- FINAL Report -

Wind Dividends: An Analysis of the Economic Impacts from Ontario's Wind Procurements

Presented to:

canwea
CANADIAN WIND ENERGY ASSOCIATION | ASSOCIATION CANADIENNE DE L'ÉNERGIE ÉOLIENNE

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Compass Renewable Energy Consulting Inc.
215 Spadina Ave, Suite 300
Toronto, Ontario

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1 Disclaimer

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2 Executive Summary

Ontario is a national leader in installed capacity of wind power, with over 4,000 MW already installed as of September 2015 and contracts or commitments for an additional 2,480 MW, as per *Achieving Balance,* the 2013 Long Term Energy Plan (LTEP). In addition to providing electrical energy at predictable rates, without the volatility of fuel costs, wind energy development provides significant economic benefits through its projects lifecycle.

The economic benefits associated with wind energy development are a function of annual installations, project costs, local spending and project size. A number of studies have estimated the local economic benefits associated with individual projects, but none providing a comprehensive evaluation of all of Ontario's wind procurements. Recognizing the factors impacting local economic benefits evolve over time, the Canadian Wind Energy Association has endeavoured to evaluate the total historic and future economic impacts from Ontario's wind energy investments, throughout the development, manufacturing, construction and operations phases.

Using historic and forecast installations, capital costs, and domestic content obligations as indicators, Compass leveraged the National Renewable Energy Laboratory's Jobs and Economic Development Impacts model to estimate project and provincial impacts. Based on this analysis, Ontario's past and future investments in wind energy will result in the following economic impacts between 2006 and 2030:

Figure 1 - Economic Impacts from Ontario's Wind Investments

73,000 Direct and Indirect FTE

$5.1 Billion Direct and Indirect Earnings

$7 Billion Direct and Indirect GDP

$14 Billion in Investment

Ontario's wind procurements have helped to create a sophisticated home grown supply chain, including component manufacturing and professional services used throughout the development and manufacturing phases of projects and employing thousands of Ontarians. Furthermore, the wind energy developments in the province will contribute dividends to municipalities, land owners and employees over the twenty five years of the projects through taxes, community vibrancy payments, lease payments and personal wages. This report clearly demonstrates how these operational benefits, which directly support local economies, endure over the useful life of these projects.

However, this report also demonstrates that beyond 2015, the outlook for increased benefits from wind development in Ontario is materially diminished relative to the past five years, and beyond 2020 there is no planned investment based on the 2013 LTEP targets. The longevity of manufacturers' facilities which form part of global supply chains are contingent on the strength and outlook of local markets. As a direct consequence, the limited role of wind within the 2013 LTEP will very likely result in the loss of wind related manufacturing, development and operations related jobs.

In contrast, the modelling employed to produce this report shows that increasing the role of wind by 1,000 MW over 2013 LTEP targets would result in an incremental 7,000 FTE by 2030. In order to realize these benefits, Ontario would need to make near-term and long-term commitments to a supply mix that enables wind power to continue to grow in installed capacity.

3 SCOPE AND OBJECTIVES

The province of Ontario is a leader in the development of wind energy in Canada with 4,042 MW installed as of September 2015, representing approximately 40% of Canada's installed capacity at that time.[1] Ontario has an additional 1,780 MW of projects under contract that are being developed[2] as well as further commitments to wind energy development as described in *Achieving Balance*, Ontario's 2013 Long Term Energy Plan (LTEP). These wind projects have been developed under a variety of procurements including both competitive and standard offer style programs. The Canadian Wind Energy Association (CanWEA) has commissioned Compass to conduct this analysis in an effort to obtain a fulsome assessment of the direct and indirect economic impacts associated with the past and future investments in wind energy in Ontario.

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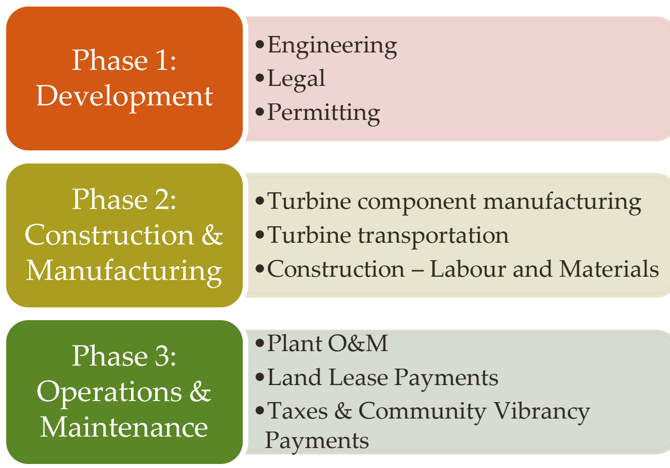
[1] Installed Capacity, Canadian Wind Energy Association, Accessed on-line October 20, 2015: http://canwea.ca/wind-energy/installed-capacity/

[2] Progress Report on Contracted Electricity Supply, Independent Electricity System Operator, Accessed on-line, October 20, 2015: http://www.ieso.ca/Documents/Supply/Progress-Report-Contracted-Supply-Q22015.pdf

4 Approach and Methodology

Wind project development results in investment and employment impacts throughout the three stages of a project's lifecycle: 1) Development, 2) Construction & Manufacturing and 3) Operations and Maintenance, see Figure 2 below. Different products and services are required for each of these phases and the level of provincial economic impacts will vary based on a number of factors including capital costs, local supply chain capability and domestic content requirements.

Figure 2 – Phases of Wind Development and Source of Economic Impacts



This analysis required translating the economic impacts throughout these three phases of development for all past and future procurements, shown in Table 1 below. In addition to current contracts, Compass used the 2013 LTEP's 2025 wind capacity target to estimate total economic impacts from Ontario's wind procurements.

