

Western Climate Initiative: Electricity Leakage Analysis

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Agenda

- E3 and PLEXOS Background
- Research Objective and Approach
- Summary of 2020 Simulated Dispatch
- Analysis Results
 - Coverage
 - Contract Shuffling
 - Leakage
- Findings
- Questions

E3 Background



■ E3 Overview

- E3 is an electricity consulting firm founded in 1993 in San Francisco.
- Clients span local, state and federal government, small and large public and investor-owned electric utilities, and energy technology companies
- Approximately 20 staff in energy economics, policy, and resource planning

■ Related Projects

- California GHG Modeling of electricity sector for AB32
- IRPs and Energy Plans in the Northwest; Idaho State Energy Plan, IRP for PNGC Power, Lower Valley Energy, Umatilla Electric Cooperative
- Long-line transmission, British Columbia – California Renewable Energy Partnership, Load Resource Balance in the Western Interconnection: Towards 2020 for Western Electric Industry Leaders (WEIL)

PLEXOS Solutions



- Software, consulting, and information services company located in Sacramento, CA
- Company utilizes PLEXOS software for regional analyses
 - Advanced linear and mixed integer programming algorithm for “operations quality” unit commitment and dispatch
 - Simultaneous (versus sequential) optimization of generation, transmission, system, emission, and storage constraints
- Four principles, each w/ 20+ years resource planning experience
- Worked with E3 on the CPUC GHG modeling
- Currently engaged to provide renewable integration study for CAISO
- Performed similar study recently for 3 CA IOUs



Investigation of 3 related questions

1. Coverage

- How well does the system cover the actual CO₂ emitted by the electricity sector in WCI states?

2. Contract Shuffling

- What is the potential to reduce CO₂ in the WCI by 'shuffling' ownership or contracts to outside the WCI?

3. Leakage

- a) What is the potential to change *generator operations* to reduce CO₂ in the WCI but increase it outside?
- b) What is the potential to change *new generation investment* choices to reduce CO₂ in the WCI but increase it outside?

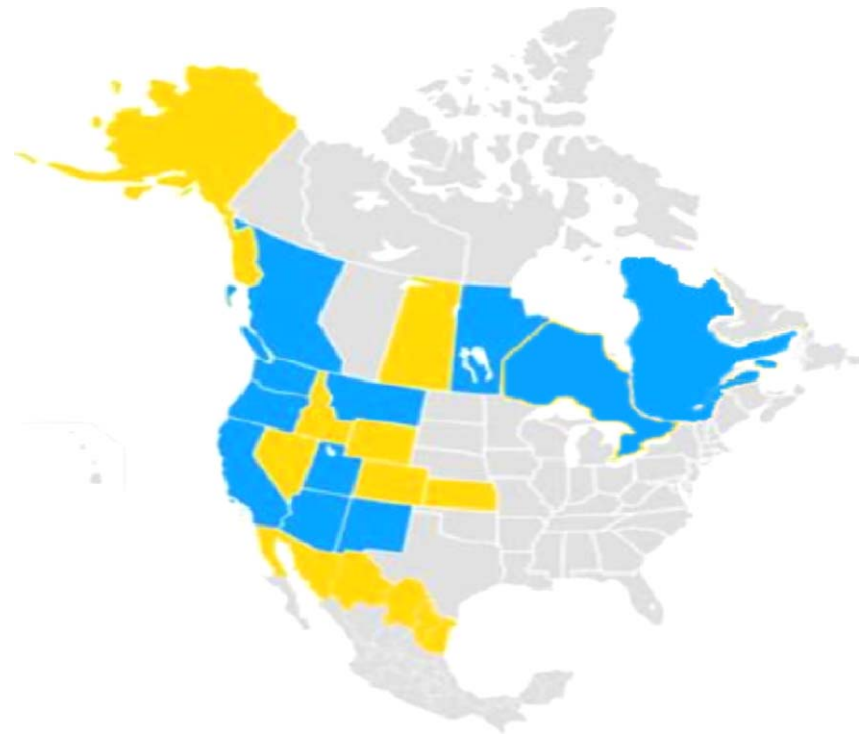
Analysis Limitations

- One month project that leverages prior analysis
- Analysis based on a single snapshot of 2020 WECC case
 - Estimate of 2020 generation and loads
 - Production Simulation yields 2020 GHG emissions



Jurisdictions Included in Analysis

- Analysis focuses on the 8 western states and provinces
 - BC, WA, OR, CA, AZ, NM, UT, MT
- PLEXOS 2020 simulation does not include the 3 eastern province members



