London Economics International LLC

Perspectives on future trade opportunities between Canada and the US, and benefits to US consumers

EUCI US/Canada Cross-Border Power Summit

Julia Frayer
April 8, 2015
Boston, MA

LEI is a global economic consulting firm with extensive electricity market expertise, including investment analysis

- **London Economics International LLC ("LEI") combines detailed understanding of specific network and commodity industries, such as electricity generation and distribution, with sophisticated analysis and a suite of proprietary quantitative models to produce reliable and comprehensible results**

Sample Generation Experience

- **Wind:** For investors and developers of wind projects, LEI has forecast revenues under a variety of markets, REC pricing and wind scenarios, results have been incorporated into offering memoranda and used to underpin board level decision making processes
- **Biomass:** LEI's biomass-related experience extends across the value chain, including fuel supply, PPA negotiation, assessment of operating contracts, and project valuation
- **Hydro:** Provision of market analysis, including projection of market revenues, energy capacity and RECs used to support financing

Sample Transmission Experience

- **Ontario-Midwest transmission rights valuation:** Revenues associated with the sale of TRs were forecasted and compared against the estimated costs of the project to arrive at an estimate of the net present value of the project and return on investment
- **Cost-benefit analysis of a proposed transmission line in New England:** For a utility in the northeastern US, LEI prepared a cost-benefit analysis of a proposed transmission line with the potential to change existing market arrangements
- **Macroeconomic impact analysis:** Assessment of benefits of a proposed transmission project in New England

ASSET VALUATION, PRICE FORECASTING & MARKET ANALYSIS

REGULATORY ECONOMICS, PBR & MARKET DESIGN

TRANSMISSION

RENEWABLE ENERGY AND PROCUREMENT

Transmission project development between Canada and the US has been a growing area of engagement for Julia Frayer and LEI

- Julia joined London Economics in February 1998; prior to consulting, Julia was with Merrill Lynch Investment Banking
- Julia holds a graduate degree in Economics from Boston University
- Julia has worked extensively in the US, Canada, Europe, and Asia in valuing electricity generation and wires assets, water and wastewater networks, as well as gas transportation assets

In the area of transmission investment, Julia's recent projects spanned such diverse issues as investor valuation, cost-benefit analysis, macroeconomic impact analysis, tariff ratemaking, transmission need assessment and non-transmission alternatives analysis, as well as negotiation of transmission rates with potential shippers. Over the past decade, Julia has led several of LEI's projects involving strategic advisory to state regulators, and other stakeholders regarding the need of proposed transmission projects, transmission ratemaking and cost

Extensive experience working on generation related projects at every stage, including conducting price forecasts, valuations, comprehensive risk analyses, with attention to role of new entrants, changing fuel prices, environmental policies, and market uncertainty

Sample Project Examples:

- prepared cost-benefit analysis of power market impacts and local macroeconomic benefits associated with construction and operations of Champlain Hudson Power Express transmission project
- testified at the Alberta Utilities Commission in 2012 regarding need for changes to import scheduling protocols in Alberta to accommodate operations of projects such as the Montana-Alberta Tie Line ("MATL") and motivate new investment
- assessed economic implications of reliability-driven transmission project between US and Canada that would create benefits to market in association with expansion of trading opportunities

Opportunities exist for both Canadian and US market participants to take advantage of low carbon generation development opportunities

- **Developing generation and then transmission to deliver Canadian power to US markets is poised to be a "win-win" situation**
  - Canada has natural endowment in low carbon generation and the economics of developing some of that generation, alongside with costs of new trnasmission to deliver it, appears to be economic based on assessment of levelized costs relative to the current outlook for long run market prices in target US markets
  - Additional supply from Canada provides potential for significant benefits for US consumers in terms of electricity cost savings and improved reliability, environmental benefits such as emissions reductions, and even local economic impacts
- **Why is "trade" important? Canada's generation potential involves large scale projects – which are difficult to develop on the basis of just domestic demand – looking to exporting to the US therefore overcomes a key problem with timing of new build**
- **Where is the opportunity? Based on LEI's 2014 study for Corporate Knights and a consortium of Canadian organizations, LEI found that 80% of the proposed cross border transmission capacity (of around 8,000 MW) is focused on Eastern US markets, which is a reflection of the market opportunities in these markets to sell energy and capacity and possibly monetize the renewable attributes of the energy imports (exports)**
- **What are the benefits to consumers? In addition to the hundreds of millions of dollars from regional wholesale energy and capacity market benefits, new infrastructure investment coupled with new energy supply can generate significant macroeconomic and broader social benefits in the form of increased employment and economic activity, as well as reduced CO_2 emissions**

Agenda

1	**Review of recent LEI analysis**
2	Benefits to US customers
3	Concluding remarks

LEI was retained in 2014 perform a high level assessment of the economic opportunity for development of low carbon energy exports from Canada to the United States

- **The scope of the study required LEI to specifically analyze:**

  - ***Generation potential:***
    - What Canadian markets have the opportunity to export low carbon energy* today and in the future, and how much?
    - Which US markets would be demanding more imports of low carbon generation in the futures?
  - ***Transmission potential:***
    - What transmission capacity currently exists between Canada and the US and what opportunities are proposed in the near term?
    - What are the potential costs of those opportunities?
  - ***Indicative opportunities*:**
    - What opportunity exists for exporters of low carbon generation into the US, and how do the economics stack up?
    - What additional considerations need to be taken into account?