Table 1 - Ontario's Wind Procurements

Procurement	Capacity (MW)
Renewable Energy Supply I,II,III	1,509
Renewable Energy Standard Offer Program	285
Feed-in Tariff	2,960
Korean Consortium	1069
Large Renewable Procurement I	300
Large Renewable Procurement II & III*	357
Total	**6,480**

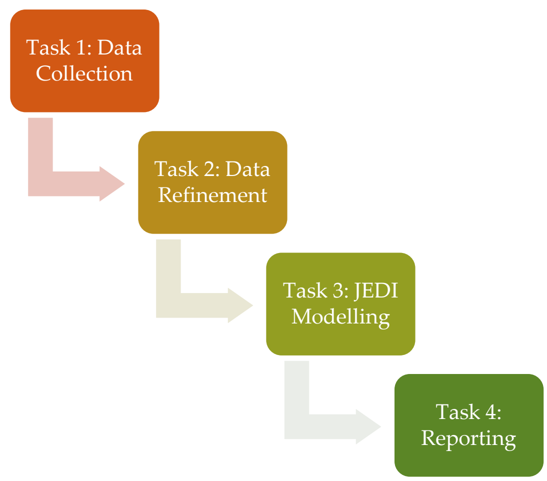
** Based on LTEP 2013 targets, only 357 MW would be needed from LRP II & III combined to achieve the 6,480 MW target.*

The challenge of translating the economic impacts for these different procurements was addressed by using the National Renewable Energy Laboratory's (NREL) Jobs and Economic Development Impact (JEDI) model. The JEDI Model, described in more detail below, is an economic input output model that allows a user to calculate project level economic impacts during all three phases of development, covering direct, indirect and induced impacts.

The representativeness of the JEDI model's outputs is dependent on the accuracy of its inputs. Therefore, an important part of this assignment was ensuring the inputs reflected the way wind projects were and will be developed under each of the procurements.

Overall, there were four main tasks in this study, see Figure 3 below. Task 1: Data Collection, Task 2: Data Refinement, and Task 3: JEDI Modelling, followed by Task 4: Reporting.

Figure 3 - Overview of Approach



Task 1: Data Collection: JEDI incorporates baseline information that is designed for use throughout the U.S. and therefore it was customized with Ontario specific data including costs, and supply chain impacts. Compass conducted secondary research on costs and local content in addition to the researching multiplier and data to correspond to the Ontario market, past and future.

Task 2: Data Refinements: Once initial research was conducted covering all market related costs and cost allocations, we refined the data through discussions with industry participants including developers, equipment manufacturers and engineering, procurement and construction (EPC) providers in addition to further third party research.

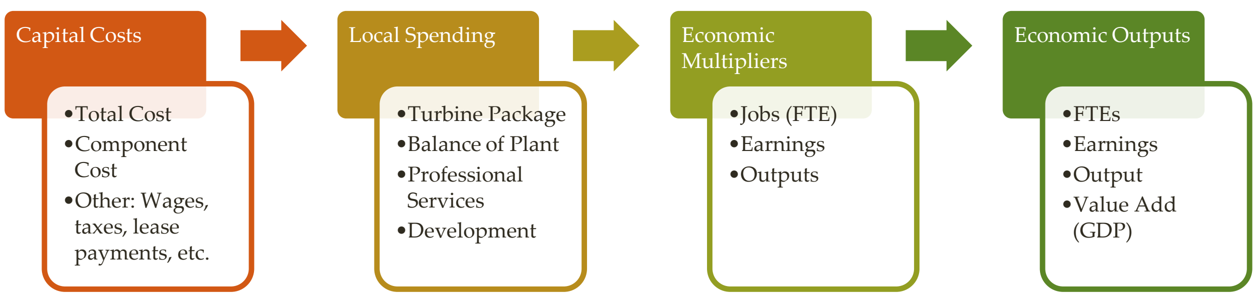
Task 3: JEDI Modelling: The JEDI Model was run for each different type of project profile, which included the following characteristics: procurement, installation year, capital costs, typical project size, domestic content requirements, land lease payments and property taxes.

Task 4: Reporting: This task involved translating the project level impacts by procurement into annual impacts by procurement by year.

4.1 Overview of the JEDI Model

NRELs JEDI model is an input-output model that assesses employment and economic impacts in a province or region from investments in a power generation project. JEDI utilizes economic data to estimate local economic activity and resulting impacts. Economic impacts are based on project specific costs (capital and operations), allocations, local spending and inter-industry effects calculated using multipliers. Multipliers for employment, wage and salary, and output and personal spending patterns are embedded in JEDI that help to calculate direct, indirect and induced impacts from power generation investments. Figure 4 provides an overview of the different types of data used by the JEDI model.

Figure 4 - JEDI Model Mechanics



A wide range of additional inputs needed to be developed for use in the JEDI model to properly estimate local economic impacts in Ontario. These included:

- Total Capital Costs and capital costs allocation amongst project components
- Local contributions towards both labour and component manufacturing
- Operations and maintenance costs and the amount spent locally
- Wage rates by major construction function

Each of these inputs has evolved over time impacting the different vintages of wind projects developed in Ontario. Contract vintages were therefore segmented in order to develop a representative profile of each type of contract. These segmentations included:

1. Renewable Energy Supply (RES) I, II, III
2. Renewable Energy Standard Offer Program (RESOP) Contracts
3. Feed-in Tariff (FIT) Contracts
4. Large Renewable Procurement (LRP)

Therefore, a unique set of assumptions was used to estimate impacts from a specific procurement type in a given year based on the inputs described above.

4.1.1 JEDI Model Limitations

Like all input output models, JEDI is subject to certain limitations. Results in JEDI reflect gross and not net impacts and are dependent on the accuracy and appropriateness of the project description. They are based on approximations of industrial input-output relationships, and the assumption that all industrial inputs and factors of production are used in fixed proportions and respond perfectly elastically.

4.1.2 JEDI Model Outputs

JEDI calculates the following economic outputs: Jobs, Earnings, Output and approximate contributions towards Gross Domestic Product (GDP), using industrial sector relationships.

Jobs refers to Full Time Equivalents (FTE) which represents full time employment for one year. (1 FTE = 2,080 hours)

Earnings refers to wage and salary compensation paid to workers.

Value Added, is an estimate of GDP and is the difference between total gross output and the cost of intermediate inputs.

Output refers to economic activity or the value of production in the state or local economy. Output is defined more broadly than other metrics of economic activity including value added (or GDP). Output is the sum value of all goods and services at all stages of production (i.e., as a raw material and as a finished product), where value added refers only to the market value of the final product.