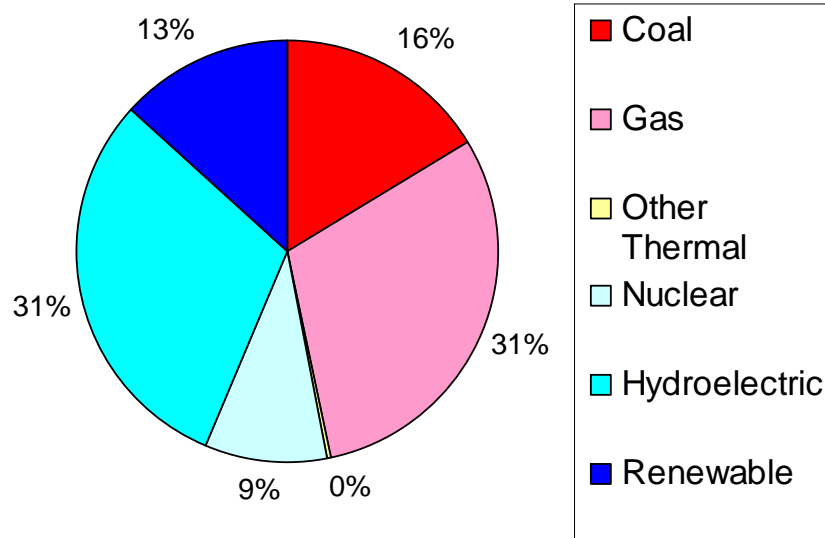


WCI Point-of-Regulation Recommendations for Electricity Sector

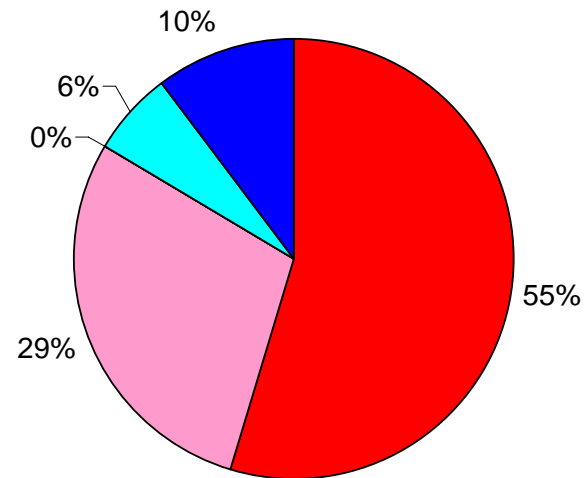
- Implement First Jurisdictional Deliverer
 - Generation within WCI is monitored at the smokestack
 - Specified imports buy CO₂ at actual rate
 - Specified: owned generation, or long-term contract
 - Unspecified imports buy CO₂ at the 'deemed rate'
 - 'Deemed rate' is a pre-defined emissions intensity applied to system power imported to WCI (lbs CO₂/MWh)
 - Unspecified: Market purchases of power or short-term contract from trading point

