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Estimating Environmental Attributes of System Imports to New England

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Requests Have Been Made to Integrate the Environmental Attributes of Imports

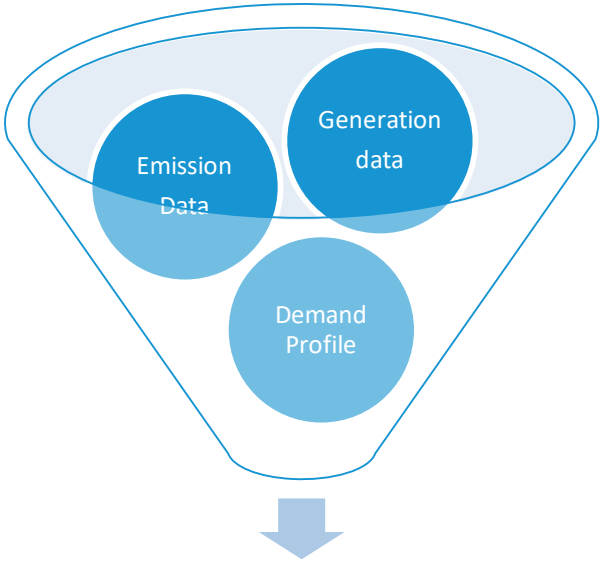
- ISO New England, with the participation of the Environmental Advisory Group, developed a methodology to account for air emissions resulting from native generation (electric generating units physically located in the New England control area)
- Several stakeholders have requested that ISO New England "include [the air emissions attributes of] imported energy when publishing total emissions and average emission intensity associated with Net Energy for Load"
- ISO New England requests input from the Environmental Advisory Group in calculating air emissions attributes of imported energy, this presentation offers three examples

Direct Emissions Data Available For Most Control Areas, but Gaps Exist

Sources of Emissions Data

- Historical emissions data available for larger (≥25 MW) emitting electric generators in the United States
  - Hourly, monthly, annual data from EPA and EIA sources
  - Most recent 4th Quarter 2019
- Limited historical emissions available for emitting electric generators in Canada
  - Annual emissions data from Statistics Canada

Calculating Carbon Emissions for Adjacent Control Areas



What We Know: Overview of Data Sources for Estimating Emission Attributes of System Imports

Timeframe	Pros and Cons	Options
Annual	• Sufficient generation & emissions data for most adjacent control areas • Misses seasonal variability	Complete data available for 2019 for NYISO and ISO-NE Federal Canadian emissions data for 2017 calendar year, incomplete
Monthly	• Generation data for NYISO and adjacent Canadian control areas available • Canadian emissions data not readily available	2019 monthly generation data for Canadian control areas, incomplete monthly 2017 emissions data For Canadian control areas could substitute emissions factors, control area fuel mix and demand
Hourly	• Available for ISO-NE, NYISO control areas • No known Canadian control area data sources	Requires estimating hourly production & attributes for Canadian control areas

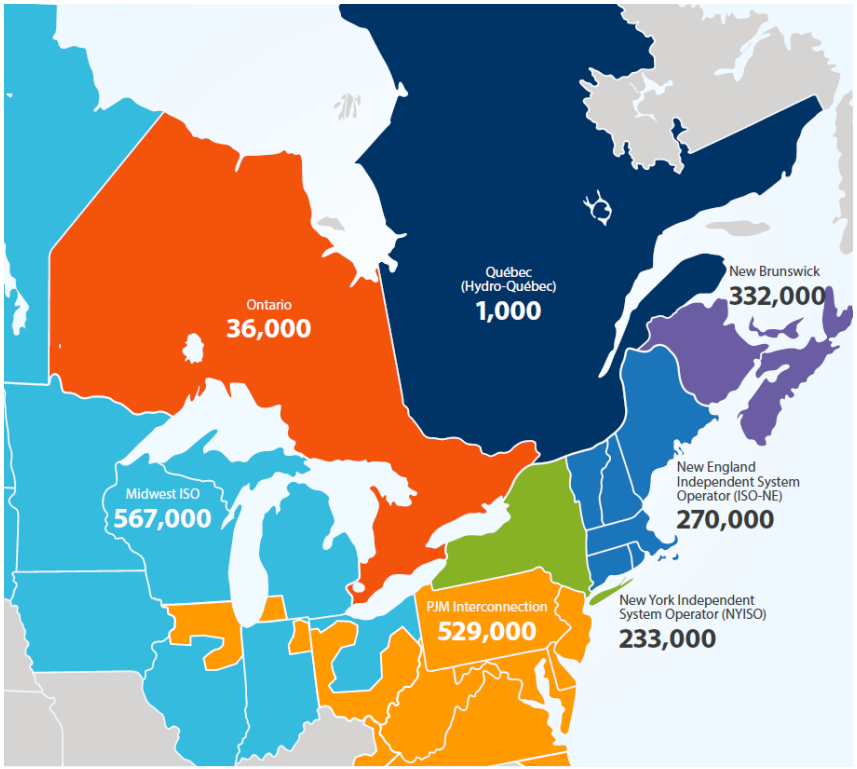
Annual CO_2 Emission Rates Available from Multiple Sources

