

Going with the flow:
Regional Power Markets and
Carbon Regulation

James Bushnell
UC Davis

Outline

- Part I: ISO's, what are they good for?
- Part II: Local Solutions for Global Carbon Problems

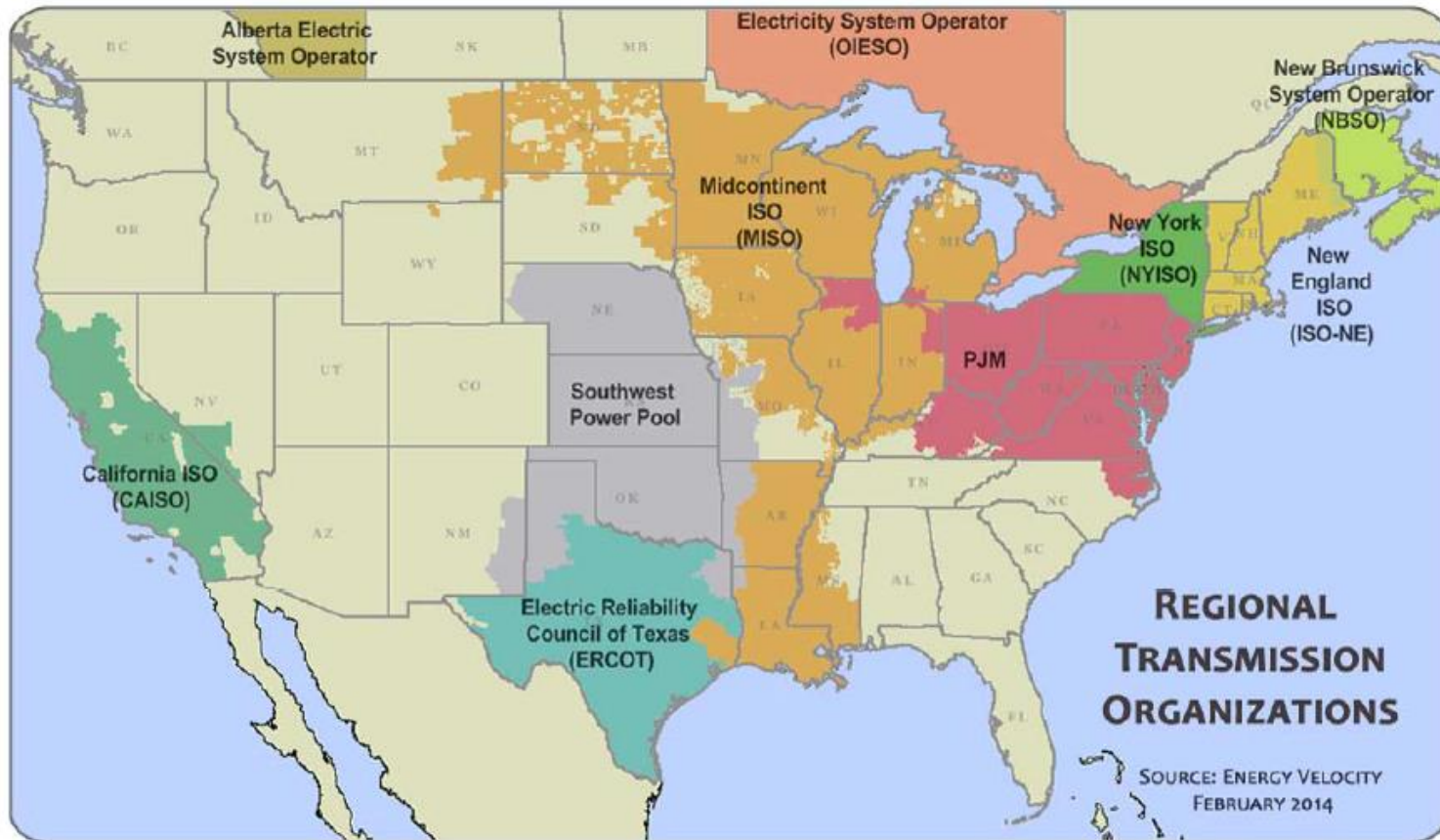
Independent System Operators

- Natural monopoly institutions created during the 1990s and 2000s to oversee non-discriminatory access to the grid
 - FERC very focused on vertical access issues
- Originally associated with deregulation of other aspects of the industry
- Increasingly oversee regulated utility systems also

