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Renewables-based Distributed Energy Resources in Ontario: A Three-Part Series of Unfortunate Truths

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The views expressed in this CCRE publication are those of the author, not the CCRE, and are based on the comprehensive analyses undertaken for Distributed Energy Resources in Ontario: A Cost and Implications Assessment, June 2018, commissioned by Ontario's Nuclear Advocacy Committee and the Power Workers' Union.

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Renewables-based Distributed Energy Resources in Ontario: A Three-Part Series of Unfortunate Truths

Part 3 – Economic Implications of "Made in Ontario"

Marc Brouillette

Today, there is significant public discussion about the potential for renewables-based distributed energy resources (DER), consisting of wind, solar and storage. Indeed, Ontario's 2017 Long-Term Energy Plan (LTEP) places significant reliance upon such DER for addressing an expected gap in the province's electricity supply mix over the next five to 15 years. The first two Commentaries in this series examined the nature of renewables intermittency and the cost implications of renewables-based wind and solar DER in comparison to pairing distributed energy storage (DES) with nuclear generation. This third, and final, Commentary shows how renewables-based DER options have less favourable economic outcomes than nuclear-based DES: the required costs would negatively impact the province's Gross Domestic Product (GDP), job creation and trade balance while diminishing Ontario's electricity cost competitiveness.[1]

"Affordable energy infrastructure underpins economic competitiveness"

CONTEXT

The earlier Commentaries in this series established that Ontario's emerging supply-capacity gap requires near-immediate procurement decisions. Three distributed energy options were compared to a natural-gas-fired generation solution for meeting daytime demand.[2] The assessed options potentially add $4 billion to $9 billion annually to Ontario's electricity system costs. Wind-based DER was identified as the highest cost option, while the nuclear-based DES had the lowest cost. However, if emissions are not considered, the natural-gas-fired solution is expected to be the lowest-cost approach.

Investing in affordable energy infrastructure underpins and stimulates economic competitiveness and growth. While some energy solutions may appear to offer lower costs, they may not be an optimal economic solution if they involve significant funds leaving the province. Maximizing the Ontario content of energy expenditures increases employment, provides a higher GDP, improves government revenues and enhances taxpayer benefits. Given the magnitude of energy-system costs, these derived economic benefits are an important consideration when formulating a procurement approach that maximizes both ratepayer and taxpayer benefits.

EXPENDITURES WITHIN ONTARIO DRIVE GDP

As an economic driver, expenditures within the province are affected by a technology's components. For example, the largest wind-turbine producers are Germany, Denmark and China, with each making up some 20 percent of the global market.[3] China is the leading producer of solar panels, with eight of the world's top 10 manufacturers.[4] For its part, Ontario has a large and active nuclear energy supply chain that delivers significant economic benefits to the province.[5]

[1] High-level assumptions about GDP and job outcomes are used to illustrate the gross differences in the economic impacts of the available technology choices.

[2] The daytime demand represents 23 TWh or 15 percent of Ontario's demand.

[3] There are currently no large Canadian wind-turbine producers.

[4] See EnergySage, 2018.

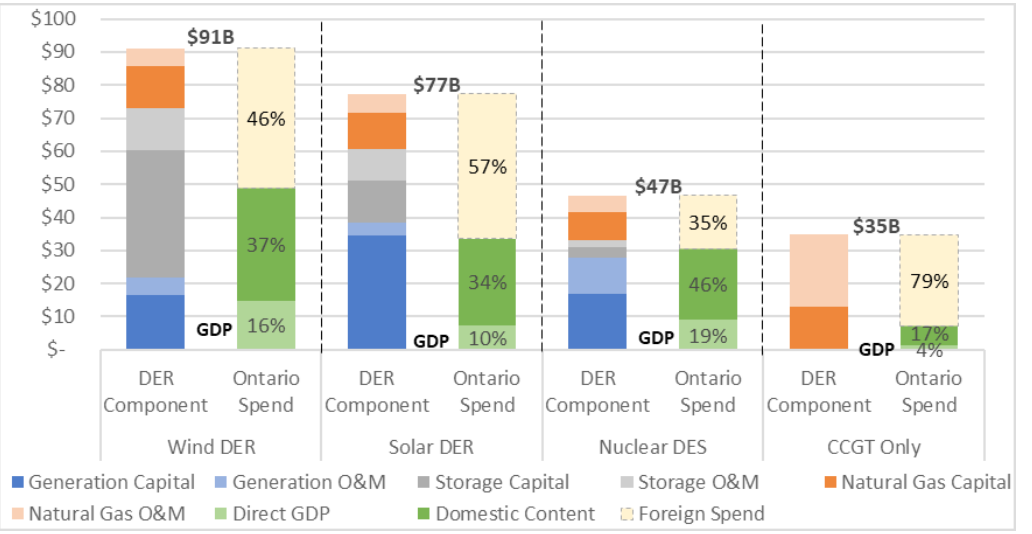
[5] See Conference Board of Canada (CBoC) 2016; Ontario Chamber of Commerce 2019.