Default GHG/CO_2 Emission Rates Available for Adjacent Control Areas

- Hydro Québec relies on default emission rates Set by the Québec provincial government for the carbon intensity of adjacent control areas (at right)
- Table below converts the Québec default rates to lbs/MWh

	MT/TWh	MT/MWh	kg/MWh	lb/MWh
Ontario	36,000.00	0.04	36.00	79.37
Québec	1,000.00	0.00	1.00	2.20
New Brunswick	332,000.00	0.33	332.00	731.93
New England	270,000.00	0.27	270.00	595.25
New York	233,000.00	0.23	233.00	513.68
PJM	529,000.00	0.53	529.00	1,166.24
MISO	567,000.00	0.57	567.00	1,250.02

Hydro Québec GHG Emission Factors in Export Markets (Metric Ton/TWh)



Source: Regulation Amending the Regulation Respecting mandatory reporting of certain emissions of contaminants into the atmosphere, Table 17-1, Gouvernement du Québec. Hydro Québec, 2018 Sustainability Report p. 61.

OPTION 1

Annual Emission Attributes of System Imports

Step 1: Calculate CO_2 Attributes to Net Imports

- Using the converted Hydro Québec default rates, CO_2 attributes were assigned to net 2018 imports into New England from New Brunswick, New York and Québec
  - Exports to New York excluded to simplify example

2018 - Net Tie Flows (GWh)*	2018 (GWh)	2018 (MWh)	CO2 (Short Tons)
New Brunswick	4,044	4,044,000	160,486
New York-Northern AC Ties	5,086	5,086,000	1,306,288
Hydro-Quebec Phase II	12,032	12,032,000	13,235
Hydro-Quebec Highgate	1,934	1,934,000	2,127
Total Net Imports (GWh)	23,096	23,096,000	1,482,137

- CO_2 emission attributed to net imports converted to lbs
  - 1,482,137 short tons
  - 2,964,273,960 lbs
- Add 2018 CO_2 import emissions to already calculated 2018 CO_2 system emissions
  - 2,964,273,960 lbs (imports)
  - 68,192,000,000 lbs (system)

Step 2: Calculate Aggregate 2018 CO2 Emission Rate

- Combined 2018 CO_2 import and CO_2 system emissions are:
  - 71,156,273,960 lbs
- Total 2018 net system generation:
  - 103,740 GWh
  - 103,740,000 MWh
- Total 2018 net imports from New Brunswick, New York and Québec
  - 23,096 GWh
  - 23,096,000 MWh
- Total combined generation:
  - 126,836,000 MWh

- Divide combined 2018 CO2 emissions (lbs) by combined generation (MWh)
  - $\frac{71,156,273,960 \text{ lbs}}{126,836,000 \text{ MWh}} = 561$ lb/MWh
  - 2018 system CO2 rate = 658 lb/MWh

2018 Net Imports CO_2 (lbs)	2,964,273,960
2018 System CO_2 (lbs)	68,192,000,000
2018 Native & Imports CO_2 (lbs)	71,156,273,960
2018 Total net gen & imports (MWh)	126,836,000
2018 Combined CO_2 Rate lbs/MWh	561