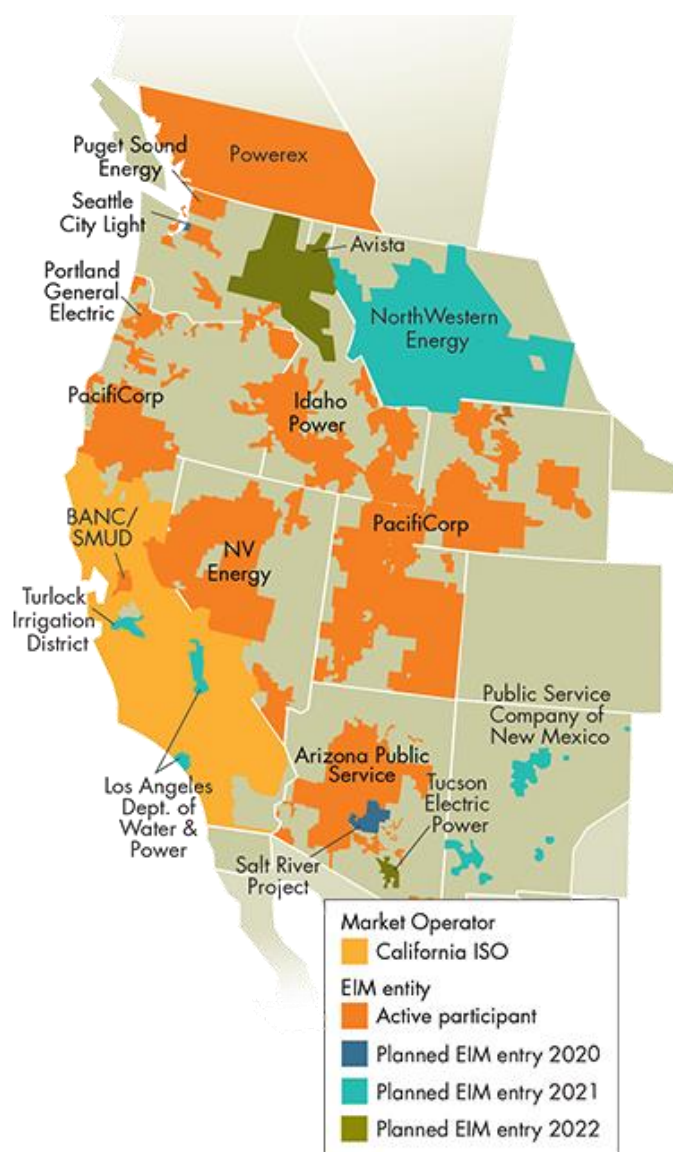
What do ISOs do?

- Operate markets for electricity supply and demand
 - Goal is to allow disintegrated but reliable supply
- “Market” software minimizes the bid-in costs of all suppliers
 - Subject to supply = demand
 - Subject to transmission and other constraints
 - Subject to complicated cost non-convexities and operating constraints
- Pool-based paradigm
 - Everyone sells into; draws out of a collective pool
 - Generally no need to pair specific supply to specific demand

Organization of Wholesale Markets



The Energy Imbalance Market



- Operates an ISO-like “balancing” market in real-time
- Handles only a fraction of supply and transmission
- Voluntary: not all units in other areas participate
- Not integrated with (“co-optimized”) reserves