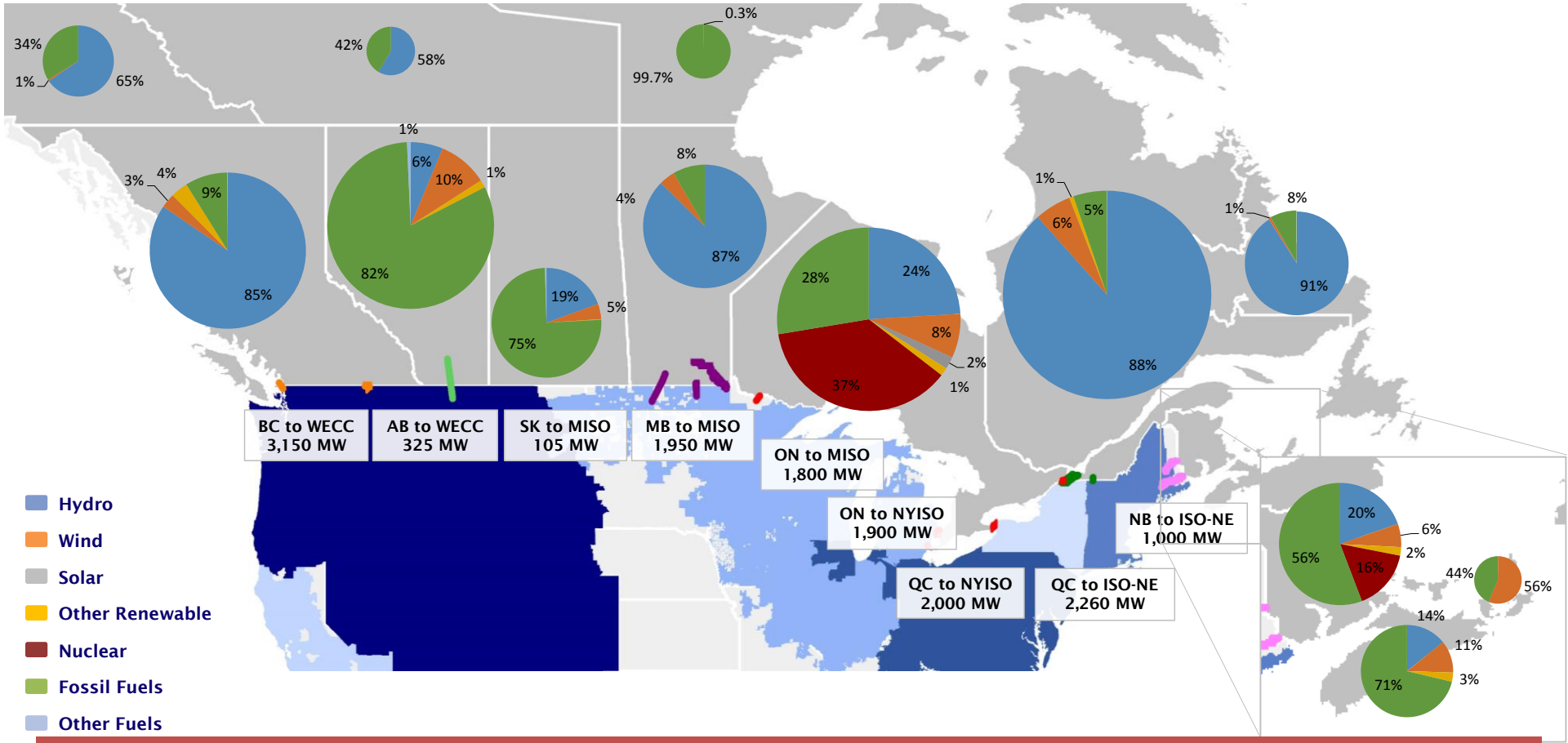
- **In answering these questions, LEI relied upon publicly available information and its own proprietary modeling of Canadian and US electricity markets**

Of the 40 GW of new hydro and wind capacity that is technically feasible for development over the long term in Canada, up to 32 GW appears economic viable for export

- **Based on number of technical studies, potential development opportunities (for hydro and wind) ranges from 30 to 39.5 GW across Canadian provinces**
- **Under LEI's "Base Case" forecast for market revenue potential (without any REC premium) and consideration of levelized costs of developing such new generation in Canada (and transmission to deliver to border), exports consisting of Ontario wind, Quebec wind and large scale hydro, and New Foundland hydro appear to be economically viable in the long term (2030)**
  - under Base Case scenario up to 14.5 to 18.5 GW of low carbon generation may become economic (exports of 63.4 to 80.8 TWh per annum)
  - maximum indicative export revenue (in 2030) under the Base Case was forecast between $7.2 billion and $9.2 billion
- **In addition to Base Case outlook, LEI tested the economics of the investment under a "Combined Scenario" where higher gas prices were assumed to prevail in combination with higher carbon allowance prices, as well as lower financing costs for new investment**
  - Due to favorable conditions, list of economic export potential expands to include resource development in British Columbia, Alberta, and Manitoba
  - Under the more optimistic "Combined Scenario", up to 24.5 to 31.5 GW of low carbon generation may become economic (exports of 107.5 to 137.3 TWh per annum)
  - Maximum indicative export revenue (in 2030) under the Combined Scenario case was forecast between $14.6 billion and $18.7 billion

