (LSD) in New Brunswick.

Table B1

Estimates of provincial direct tax revenues of a 99 MW wind farm in New Brunswick.

	Provincial Assessment Evaluation	**LSD Tax Estimates**[f]	**Provincial Tax Estimates**[g]
WTG towers	$5,219,940.[a]	$23,490.	$118,493.
WTG foundations	$2,881,560.[b]	$12,967.	$65,411.
Roads	$2,000,000.[c]	$9,000.	$45,400.
Buildings	$300,000.[d]	$1,350.	$6,810.
Electrical system components	$20,800,000.[e]		$472,160.
Wind Farm Total	**$31,201,500.**	**$755,081.**[h]	

[a] *Based on New Brunswick Assessment Act (O.C. 2008-155); 99 MW installed capacity (33 WTG with 3 MW installed capacity each); each WTG tower is of 80 m height, is composed of 3 sections per tower with an elevator, and weights 160 metric tons.*

[b] *Based on New Brunswick Assessment Act (O.C. 2008-155); WTG foundations of 590 m^3 of concrete each.*

[c] *Based on 1% of total wind farm investment[23].*

[d] *Based on industrial building.*

[e] *Based on 10.4% of total wind farm investment[23].*

[f] *Based on a Local Service District non-residential tax rate of 0.45$ per 100$ of assessment evaluation.*

[g] *Based on a provincial tax rate of 2.25$ per 100$ of assessment evaluation and with an assessment cost of 0.02$ per 100$ of assessment evaluation.*

[h] *The revenues from the assessments in the Local Service Districts are collected by the province and are thus treated as provincial tax in this analysis.*

APPENDIX C: PEI ENERGY CORPORATION CASE STUDY

The Prince Edward Island Energy Corporation (PEIEC) is a provincial crown corporation of the government of Prince Edward Island (PEI) and is responsible for pursuing and promoting the development of energy systems and the generation, production, transmission and distribution of energy, in all its forms, on an economic and efficient basis [6]. The PEIEC built, owns and operates both the North Cape (10.56 MW) and Eastern Kings (30 MW) wind farms in PEI. This case study looks at the economic impacts arising from some of the PEI Energy Corporation's investment activities.

North Cape Wind Farm

The North Cape wind farm is located in North Cape (PEI) at the north-western tip of the island. The 10.56 MW wind farm is owned and operated by the PEI Energy Corporation. The wind farm was constructed in two phases; eight Vestas V47 660 kW wind turbines were commissioned in November 2001 (Phase I), while eight more Vestas V47 660 kW wind turbines were commissioned in November 2003 (Phase II). The total project investment was approximately $16.4 million for both project phases. The North Cape wind farm generates approximately 3.5% of the electricity needs of PEI [26].

Eastern Kings Wind Farm

The Eastern Kings wind farm is located near East Point (PEI) at the north eastern tip of the island. The 30 MW wind farm consisting of ten Vestas V90 3MW wind turbines is owned and operated by the PEI Energy Corporation. The wind farm was constructed using a variety of local PEI contractors and businesses; this resulted in approximately $10 million of direct provincial expenditures which represented 21.3% of the final total project investment of $47 million. The wind farm began operations in early 2007 and supplies approximately 7.5% of the current electricity needs of PEI [6,7,8].

Wind Farm Profits

Table C1 shows the profits received by the PEI Energy Corporation, for the financial periods of 2007-08 and 2008-09, from the electricity generation of both the North Cape and Eastern Kings wind farms [6]. It can be seen that the annual profits from both wind farms (representing a total installed capacity of 40 MW) are in excess of $3.1 million annually.

Table C1

Profits generated by the North Cape and Eastern Kings wind farms[6].

PEI Energy Corp. Wind Farms	Installed Capacity	Estimated Revenues[a]	Profits 2007-08	Profits 2008-09
North Cape Wind Farm	10.56 MW	$2,664,161.	$1,372,000.	$1,588,000.
Eastern Kings Wind Farm	30 MW	$7,568,640.	$1,781,000.	$2,303,000.
Total Wind Farms	**40 MW**	**$10,232,801.**	**$3,153,000.**	**$3,891,000.**

[a] *Capacity Factor = 36%[1] ; 0.08$/kWh.*

Economic Impacts

The PEI Energy Corporation has been able to use a portion of the profits from the operations of both the North Cape and Eastern Kings wind farms to finance other initiatives [6]:

- North Cape Wind Farm Phase II:

  After building the first phase of the North Cape wind farm in 2001, the PEI Energy Corporation invested approximately $800,000 of the profits generated by Phase I of the wind farm to develop and build Phase II of the wind farm at a cost of approximately 8 million Canadian dollars.