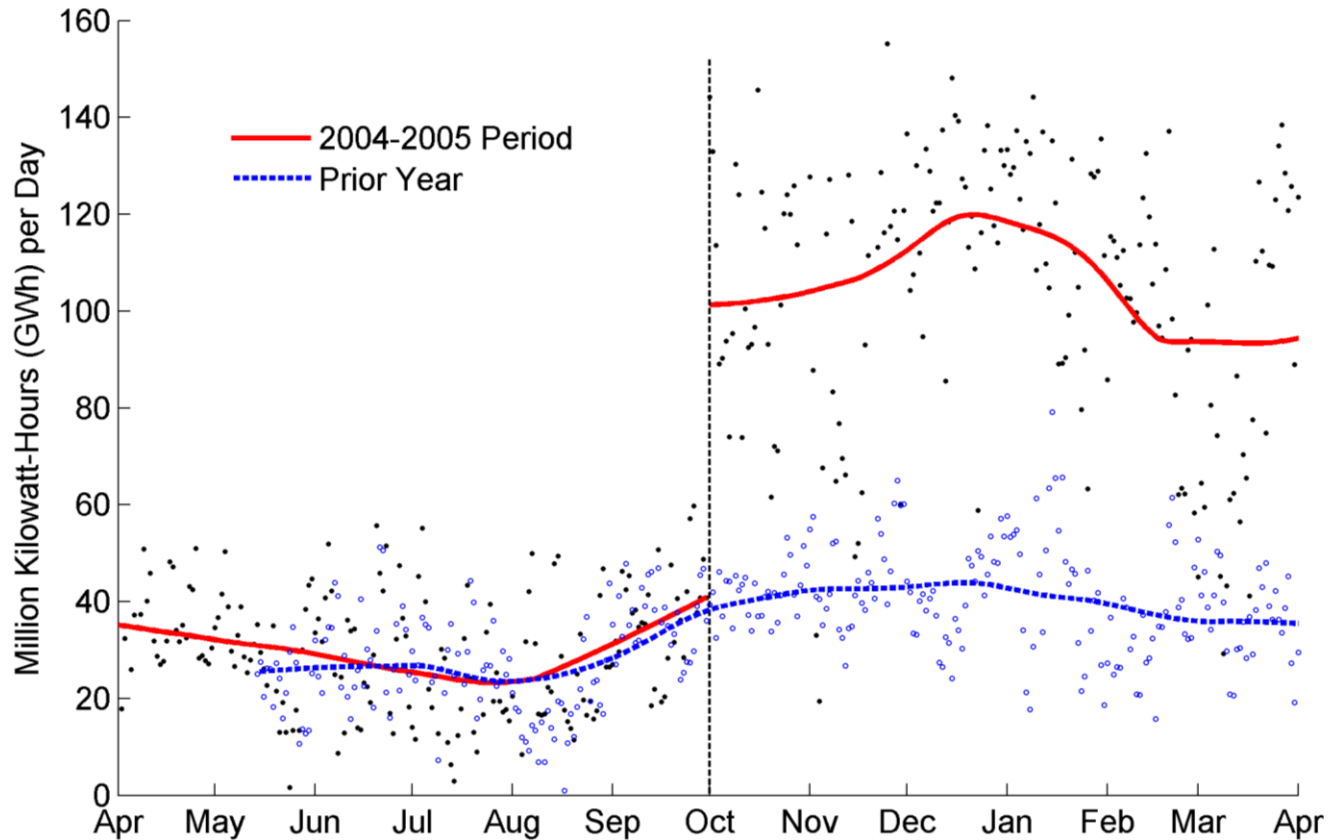
How ISOs Have Helped:

The big ticket items

- Allocating transmission capacity
 - Traditional bilateral methods very inefficient
 - Facilitates trade to minimize overall cost of service
- Optimizing internal balancing operations
 - Systematic and transparent
- Platforms for policy coordination
 - “united nations” of electric utilities and state regulators