OPTION 2

Monthly Emission Attributes of System Imports

Step 1: Calculate CO_2 Attributes to Monthly Net Imports

- Using the converted Québec default rates, CO_2 attributes were assigned to net January 2018 imports into New England from New Brunswick, New York and Québec
  - Exports to New York excluded to simplify example

Jan 2018 - Net Tie Flows (GWh)*	Jan 2018 (GWh)	Jan-18 (MWh)	CO_2 (Short Tons)
New Brunswick	541	541,000	197,987
New York-Northern AC Ties	547	547,000	140,489
Hydro-Quebec Phase II	944	944,000	345,471
Hydro-Quebec Highgate	166	166,000	183
Total Net Imports (GWh)	2,198	2,198,000	684,129

- CO_2 emission attributed to net imports converted to lbs
  - 684,129 short tons
  - 1,368,258,740 lbs
- Add January 2018 CO_2 import emissions to already calculated 2018 CO_2 system emissions
  - 1,368,258,740 lbs (imports)
  - 5,636,922,800 lbs (system)
  - 7,005,181,540 lbs (combined)

Step 2: Calculate Aggregate 2018 CO2 Emission Rate

- Combined January 2018 CO_2 import and CO_2 system emissions:
  - 7,005,181,540 lbs lbs
- Total January 2018 net system generation:
  - 9,470 GWh
  - 9,470,000 MWh
- Total January 2018 net imports from New Brunswick, New York and Québec
  - 2,198 GWh
  - 2,198,000 MWh
- Total combined generation:
  - 11,668,000 MWh

- Divide combined January 2018 CO_2 emissions (lbs) by combined generation (MWh)
  - $\frac{7{,}005{,}181{,}540 \text{ lbs}}{11{,}668{,}000 \text{ MWh}} = 600$ lb/MWh
  - 2018 system CO_2 rate = 658 lb/MWh

January 2018 Net Imports CO_2 (lbs)	1,368,258,740
January 2018 System CO_2 (lbs)	5,636,922,800
January 2018 Combined CO_2 (lbs)	7,005,181,540
January 2018 Combined gen (MWh)	11,668,000
January 2018 Combined CO_2 rate (lbs/MWh)	600

OPTION 3

Hourly Environmental Attributes Calculation Method

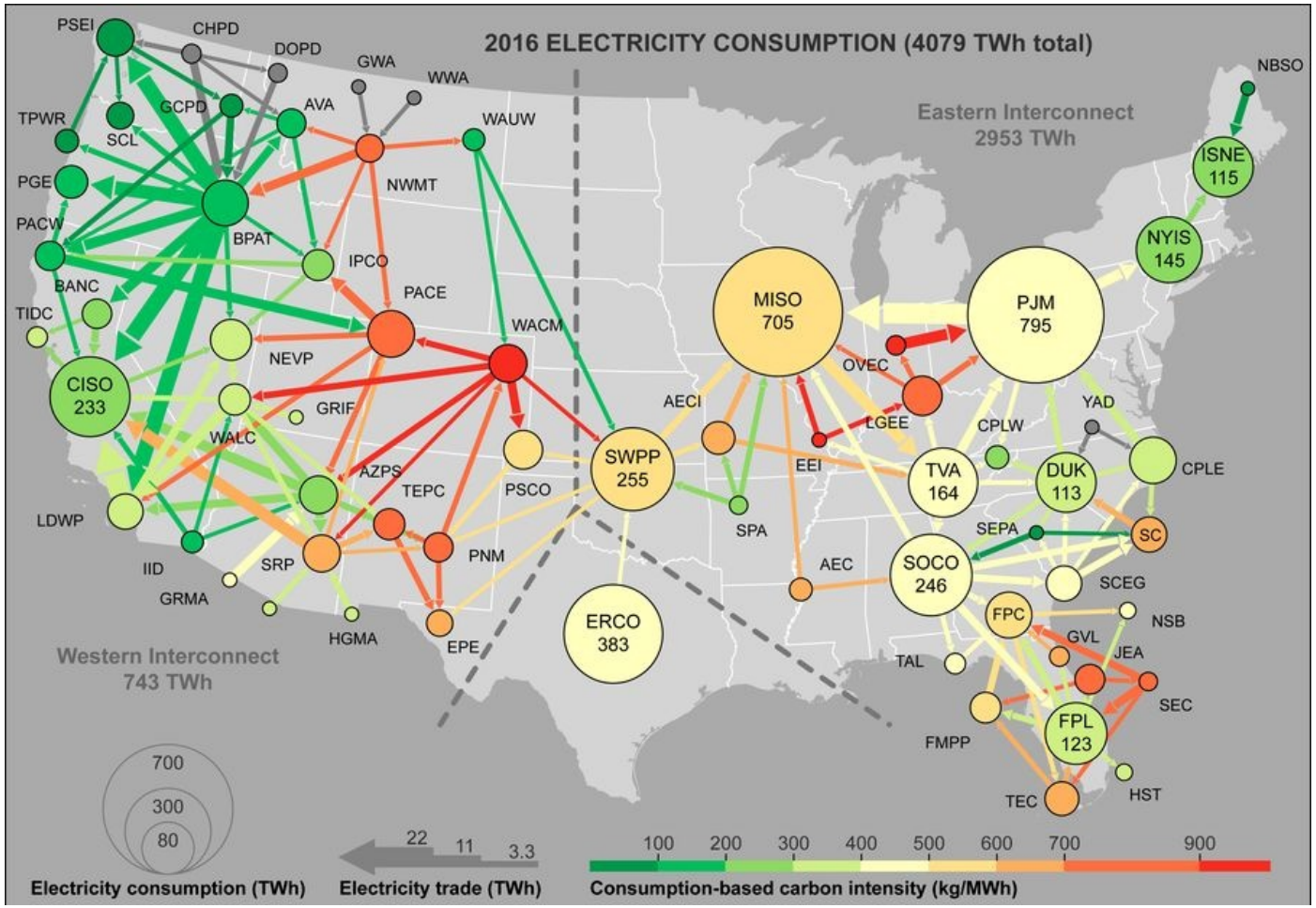
Overview Hourly Balancing Area Import/Export Environmental Attribute Methodology