- Wind Energy Institute of Canada (WEICan):

  The Wind Energy Institute of Canada (WEICan) located in North Cape (PEI) is Canada's leading testing and research institute for wind energy systems. The institute's research activities date back to 1980 when its predecessor, the Atlantic Wind Test Site (AWTS), started operating an experimental test facility for wind turbines and wind-diesel technologies. WEICan is currently involved in various activities from wind turbine testing leading to IEC certification, to research and development activities with the wind industry and Canadian universities. The PEI Energy Corporation provides $154,000 annually from the North Cape wind farm profits towards core funding of the Wind Energy Institute of Canada (WEICan).

- PEI Wind-Hydrogen Village Project:

  In order to investigate the potential of hydrogen in the Canadian economy, and the application of hydrogen storage in island communities, a wind-hydrogen demonstration project is being undertaken in North Cape (PEI). The $3.35 million project is lead by the PEI Energy Corporation and Natural Resources Canada, while a consortium of industry,

government and academic partners participate in the three year project. The project is currently in its first phase which includes the installation and operation of a hydrogen production system that is powered independently of the grid by several wind turbine generators at WEICan's test site [27]. Over the past two years, the PEI Energy Corporation has invested $1,626,000 in this endeavour with all of this investment coming from the profits generated by both the North Cape and Eastern Kings wind farms.

APPENDIX D: EDMUNDSTON ENERGY CASE STUDY

In New Brunswick, three municipalities offer services in the electricity sector. In the case of the City of Edmundston, its energy division was created in 1910 and was incorporated in 1911 [28]. In that same year, the construction of a hydroelectric dam at Deuxième-Sault was launched. Initially, the dam had an installed capacity of 250 kW; with the success of multiple expansion projects at the site, its current installed capacity is 2 MW.

In 1961, Edmundston Energy signed an agreement with NB Power in order to integrate its distribution grid to the provincial grid; thereby, alleviating the problem that its electricity production capacity was less than the electricity demand from its customers [29]. Since, Edmundston Energy's clients use electricity generated by both organisations. Currently, Edmundston Energy has over 5,700 clients [30].

Table D1 presents Edmundston Energy's profile of investments for the fiscal years of 2006 and 2007. As can be seen from Table D1, Edmundston Energy has capital expenditures of over $1 million dollars per year. These expenditures represent an average of 8.8% of the organisation's revenues from the generation and distribution of electricity to its clients.

Table D1

Profile of investment of Edmundston Energy

	2005	**2006**	**2007**	**2008**	**Total**
Revenues	$18,113,761.	$18,998,493.	$29,843.267.	$23,355,268.	$90,310,789.
Capital expenditures	$4,449,935.	$1,183,529.	$1,255,434.	$1,065,038.	$7,953,936.
% of Capital expenditures / Revenues	24.6%	6.2%	4.2%	4.6%	8.8%

After acquiring the 2 MW Madawaska River hydroelectric facility from Fraser Papers Nexfor in 2005, at a cost of $2.5 million, Edmundston Energy has recently announced a capital works project totalling $15.5 million of investments for both the refurbishment of the facility and the installation of new equipment [31], thus permitting a generation capacity increase of 3.5 MW, for a total of 5.5 MW at the site.