5 TASK 1: DATA COLLECTION

The data collection required collecting information on the following inputs:

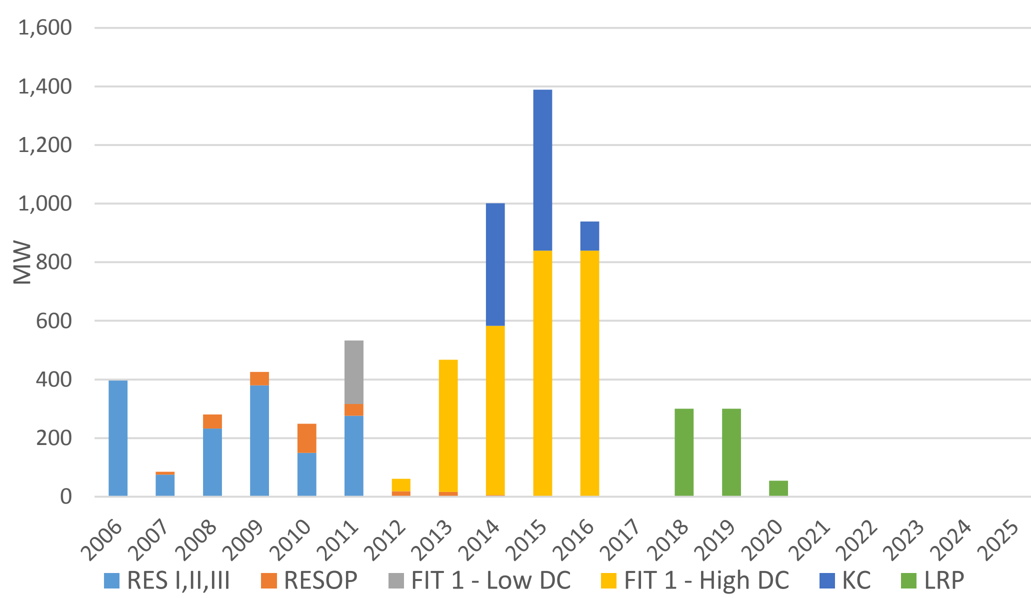
- Installation Profile
- Domestic Content Profile
- Capital Cost
- Wage Rates
- Operations and Maintenance Costs
- Land lease Payments
- Property Taxes and Community Vibrancy Payments
- Ontario Economic Multipliers

Each of these is described in more detail below.

5.1 Installation Profile

Ontario's wind procurement started in 2002 with the initial RES procurements, but projects did not achieve commercial operation until 2006. Figure 5 below presents the historical and forecast wind installations by procurement by year they are expected to achieve commercial operation. This profile assumes that wind procurements will be capped based on the 2013 LTEP targets of 6,480 MW by 2025, and that there will be no attrition for all unbuilt and committed projects. As shown below, post FIT and Korean Consortium (KC) projects, wind installations in Ontario drop off significantly based on 2013 LTEP targets.

Figure 5 - Historical and Forecast Ontario Wind Installations by Procurement

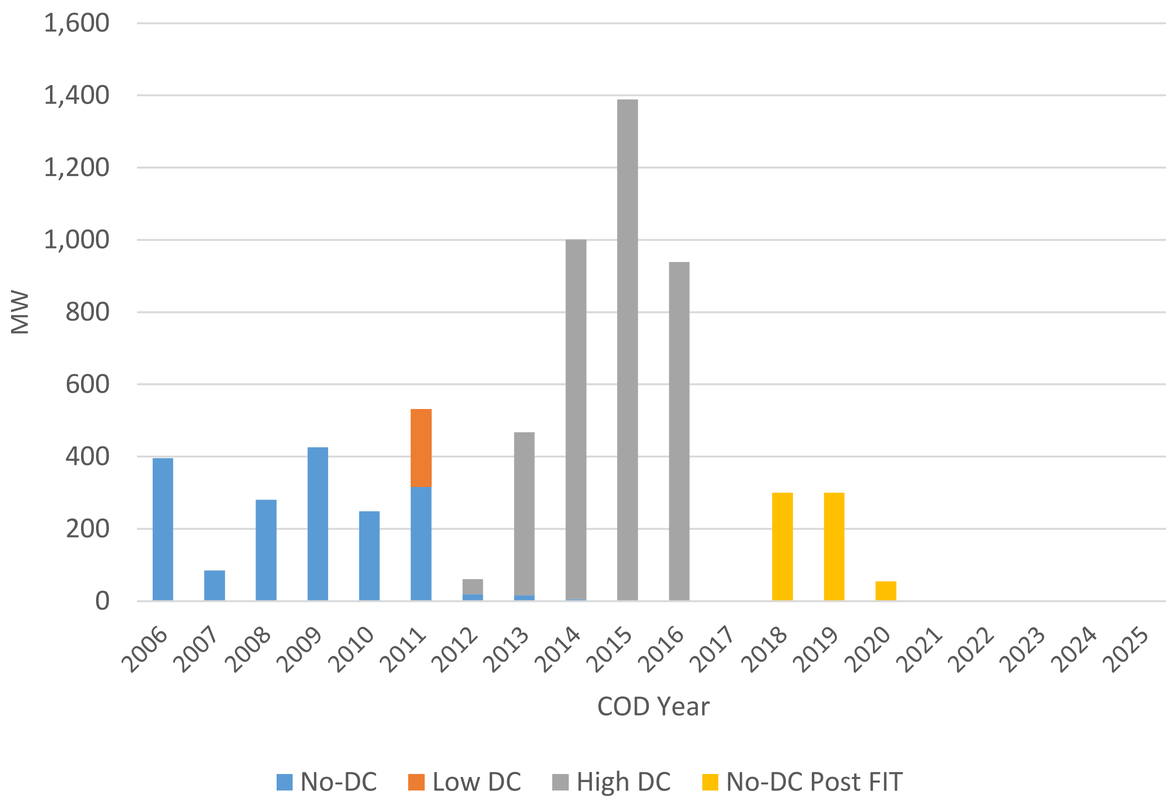


Source: Independent Electricity System Operator with Compass Analysis

5.1 Domestic Content Profiles

Ontario's FIT program as well as the KC projects incorporated Domestic Content (DC) obligations in their contracts. In total these two sets of procurements exceed 4 GW or over 60% of all historic and forecast wind development in Ontario up to the 2013 LTEP targets. Figure 6 below classifies projects based on their DC obligations.

