Carbon Pricing: Electricity Sector Impacts

Planning, Law and Aboriginal Relations,
IESO

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-Confidential-

ieso
Independent Electricity System Operator

Outline

- Purpose & Context of September Update
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  - Modeling of Carbon
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Purpose and Context of September Update

- The purpose of this presentation is to illustrate the of impact the “September 2015 – Aggregate Average Carbon Cost” trajectory for 2017 to 2030 (see slide 6) on the Ontario electricity sector, with a focus on changes to:
  - Wholesale market clearing prices and global adjustment (GA) rates
  - The cost of electricity service in Ontario
  - Customer impacts (industrial rates and residential bills)
  - Ontario energy production and import / export volumes
- The analysis highlights the customer impacts (industrial rates and residential bills) with two different assumptions pertaining to recycling of proceeds from auction allowances in both the electricity and natural gas sectors:
  1. Recycling of proceeds from auction allowances in the electricity sector
  2. Recycling of proceeds from auction allowances in the electricity sector and an additional $250M/year from the natural gas sector
- None of the recycling of proceeds include administration costs

Summary of Findings

- The following impacts were observed from imposing a carbon price on Ontario electricity generators and electricity imports, with respect to the 2013 LTEP, within the context of the same Ontario electricity demand assumed in the 2013 LTEP:
  - Costs
    - Wholesale market clearing prices increase as carbon cost are embedded into offer prices (variable costs) of gas facilities (maximum rate change in 2030 is $17.30/MWh or 44%)
    - Cost recovery ratio between market revenues and global adjustment shift, as the market clearing prices rise
    - Total cost for electricity services will vary slightly (positive and negative) assuming the full electricity sector's revenue collected from carbon compliance is recycled to the sector.
    - Industrial rates increase as they are less exposed to the GA reduction:

Industrial Rate Change

Maximum Rate Change in 2030	$/MWh	% change
No Revenue Recycling	$12.26	10.3%
Electricity Recycling	$10.30	8.7%
Electricity plus $250M/yr Recycling	$8.97	7.5%

    - Residential monthly bill impact declines marginally as Class B customers benefit more from lower GA

Residential Monthly Bill Impact

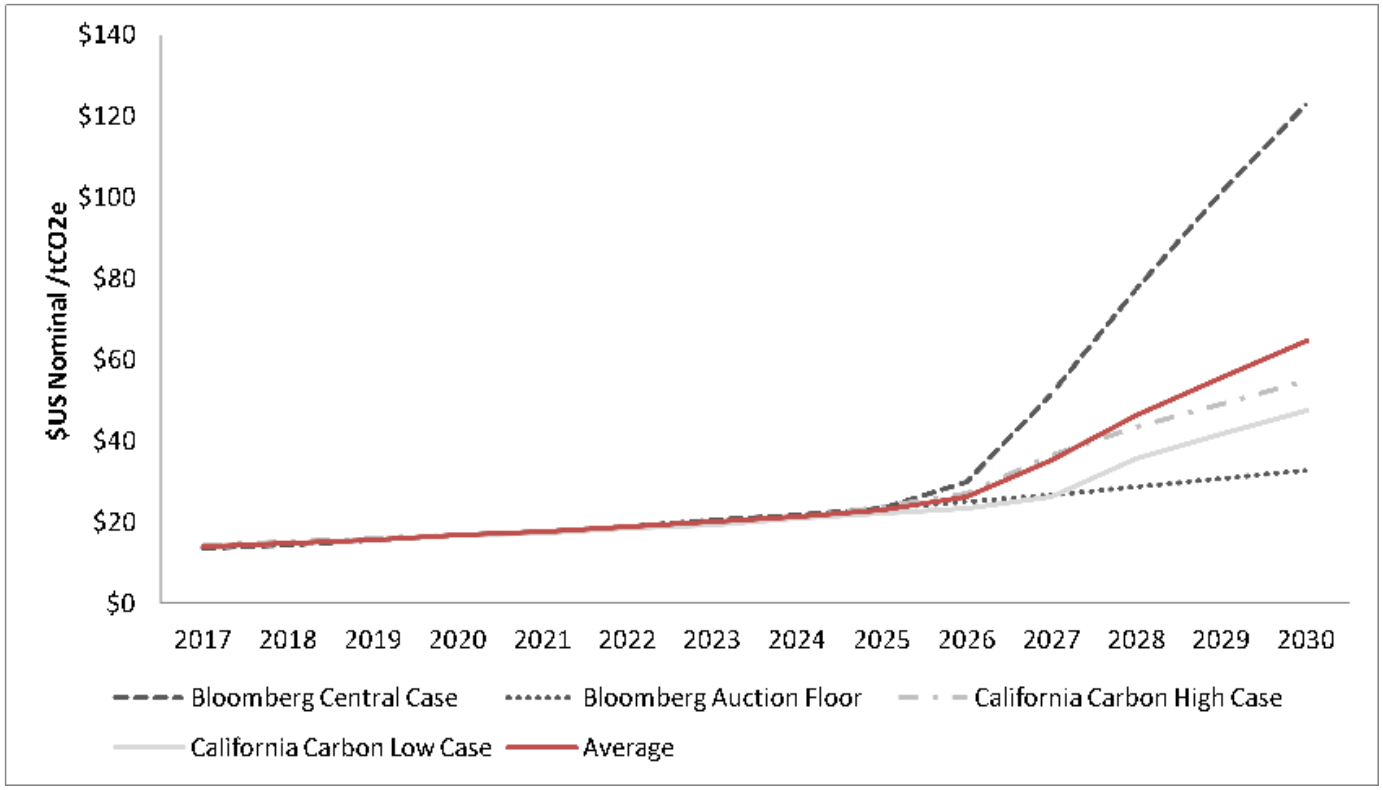
Maximum Bill Change in 2030	$/Mth	% change
No Revenue Recycling	$1.71	0.8%
Electricity Recycling	($1.44)	-0.7%
Electricity plus $250M/yr Recycling	($3.58)	-1.7%

Summary of Findings cont'd

- Market Fundamentals
  - Market demand in Ontario decreases as the wholesale prices increase and become less competitive
    - Imports: increase from Quebec and Manitoba, decrease from the US
    - Exports: decrease to all jurisdictions
    - Ontario production from natural gas decreases
- The effect of the above findings are amplified as the carbon price increases

- Key risks to the sector costs and emissions include:
  - downward pressure on Ontario electricity demand due to economic effect of a carbon price
  - potential differences in the value of the revenues collected for carbon compliance and those recycled back to the sector due to market value fluctuations of allowances
  - volatility in production from natural gas to meet actual system conditions could be higher or lower than those modeled
  - Impact of US carbon policy; for example, the impact of the Regional Greenhouse Gas Initiative (RGGI) to the New York and New England markets.
  - administration costs

Aggregate Average Carbon Price Projection



- The carbon price projection is an average of the following cases: Bloomberg Central Case, Bloomberg Auction Floor, California Carbon High Case and California Carbon Low Case
- Carbon cost trajectory ranges from $12.50 U.S./t $CO_{2\ eq}$ in 2017 to $64.60 U.S./t $CO_{2\ eq}$ by 2030
- Carbon price projection obtained from MoF, and agreed upon via the working group of MOECC, MoF, MoE and IESO.

Energy Modeling Assumptions

Base Model and Demand Assumption:

- Energy modeling was conducted in UPlan – a tool used to simulate the electricity market through economic dispatch of electricity resources
- The base case of the analysis is the 2013 LTEP, run with an updated UPlan version. The 2013 LTEP demand forecast is also assumed, with no change for the economic effect of a carbon price on this demand forecast for electricity

Recycling of Proceeds:

- Proceeds collected from the electricity sector from carbon compliance is modeled with two assumptions:
  1. Recycling of proceeds from auction allowances in the electricity sector
  2. Recycling of proceeds from auction allowances in the electricity sector and an additional $250M/year from the natural gas sector
- No administration costs have been included in the analysis. Admin. cost would reduce the proceeds returned back to electricity rate-payers and cause a further cost increase.