Impact of PJM Expansion:

Day-Ahead Net Exports, Midwest → East



Source: Mansur and White, 2007

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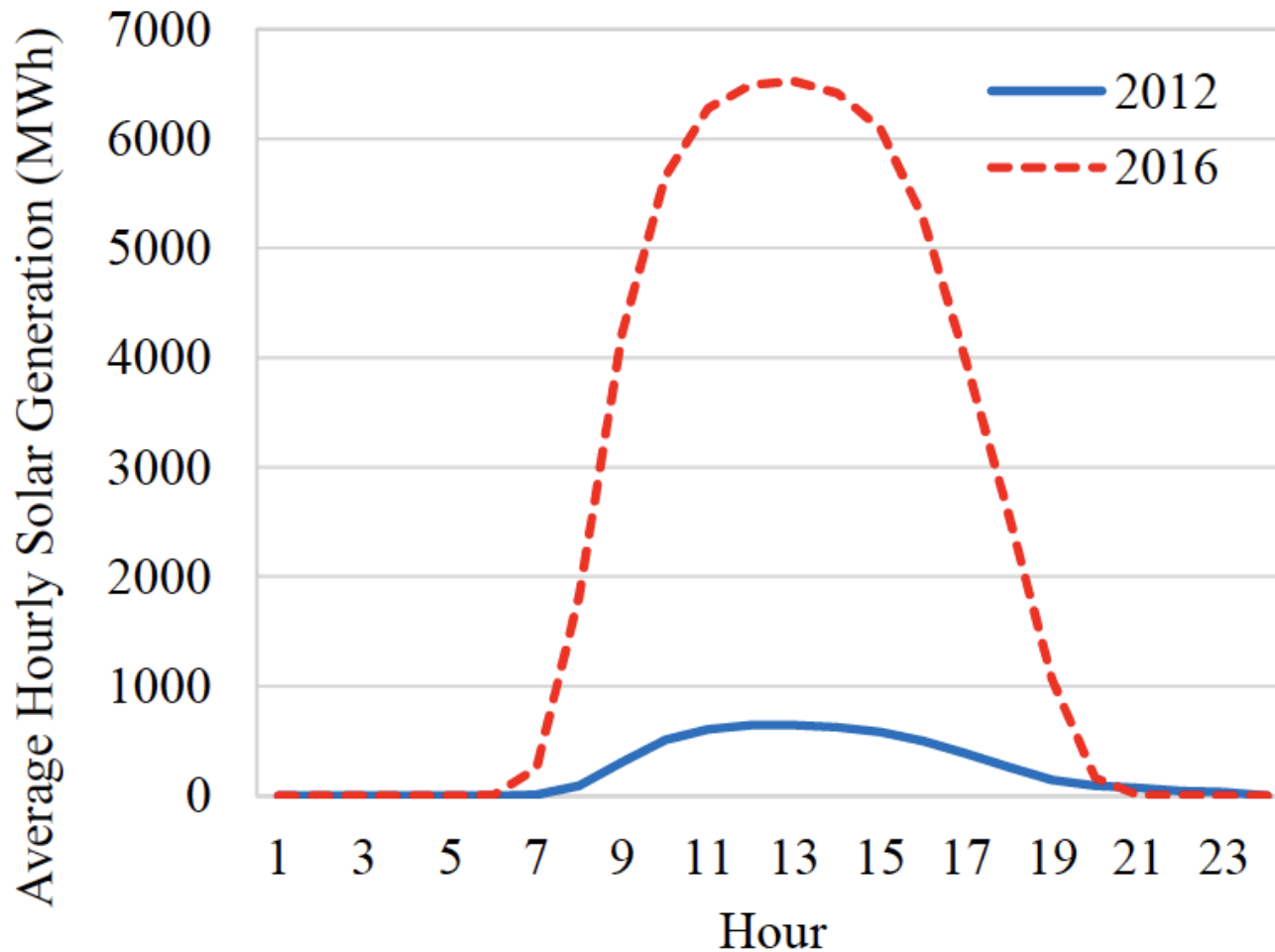
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Markets and Renewables: Why ISOs help even more