Figure 6 - Ontario Wind Installations by DC Requirement



Although there no contractual obligations to use local labour or components outside of the FIT and KC procurements, many of these past projects did incorporate a variety of local service providers associated with permitting, legal and construction services. Many of these construction providers used their own local suppliers for balance of plant related materials such as concrete and rebar needed for foundations.

Furthermore, the DC requirements have necessitated the development of local supply chain in Ontario some of which continue to serve projects in Ontario and abroad, who are anticipated to serve part of the market in future procurements.

Therefore, we developed five distinct domestic content profiles reflecting domestic content obligations and local supply chain availability for the purposes of modelling different procurements in JEDI. These are summarized below.

DC Scenario 1: No DC Requirement Pre-FIT

Projects in this category feature no turbine package components made in Ontario, but most of the construction and services provided from Ontario. Projects include those in RES I,II,III and RESOP.

DC Scenario 2: Low DC Requirement

The FIT program had two tiers of domestic content obligations based on when a project would achieve commercial operation. FIT Projects in the Low DC Requirement had to achieve a 25% DC threshold, as defined in the FIT contract, which required purchasing steel for towers as well as all construction and consulting related services from Ontario service providers.

DC Scenario 3: High DC Requirement Blades

FIT and KC projects had to achieve a higher DC threshold of 50%, as defined in the FIT contract. There were two prominent approaches for achieving this higher threshold, the first included purchasing DC-compliant blades in addition to steel and tower formation from Ontario manufacturers.

DC Scenario 4: High DC Requirement Non-Blades

The alternative approach for achieving the higher DC threshold included purchasing Ontario steel and towers formed in Ontario, as well as a variety of other smaller components.

DC Scenario 5: No DC Requirement LRP

Although DC obligations have been removed, a strong Ontario supply chain remains and anticipate serving part of the post FIT market.

5.2 Capital Cost Profile

As described above, one of the important inputs used in the JEDI model is the total capital costs. Capital costs for wind projects have fluctuated over time based on global demand and supply conditions as well as technology advancement. Furthermore, project size and DC obligations also impact project level capital costs. Therefore, an annual capital cost profile was developed for each procurement in recognition of project size and DC obligations.

There is limited publicly available data on historic capital costs in Canada or Ontario, therefore our approach to developing these cost profiles started with the latest U.S. Department of Energy (DOE) data[3] converted to Canadian dollars. These numbers were then discussed with industry participants and revised to account both for project size, DC obligations and interconnection costs.

Future capital costs were based on forecasts of capital costs declines using learning curves as described in the International Energy Agency's (IEA) Wind Task 26, *The Past and Future Cost of Wind Energy*, which suggests that a 20 – 30% capital costs decline in wind power is anticipated between 2012 and 2030.[4]

5.3 Wage Rates

Preliminary wage rates were obtained through available public resources and presented to industry participants who noted that wage rages can vary significantly depending on the union versus non-union labour pools. Based on a variety of input from industry, we established a representative wage rate and payroll overhead percentage for 2015, which was then inflated or deflated based on the projects installation year.

5.4 Operations and Maintenance Profile

An O&M profile was developed from the latest DOE wind market report, reviewed with Ontario industry participants and then updated. Wind projects that achieved commercial operation prior to 2011 tend to have higher O&M costs and this is reflected in the modelling.

5.5 Land Lease Payments

A land lease payment profile was developed to reflect the evolving payments across procurements. Payments increased during the FIT procurement relative to RES/RESOP but are expected to decrease under LRP, which was factored into the analysis based on procurement type.

5.6 Property Taxes and Community Vibrancy Payments

Property tax and Community Vibrancy Payments were also incorporated into the Operations and Maintenance benefits provided by wind projects in Ontario. These too have evolved over time based on changes to assessment of wind turbine towers as well as engagement with local municipalities.

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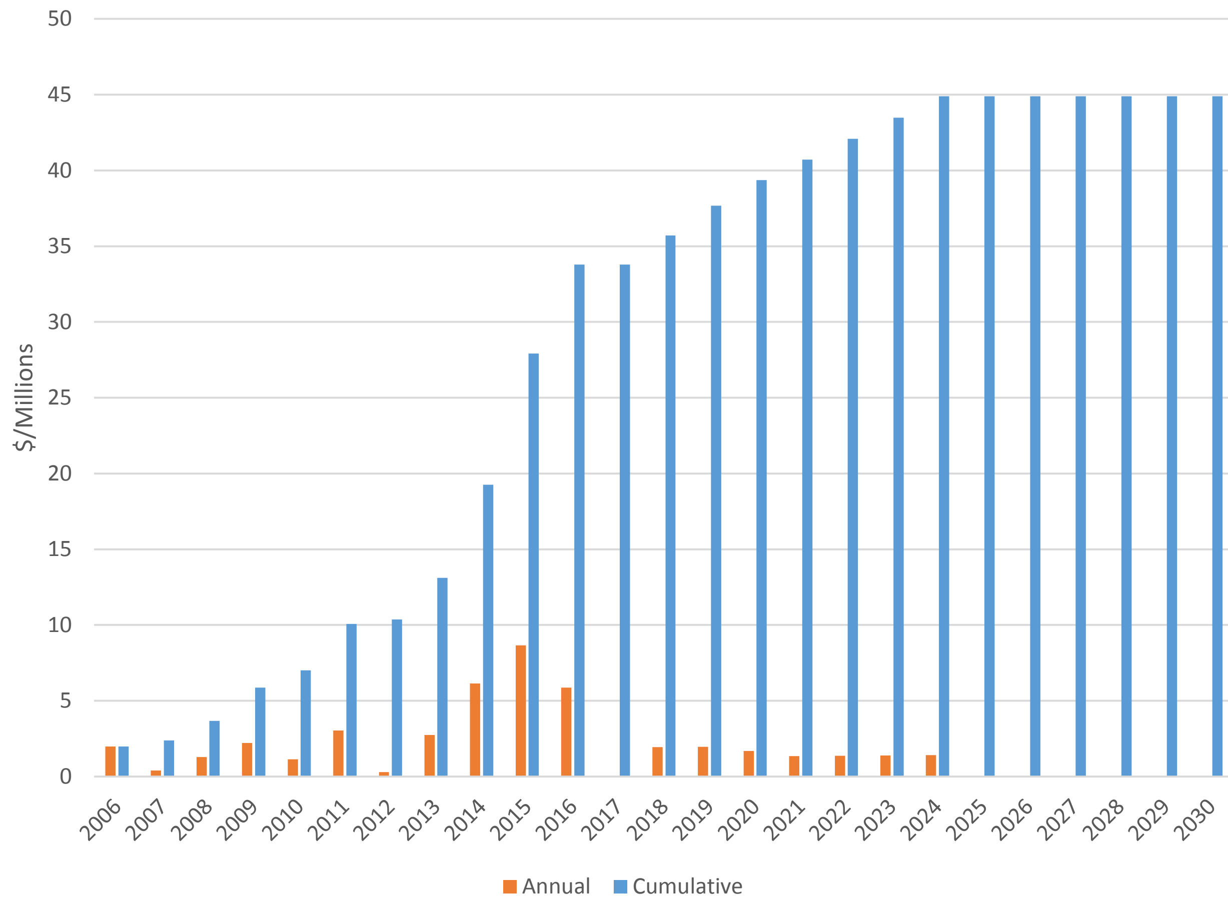
[3] US Department of Energy, *2014 Wind Technologies Report*, Accessed On-line: http://energy.gov/sites/prod/files/2015/08/f25/2014-Wind-Technologies-Market-Report-8.7.pdf