As of July 2014, Canada had an installed capacity of over 136 GW, of which over 70% was sourced from low carbon generation

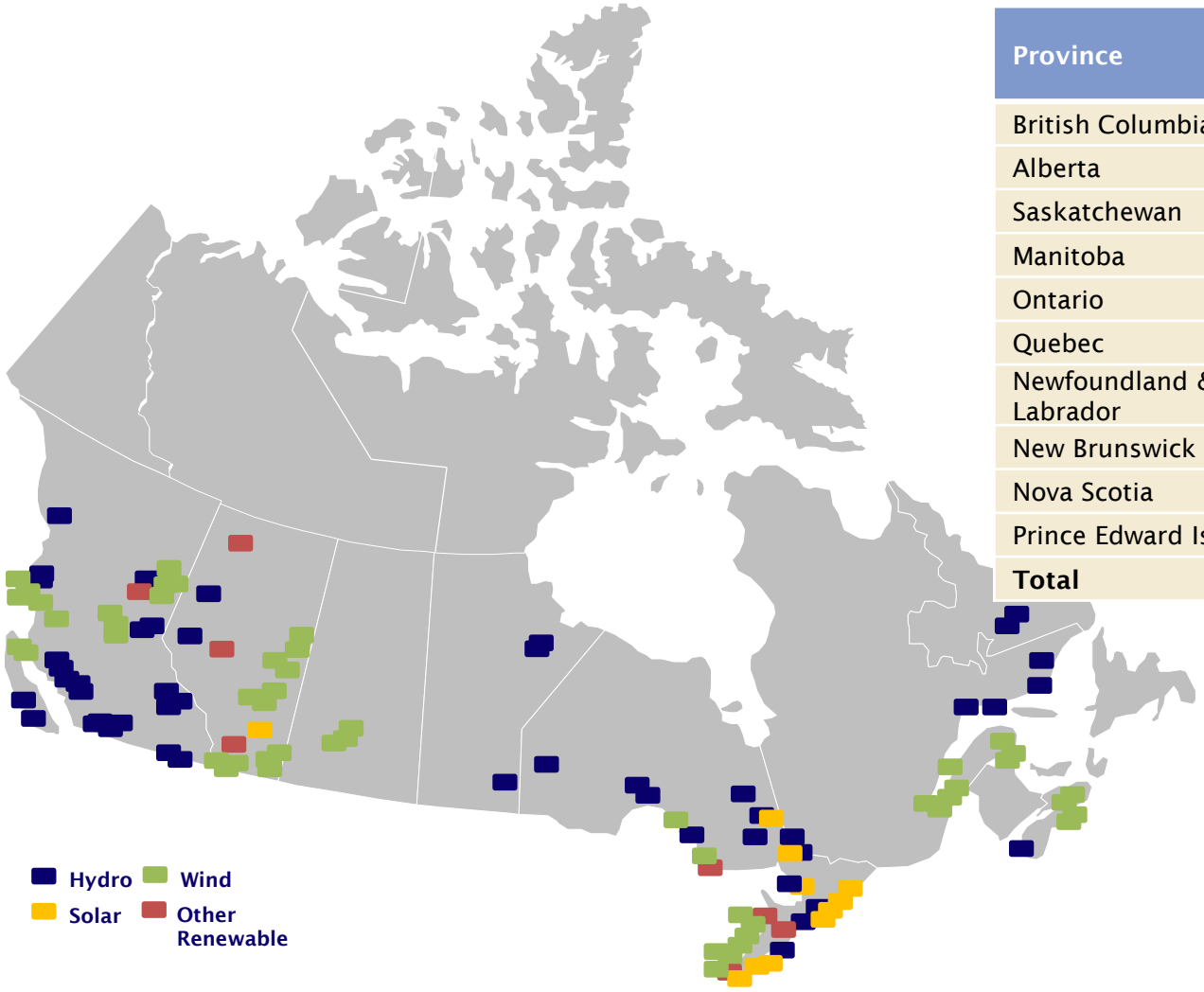
Total Installed Electric Generation Capacity (as of July 2014)



In 2013, StatsCan reported total energy exported into the US of approximately 62.5 TWh (or $2.5 billion and approximately 10.2% of total production)

Note: Low carbon generation include nuclear, hydro, wind, solar and other renewable technologies
Source: Ventyx, AESO, BC Hydro, Manitoba Hydro, ISO-NE, IESO, Hydro Quebec, SaskPower

Over 200 low carbon generation projects constituting approx. 33 GW are in various stages of development (ranging in status from "proposed" to "under construction")