2020 Generation by Jurisdiction

WCI Jurisdiction



Non-WCI Jurisdiction

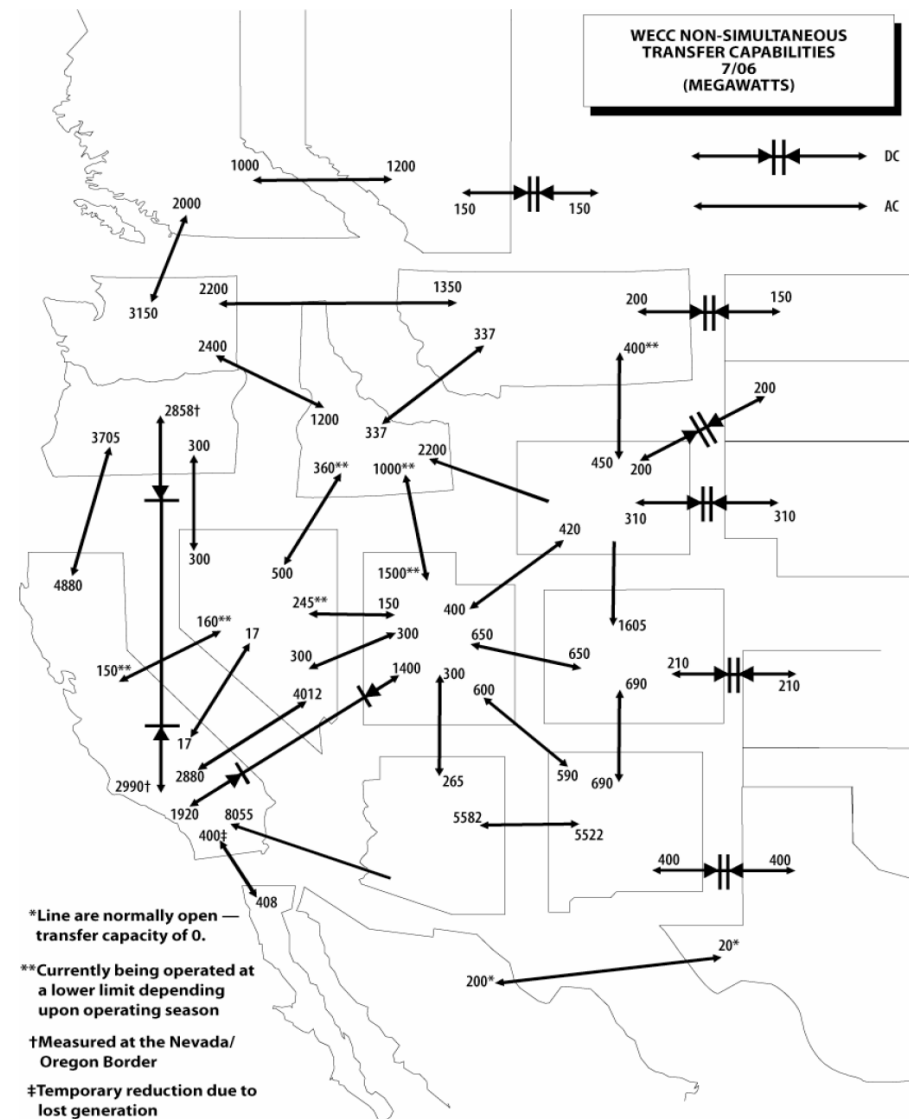


Generation (GWh)

	WCI	Non-WCI	Tribal Lands	TOTAL
Coal	126,675	146,510	42,556	315,741
Gas	233,015	77,355	0	310,371
Other Thermal	3,257	0	0	3,257
Nuclear	72,512	0	0	72,512
Hydroelectric	232,532	16,661	0	249,193
Renewable	103,298	27,653	0	130,951
TOTAL	771,289	268,180	42,556	1,082,024

Resulting Transmission Flows

- PLEXOS database contains a full model of high voltage transmission system in the WECC
- Results are based on a zonal simulation of the WECC with transmission flows between regions
- Results provide hourly flows on each major line in the WECC





Coverage Results

“Coverage” is measured as the share of emissions attributable to WCI consumption that is captured by the market design



1. Coverage Analysis

- Two bookends
 - ‘Source-based’ emissions: emissions from smokestacks within WCI
 - ‘Consumption-based’ emissions: best estimate of actual emissions based on generation assignment to states and provinces
- Ratio of source-based to consumption-based emissions provides estimate of coverage for source-based method
- FJD regulation of imports improves coverage



Consumption-Based Methodology

- Use 2020 PLEXOS Simulation
- Assign coal, hydro, and nuclear units by state based on LSE ownership / contracts
 - For LSEs that serve multiple states we apportion their fuel mix based on share of sales in each state
 - For BPA resources we assign based on share of customer requirements in each state
 - For WAPA resources we assign known specific projects to states or to the state in which the resource resides without better information
 - Assigns renewables to geographic jurisdiction (WCI & non-WCI)
- Remaining generation is natural gas, which is assigned to states based on the remaining load served using the average natural gas emissions rate

Emissions Coverage

- Source-based regulation would cover approximately 74% of WCI emissions

Regulation at the Source MMT CO2

	WCI	Non-WCI	Tribal Lands	TOTAL
Coal	122	145	41	309
Gas	90	30	0	119
Other	4	0	0	4
<i>TOTAL</i>	216	175	41	432

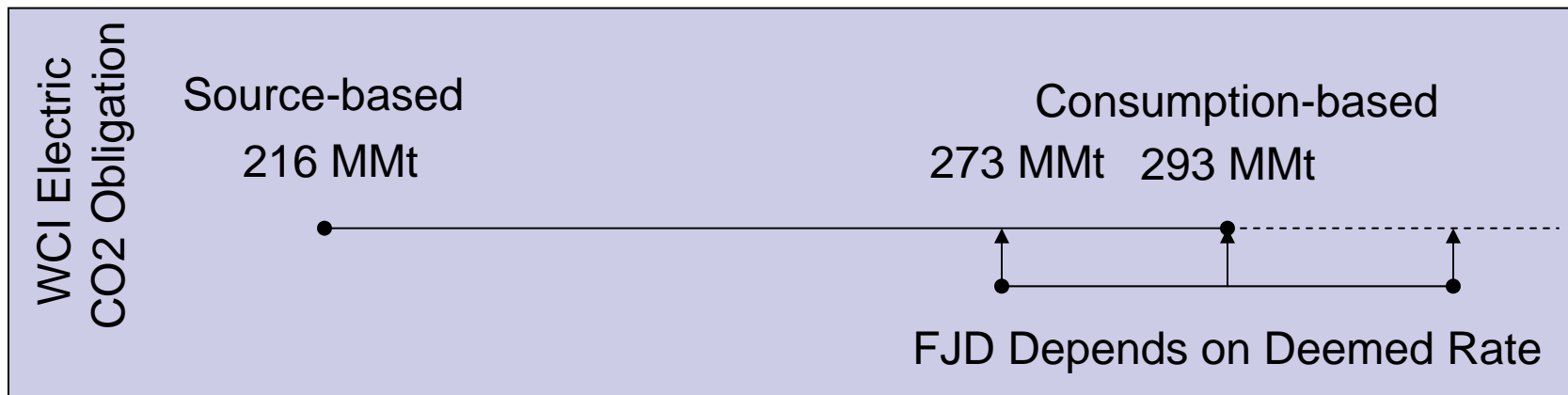
Regulation based on Consumption MMT CO2

	WCI States	Non-WCI States	TOTAL
Coal	179	129	309
Gas	110	10	119
Other	4	0	4
<i>TOTAL</i>	293	139	432