[4] International Energy Agency, The Past and Future Cost of Wind Energy, Accessed On-line: https://www.ieawind.org/index_page_postings/WP2_task26.pdf

Figure 7 below presents the total incremental annual and cumulative community vibrancy and property tax payments paid from Ontario's wind projects, which peak in 2015 at approximately 8.5 million and grow to $45 million by 2024.

Figure 7 – Incremental and Total Annual Community Vibrancy and Property Tax Payments



5.7 Ontario Specific Economic Multipliers

JEDI maps the various costs within each wind project to one of fourteen sectors of the economy shown below. These sectors are an aggregate of various North American Industry Classification (NAICs) codes. Direct, indirect and induced multipliers are required for jobs, earnings and output. Using Ontario specific multipliers from Statistics Canada, Compass selected the most representative multipliers that correspond to the JEDI specific sectors of the economy.

Table 2 – JEDI Sectors of the economy

JEDI Economic Sectors
Agriculture
Mining

JEDI Economic Sectors
Construction
Manufacturing
Fabricated Metals
Machinery
Electrical Equipment
Transportation, Communication and Public Utilities (TCPU)
Wholesale Trade
Retail Trade
Finance, Insurance and Real-estate (FIRE)
Misc. Services
Professional Services
Government

6 TASK 2: DATA REFINEMENTS

The information presented in the section above reflects the final data set that was used in the JEDI modelling including a number of Ontario specific customizations that were made to the initial set of inputs. The customizations were primarily related to costs and local spending allocations that were a product of the Ontario market dynamics including project sizes and domestic requirements. A brief discussion on these refinements is provided below.

6.1 Capital Costs

As described in section 4.3 above, capital costs were initially based on U.S. experience, converted to Canadian dollars, and a single cost profile was to be used for all procurements. However, two important changes to this initial data set were 1) ensuring projects with DC obligations had higher capital costs than U.S. project costs due to a smaller pool of potential suppliers and 2) recognizing dis-economies of scale for smaller projects. As a result, procurement specific capital costs profiles were developed.

6.2 Logistics (Shipping)

Turbine component logistics can represent 15% of the turbine package costs. Initially, we had assumed that 100% of these costs would be spent in Ontario for projects with DC obligations and 0% for projects without them. However, this assumption was updated to reflect that with or without DC obligations part of the logistics costs would still be spent in Ontario. In absence of DC obligations shipping costs to Ontario would generally be spent outside of Ontario, but logistics within Ontario would be obtained from Ontario shipping providers. When DC obligations were in place, a higher percentage of components were made in Ontario and therefore a higher percentage of logistic costs were assumed to be obtained through Ontario shipping provider.

6.3 Post FIT Domestic Content

As described above, we initially did not include any locally manufactured content for post FIT procurements. However, the proximity of major components like towers and blades in Ontario, provide these manufacturers with a relative advantage due to reduced logistics costs. Therefore, we updated our post FIT procurements to incorporate some locally manufactured components, including blades and towers.

6.4 Operations and Maintenance Costs

Operations and Maintenance (O&M) costs were extracted from US DOE data and then checked with industry participants in Ontario. Revisions to the initial assumptions included an increase in the overall O&M costs as well as a reduction in the sourcing of turbine related components. It was originally anticipated that 50% of wind turbine related O&M components would come from Ontario; this was updated to reflect new information from industry that little or no components would come from Ontario.

7 Additional Assumptions

All wind power projects are subject to unique development and cost circumstances impacting the project specific economic benefits. In order to conduct this analysis, several methodological and simplifying assumptions were required or inherent in the approach. Furthermore, the analysis presented in this report is focused on the economic impacts generated in Ontario due to project development that occurred in Ontario. The analysis excludes some impacts due to data limitations or the nature of the impacts, which would have introduced a greater degree of uncertainty in the results.

The methodological and simplifying assumptions as well as the exclusions are described below.

7.1 Methodological Assumptions

Methodological assumptions include:

- 2013 LTEP targets represented the Base Case wind installation target of 6,480 MW
- All projects within a given procurement had similar costs and economic impacts
- No additional attrition for contracted FIT or KC projects.
- Jobs and investments were calculated on a per MW basis by procurement type, by year and then applied to actual Ontario installations
- Only direct and indirect impacts included

7.2 Simplifying Assumptions

Simplifying assumptions include:

- Economic activity, and costs, were linked to the year that projects achieved Commercial Operation
- Turbines were assumed to make up 69% of total project cost
- Interconnection costs were based on $10 million for a 100 MW project in 2014/2015 and were both scaled up or down and inflated or deflated as appropriate
- Wind projects have a 25 year operating life
- Annual Inflation is assumed to be 2%

7.3 Exclusions

The following economic impacts were not included in this analysis:

- **Export Activity** – Ontario's wind supply chain has grown to serve all stages of development, from land acquisition and engineering through to manufacturing and construction. While parts of the supply chain did export during the study period these impacts were not included, due to limitations in obtaining representative data.