APPENDIX E: CASH FLOW ANALYSIS OF A GENERIC 100 MW WIND FARM

100 MW Wind Farm Cash Flow Model

Assumptions

Total Wind Farm Installed Capacity	100	MW
Capacity Factor	36%	
Annual Energy Output	315,360,000	kWh/yr
Installed Cost per MW	$ 2,000,000	
Total Installed Cost	$ 200,000,000	
O&M	0.01	$/kWh
Insurance	0.3%	of Capital Costs
Purchase Price of Electricity (Year 1)	0.08	$/kWh
Indexation of Price of Electricity (Annual)	2.0%	
Inflation Rate	2%	
Down Payment	20%	
Equity Cash	$ 40,000,000	
Loan Term	15	yrs
Loan Interest	6.0%	
Income Tax	35%	
Landowners Royalties (Annual)	2.50%	of Revenues
Property Taxes (Annual)	$ 755,081	

Cash Flow Table (2009 Dollars)

Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	01/01/2009	01/01/2010	01/01/2011	01/01/2012	01/01/2013	01/01/2014	01/01/2015	01/01/2016	01/01/2017	01/01/2018	01/01/2019	01/01/2020	01/01/2021	01/01/2022	01/01/2023	01/01/2024	01/01/2025	01/01/2026	01/01/2027	01/01/2028	01/01/2029	01/01/2030	01/01/2031	01/01/2032	01/01/2033	01/01/2034
CASH RECEIPTS																										
Cash Sales		25,228,800	25,733,376	26,248,044	26,773,004	27,308,464	27,854,634	28,411,726	28,979,961	29,559,560	30,150,751	30,753,766	31,368,842	31,996,219	32,636,143	33,288,866	33,954,643	34,633,736	35,326,411	36,032,939	36,753,598	37,488,670	38,238,443	39,003,212	39,783,276	40,578,942
TOTAL CASH RECEIPTS		**25,228,800**	**25,733,376**	**26,248,044**	**26,773,004**	**27,308,464**	**27,854,634**	**28,411,726**	**28,979,961**	**29,559,560**	**30,150,751**	**30,753,766**	**31,368,842**	**31,996,219**	**32,636,143**	**33,288,866**	**33,954,643**	**34,633,736**	**35,326,411**	**36,032,939**	**36,753,598**	**37,488,670**	**38,238,443**	**39,003,212**	**39,783,276**	**40,578,942**
CASH PAID OUT																										
Operating Expenses																										
Wind Farm Construction	200,000,000																									
Down Payment	40,000,000																									
Landowners Royalties		630,720	643,334	656,201	669,325	682,712	696,366	710,293	724,499	738,989	753,769	768,844	784,221	799,905	815,904	832,222	848,866	865,843	883,160	900,823	918,840	937,217	955,961	975,080	994,582	1,014,474
O&M		3,153,600	3,216,672	3,281,005	3,346,626	3,413,558	3,481,829	3,551,466	3,622,495	3,694,945	3,768,844	3,844,221	3,921,105	3,999,527	4,079,518	4,161,108	4,244,330	4,329,217	4,415,801	4,504,117	4,594,200	4,686,084	4,779,805	4,875,401	4,972,910	5,072,368
Insurance		660,000	673,200	686,664	700,397	714,405	728,693	743,267	758,133	773,295	788,761	804,536	820,627	837,040	853,780	870,856	888,273	906,039	924,159	942,643	961,495	980,725	1,000,340	1,020,347	1,040,754	1,061,569
Property Taxes		755,081	770,183	785,586	801,298	817,324	833,670	850,344	867,351	884,698	902,392	920,440	938,848	957,625	976,778	996,313	1,016,240	1,036,564	1,057,296	1,078,442	1,100,010	1,122,011	1,144,451	1,167,340	1,190,687	1,214,500
Loan Interest Payment		9,600,000	9,187,557	8,750,368	8,286,948	7,795,722	7,275,023	6,723,082	6,138,024	5,517,863	4,860,493	4,163,680	3,425,058	2,642,119	1,812,203	932,493	0	0	0	0	0	0	0	0	0	0
Loan Principal Payment		6,874,042	7,286,485	7,723,674	8,187,094	8,678,320	9,199,019	9,750,960	10,336,018	10,956,179	11,613,550	12,310,363	13,048,984	13,831,924	14,661,839	15,541,549	0	0	0	0	0	0	0	0	0	0