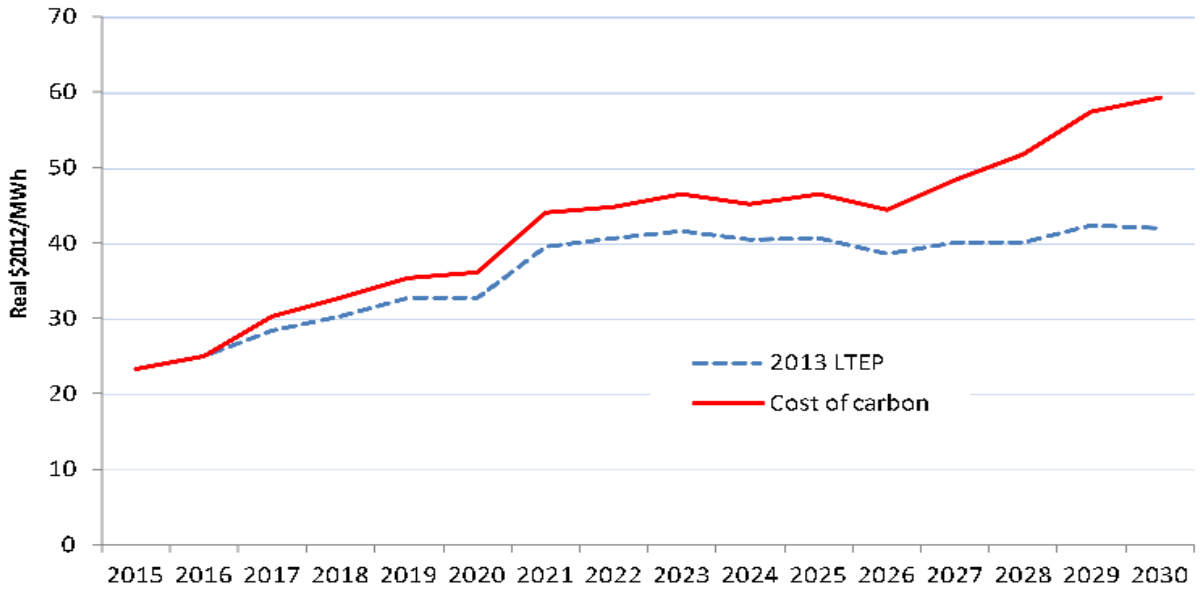
Energy Modeling Assumptions con't

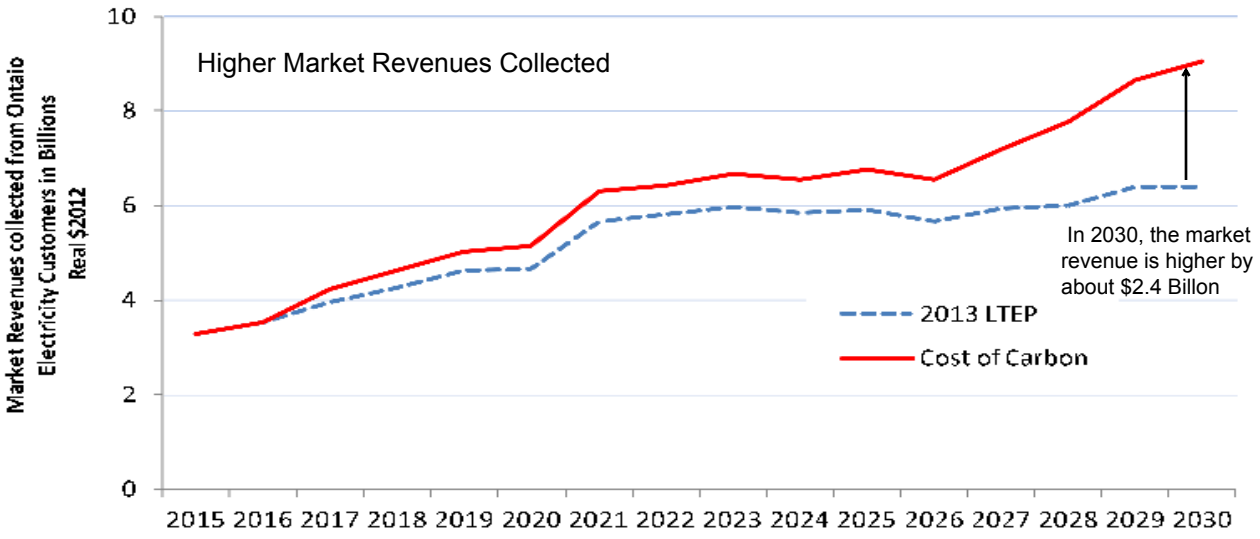
Modeling of Carbon:

- The carbon price forecast (supplied by government) was applied to the Ontario electricity generators using fossil fuel (the "emitters") and incorporated into their variable costs. These facilities tend to set the price and, as such, the impact of a carbon cost is reflected in the wholesale MCPs (refer to the following slides for illustrative concepts).
- The carbon price was applied to imports into Ontario from the US using a default marginal emission factor of 0.575 T $CO_{2(eq)}$/MWh
  - The carbon price was also applied to imports into Quebec and Manitoba from the US to prevent the wheel-through of power from the US to Ontario, avoiding the carbon cost, through these jurisdictions
- A carbon price was not applied to imports into Ontario from Quebec and Manitoba to account for: the large portion of hydro-electric in their supply mixes, and the carbon price regimes that are already in-place (or a potential) in these provinces

- Results -

Higher Market Clearing Prices





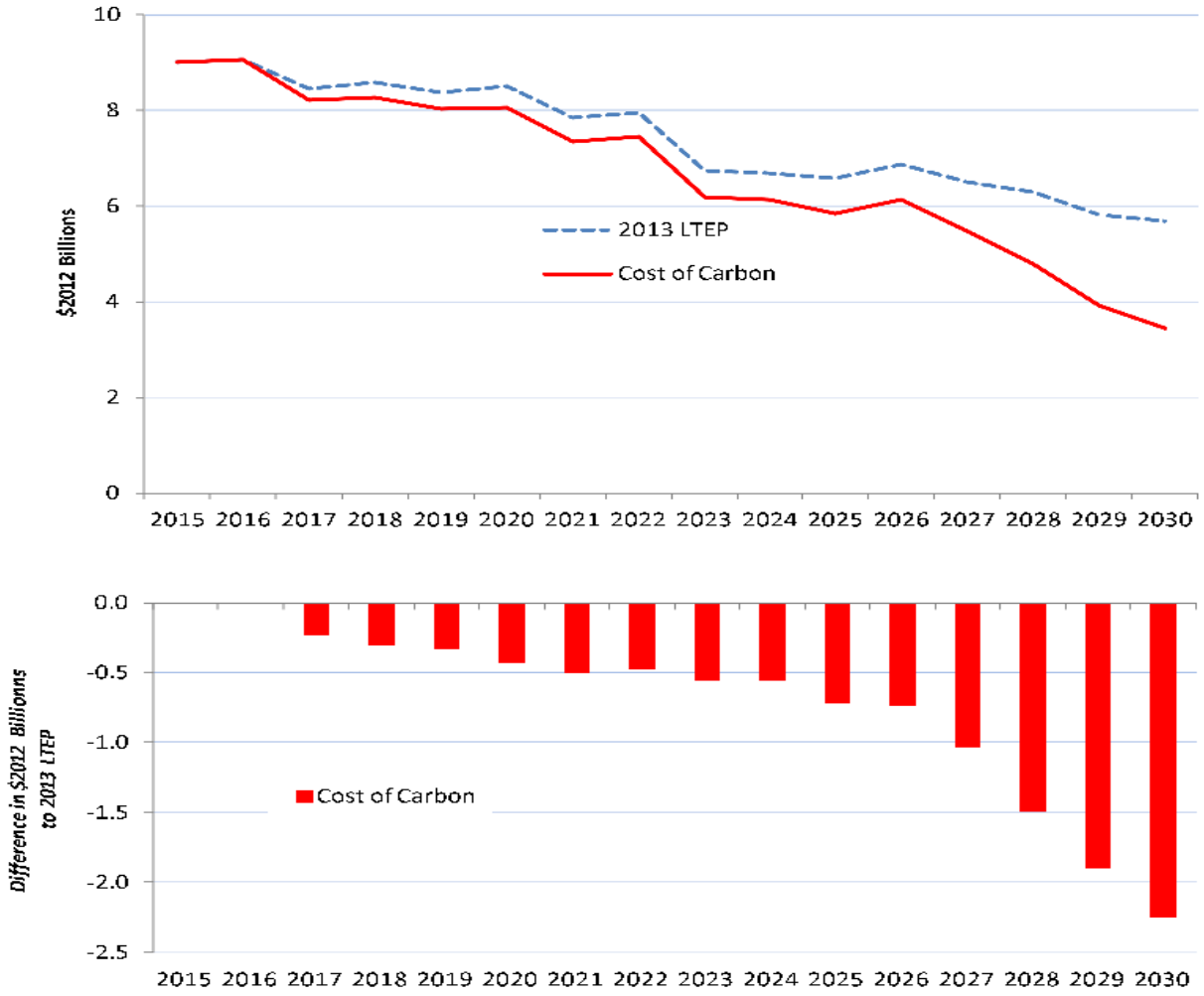
- Higher wholesale market clearing prices as carbon cost are embedded into offer prices (variable costs) of gas facilities shown in the “Cost of Carbon” scenario

- Market clearing prices (i.e., HOEP) gradually increase by $1.90/MWh in 2017 to an additional $17.30/MWh by 2030, due to carbon

- Implication of higher market clearing prices result in an increase of market revenues collected from Ontario electricity customers

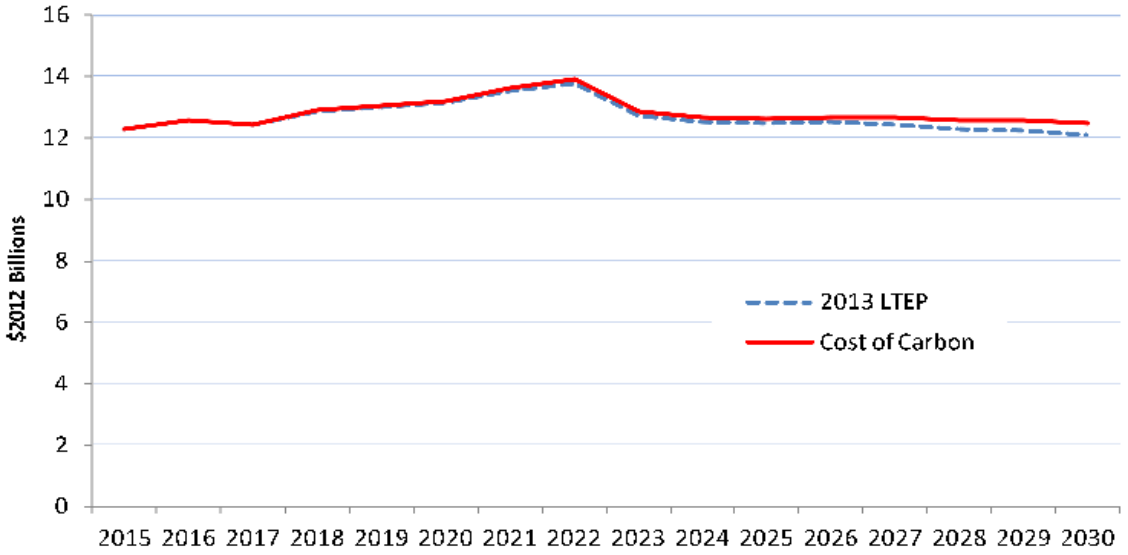
- Higher market clearing prices will additionally impact other market fundamentals such as exports and imports

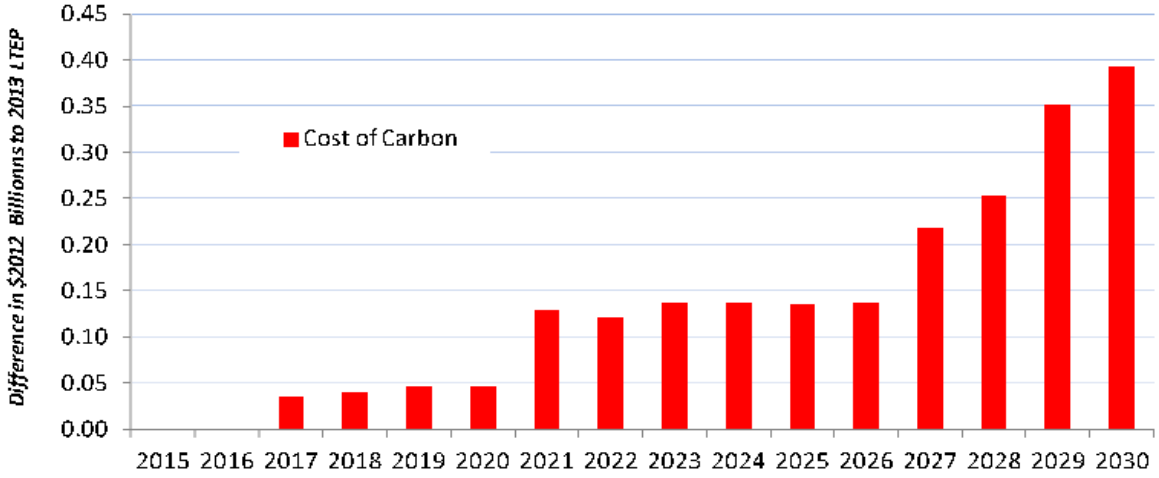
Lower Global Adjustment (GA) Costs Prior to Revenue Recycling