"Along with lower cost, nuclear DES sustains high spend in Ontario"

The two storage systems modelled for DER application are similarly affected. Currently, most lithium-ion (Li-ion) batteries are manufactured in China, Japan and South Korea, with production beginning to increase in the U.S.[6] While compressed air energy storage (CAES) utilizes widely available conventional components, assumed to be available in Ontario, the viability of the technology is dependent upon the availability of suitable geographical features such as Ontario's salt caverns.[7]

Among DER options, the Ontario-sourced content associated with the capital-construction, operations and maintenance (O&M) phases vary significantly (Figure 1).[8] Nuclear DES has the highest share of Ontario spend at 66 percent. This reflects the content provided by Ontario's well-established nuclear supply chain.[9] Wind DER has a 54-percent Ontario spend – the majority due to CAES storage.[10] Solar DER and natural-gas-fired combined cycle gas turbines (CCGT) have the lowest Ontario content, with the former being dependent upon imported technology and the latter upon imported natural gas.

Figure 1 – DER Option Expenditures and Ontario Spend [11]
($B, 20-year expenditures)



Source: Strapolec Analysis
Note: 20-year expenditures include capital/construction phase and the first 20 years of operations.

Meanwhile, direct GDP is based on the labour income that derives from the Ontario spend.[12] While wind-based DER has the greatest total direct impact on GDP, this results from wind DER's higher cost, double that of nuclear DES. This significant cost difference suggests that the traditional project-based economic impact assessment approach may not highlight the best overall economic choice.

We apply two measures to compare economic impact for investments with widely differing costs: (1) direct GDP intensity; and (2) net contribution to the economy, given the cost to ratepayers.

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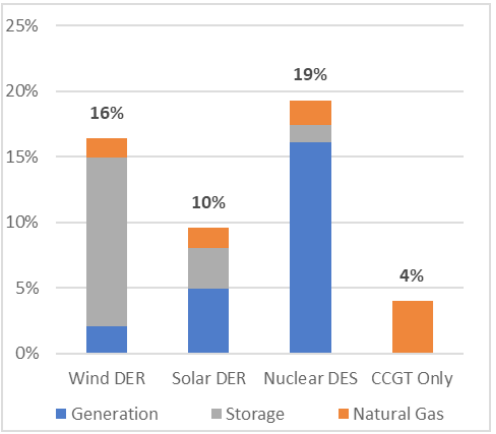
[6] See ELE Times, 2018; Clean Technica, 2016.
[7] See Ontario Petroleum Institute, 2017.
[8] Costs reflect: (1) each option's capacity to supply the 23 TWh of daytime demand as defined in the first of these Commentaries; and (2) future levelized costs of energy (LCOE) and capital costs for systems to be installed in 2030, as defined in the second Commentary.
[9] See Strapolec 2013 assessment of Conference Board of Canada and Canadian Manufacturers and Exporters (CME) reports for a new CANDU.
[10] CAES is used as it is the forecast lowest-cost storage option for pairing with wind (Strapolec, 2018).
[11] Ontario spend assumptions are described in Strapolec, 2019. Hydroelectric proxies are used for CAES, and solar model proxies are used for Li-ion.
[12] The income approach was used to calculate direct GDP, which is typical of economic-impact assessments for energy projects. Financing contributions to GDP are not reflected.

DIRECT GDP INTENSITY

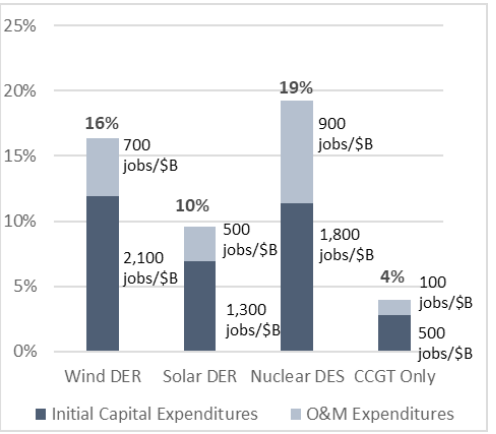
To normalize the differences in total costs, direct GDP intensity compares the economic efficiency of direct GDP outcomes for each dollar spent. Nuclear DES has the highest GDP intensity, driven by the expenditures for nuclear generation (Figure 2). Wind DER has a 15-percent lower GDP intensity, with storage expenditures being its largest driver.