$$216 \text{ MMT} \div 293 \text{ MMT} = 74\%$$

First Jurisdictional Deliverer

- Regulation of imported electricity improves coverage
- Apply actual emissions intensity of specified generation (known contracts and ownership of generation in non-WCI states)
- Remaining imports: apply deemed emissions rate
 - High deemed rate can lead to more than 100% coverage
 - Low deemed rate can lead to less than 100% and more opportunities for leakage and incentive for shuffling





Coverage Analysis Conclusions

- Regulation of imports is necessary because a source-based point of regulation (i.e. ignoring imports) would only include approximately 74% of WCI electricity sector CO₂
- Coverage analysis also provides an upper bound on contract shuffling



Contract Shuffling Results

Contract shuffling is an action that reduces WCI CO2 obligations without any change in operations



2. Contract Shuffling Analysis

1. Evaluate unconstrained shuffling
2. Evaluate shuffling to specified imports
 - Potential is limited by non-WCI hydro
3. Evaluate shuffling to unspecified imports
 - Potential is limited by deemed emissions intensity for system power
 - Evaluate regional exceptions



Unconstrained Contract Shuffling

- Contract shuffling is measured as the difference between pre-WCI consumption-based emissions and WCI regulated emissions
- The difference between the consumption-based CO2 emissions and source-based CO2 and is the upper bound for shuffling
- If all fossil-based imports were shuffled to zero carbon resources, 26% of the WCI carbon emissions could be shuffled (77 MMt CO2)

Unconstrained Contract Shuffling Potential MMT CO2

	WCI States	Non-WCI States	Change in CO2
Coal	57	-57	0
Gas	20	-20	0
Other	0	0	0
<i>TOTAL</i>	<i>77</i>	<i>-77</i>	<i>0</i>

Contract Shuffling to Specified Imports

- Non-WCI hydro and renewables are the only source for shuffling to zero-carbon specified imports
 - Assumes renewables are not available for shuffling due to RPS targets
- Idaho contains most non-WCI, non-Federal hydro
- Maximum potential shuffling from hydro of 20 MMTCO₂ if all non-WCI hydro was shuffled to coal (2,200lbs/MWh)

Hydroelectric Generation (GWh)