- Lower GA cost are required as carbon costs increase market clearing prices as shown in the “Cost of Carbon” scenario
- This GA impact does not include recycling of proceeds, only the impact of a higher market clearing price
- In 2030, the GA cost recovery is lower by about $2.2 billion due to the higher market clearing price

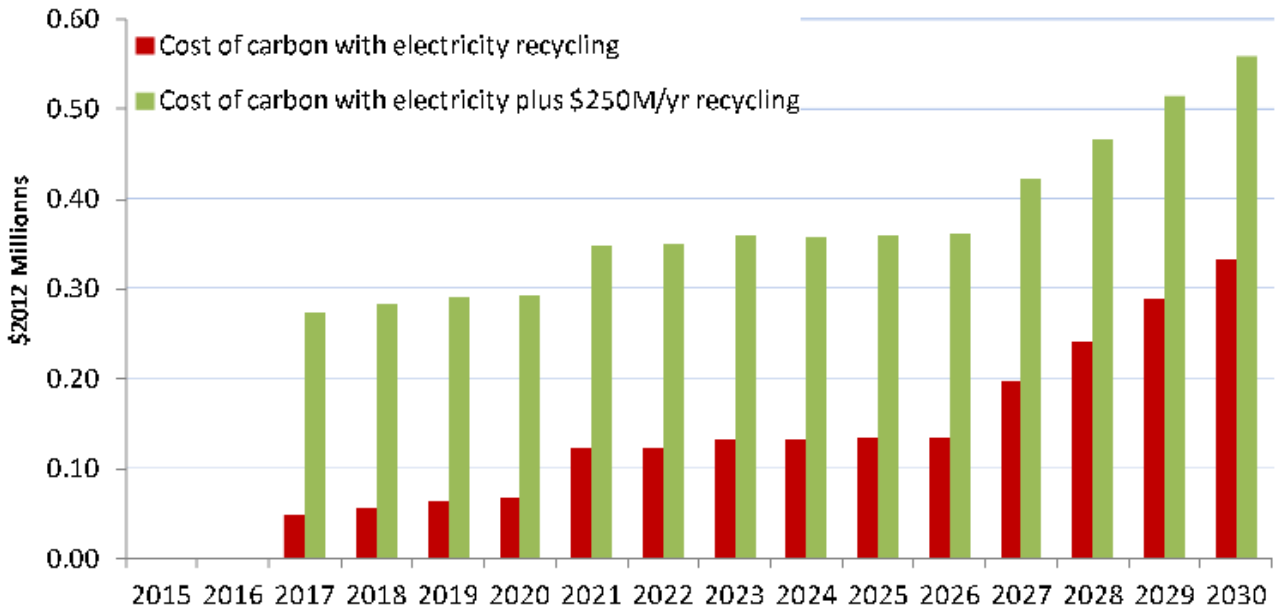
Total Generation Cost





- Total Generation Cost is equal to the market revenue plus the global adjustment
- Total Generation Cost increases in the “Cost of Carbon” scenario as the effect of higher market clearing prices are not fully offset by a reduction in the global adjustment
- The cost of carbon will result in a higher generation cost of about $390 M by 2030
- Assumes no recycling of proceeds from auction allowances from either the electricity and natural gas sectors

Recycling of Proceeds to Electricity Customers via the Global Adjustment



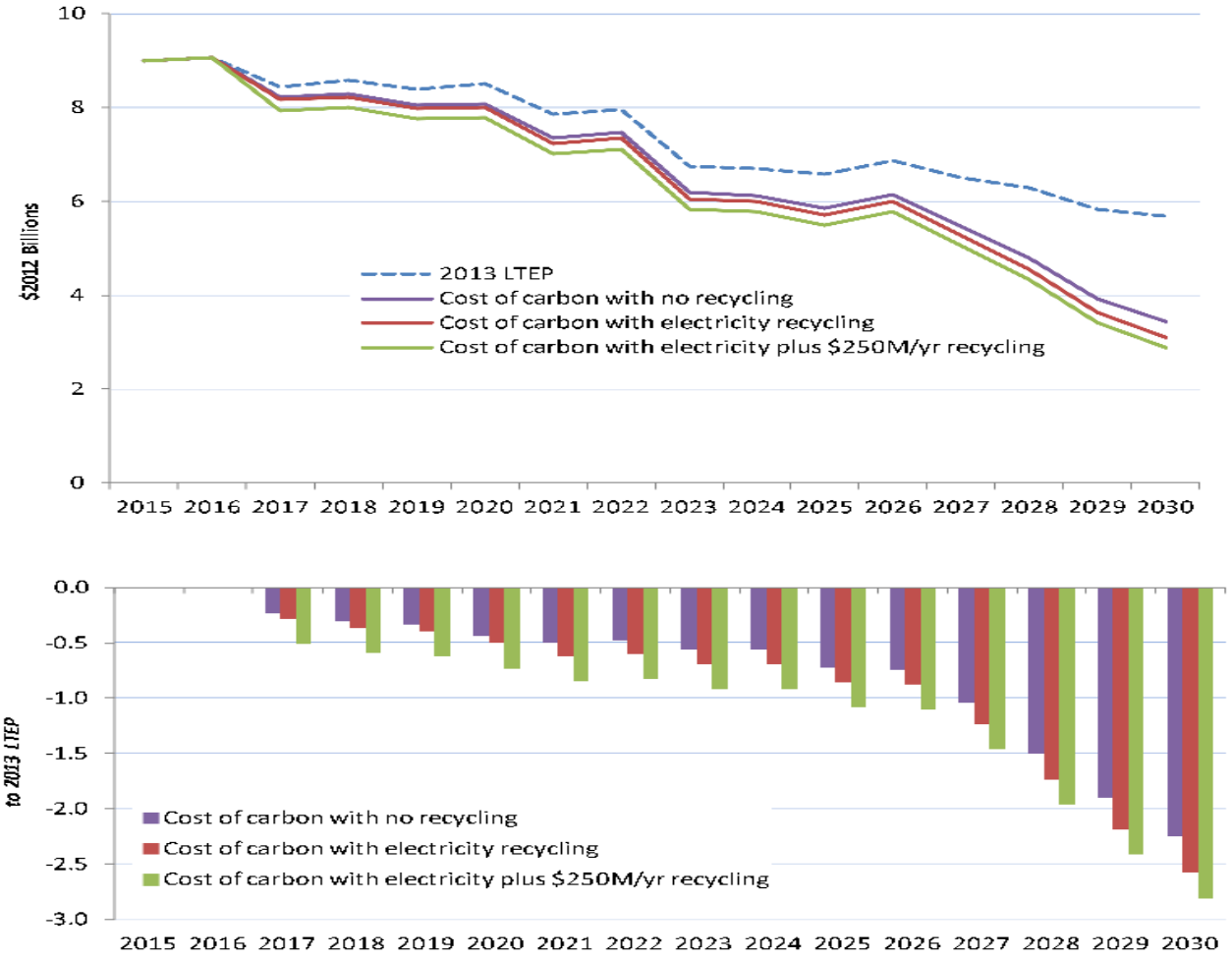
- GA costs would further decline with the inclusion of recycling proceeds from auction allowance in the electricity and natural gas sectors

- The recycling of proceeds from the auction allowance in the electricity sector is about $333 M by 2030 (labeled: Cost of Carbon with electricity recycling)

- The proceeds from recycling auction allowances in the electricity sector plus $250M/year from the natural gas sector is labeled “Cost of carbon with electricity plus $250M/yr recycling”

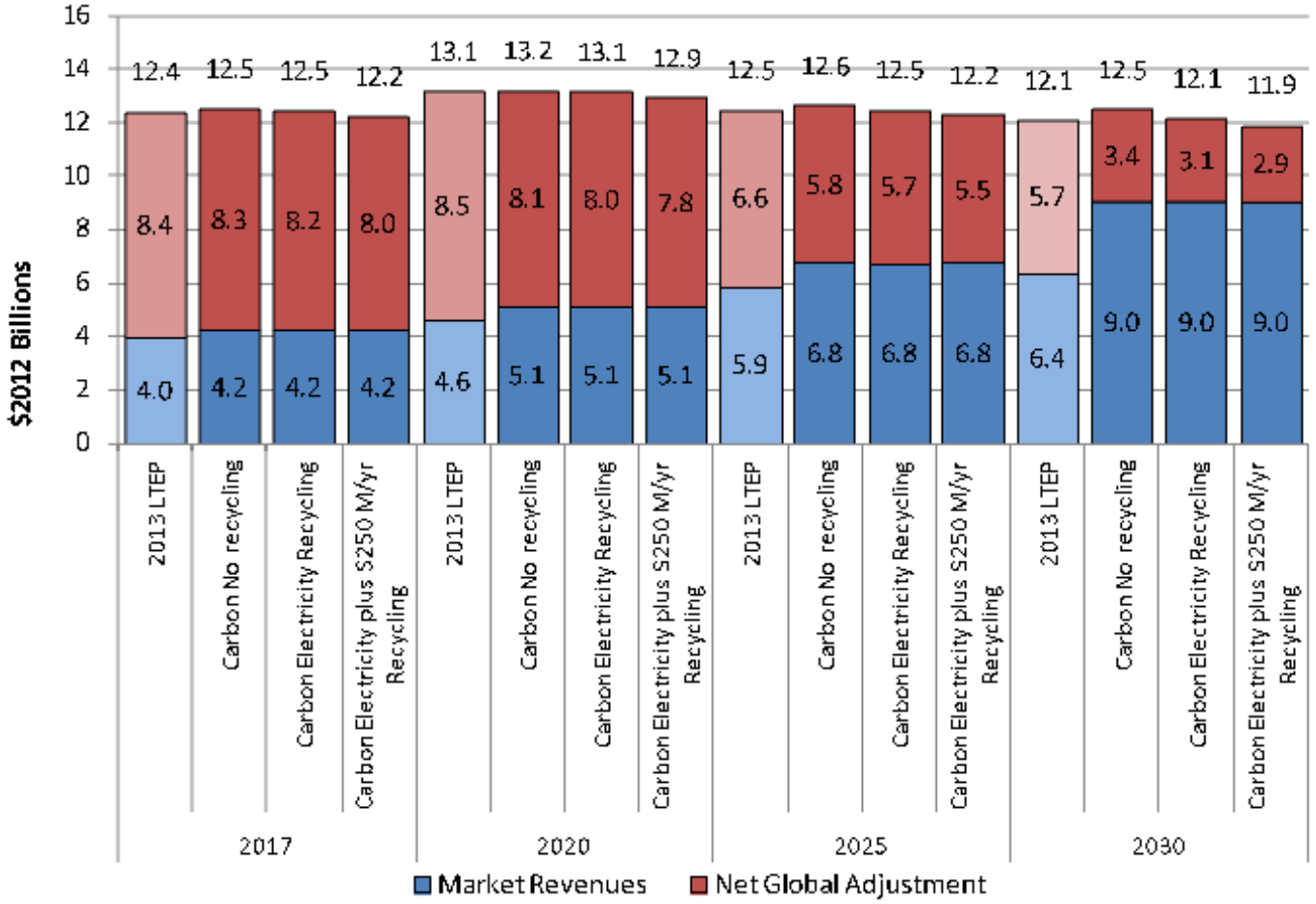
- No loss of revenue recycling is assumed for administration costs