Figure 2 – Direct GDP Contribution Intensity
(Direct GDP as % of total spend)



Source: Strapolec Analysis

Figure 3 – DER GDP Contribution by Phase
(Direct GDP as % of total spend)



Source: Strapolec Analysis

"Nuclear DES contributes the most economic activity at low ratepayer cost"

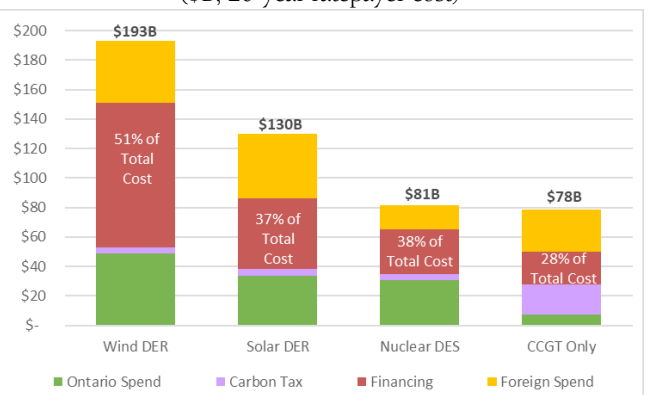
GDP generated over the life of an energy project can also impact long-term, sustainable economic benefits. Each DER system has two distinct life-cycle phases – the capital-project (or construction) phase and the O&M phase – with a commensurate effect on sustained jobs (Figure 3).

Nuclear DES has the most balanced direct economic contribution, with benefits distributed more evenly between the initial capital project and the longer-term sustainment of operations. The nuclear DES-sustaining O&M GDP is two to three times greater than any renewable-based option. This high Ontario-based O&M footprint represents an ongoing sustainable economic benefit as it supports an active well-established Ontario nuclear supply chain. As a result, nuclear DES sustains 900 jobs per $1 billion spent, 30 percent to 80 percent more than that for the wind and solar options, and nine-fold greater than the CCGT option.[13]

NET ECONOMIC CONTRIBUTION

Net economic contribution considers not only the direct spend but also the impacts of higher ratepayer costs. These costs are estimated from total annual bill expenditures over a 20-year period and consist of Ontario spend, carbon taxes, project-financing costs and imports (Figure 4).[14]

Figure 4 – DER Ratepayer Life-Cycle Costs
($B, 20-year ratepayer cost)



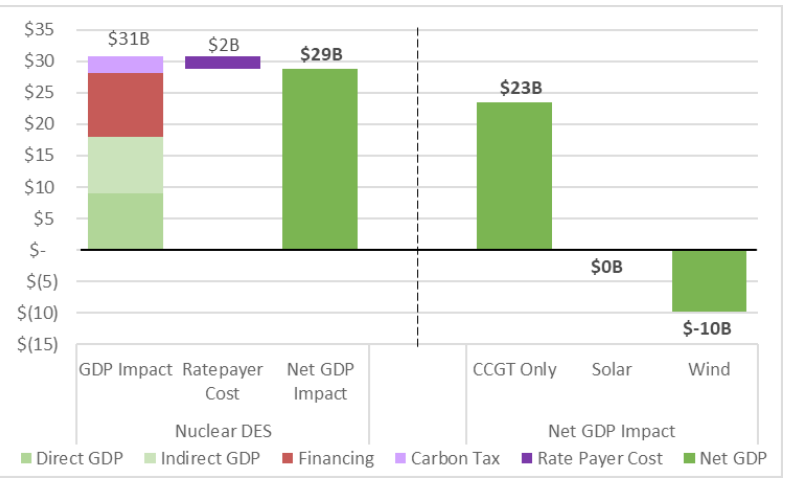
Source: Strapolec Analysis

[13] The wind-based job numbers assume that locations are available to provide the required 100,000 MWh of CAES storage capacity. It may or may not be physically feasible to fully install CAES collocated with Ontario wind farms.

[14] Total annual costs were discussed in the second CCRE Commentary and are based on the respective LCOE. Ontario spend and import costs are identified in Figure 1. The carbon tax is $115/tonne, which makes the CCGT cost equivalent to a carbon-capture system as discussed in the previous Commentary.