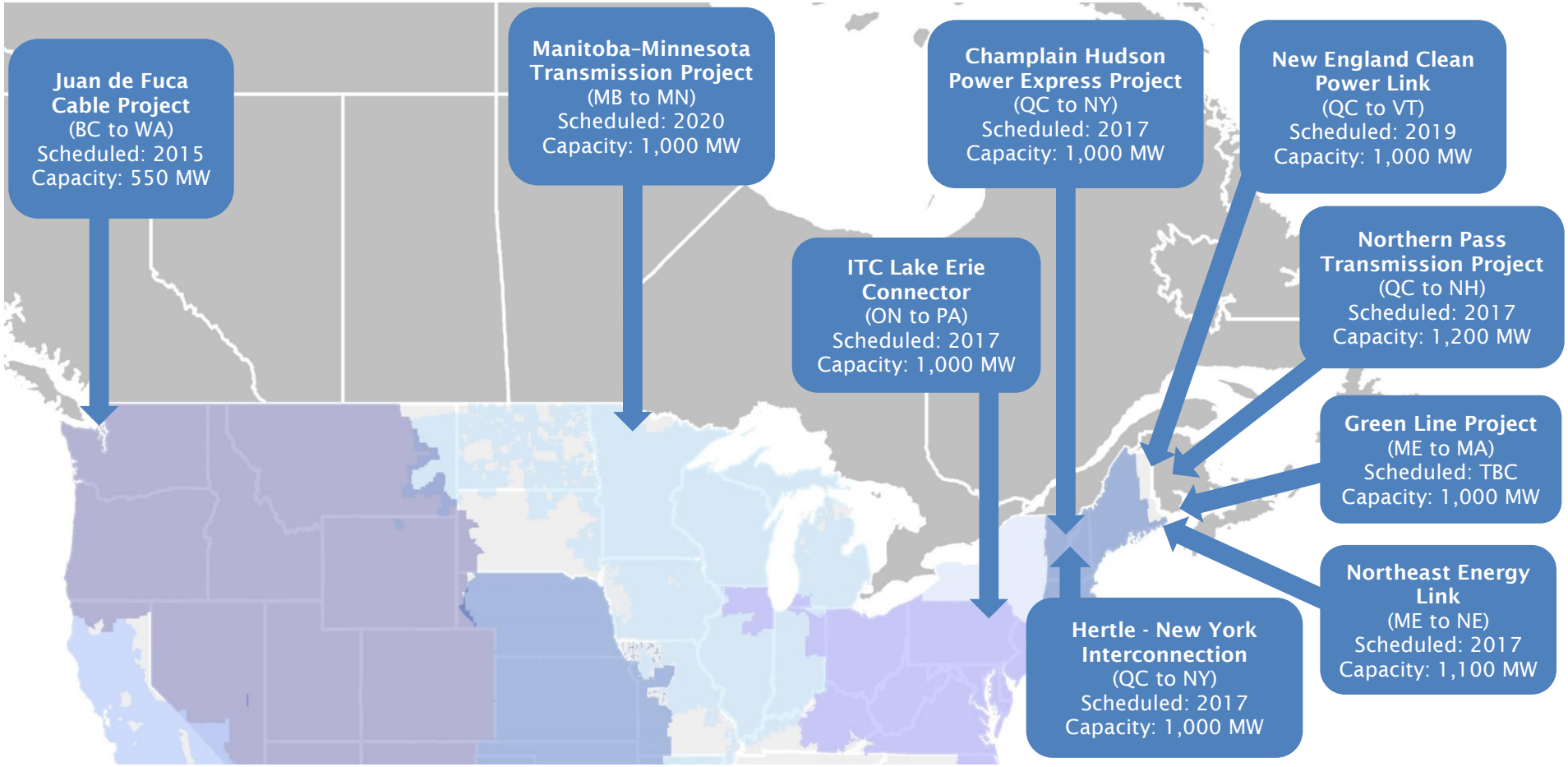


Province	No. of Projects	Total Capacity
British Columbia	83	12,641
Alberta	35	4,242
Saskatchewan	3	210
Manitoba	3	2,065
Ontario	77	4,811
Quebec	26	5,333
Newfoundland & Labrador	2	3,074
New Brunswick	3	180
Nova Scotia	7	319
Prince Edward Island	2	88
Total		**32,963**

- Largest of the known proposed projects is Gull Island 2,250 MW hydro facility to be developed in Newfoundland & Labrador
- 56 projects have a proposed nameplate capacity of 10 MW or less

Many of these generation projects are targeting domestic consumers as well as trade opportunities