Net Global Adjustment with Recycling of Proceeds



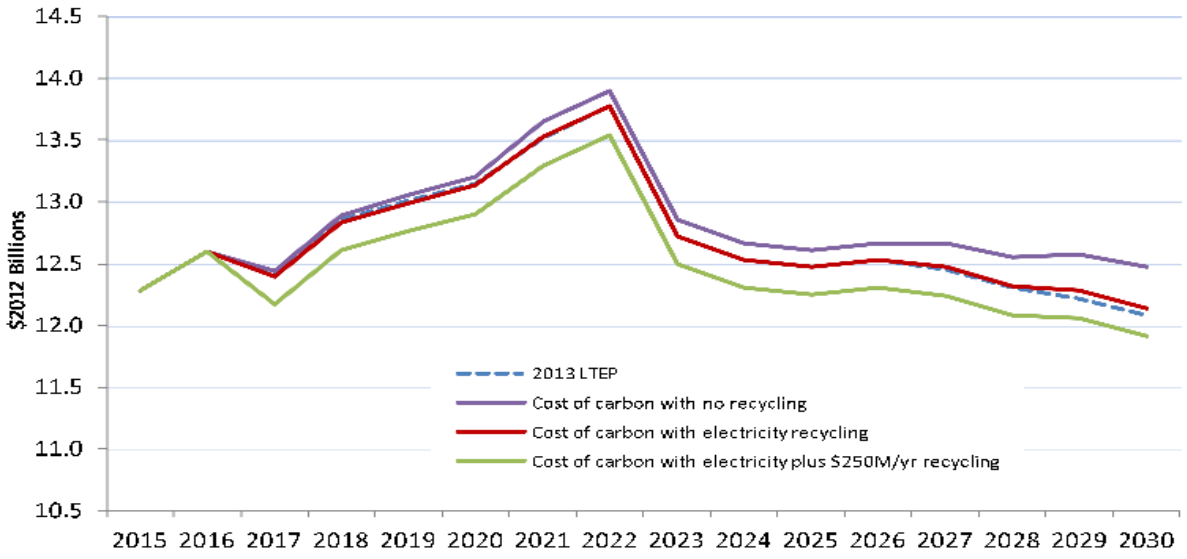
- The GA without recycling of proceeds illustrates the decline in GA due purely from the higher market clearing prices
- GA costs are further reduced when there is recycling of proceeds from auction allowances
- Lowest Net Global Adjustment case includes the full electricity sector proceeds recycled plus the addition of $250 M/year of proceeds from the natural gas sector

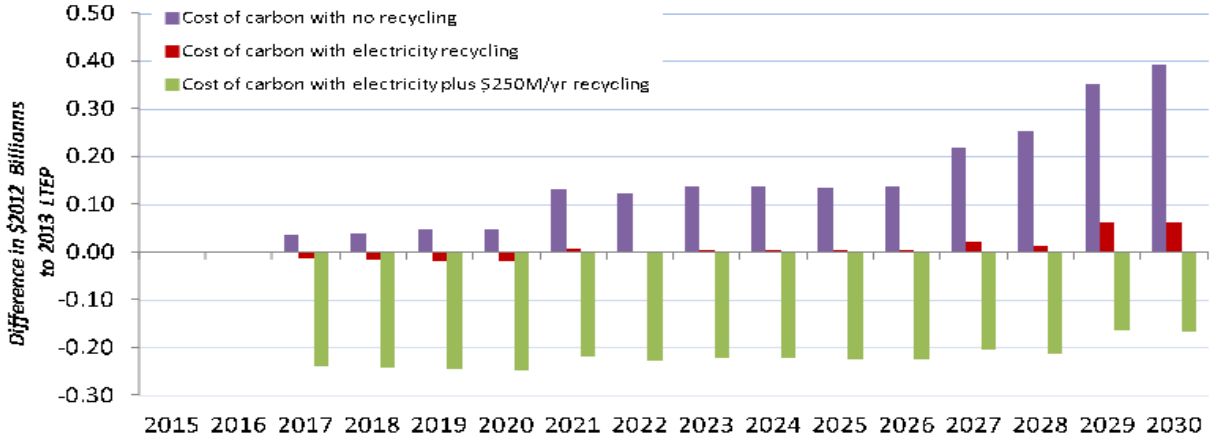
Total Generation Cost by Market Revenue and Global Adjustment



- Total cost of generation does not change significantly as Ontario demand is assumed to be held constant
- The share of cost recovery between market revenue and GA are shifting due to higher market clearing prices
- The case of higher recycling of proceeds results in a greater lowering of the global adjustment costs

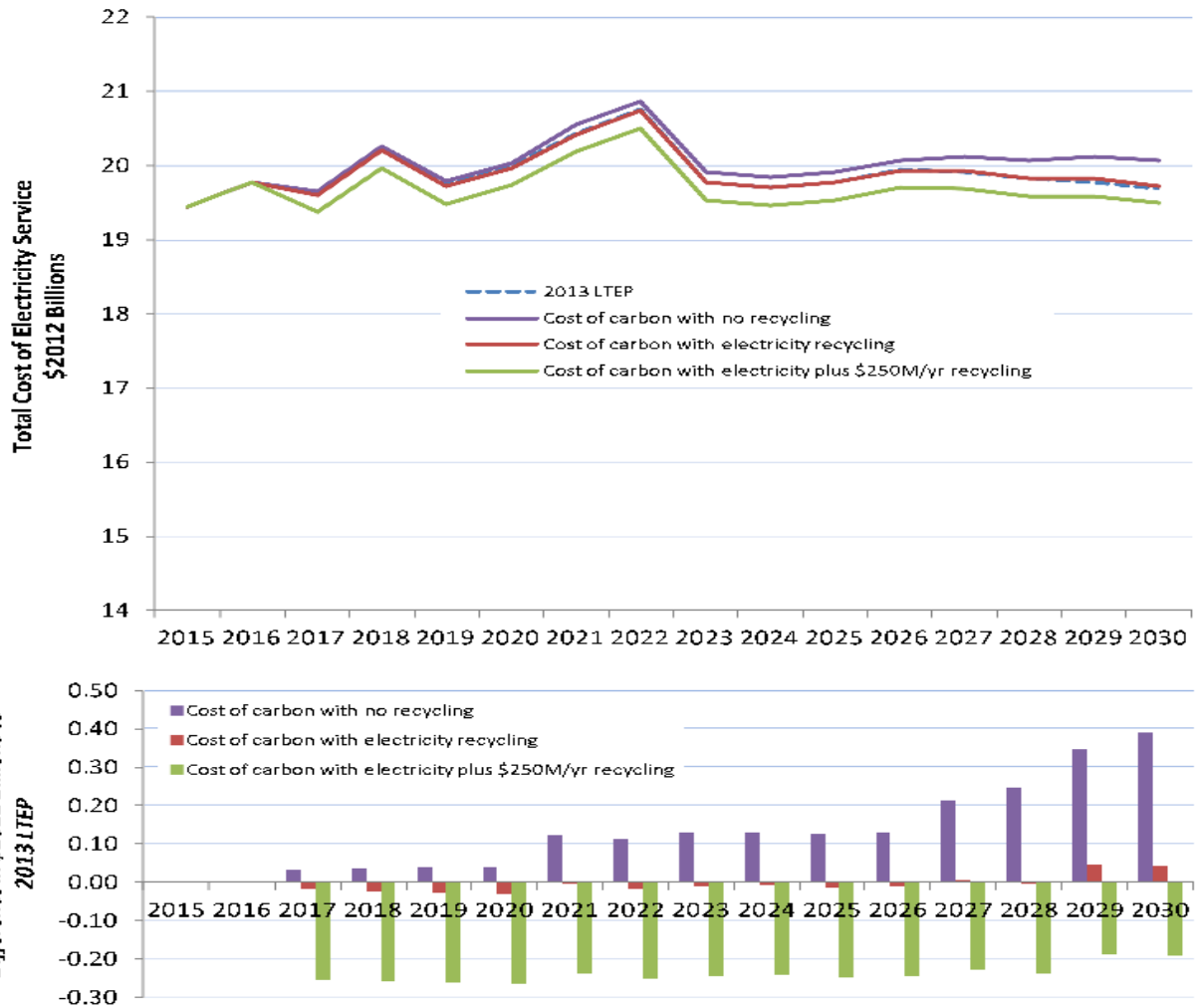
Generation Cost with Recycling of Proceeds





- Cost of generation is the market revenues plus the net global adjustment
- No recycling of proceeds from auction allowances results in a higher generation cost vs. 2013 LTEP
- Recycling proceeds of auction allowances for the electricity sector results in small negative to positive changes to the cost of generation.
- Recycling proceeds of auction allowances for electricity and natural gas sectors result in a lower cost of generation compared to the 2013 LTEP