- **Financing / Local Ownership** – The equity and debt capital needed to develop, construct and operate these facilities comes from both local and extra-Ontario sources. While several locally owned developers and debt providers serve the Ontario market, their relative share of the total capital requirements was not incorporated into the analysis.

- **Induced Impacts** – the JEDI model does calculate induced impacts based on input assumptions provided, including Ontario specific induced multipliers. However, due to the nature of induced impacts, being associated with personal expenditures, and the assumption that these impacts respond perfectly elastically from direct and indirect activity, they can overstate actual impacts and were therefore ignored.

8 Results

Using the data described above, JEDI models for each procurement by year were populated using a representative project size. For each JEDI model, economic impacts were calculated on a per MW basis and then applied to the total MW for a specific procurement in a given year based on the procurement profile.

JEDI provides the following outputs: Jobs, Earnings, Value Added activity and Output.

Jobs refers to Full Time Equivalents (FTE) which represents full time employment for one year. (1 FTE = 2,080 hours)

Earnings refers to wage and salary compensation paid to workers.

Value Added, is an estimate of GDP and is the difference between total gross output and the cost of intermediate inputs.

Output refers to economic activity or the value of production in the state or local economy. Output is defined more broadly than other metrics of economic activity including value added (or GDP). Output is the sum value of all goods and services at all stages of production (i.e., as a raw material and as a finished product), where value added refers only to the market value of the final product.

In addition, to these parameters, we have also calculated total investment which is a function of the total installations and total project capital costs.

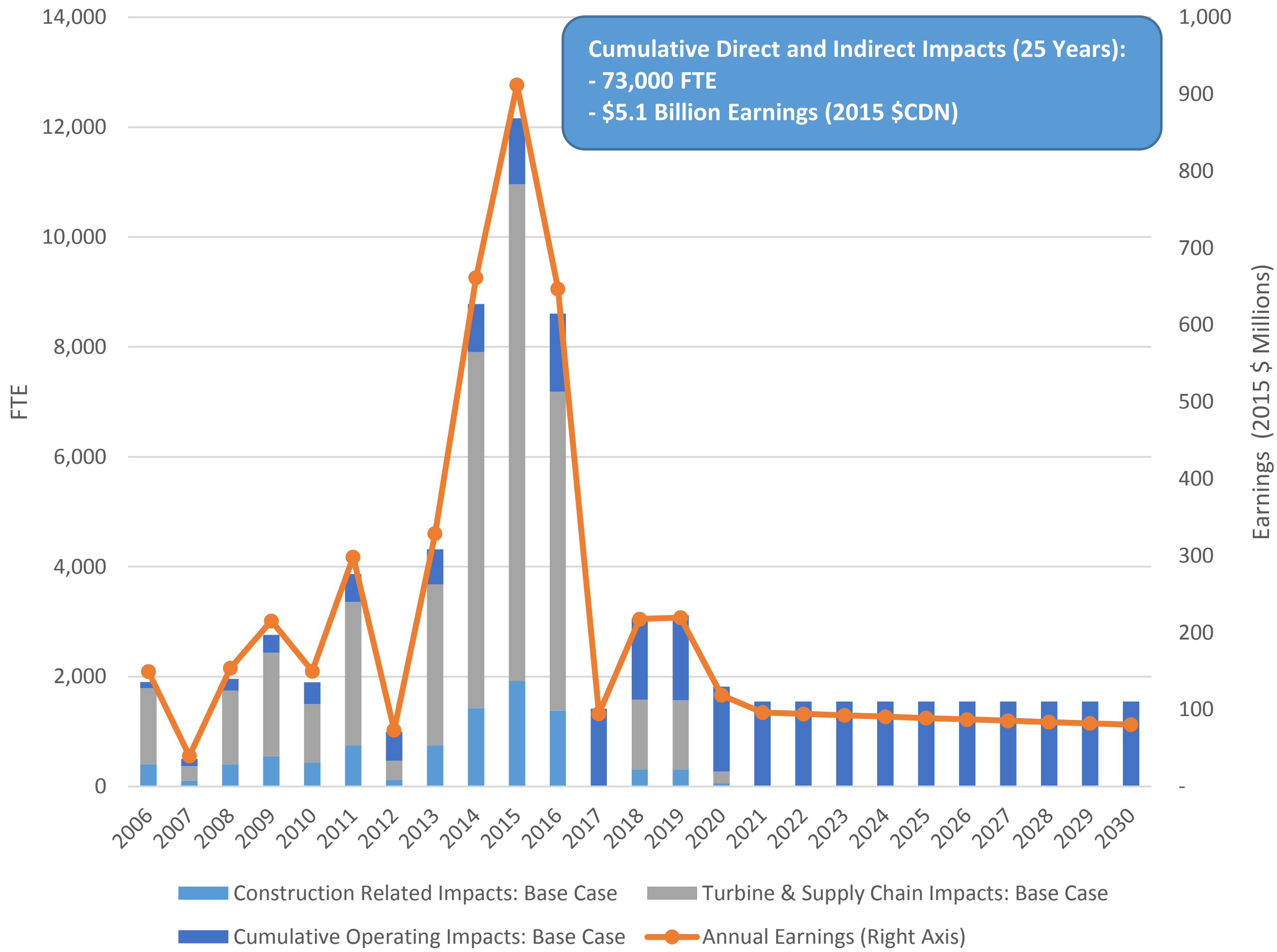
Overall Ontario's past and future investments in wind energy will result in the following impacts between 2006 and 2030 ($ 2015)

- 73,000 Direct and Indirect FTE
- $5.1 Billion Direct and Indirect Earnings
- $7 Billion Direct and Indirect GDP
- $14 Billion in Investment

The annual profile for each of these outputs is presented in the figures below.

Between 2006 and 2030, Ontario's past, current and planned wind procurements will create approximately 73,000 FTEs and will generate over $ 5 billion in individual earnings and benefits, see Figure 8.

Figure 8 – Annual Direct and Indirect FTEs and Earnings



Between 2006 and 2030, Ontario's past, current and planned wind procurements will generate approximately $ 7 billion in value added activity (GDP), see Figure 9, and over $14 billion in economic output in Ontario.