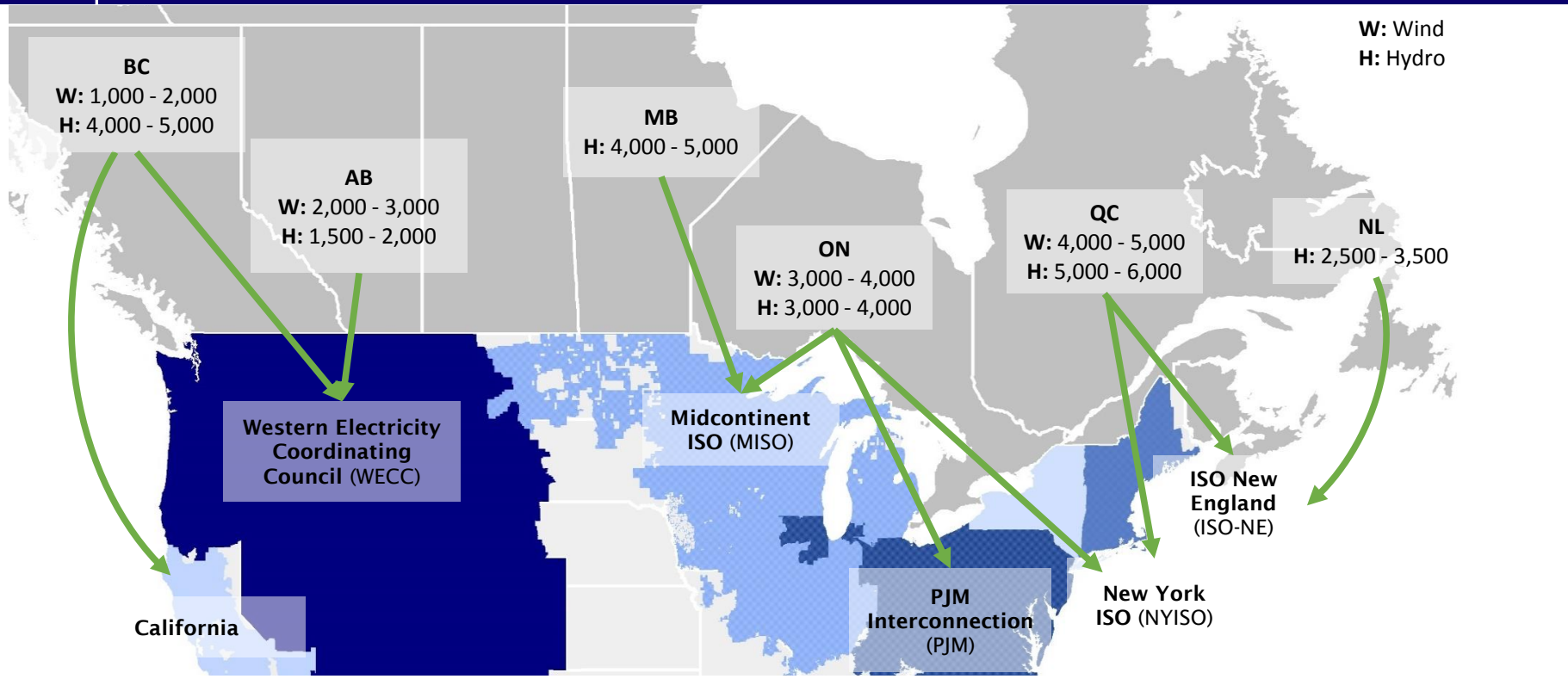
Nearly 8,000 MW of proposed new transmission capacity is currently at various stages of development to bring energy from Canada into the US



Almost 80% of proposed cross border transmission capacity is focused on Eastern US markets, because of the current appetite for large scale low carbon/renewable resources to diversify the predominantly gas-fired supply mix

Note: TBC denotes "to be confirmed"

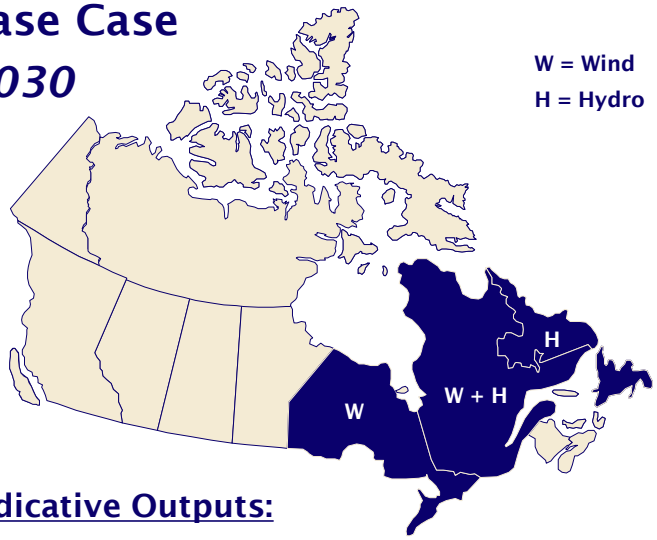
LEI's 2014 study identified six export opportunities across Canada providing for both new hydro and wind generation developments



- **Approximately 30 to 39.5 GW of low carbon energy (20 to 25 GW of hydro and 10 to 14 GW of wind) has been identified across provinces**
  - **Quebec has the largest potential – in both hydro and wind (combined 9 to 11 GW)**
  - **Significant hydro potential also exists in British Columbia (4 to 5 GW), Manitoba (4 to 5 GW), and Ontario (3 to 4 GW)**
- **LEI's analysis assumes exports are sold into closest destination markets, consistent with existing trade flows**
  - **Supply to US markets further south of the border would require additional (costly) transmission investment**

Based on the identified generation opportunities in Canada and market prices in US regional markets, economic export potential for the long term ranges between 14.5 GW and 31.5 GW