Cost for Electricity Service Deceases with Recycling of Proceeds

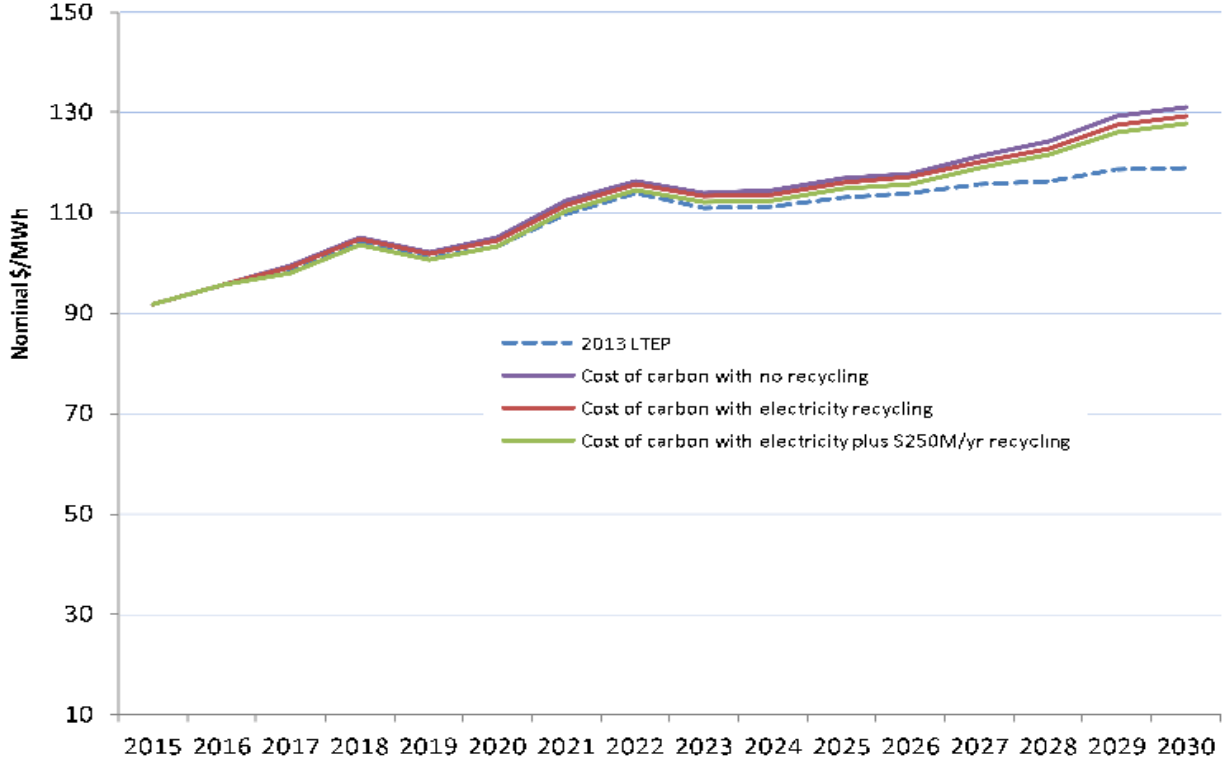


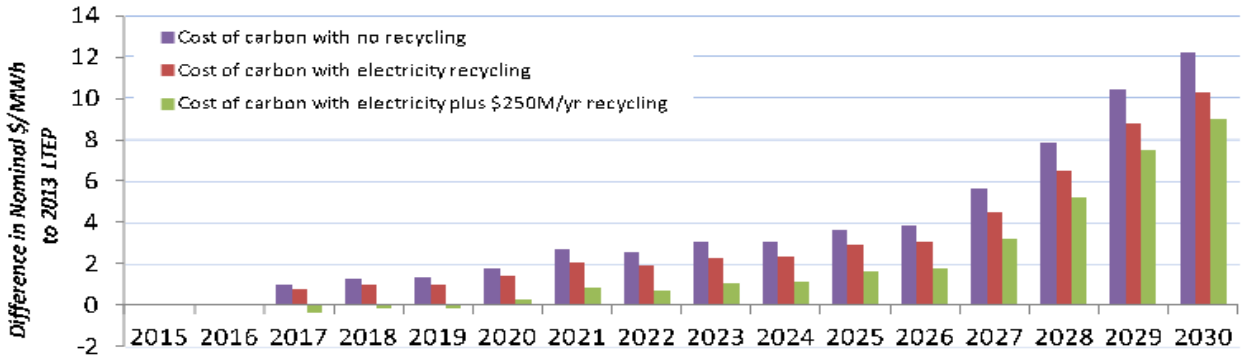
- Total Cost for Electricity Service includes all cost components: generation, conservation, transmission, distribution and wholesale market charges

- The cost delta between the various recycling of proceeds are consistent to the changes shown in the previous generation cost slide (slide 16)

- Recycling of electricity proceeds and an additional $250M/year results in the greatest reduction to the cost of electricity service

Industrial Electricity Prices Increase (Large User Rate, Class A)





- Higher average unit rate for large user class A, as they are less exposed to the GA; and thus the reductions associated with recycling of proceeds

- Highest impact to industrial rates is when there is no recycling of proceeds.

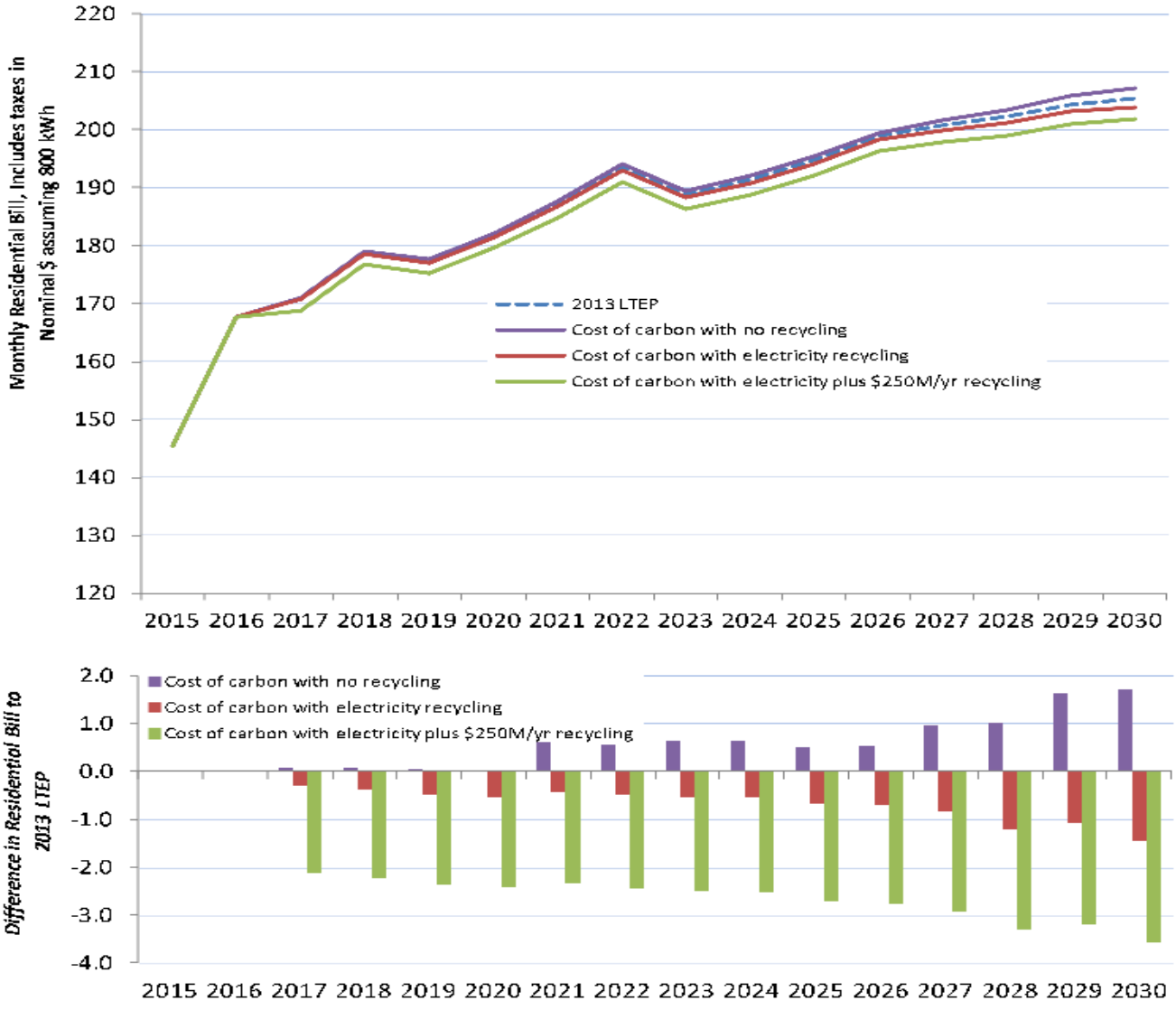
- Although industrial rates still increase with recycling proceeds, the percentage increase is lower when there is a larger recycling of proceeds to the GA (i.e., Cost of Carbon with electricity plus $250M/yr recycling)

Industrial Electricity Price Forecast

Nominal $/MWh	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
2013 LTEP	$91.73	$95.49	$98.38	$103.86	$100.89	$103.20	$109.64	$113.83	$110.94	$111.32	$113.14	$114.02	$115.64	$116.30	$118.65	$118.92
Cost of carbon with electricity recycling	$91.73	$95.49	$99.12	$104.84	$101.91	$104.62	$111.69	$115.71	$113.25	$113.68	$116.06	$117.07	$120.16	$122.80	$127.44	$129.22
Cost of carbon with electricity plus $250M/yr recycling	$91.73	$95.49	$97.99	$103.69	$100.74	$103.44	$110.51	$114.50	$112.01	$112.43	$114.79	$115.79	$118.87	$121.49	$126.13	$127.89
Cost of carbon with no recycling	$91.73	$95.49	$99.36	$105.13	$102.24	$104.96	$112.33	$116.37	$113.97	$114.41	$116.80	$117.83	$121.29	$124.19	$129.12	$131.18

$/MWh Difference to 2013 LTEP	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Cost of carbon with electricity recycling	$-	$-	$0.74	$0.98	$1.01	$1.42	$2.05	$1.88	$2.31	$2.36	$2.91	$3.05	$4.52	$6.50	$8.79	$10.30
Cost of carbon with electricity plus $250M/yr recycling	$-	$-	($0.39)	($0.18)	($0.15)	$0.24	$0.86	$0.67	$1.08	$1.11	$1.65	$1.77	$3.23	$5.19	$7.47	$8.97
Cost of carbon with no recycling	$-	$-	$0.98	$1.27	$1.35	$1.76	$2.69	$2.54	$3.03	$3.09	$3.66	$3.82	$5.65	$7.89	$10.47	$12.26

Residential Monthly Bills Decrease (Class B)