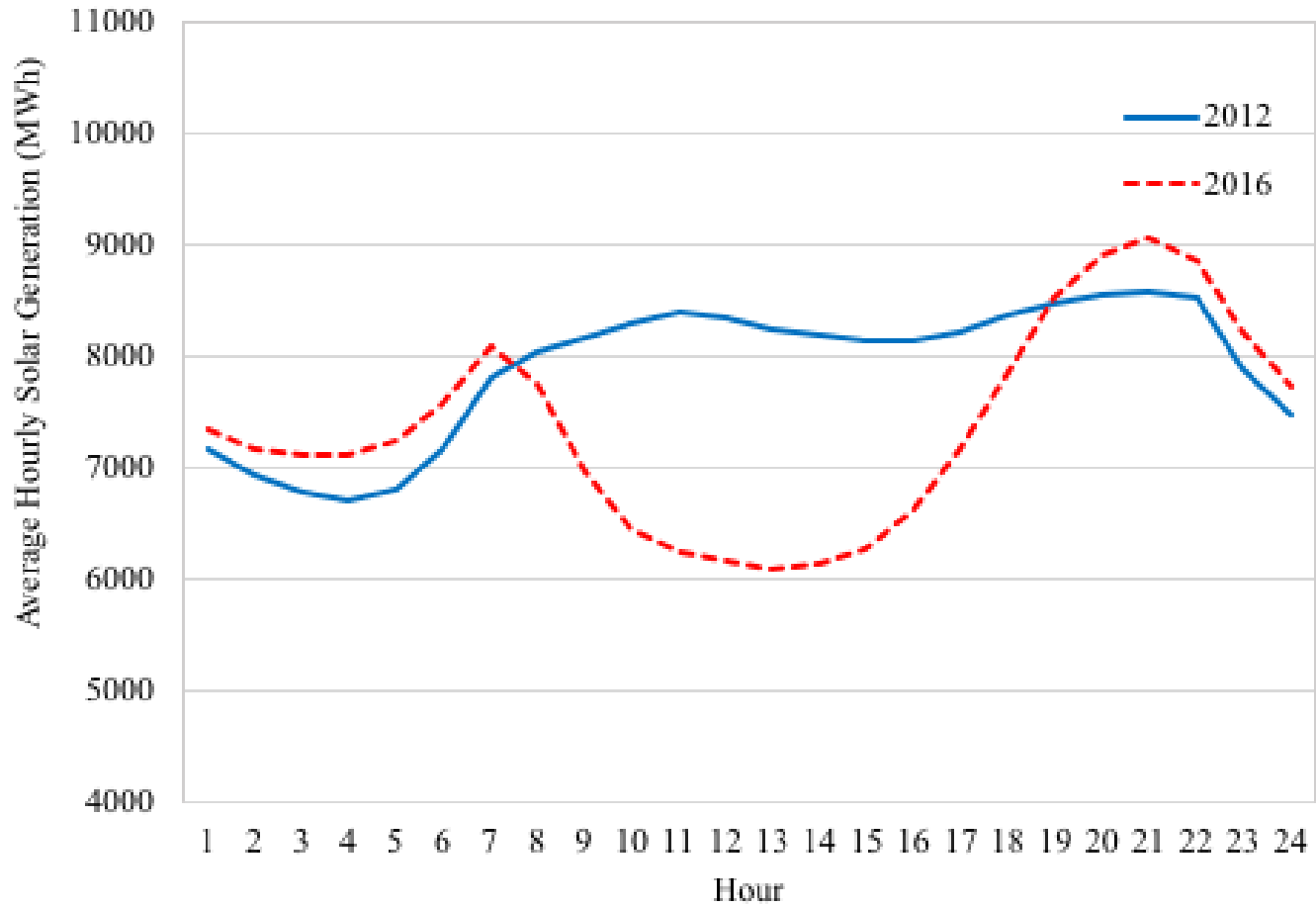
- Need to take advantage of resource diversity
 - Particularly diversity in wind output
- Greater need for transparency and efficiency in balancing services
 - Helps investment and planning as well as operations
- More volatile supply conditions create less predictable gains from trade
 - ISO markets well positioned to handle last minute transactions