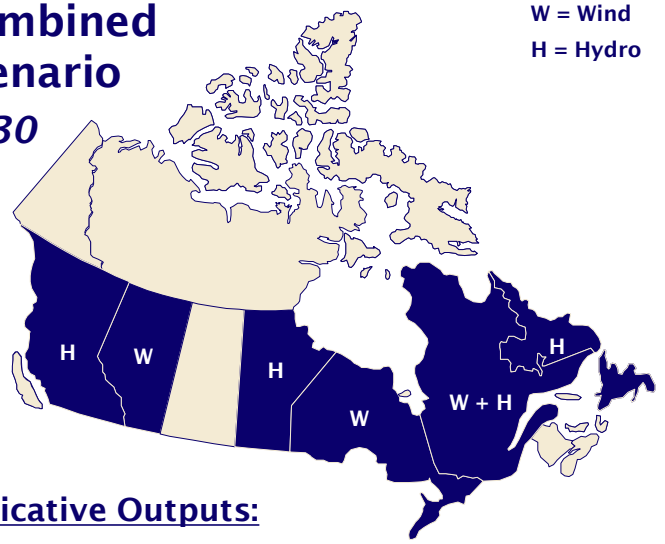
Base Case
2030



Indicative Outputs:

Capacity (MW) = 14,500 – 18,500
Energy (TWh) = 63.4 – 80.8
Export Revenue = $7.2 - $9.2 Billion
Generation + Tx Investment = $7.2 to $9.2 Billion

Combined Scenario
2030



Indicative Outputs:

Capacity (MW) = 24,500 – 31,500
Energy (TWh) =107.5– 137.3
Export Revenue = $14.6 - $18.7 Billion
Generation + Tx Investment = $10.1 to $12.9 Billion

- The range of energy export potential identified above would double to quadruple existing export levels to the US (62.5 TWh in 2013)
- Projects are not usually built exclusively to realize export potential; in fact the export opportunity may complement the need to build new infrastructure (generation and transmission) to meet domestic needs
- Additional testing by LEI of the cost of transmission development show export opportunities remain viable even if delivery costs rise (up to a 50% increase in tx costs)

Agenda

1	Review of recent LEI analysis
2	**Benefits to US customers**
3	Concluding remarks

What would entice US consumers to enter into long term agreements to motivate development of low carbon generation in Canada?

In addition to any structured risk mitigation features of a power purchase agreement, ratepayers could see benefits associated with the following:

- ***Improved affordability of supply***: Electricity imports from Canada can serve as a cost-effective resource, reducing the cost of electricity prices due to the scale and relative efficiency of the exported energy relative to domestic generation

  ISO-NE External Market Monitor noted in its 2013 Assessment that electricity imports "reduce wholesale power costs for electricity consumers in New England"

- ***Improved resource adequacy***: Higher value in markets that are currently in need for resources (potential positive net benefit of procuring low cost imported generation and positive capacity spot market impact)

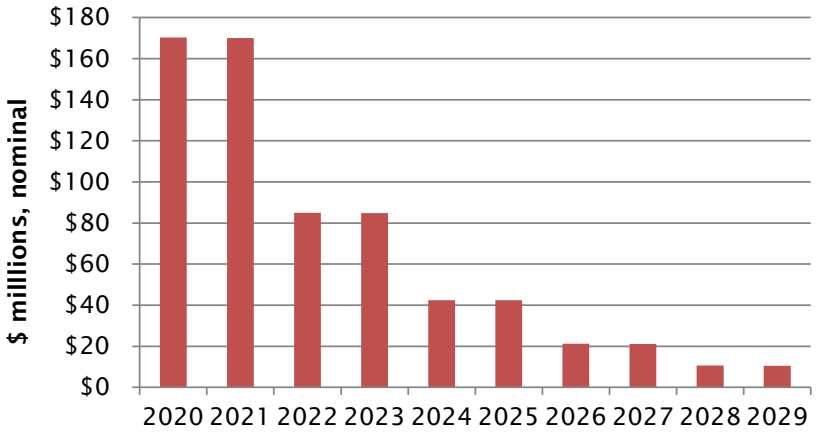
- ***Environmental benefits***: Positive externalities associated with new developments, including emission reductions

- ***Macroeconomic benefits***: Growth in GDP, employment due to the local spending during construction in Canada and growth in GDP and employment during operations in the US (due to lower costs of electricity for US consumers)

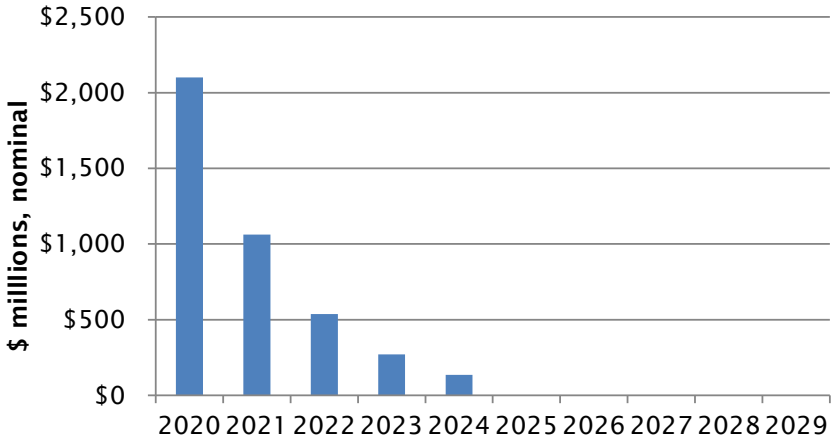
In analyzing the development potential, it is imperative to look not only at the relative economics of a proposed new development to the project sponsors but also the needs of the consumers and broader societal benefits associated with new investment