- Researchers developed an hourly data set for 2016:
  - EPA Continuous Emissions Monitoring Systems database for hourly CO_2, SO_2, and NO_x emissions (EPA AMPD)
  - US Energy Information Administration hourly consumption, production, and interregional exchanges at the balancing area level (EIA Form 860)
  - EPA Emissions and Generation Integrated Resource (eGrid) database used to adjust emissions levels when dealing with missing data and for validation (eGrid 2016)

- To estimate the pollution emitted on behalf of electricity consumption at a certain node, researchers assumed that emissions are embodied in traded electricity and written as the following balance equation for a given pollutant (CO_2, SO_2, or NO_x):
- $x_i d_i = f_i + \sum x_j u_{ij} - \sum_i k x_i v_{ki}$
- $= f_i + \sum_j x_j u_{ij} - \sum k x_i v_{ki}$,
  - where for node i,
  - d_i is electricity consumed,
  - x_i is the intensity of electricity consumed, f_i is pollutant production,
  - uij is electricity imported from j to i, and vki is electricity exported from i to k.
- This represents the balance equation for a fully coupled MRIO model, accounting for transfers of electricity and embodied pollution. All quantities (and, in particular, trade) are positive.

Tracking emissions in the US electricity system, Jacques A. de Chalendar, John Taggart, Sally M. Benson, Proceedings of the National Academy of Sciences Dec 2019, 116 (51) 25497-25502; DOI: 10.1073/pnas.1912950116