Hourly Utility Scale Solar Output on CAISO System

Average Hourly Solar Generation



Average Hourly Imports



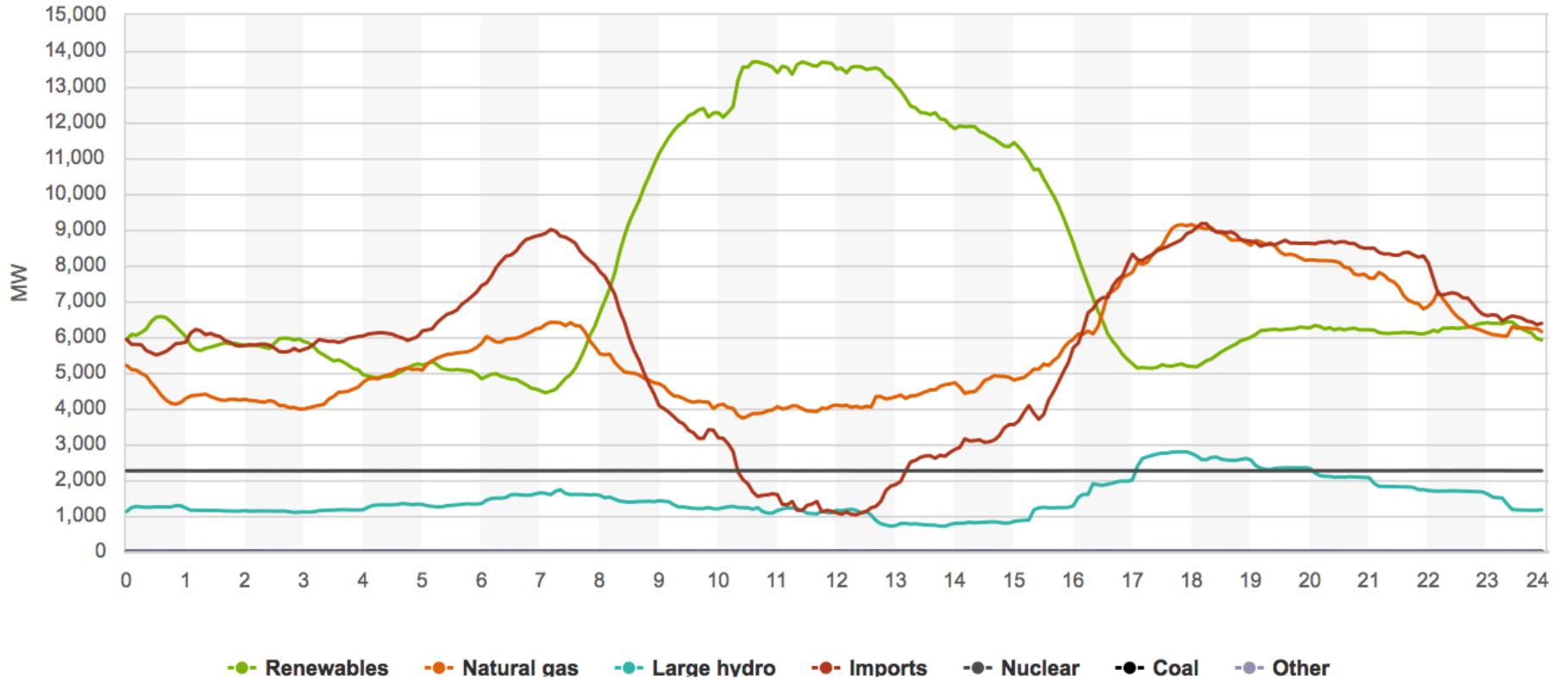
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01/21/2019