Significant ratepayer benefits stem from wholesale market price reductions associated with new transmission line development that provides for new sources of supply

Energy Market Benefits in New England



Capacity Market Benefits in New England



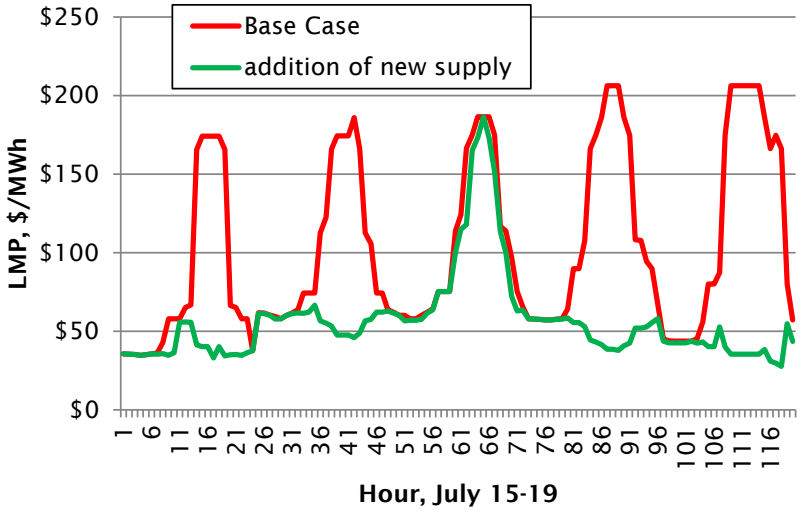
- Assuming an 1,000 MW transmission line with baseload energy flows (8,322 TWh of energy per annum), and a $0.5/MWh average annual realized reduction in average LMPs over 10 years, New England wholesale load will see energy market savings of about $65 million per year on average under "normal" supply and demand conditions
- Over 10 years, at a 7% discount rate, the amounts to $537 million in consumer benefits for the New England market

- Based on demand curve parameters currently instituted in ISO-NE's FCA, every 100 MW of supply reduces the capacity clearing price (holding all else constant) by approximately $0.5/kW-month
- A transmission line delivering 1,000 MW of new resources would reduce capacity clearing prices by $5.0/kW-year in the first years; if we allocate this price reduction to the system-wide capacity requirement (ICR) would mean an annual average savings of $411 million per year or $3.6 billion at a 7% discount rate
- Peak demand grows yearly in ISO-NE by 300-400 MW so impact would eventually dissipate as market rebalances and prices rise back to net CONE

New transmission coupled with energy can serve as a physical insurance policy against insufficiency of local supply – savings consumers millions and improving overall resource adequacy

Back-cast analysis of summer 2013 heat wave

- In the hot summer of 2013, New England experienced higher than normal temperatures (≥89˚ F) for five consecutive days
  - necessitated use of more expensive peaking units to serve higher electricity loads
- Through back-cast simulation modeling, LEI recreated past market conditions that exhibited very high energy prices under summer stress events



- LEI replicated the market conditions and outcomes for five consecutive days in 2013 (July 15-19), using actual market data on supply, demand, and fuel prices; LEI then simulated 1,000 MW of shift in the supply curve and re-estimated LMPs
- Based on simulation results, over the five days, average system LMPs dropped by more than $40/MWh as a result of the additional energy
- Over the five days, based on a total wholesale load of ~510 GWh/ day for ISO-NE, the energy supply would have saved wholesale load a total of nearly $120 million

Transmission lines bringing new, baseload supply can be viewed as an insurance policy, protecting consumers from local supply interruptions or high local demand, and mitigating the cost consequences of "High Impact/Low Probability" system events

1,000 MW of carbon-free energy imports from Canada can potentially reduce CO_2 emissions by 3 to 9 million tons per year, depending on the type of fossil fuel fired resource that they are displacing

- Import of Canadian energy into US is likely to displace gas-fired, oil-fired and coal-fired generation resources
- With this displacement comes a reduction in the total market emissions, the size of which will be dependent primarily on the carbon footprint of the resources being displaced at the "margin" in the energy market (e.g., CCGT or coal-fired plant)