With the exception of imports, these ratepayer costs contribute to net GDP. However, the higher cost options reduce net available ratepayer income that may otherwise be spent within the economy. As a result, higher cost options have a negative ratepayer impact on net GDP (Figure 5).[15] Still, despite its cost being higher than a CCGT, nuclear DES makes a greater net GDP contribution. In contrast, the renewables-based DER options represent a net drain to the economy.

Figure 5 – DER Net Economic Contribution
($B, 20-year ratepayer cost)



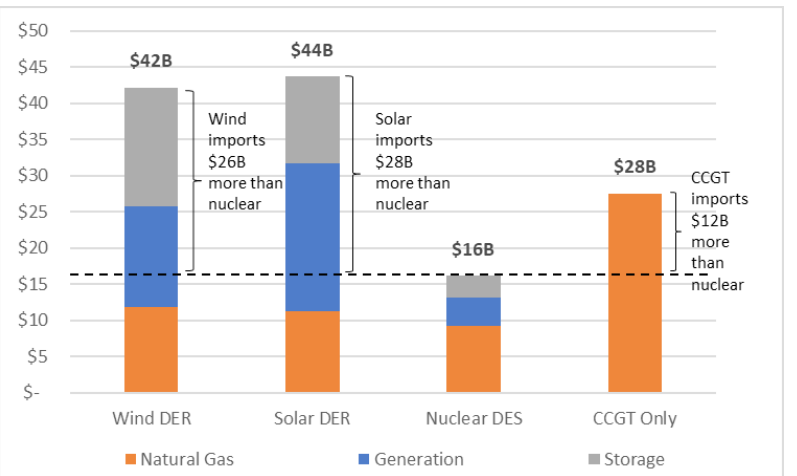
Source: Strapolec Analysis

"Trade balance implications significantly impact GDP benefits"

TRADE BALANCE

Ontario's energy trade balance with other jurisdictions underscores the findings of net economic impact. Spending on energy imports adds no GDP to Ontario. Nuclear DES requires the lowest amount of imports, at $16 billion over a 20-year time frame (Figure 6). The natural gas option requires estimated fuel imports costing $28 billion over the same period.

Figure 6 – DER Option Spend on Imports
(20-year spend $B)



Source: Strapolec Analysis

Note: Ontario spend for nuclear is $30 billion and $7 billion for CCGT. When compared to the CCGT, the nuclear option effectively repatriates $12 billion of imports to offset the cost difference and creates additional jobs and GDP.

[15] While Figure 5 illustrates the nuclear case, similar assumptions have been applied to all cases. To convert the income-based GDP calculation into an expenditure-based framework, direct GDP has been multiplied by a factor of two to illustratively account for indirect and induced factors. The multiplier is rounded and conservatively below Strapolec benchmarks. Financing contributions assume 50-percent Ontario financing with 100 percent of the proceeds assigned to income. Carbon tax and ratepayer costs have both been assumed to reflect a 65-percent GDP impact based on 35 percent of all household expenditures spent on imports. Aligning assumptions for ratepayer costs makes the conclusion insensitive to carbon price. While a more detailed analysis may yield higher accuracy, the overall conclusions are of such a significant magnitude that a refined analysis is unlikely to change the directional results.

Renewables-based options create an even greater trade imbalance. For example, solar-based DER would require $28 billion more imports than nuclear DES, potentially reducing the province's GDP by more than $36 billion.[16] Furthermore, nuclear DES imports are an estimated $12 billion less than the natural-gas-fired option. While nuclear DES has a higher lifetime cost, this is offset by repatriating and reinvesting this avoided $12 billion to create jobs and economic growth. This would generate an estimated $15 billion in GDP and add $2.5 billion to government revenues, thereby reducing the tax burden on Ontario's residents.[17]

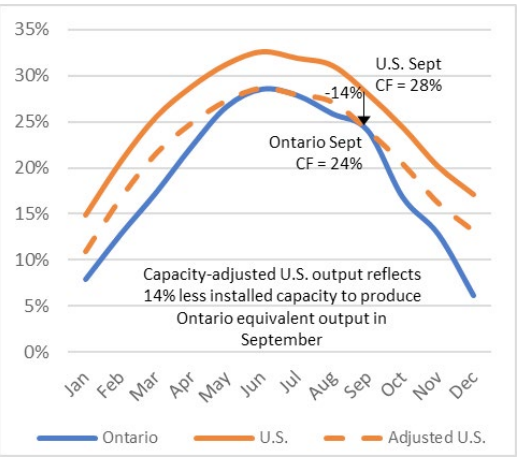
U.S. COMPETITIVENESS

Economic competitiveness is impacted by electricity-cost differences between neighbouring jurisdictions.[18] Due to weather and geography, the U.S. offers a more suitable environment for renewables-based DER than Ontario. For example, U.S. solar generation capacity factors are much higher than in Ontario (Figure 7),[19] requiring 14-percent less solar capacity to produce the same energy output.[20] U.S. solar output is also more consistent throughout the year, improving the effectiveness of associated storage and minimizing the need for backup natural-gas-fired generation. As a result, the costs for renewables-based DER in Ontario are up to 25 percent greater (Figure 8). Choosing higher-cost renewables-based DER options could lock Ontario into a long-term systemic competitive disadvantage.