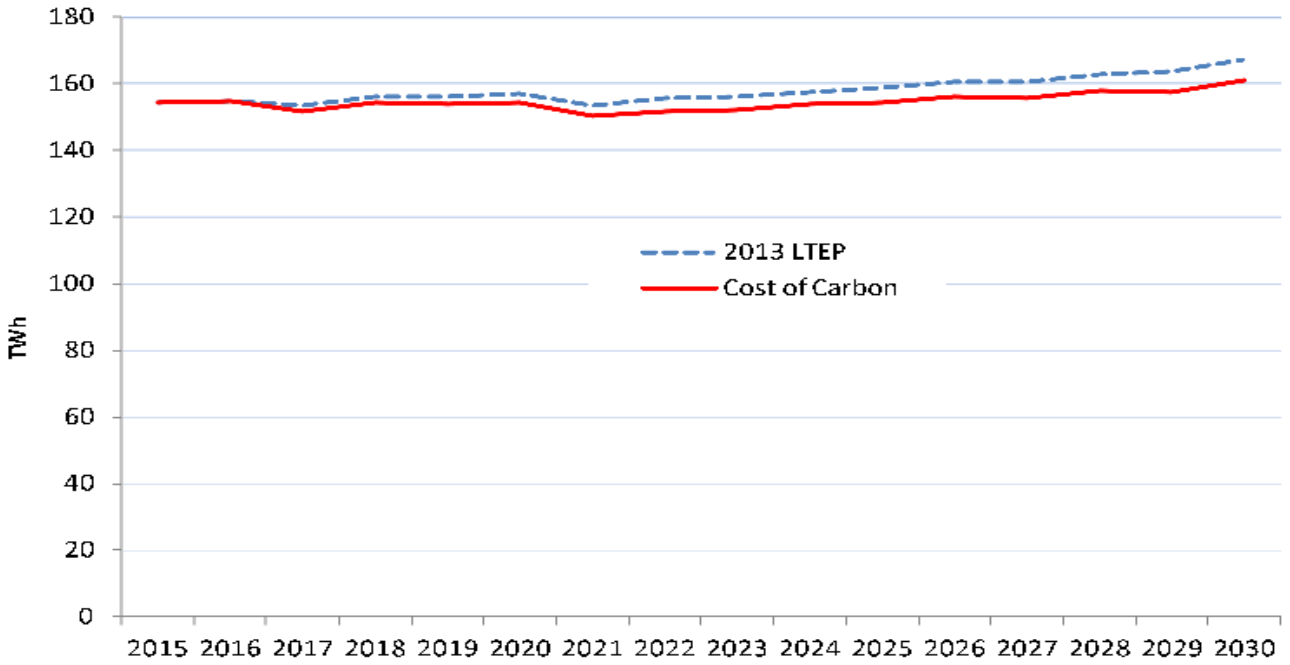
- Lower residential monthly bills with recycling of proceeds as Class B customers benefit more from lower GA

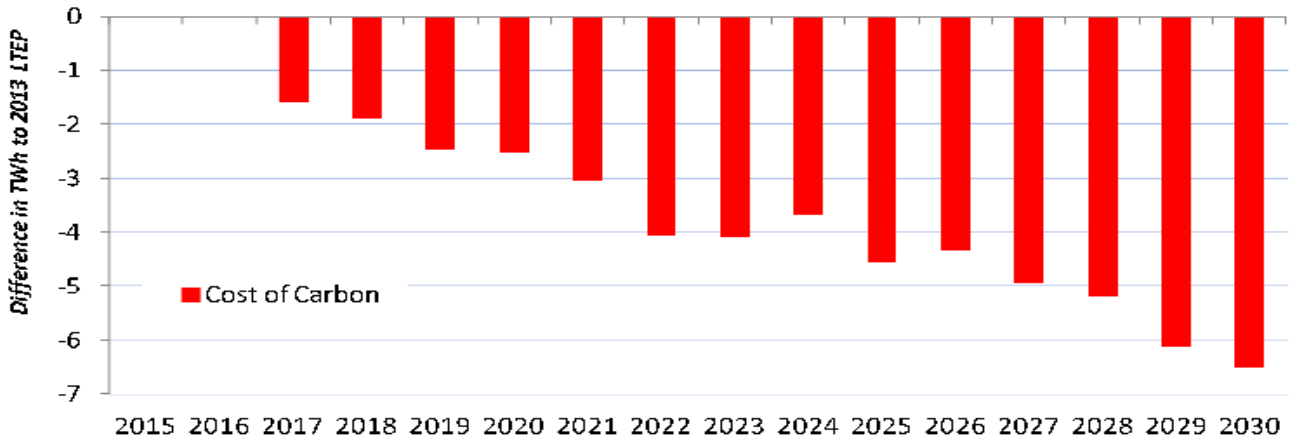
- No recycling of proceeds will cause residential bills to increase by about $1.70/month in 2030.

- Recycling of proceeds from the electricity sector will produce bill declines of about $1.40/month in 2030

- An additional $250M/yr of proceeds recycled from natural gas sector, will reduce residential bills by about $3.60/month in 2030

Market Demand Decreases





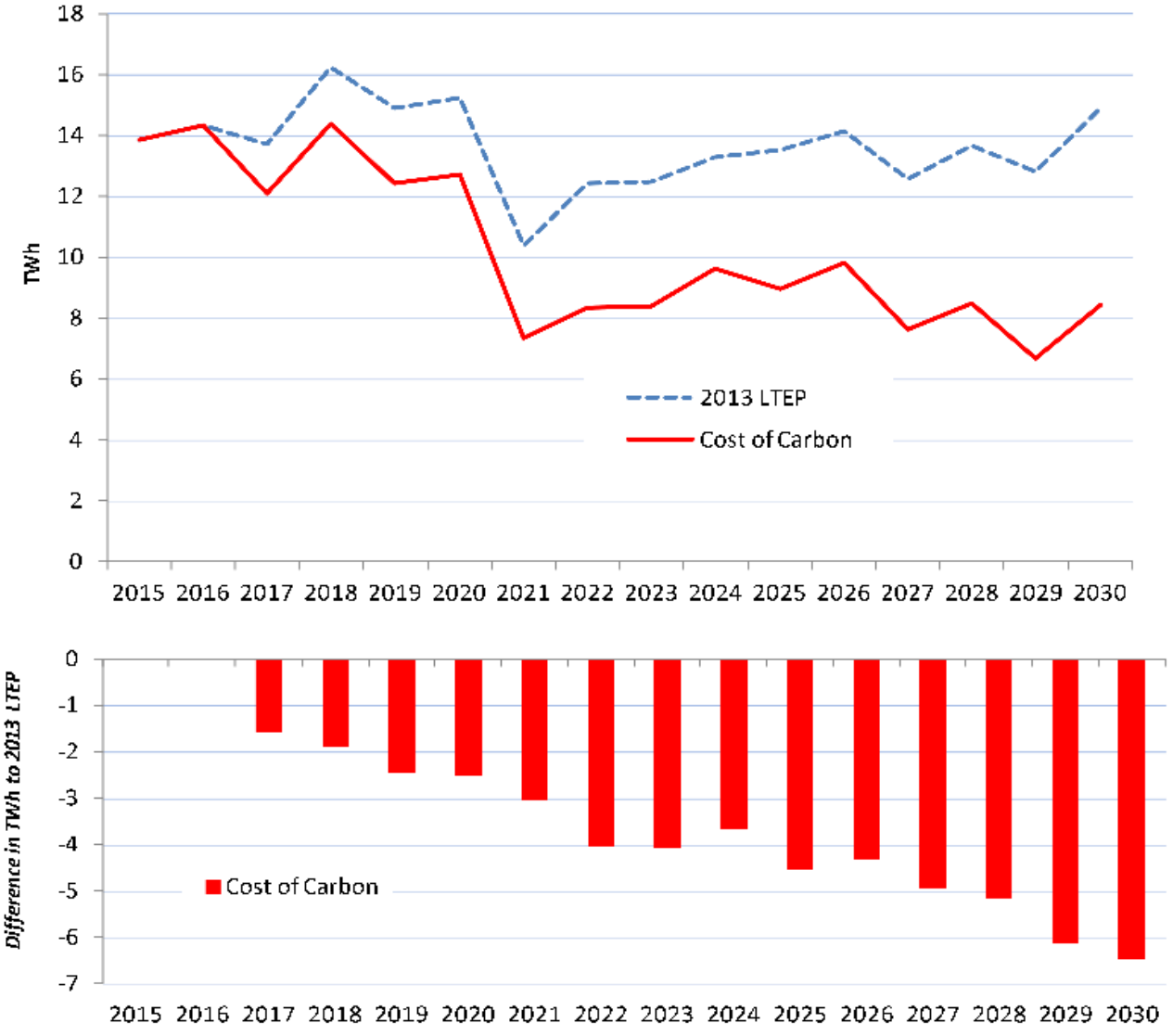
- Ontario domestic demand is assumed to be the same as LTEP. However since prices in Ontario will rise due to addition of carbon costs exports will decrease resulting in a lower market demand

- In addition, imports from low emitting jurisdictions especially Quebec are expected to increase

- The market demand can decline by about 6.5 TWh in 2030

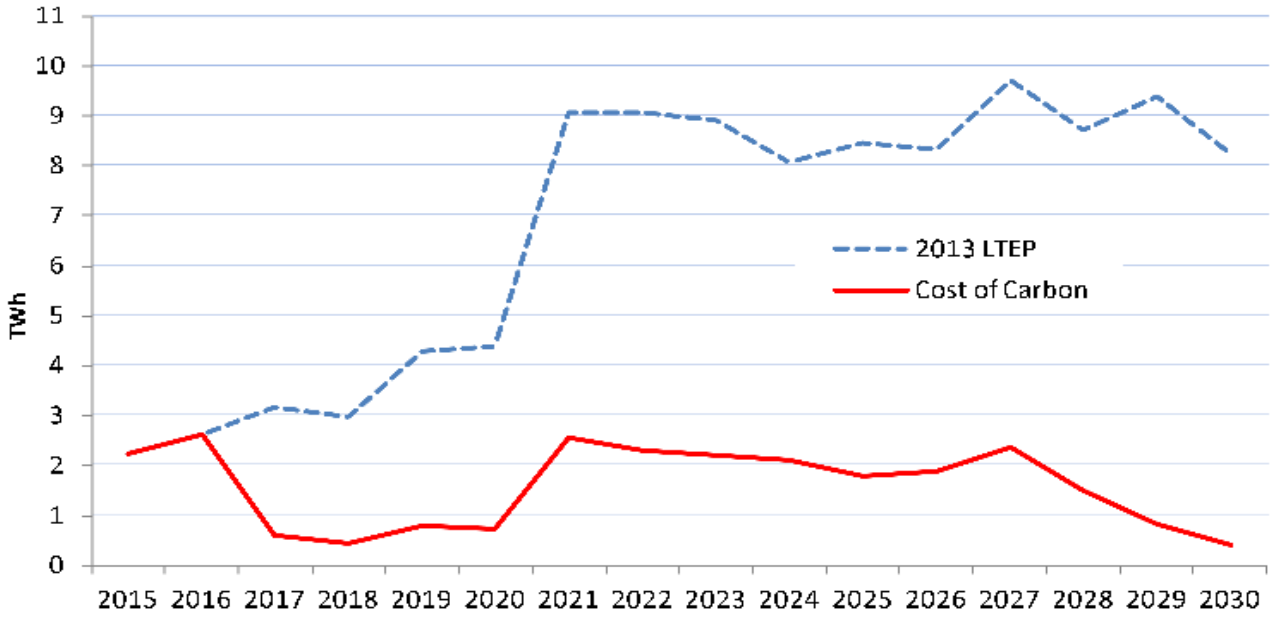
***Ontario demand is assumed to be held constant**
Note: Modeling of RGGI could impact the results