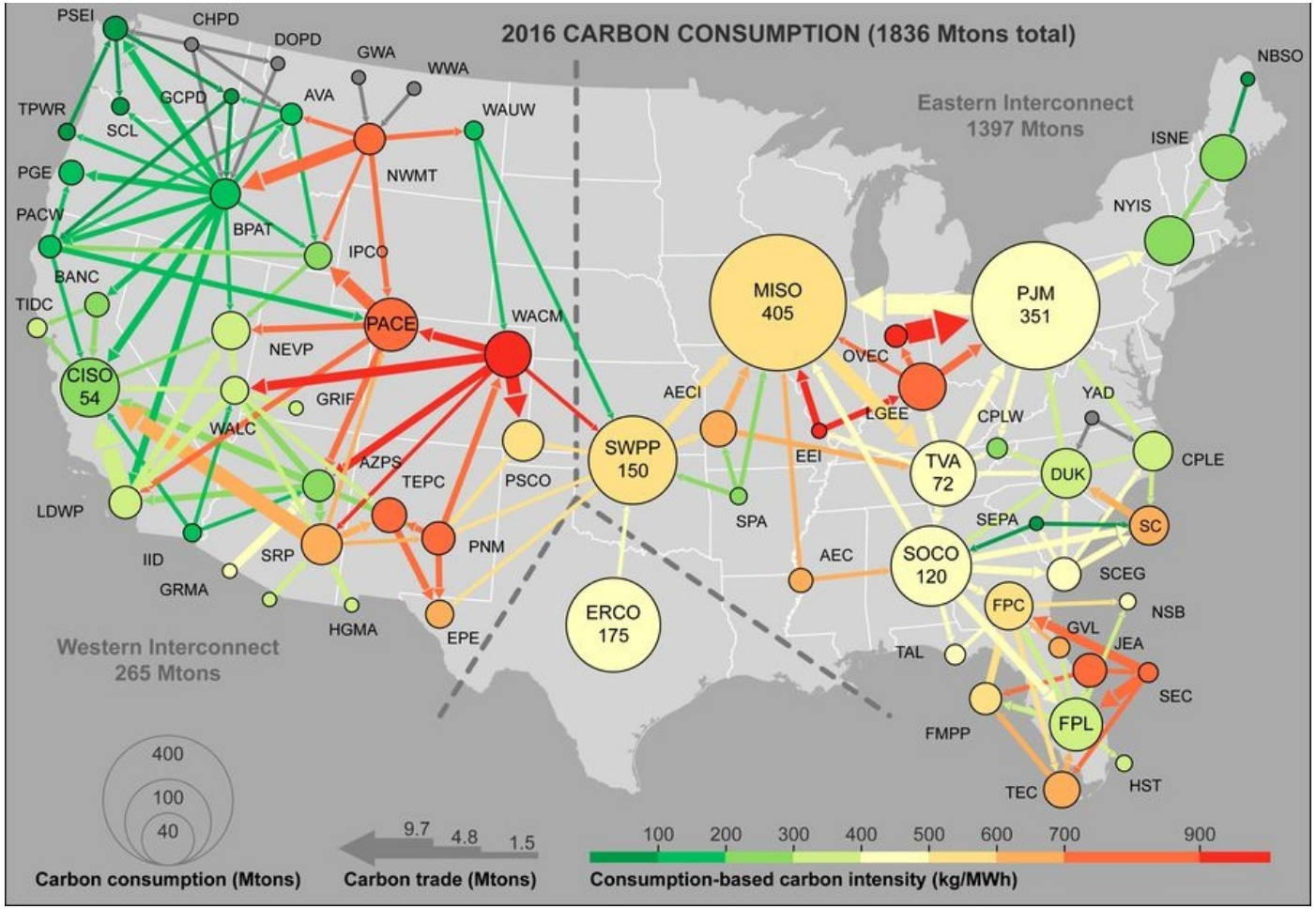
2016 US Electricity System Generation & Carbon Intensity (TWh)



Electricity consumption and exchanges and consumption-based carbon intensity of grid electricity for the 66 US balancing areas in 2016. The radius of the nodes and width of the arrows scale with consumption and trade, respectively. The color of the nodes and arrows scale with consumption-based carbon intensity. The gray nodes and arrows correspond to regions for which no emissions were reported.

Source: Jacques A. de Chalendar et al. PNAS 2019;116:51:25497-25502

2016 US Electricity System Carbon Consumption



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Source: Jacques A. de Chalendar et al. PNAS 2019;116:51:25497-25502

Summary

- ISO New England offered three options that may be utilized to in calculating air emissions attributes of imported energy
- ISO New England requests input from the Environmental Advisory Group
  - Submit your comments in writing by May 1, 2020 to psilva@iso-ne.com
  - Cite reasons for support or dislike of an approach, or suggest an alternative. In any response, please reference any supporting documentation or data sources if possible
- Next Steps:
  - ISO New England to review feedback and determine if efforts should be allocated to this endeavor
    - Given uncertainty created by the COVID-19 pandemic, this may take a few months

Questions