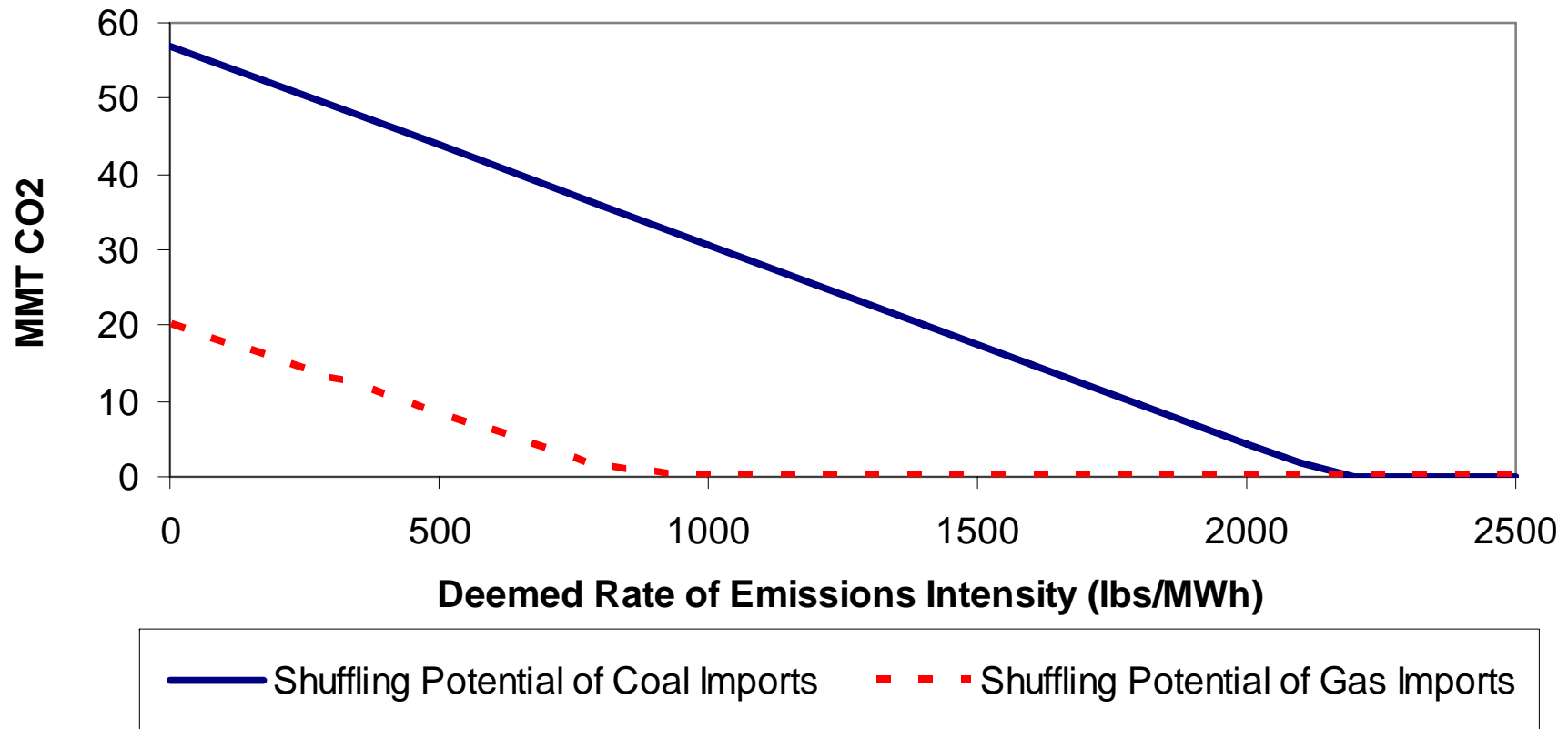
	AB	CO	ID	WY	TOTAL
Federal Hydro	0	1984	3672	1280	6936
Non-Federal Hydro	2051	1380	8835	561	12827
<i>Total</i>	<i>2051</i>	<i>3364</i>	<i>12507</i>	<i>1841</i>	<i>19764</i>