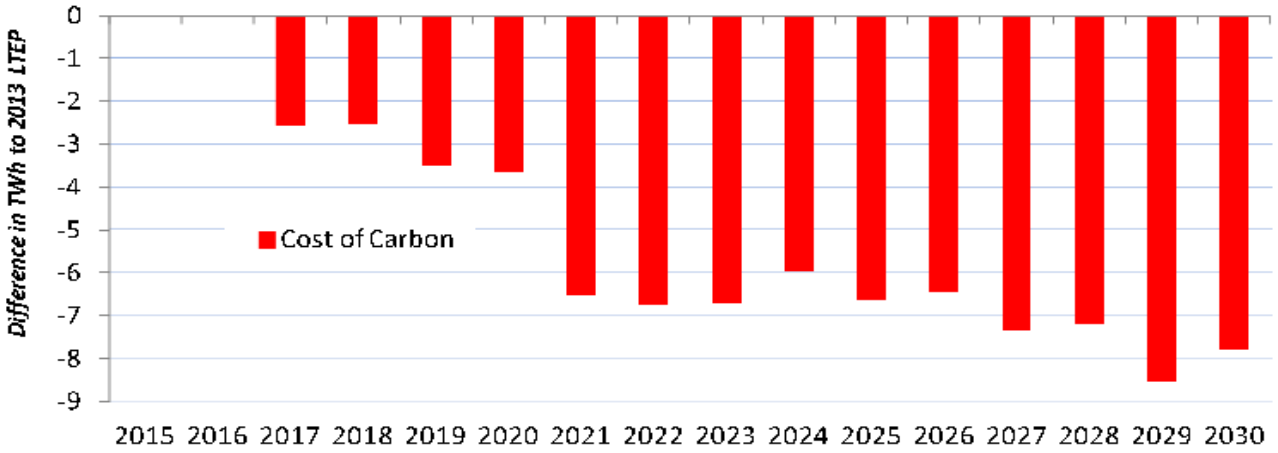
Ontario Exports Decrease



- Market Demand decline is primarily driven by a decline in Ontario exports
- Inclusion of carbon costs result in higher MCPs which makes Ontario exports less competitive to neighboring jurisdictions
- Exports decline by 6.5 TWh in 2030

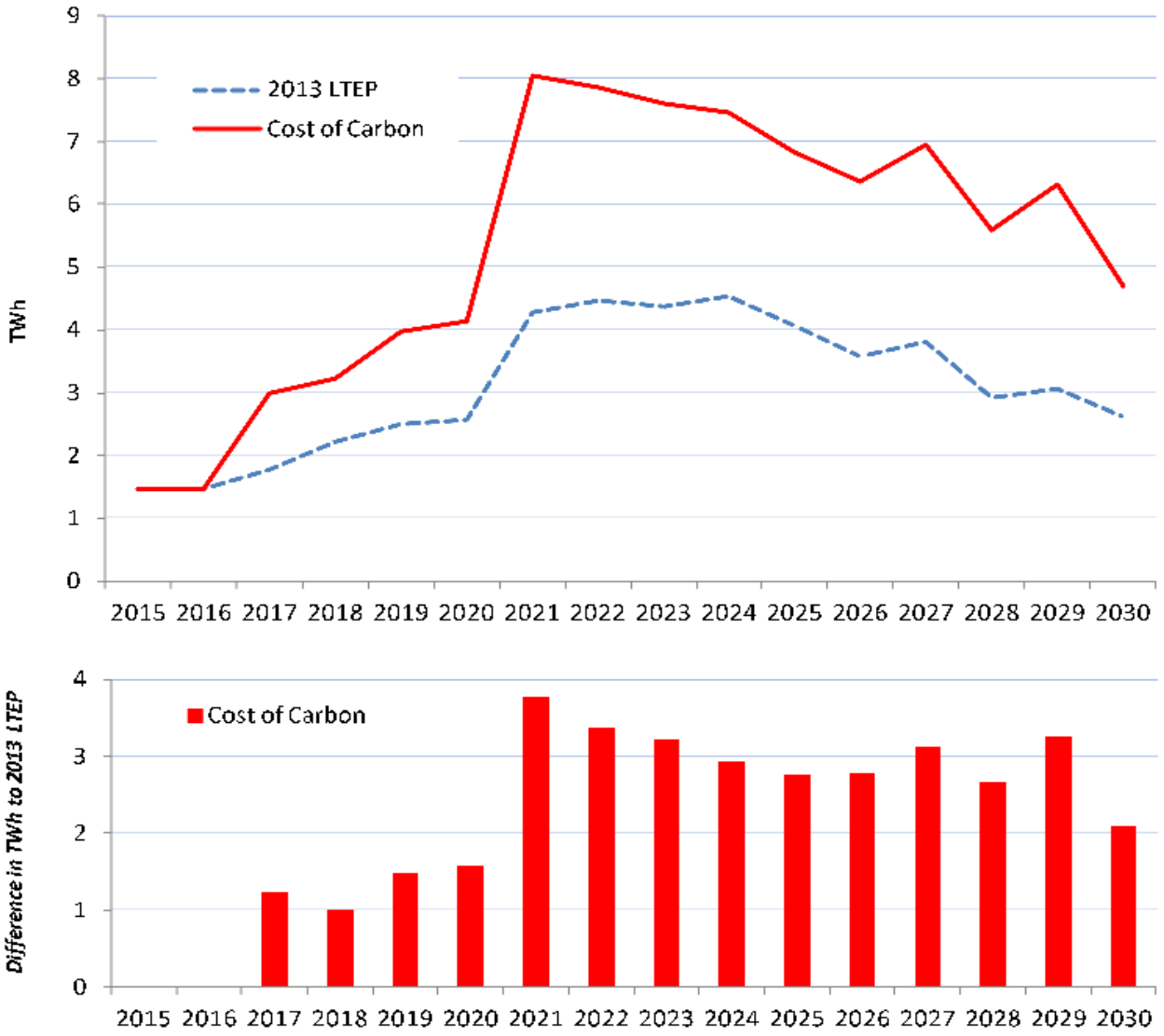
Imports from the U.S. Decrease





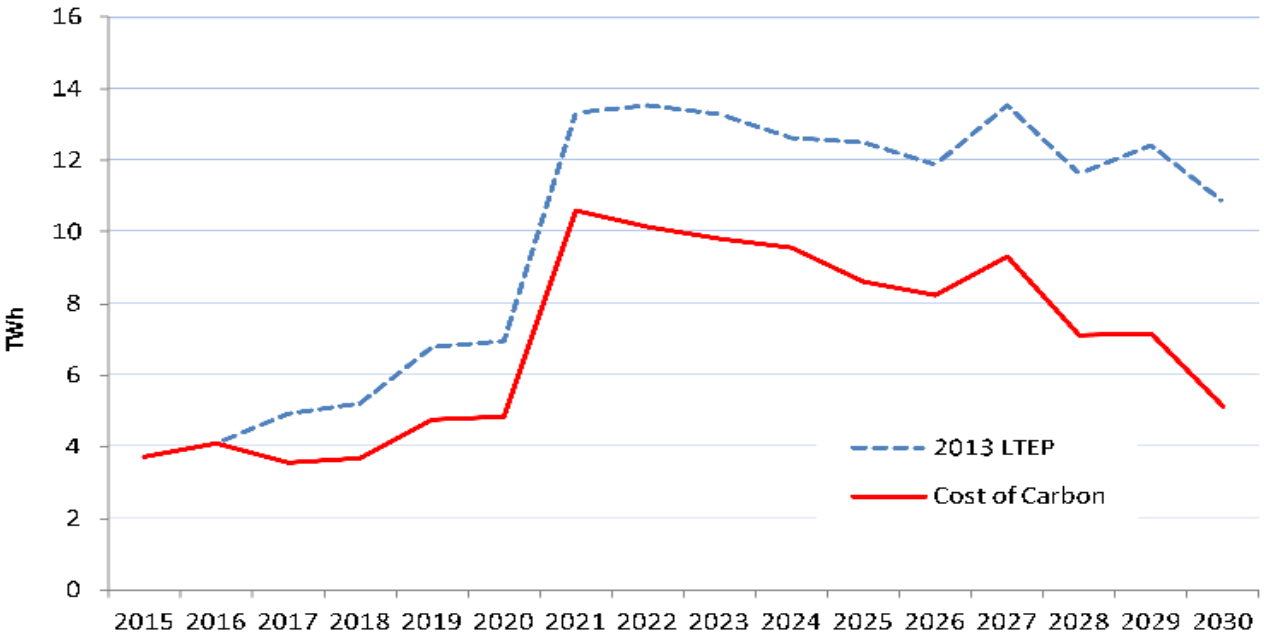
- Imports from the U.S. will decrease, as they are required to pay for the cost for carbon and will be less competitive
- U.S. Imports will be impacted differently than Canadian imports due to differences in supply mixes
- the maximum U.S. Import decline is about 8.6 TWh in 2029

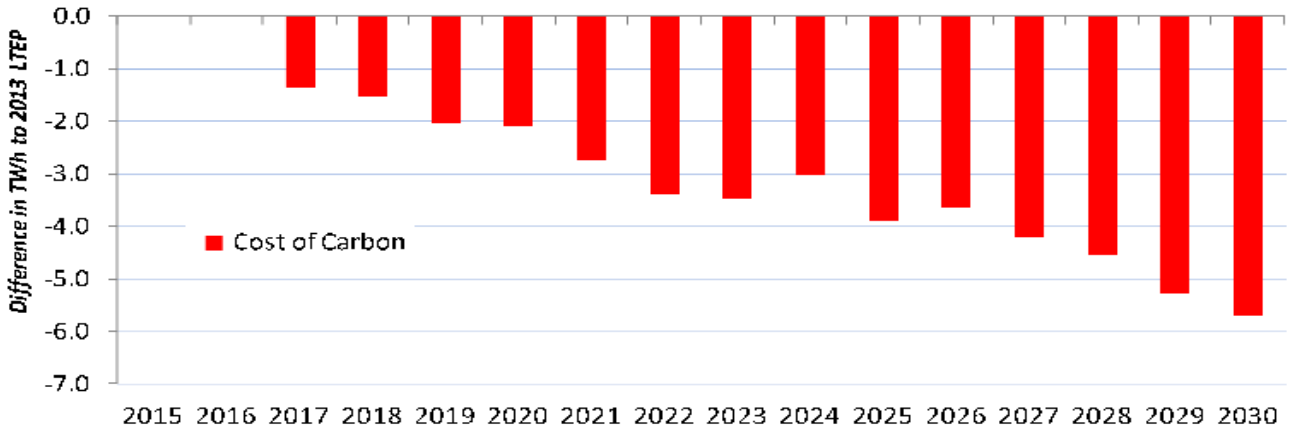
Imports from Canada Increase



- Clean imports from Quebec and Manitoba increase
- No carbon cost applied to Canadian imports as source is hydro-electric
- Ontario's higher MCPs with carbon cost will create a more profitable environment for these jurisdictions
- Canadian imports maximum increase is in 2021 of about 3.9 TWh