Supply trend

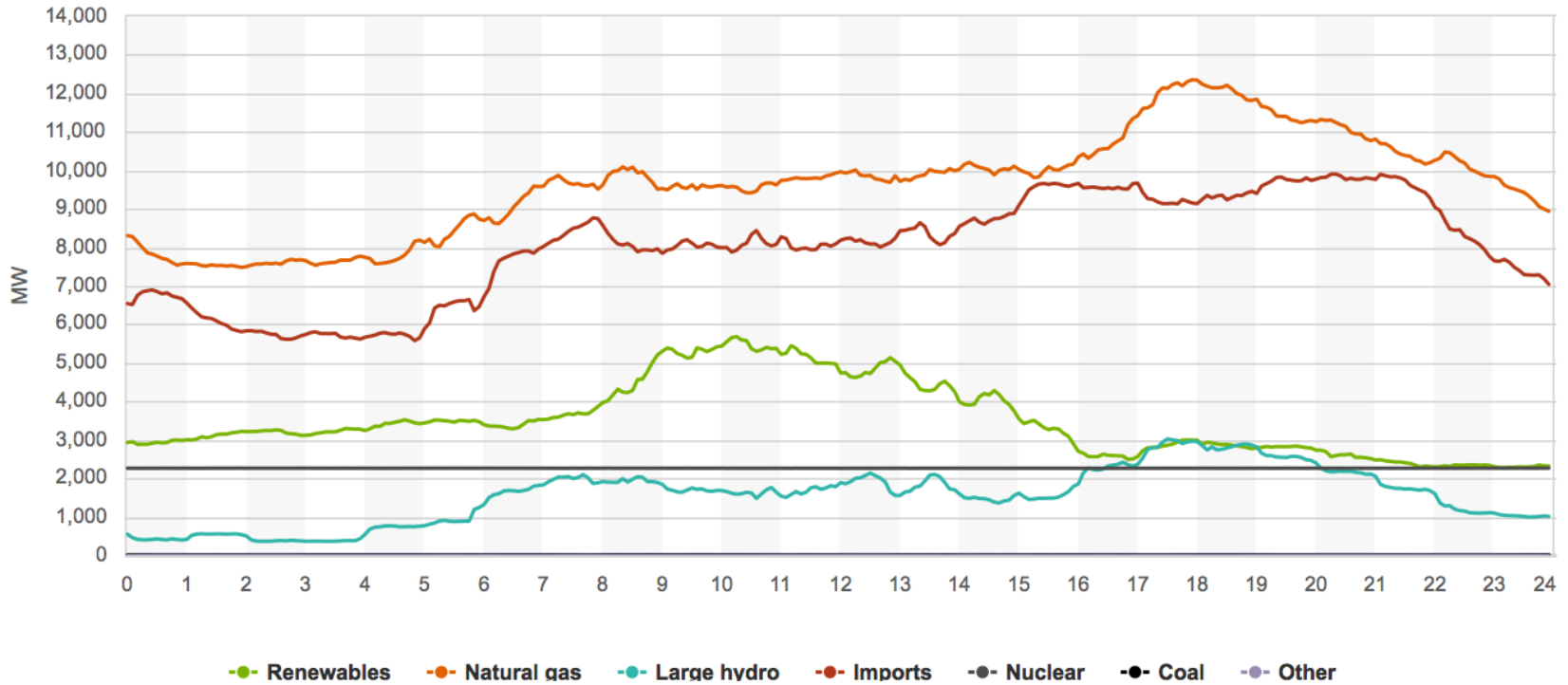
Data



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Supply trend