MMT CO₂ - Maximum Shuffling

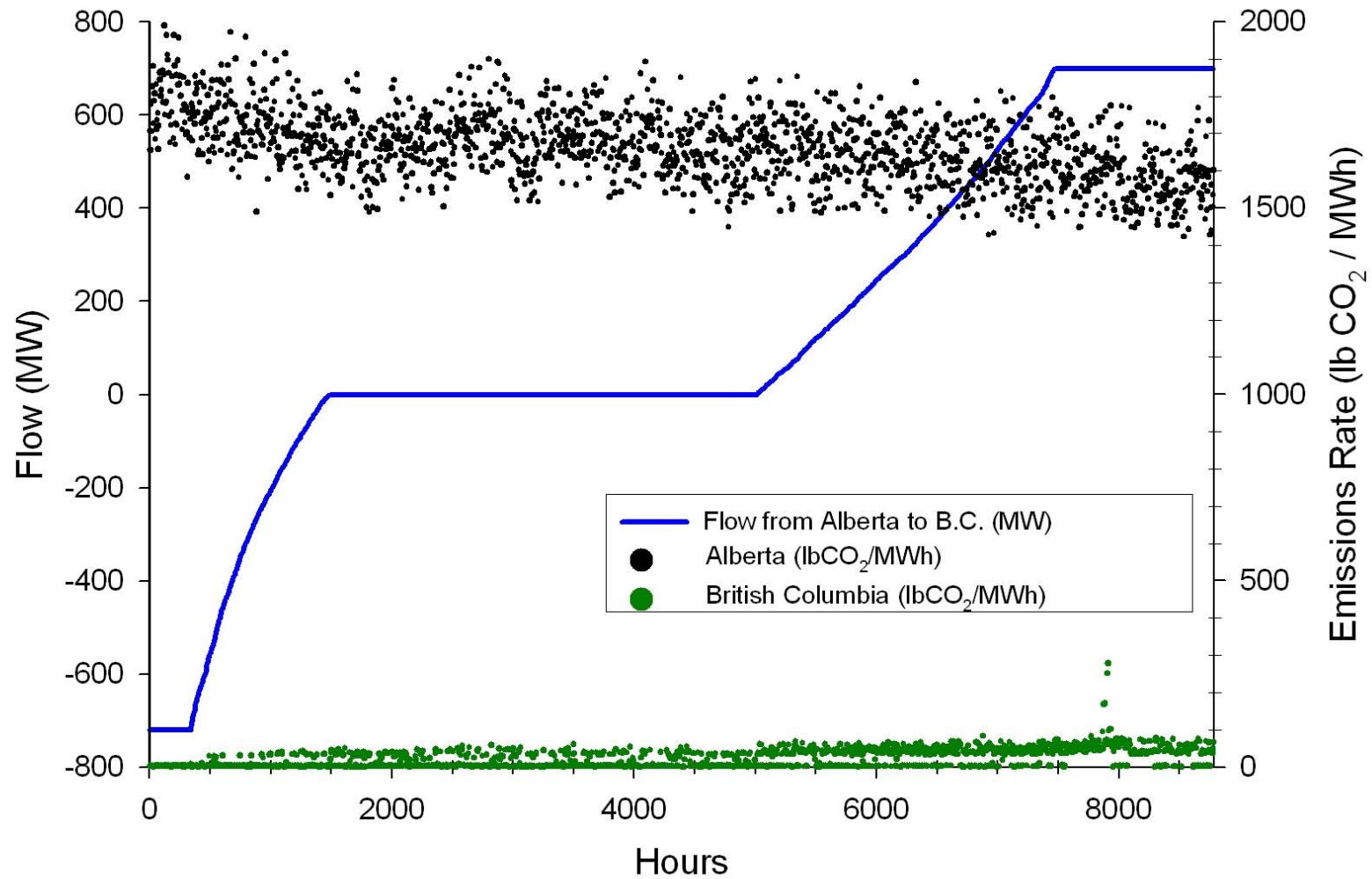
	AB	CO	ID	WY	TOTAL
Federal Hydro	0	2	4	1	7
Non-Federal Hydro	2	1	9	1	13
<i>Total</i>	<i>2</i>	<i>3</i>	<i>12</i>	<i>2</i>	<i>20</i>