Figure 9 - Direct and Indirect GDP Impacts

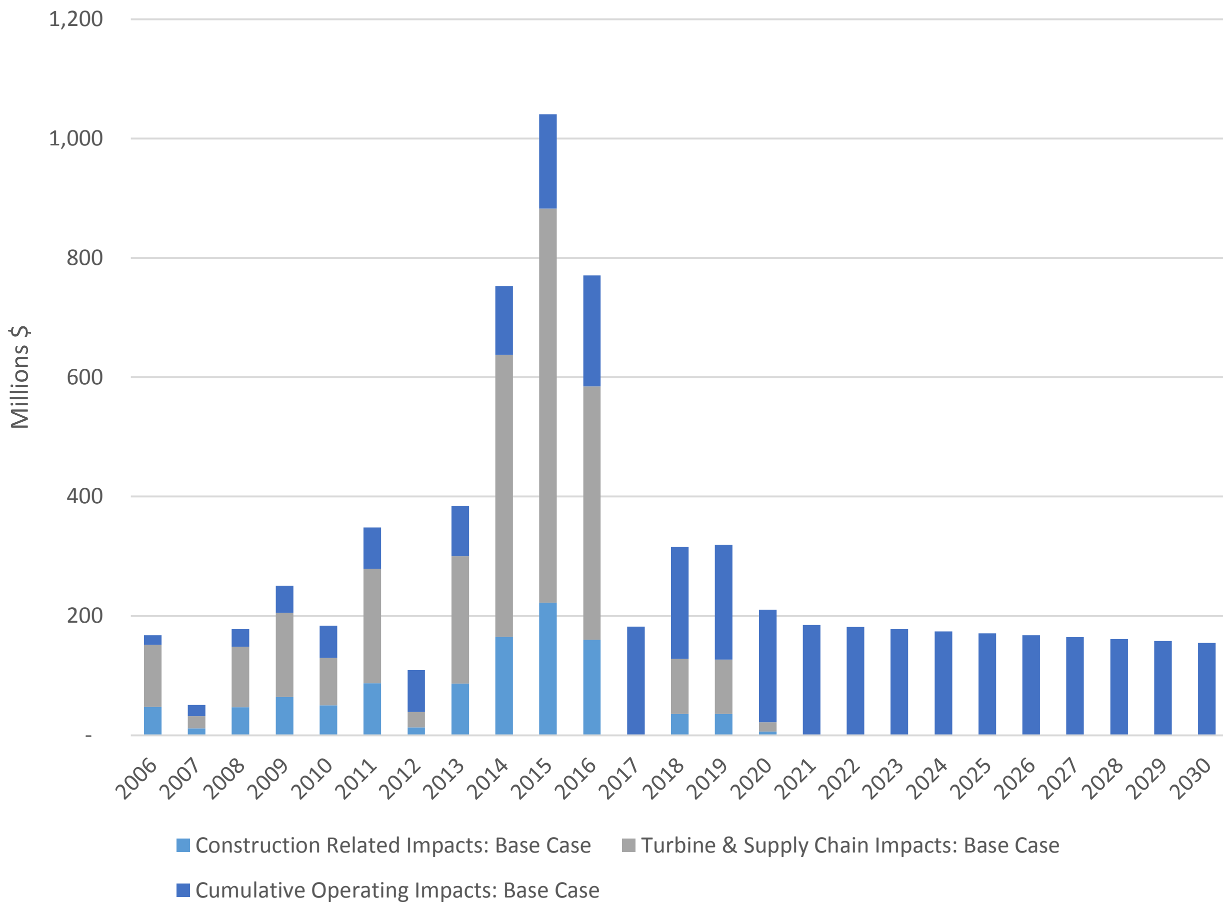


Figure 10 below presents the annual investments by procurement type. Unlike other economic impacts, investment is directly linked to new procurements. Total investment peaks in 2015 at over $3 billion CDN, then falls significantly as the 2013 LTEP targets are achieved.