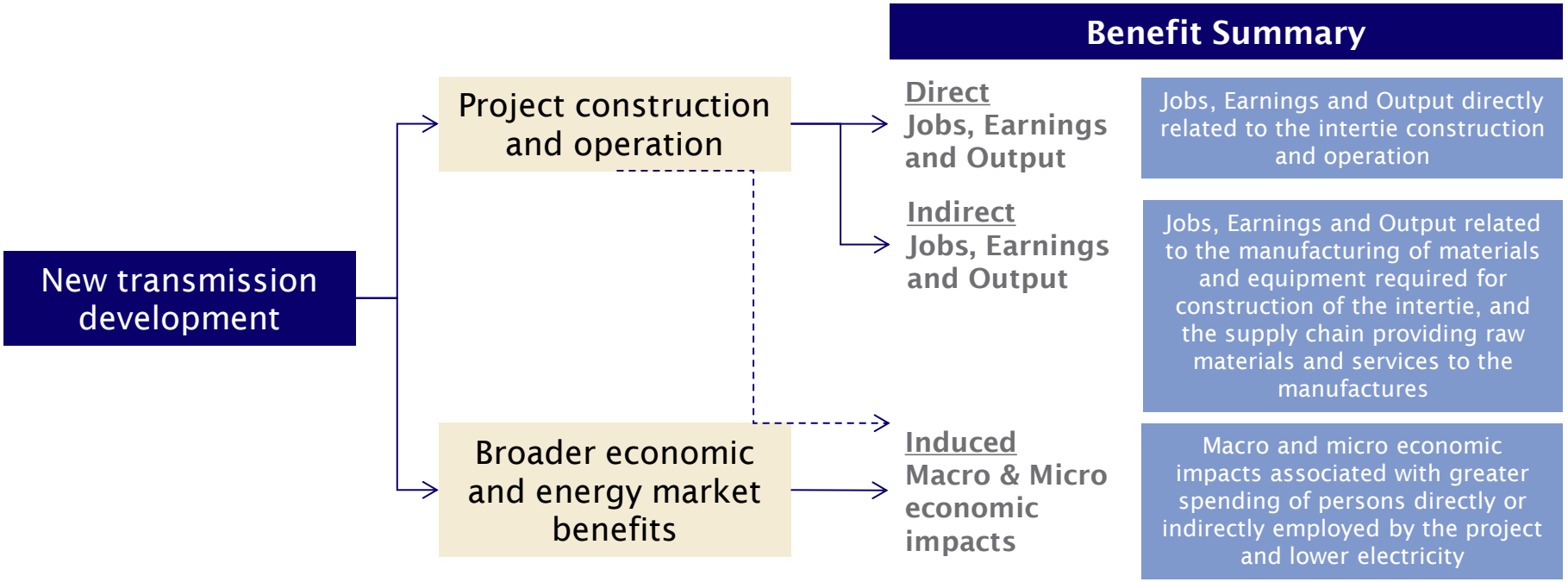
	CCGT	Coal (Sub-bituminous)
CO_2 emission rate (lb/MMBtu)	117	212
Assumed heat rate (MMBtu/MWh)	7	10.1
CO_2 footprint of displaced resource (tons/MWh)	0.38	1.07
Implied social cost saving @ $80 per ton ($/MWh)	30.4	85.6
Notionally avoided CO_2 emissions for 8,322 GWh (tons)	3,164,441	8,905,751

- The EPA estimated the Social Cost of Carbon ("SCC") in 2030 in the range of $55 to $80 per metric ton of CO_2 emissions
- At $80/ton, for every MWh of low carbon energy imported, avoided social costs associated with the reduction in CO_2 emissions is valued between $30.4/MWh and $85.6/MWh, depending on the generation source being displaced (gas or coal)

Baseload carbon-free energy transmitted along a new 1,000 MW transmission line produces over $250 million a year in environmental benefits if gas-fired generation is being displaced or as much as $760 million per year if coal output is being displaced

New transmission bringing baseload imports that leads to lower electricity prices will create positive economic impacts throughout the economy

Economic benefits of potential transmission projects are measurable and significant



Using REMI PI+ model of the New England state economies, LEI analyzed the economic impacts associated with a generic 1,000 MW new transmission lines delivering baseload energy into New England:

- During the construction phase, approximately 6 – 8 total jobs (direct, indirect and induced) are created for every $1 million of local spending; GDP increases by an annual average of over $250 million per year
- During the operations phase for a new 1,000 MW transmission line (with baseload energy flows), between 6,500 and 7,900 new jobs are created on average per annum across the New England region, primarily as a result of reduced retail electricity costs (first 10 years of operations)
- Electricity cost savings also fuel GDP growth – regional GDP across all New England states increases by an average of between $1.1 billion and $1.3 billion per year (first 10 years of operations)

Agenda

1	Review of recent LEI analysis
2	Benefits to US customers
3	**Concluding remarks**

Prognosis for increased trade as a result of new infrastructure development is promising, but there are many practical hurdles to overcome to bring such investments to commercial reality

BUYERS

US stakeholders will seek …

- Reduced electricity costs due to the supply shifts created by new energy and capacity
- Improved resource adequacy, particularly in times of system stress when imported energy can serve as insurance value
- Environmental benefits, including emissions reductions
- Local economic (macroeconomic) benefits in terms of GDP growth and new jobs

SELLERS

Canadian stakeholders (project developers/sponsors) will want to see…

- Economically viable projects (where the levelized cost of investment is recouped from market sales of the output (energy capacity, environmental attributes)
- Large scale development of low carbon projects may not be possible when catering to domestic load growth alone

What needs to be done to get these opportunities commercialized?

1. project specific feasibility studies with more detailed costs and detailed analysis of returns for project sponsors and consumer benefits
2. permitting and siting – are the project ideas "feasible"?
3. negotiations of risk sharing arrangements between developers/project sponsors and entities representing consumers so as to allow for financing of the new infrastructure construction, etc.