Contract Shuffling to System Power

- Deemed emissions rate reduces opportunity for contract shuffling to system power



Alberta to British Columbia Cross-Tie Flows and CO₂ Emission Rates





Shuffling Analysis Conclusions

- Ability to shuffle to specified imports is relatively small, limited by non-WCI hydro generation and federal control
- Rules for specified imports could capture most remaining coal imports
- Deemed emissions rate can limit economic incentive to shuffle remaining imports in most cases
 - Alberta to BC intertie may require separate deemed emissions intensity



Leakage Results

Leakage is a change in operations or investment which reduces WCI CO2 emissions while increasing non-WCI CO2 emissions



3. Leakage Analysis

- Two types of leakage:
 1. Change in power plant operations
 - For example, increase generation of non-WCI coal and decrease WCI generation
 2. Change in new power plant investment in non-WCI regions to avoid CO₂ obligations
 - For example, build new coal plant in a non-WCI state and import generation into WCI

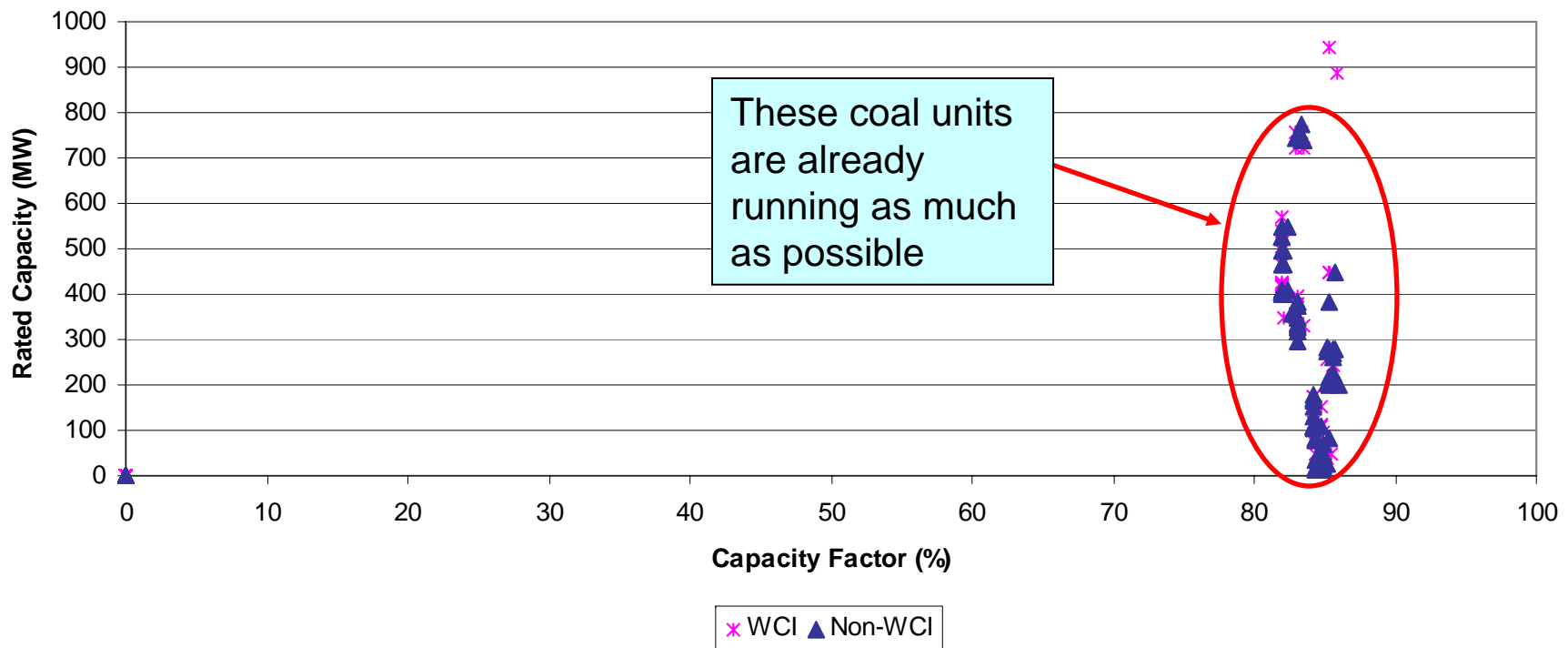


Inherent Barriers to Leakage

- For existing non-WCI power plants to increase operation:
 - Requires available non-WCI generation capacity
 - Requires transmission capacity to import electricity
- For new power plant construction to create leakage:
 - Requires transmission capacity to import electricity
 - Requires shuffling; either sale of electricity into WCI as system power to get the deemed emissions rate (e.g. unspecified merchant generation), or shuffling to lower carbon resource such as hydro

Leakage Potential from Change in Coal Operations is Extremely Limited

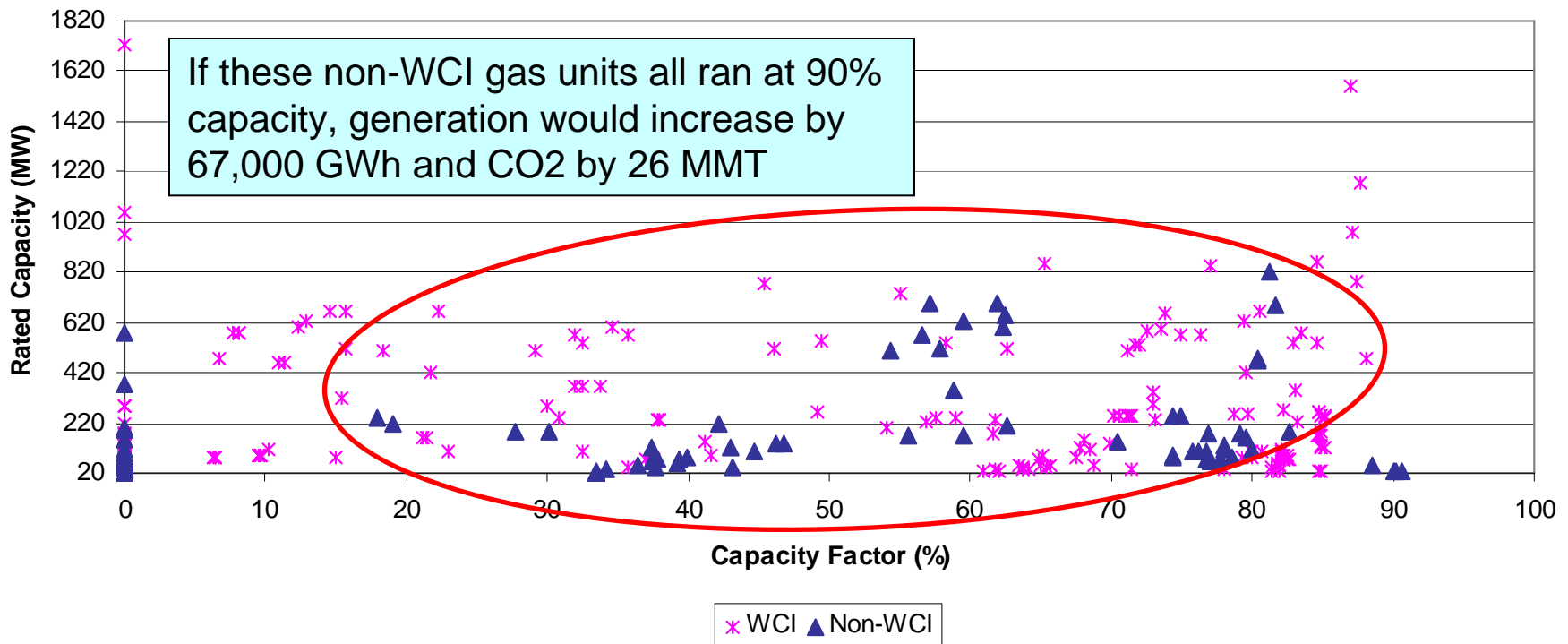
Available Capacity Among WECC Coal-Fired Units



Since coal operates near the maximum technical capacity factor, there is limited potential for leakage through increased coal usage.