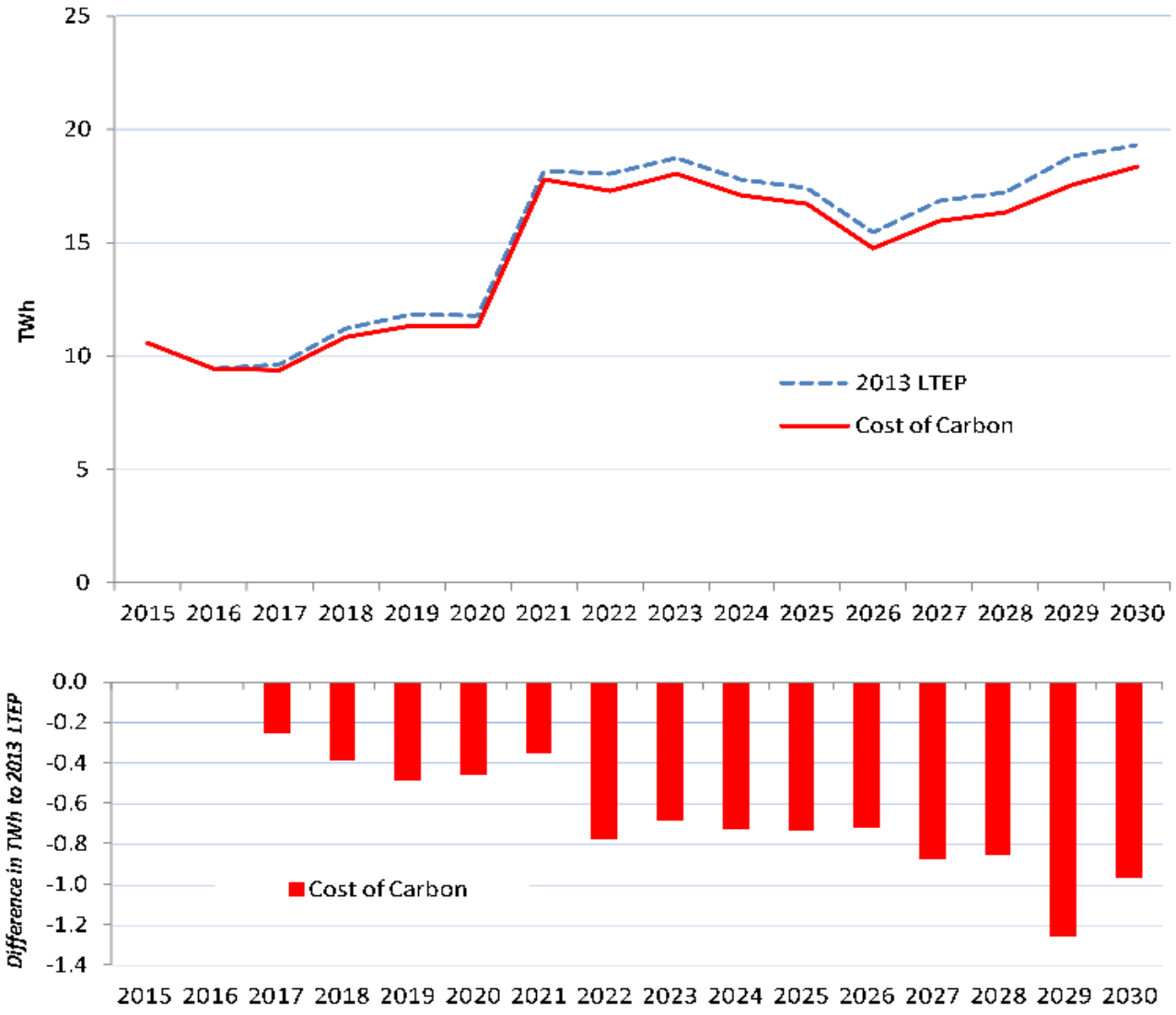
Total Imports Decrease





- Total Imports are lower relative to the 2013 LTEP
- As the carbon prices rise the CAN imports will increase but are insufficient to offset decline of US import
- By 2030, total imports will decline by 5.7 TWh

Ontario Natural Gas Production Decreases



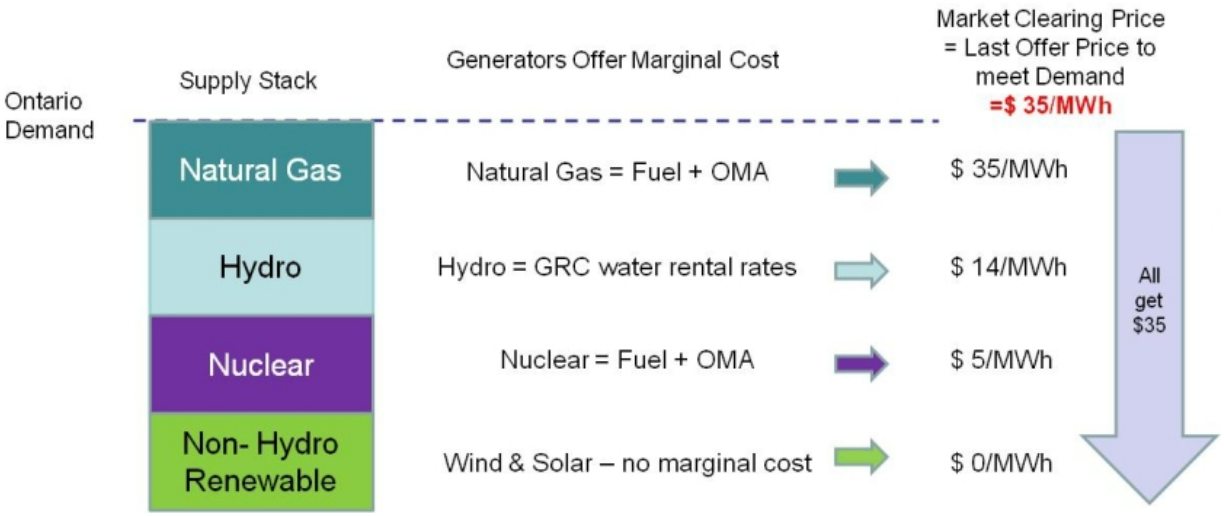
- Ontario natural gas production declines as Ontario market demand is smaller, largely due to decreased exports
- The maximum Natural gas production decline is in 2029 of about 1.3 TWh

Risks

- Potential for bad press
  - Quebec and Manitoba will see higher profits as Ontario market clearing prices increase with the cost of carbon
  - Class A large user customers (industrial) will absorb a higher portion of the cost increase
- Potential for greater impact to costs
  - Administrative costs have not been included
  - Potential changes (higher or lower) in the market value of allowances, from the point of sale in the auction to the point of retirement have not been captured. Changes in market value could cause a discrepancy between the amount of auction proceeds returned to the global adjustment and increases in costs due to MCP
  - Any declines in the demand for electricity in Ontario as a result of a carbon price would further increase the costs on a rate basis. The current analysis assumes that demand levels remain constant at the 2013 LTEP levels
- Potential for increases in electricity sector emissions
  - The CO2 emissions in the 2013 LTEP are based on average planning conditions
  - In any given year, gas production and US imports may be higher or lower due to actual market conditions; this could increase or decrease CO2 emissions and the need for allowances

- Conceptual Impacts of a Carbon Price on Electricity Market Dynamics -

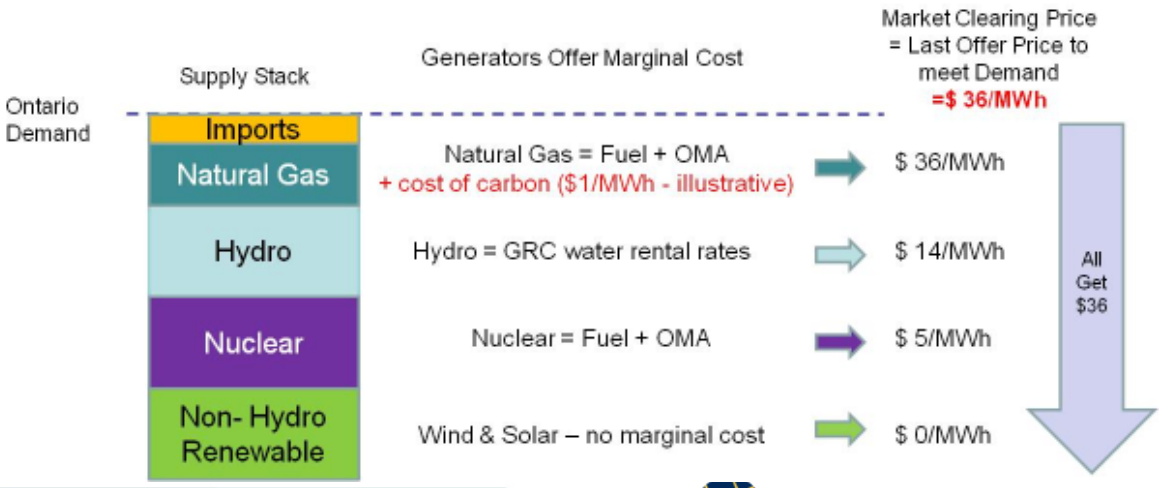
Illustrative Impact of Carbon Price on MCP



Without a Carbon Price

With a Carbon Price

- Market clearing price will increase when fossil generation is on the margin
- Increased opportunity for clean imports due to higher market price (note: imports do not set the price)
- Overall ratio of cost recovery between GA and Market will change



Impact of Carbon Price on Export and Import Dynamics

Exports to Canada decrease; Imports from Canada increase

- Ontario is less economic with higher wholesale MCPs causing fewer exports
- Imports from Quebec and Manitoba do not need to pay a carbon cost as this energy is provided by hydro-electric, which does not emit CO_2

Exports / Imports to / from the US decrease:

- Ontario is less economic with higher wholesale MCPs causing fewer exports
- US imports must be treated on a level playing field with Ontario generation and thus must pay a cost of carbon, even though the source jurisdiction may not be covered by a carbon policy