TOTAL OPERATING EXPENSES	**40,000,000**	**21,673,443**	**21,777,431**	**21,883,499**	**21,991,688**	**22,102,041**	**22,214,601**	**22,329,412**	**22,446,520**	**22,565,969**	**22,687,808**	**22,812,083**	**22,938,844**	**23,068,140**	**23,200,022**	**23,334,541**	**6,997,709**	**7,137,663**	**7,280,417**	**7,426,025**	**7,574,545**	**7,726,036**	**7,880,557**	**8,038,168**	**8,198,932**	**8,362,910**
NET CASH FROM OPERATING EXPENSES	**-40,000,000**	**3,555,357**	**3,955,945**	**4,364,544**	**4,781,316**	**5,206,423**	**5,640,033**	**6,082,314**	**6,533,441**	**6,993,591**	**7,462,944**	**7,941,683**	**8,429,998**	**8,928,079**	**9,436,121**	**9,954,324**	**26,956,934**	**27,496,073**	**28,045,994**	**28,606,914**	**29,179,052**	**29,762,633**	**30,357,886**	**30,965,044**	**31,584,345**	**32,216,031**
Other Expenses																										
Income Tax		3,650,290	3,934,850	4,230,876	4,538,944	4,859,660	5,193,668	5,541,646	5,904,311	6,282,419	6,676,773	7,088,216	7,517,644	7,966,001	8,434,286	8,923,556	9,434,927	9,623,625	9,816,098	10,012,420	10,212,668	10,416,922	10,625,260	10,837,765	11,054,521	11,275,611
Decommissioning Reserve		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reserves		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL CASH PAID OUT	**40,000,000**	**25,323,733**	**25,712,282**	**26,114,375**	**26,530,632**	**26,961,701**	**27,408,269**	**27,871,058**	**28,350,830**	**28,848,389**	**29,364,580**	**29,900,299**	**30,456,488**	**31,034,141**	**31,634,308**	**32,258,097**	**16,432,636**	**16,761,289**	**17,096,515**	**17,438,445**	**17,787,214**	**18,142,958**	**18,505,817**	**18,875,934**	**19,253,452**	**19,638,521**
CASH ON HAND (End of year)	**0**	**-94,933**	**21,094**	**133,668**	**242,373**	**346,763**	**446,365**	**540,668**	**629,131**	**711,172**	**786,171**	**853,467**	**912,354**	**962,078**	**1,001,835**	**1,030,769**	**17,522,007**	**17,872,447**	**18,229,896**	**18,594,494**	**18,966,384**	**19,345,712**	**19,732,626**	**20,127,278**	**20,529,824**	**20,940,420**
CUMULATIVE CASH (End of year)	**0**	**-94,933**	**-73,838**	**59,830**	**302,202**	**648,965**	**1,095,330**	**1,635,998**	**2,265,129**	**2,976,300**	**3,762,471**	**4,615,938**	**5,528,292**	**6,490,370**	**7,492,205**	**8,522,974**	**26,044,981**	**43,917,428**	**62,147,325**	**80,741,819**	**99,708,203**	**119,053,914**	**138,786,540**	**158,913,818**	**179,443,642**	**200,384,063**
OTHER OPERATING DATA																										
Depreciation		8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000
Price of Electricity ($/kWh)		0.080	0.082	0.083	0.085	0.087	0.088	0.090	0.092	0.094	0.096	0.098	0.099	0.101	0.103	0.106	0.108	0.110	0.112	0.114	0.117	0.119	0.121	0.124	0.126	0.129
Average Price of Electricity ($/kWh)	0.102																									
Pre-tax IRR	17.4%																									
Pre-tax ROI		5.2%	5.6%	6.0%	6.5%	6.9%	7.4%	7.9%	8.4%	9.0%	9.5%	10.1%	10.7%	11.4%	12.0%	12.7%	13.5%	13.7%	14.0%	14.3%	14.6%	14.9%	15.2%	15.5%	15.8%	16.1%
Average Pre-tax ROI	11.1%																									
After-tax ROI		3.4%	3.7%	3.9%	4.2%	4.5%	4.8%	5.1%	5.5%	5.8%	6.2%	6.6%	7.0%	7.4%	7.8%	8.3%	8.8%	8.9%	9.1%	9.3%	9.5%	9.7%	9.9%	10.1%	10.3%	10.5%
Average After-tax ROI	7.2%																									
NPV OF TOTAL CASH ON HAND	59,448,107																									

NOTES: O&M Costs, Insurance Costs, Landowner Royalties, and Property Taxes are indexed annually with the inflation rate.

Table E1: Cash flow analysis of a generic 100 MW wind farm.