"Renewables-based DER put Ontario at a systemic competitive disadvantage"

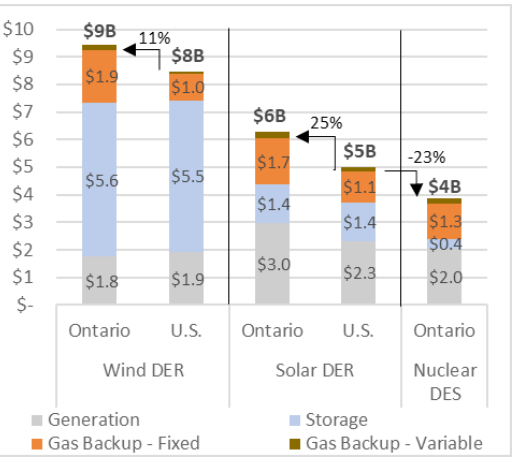
Few studies have quantified the impact of increasing electricity prices on GDP, analysis of which suggests that Ontario's GDP could be negatively impacted by 0.3 percent for every 10-percent electricity cost increase.[21] This suggests a 0.72-percent impact[22] on GDP from the aforementioned 25-percent higher Ontario cost of solar DER. By comparison, the nuclear DES option offers Ontario a 23-percent cost advantage over the U.S. implementation of solar DER. The net relative impact on Ontario's competitiveness of choosing between these two options could be $200 million per year and represents up to 1,700 jobs for the broader economy.[23] Over 20 years, this could amount to a $4 billion impact.

Figure 7 – Solar Capacity Factor
(Average 2015-2017; U.S. vs. Ontario)



Source: Independent Electricity System Operator, U.S. EIA, Strapolec Analysis. (CF = Capacity Factor.)

Figure 8 – DER System Annual Cost, 2030
(Ontario vs. U.S.; $B)



Source: Strapolec Analysis.
(US costs shown in Canadian dollars.)

[16] 65 percent of 2017 general expenditures in Ontario contribute to direct GDP per Statistics Canada, 2019. Economic multiplier for indirect impacts is assumed to be two. Impact of greater imports from solar DER, as compared to nuclear DES, is calculated as $28B*65%=$18, *2 for indirect multiplier = $36B in lost or reduced GDP.

[17] Calculated as $12B*65%=7.6*2=$15.2B GDP impact, estimated 17 percent for government revenue = $2.6B.

[18] The U.S. Energy Information Agency (EIA) has estimated cost premiums for installations in various U.S. locations. Installation costs are estimated as 10-percent higher in Ontario for wind and 16-percent higher for solar. Exchange rate for imported goods is included. See Strapolec, 2018.

[19] See U.S. EIA, 2019; Strapolec, 2018.

[20] September is used as a storage-sizing design reference for these Commentary assessments.

[21] Strapolec, 2019 summarizes studies that examined GDP impacts in Manitoba, Ontario, South Africa and the EU.

[22] The 0.72-percent impact applies only to the 23 TWh of electricity that will have a higher price, or 15 percent on the expected 151 TWh of Ontario demand. This leads to a net GDP impact of 0.11 percent or $100 million.

[23] 7.2M Ontario jobs / $854B Ontario GDP * $200M net GDP impact = 1.5k jobs impact. Jobs & GDP from Ontario Ministry of Finance, 2019.

"Nuclear DES is most effective at creating jobs and competitive advantage"

SUMMARY

Investing more in renewables-based DER solutions to meet Ontario's future electricity needs presents several risks: a GDP drain on the provincial economy and a systematic energy-cost disadvantage compared to the U.S. that would have negative impacts on Ontario's manufacturing sector. Of the low-emission, DER-system options available to Ontario, nuclear DES has the lowest cost. At the same time, it most effectively creates jobs, contributes more to the province's GDP, reduces the energy-trade balance and delivers a competitive electricity-cost advantage over the U.S.

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