Some Potential for Non-WCI Gas to Increase Output

Available Capacity Among WECC Combined Cycle Natural Gas Units



However, FJD with a deemed emissions rate at least as high as combined cycle gas reduces the potential for leakage to natural gas

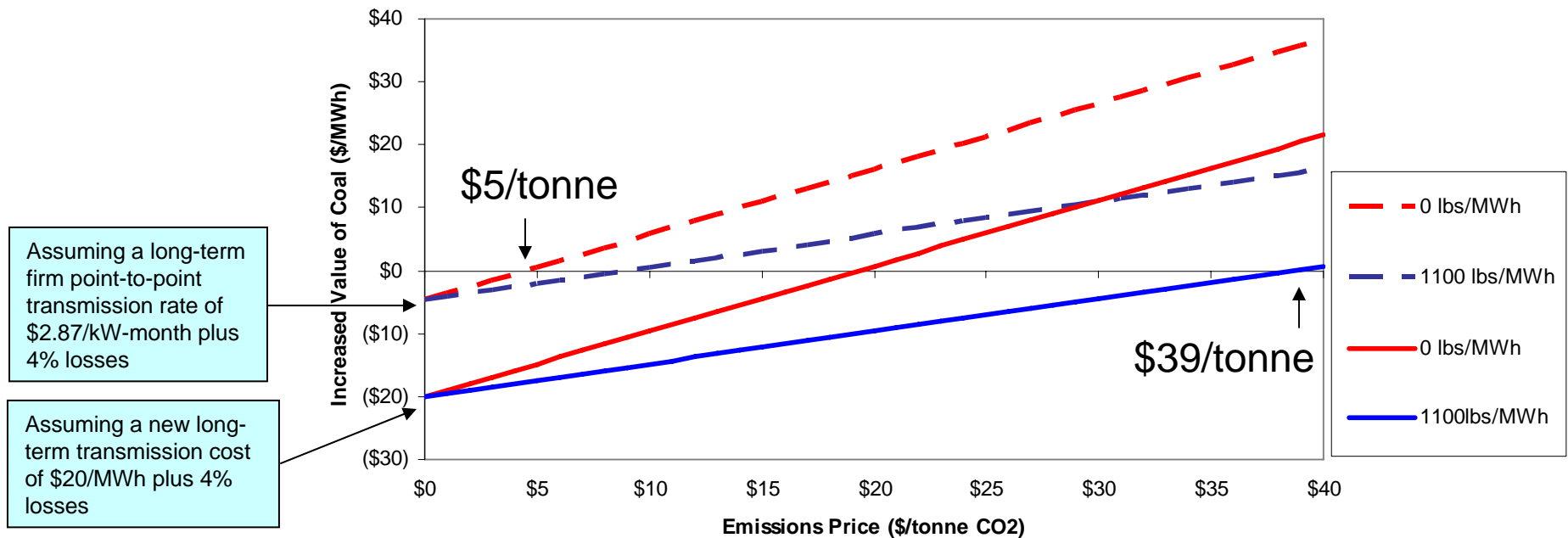


Leakage through New Construction

- Will WCI carbon regulation tip the economics towards more new coal generation in non-WCI jurisdictions?
- Approach
 - Compare economics of a new coal plant within WCI to a non-WCI jurisdiction including CO₂ price differential, transmission cost and losses
- Three situations for new non-WCI coal generation:
 1. Signs long-term contract (i.e. specified generation) – no leakage if owner must purchase CO₂ allowances under reporting rules for specified generation
 2. New plant is able to sell into WCI as system power at the FJD deemed emissions rate
 3. New plant is able to sell into WCI as zero-carbon

Profit of Building New Coal Outside WCI

Increased Value to Building New Coal Outside WCI



- CO2 price changes incentive for new non-WIC coal – but the cost of new transmission and the deemed emissions factor for imports are also important
- **Economics may not be the primary constraint for new projects**



Leakage Analysis Conclusions

- Limited leakage potential for changes in operation of coal generation
- Some leakage potential for changes in operation of combined cycle generation
 - Limited by deemed emissions rate under FJD
- Some leakage potential to new non-WCI coal investment at CO₂ prices above \$5 - \$39/tonne
 - Limited by rules for specified generation under FJD
 - Limited by non-economic factors for new construction



Summary



Findings

- Regulation of CO₂ from electricity imports is necessary to increase coverage above ~74% of WCI electricity sector CO₂
- Contract shuffling potential is limited under FJD
 - ~13 MMT CO₂, assuming no shuffling potential from non-WCI federal hydro or renewables
 - Regionally specific deemed emissions rates may reduce contract shuffling potential, i.e. Alberta to BC
- Leakage potential is limited under FJD
 - Potential to increase non-WCI coal operations is approximately zero
 - Potential to increase non-WCI gas operations is small and limited by deemed rate
 - Potential for leakage through new coal investment outside of WCI is limited by FJD rules on specified generation and other factors



Any questions?



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