Figure 10 – Annual Investment by Procurement Type

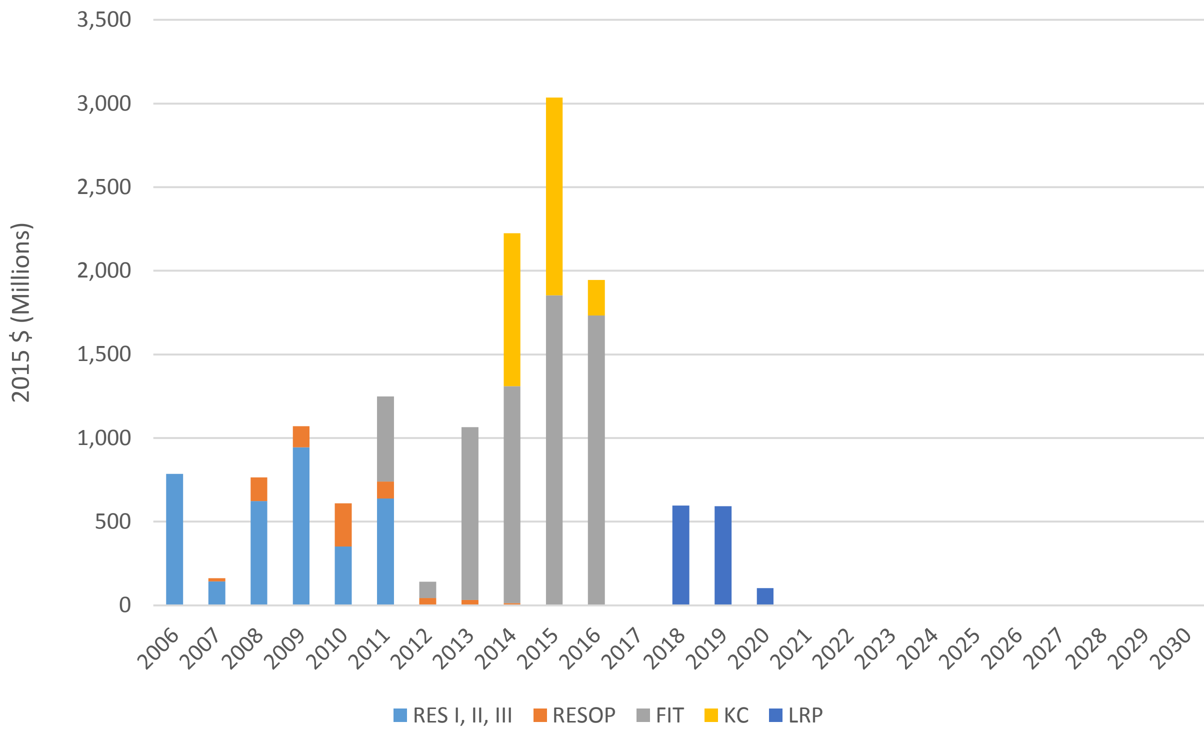
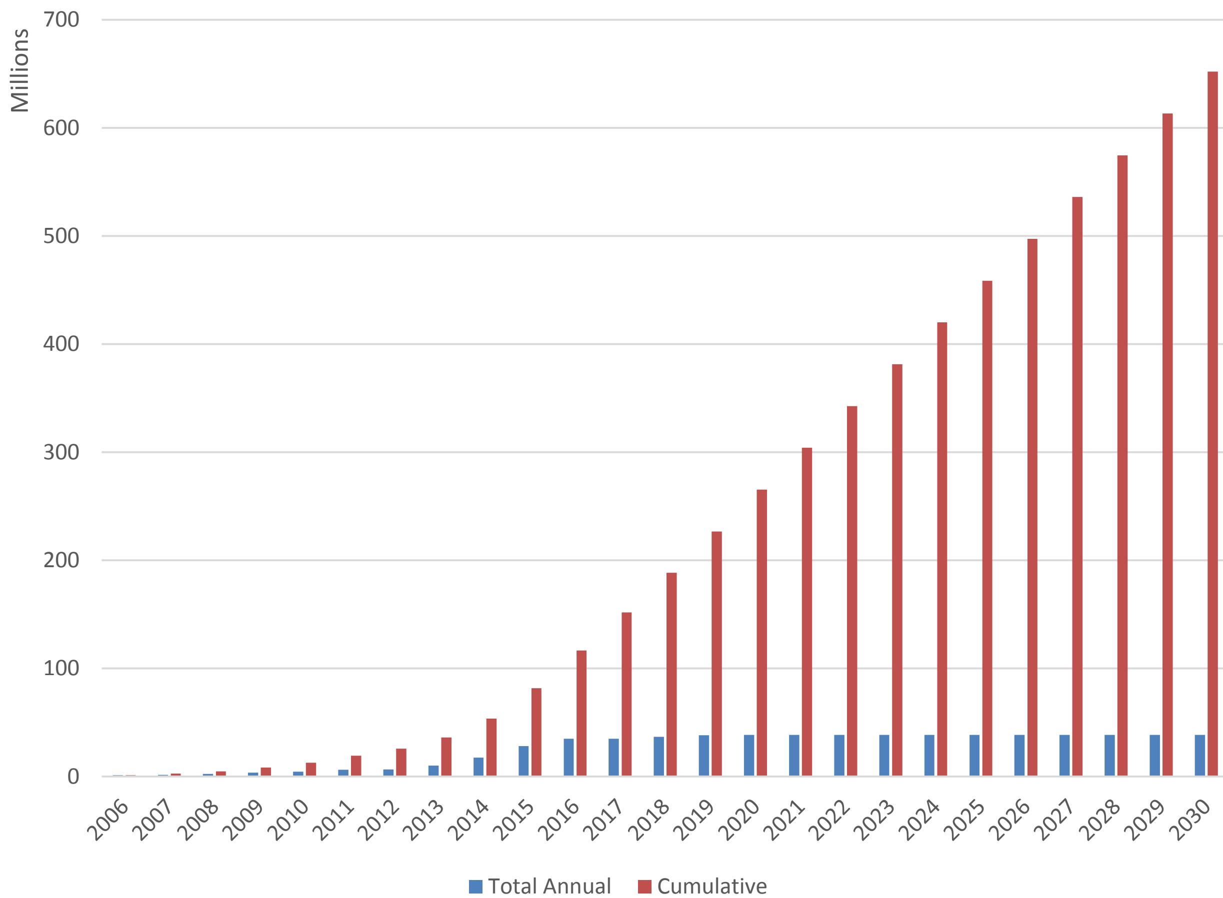


Figure 11 below presents the total annual and cumulative land lease payments made from wind projects to land owners over the twenty five year project life of these assets. Total annual payments are forecasted to increase to just under $39 million per year in 2020 and then plateau.

Figure 11 – Land Lease Payments



Finally, Table 3 below provides a breakdown of all of the economic metrics across the study period.

Table 3 – Summary of Economic Impacts Across Study Period[5]

Economic Metric	Time Period			
	2006 - 2012	2013 - 2019	2020 - 2030	Total
FTE	13,900	41,500	17,300	72,700
Earnings ($ Millions 2015)	1,100	3,100	1,000	5,200
Value Added ($ Millions 2015)	1,300	3,800	1,900	7,000
Output ($ Millions 2015)	2,600	8,500	3,700	14,800
Investment ($ Millions 2015)	4,800	9,500	100	14,400

[5] Values in this table have been rounded to the nearest hundred and therefore may vary slightly from other parts of the report.

9 CONCLUSIONS

Ontario is the leader in Canada's wind power development sector. Since 2006, the various provincial procurement programs have created substantial investment and employment opportunities within the province. Ontario's wind procurements have helped to create a sophisticated home grown supply chain, including component manufacturing and professional services used throughout the development and manufacturing phases of projects and employing thousands of Ontarians. Furthermore, the wind energy developments in the province will contribute dividends to municipalities, land owners and employees over the twenty five years of the projects through taxes, community vibrancy payments, lease payments and personal wages. These operational benefits directly support local economies.

However, beyond 2015, the outlook for increased benefits from wind development in Ontario is materially diminished relative to the past five years, and beyond 2020 there is no planned investment based on the 2013 LTEP targets. The longevity of manufacturers' facilities which form part of global supply chains are contingent on the strength and outlook of local markets. As a direct consequence, the limited role of wind within the 2013 LTEP will very likely result in the loss of wind related manufacturing, development and operations related jobs.

In contrast, the modelling employed to produce this report shows that increasing the role of wind by 1,000 MW over 2013 LTEP targets would result in an incremental 7,000 FTE by 2030. In order to realize these benefits, Ontario would need to make near-term and long-term commitments to a supply mix that enables further development of wind power.