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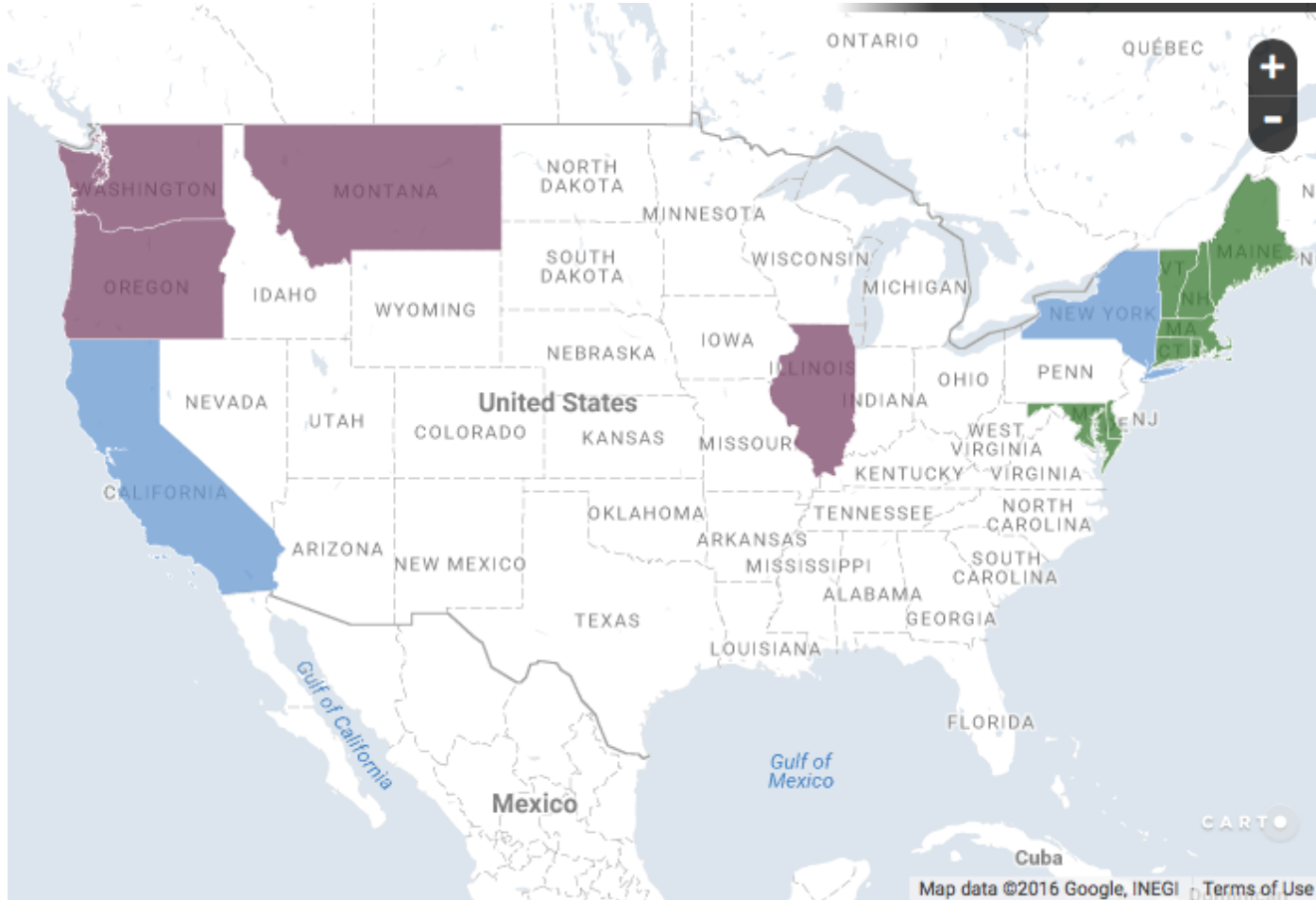
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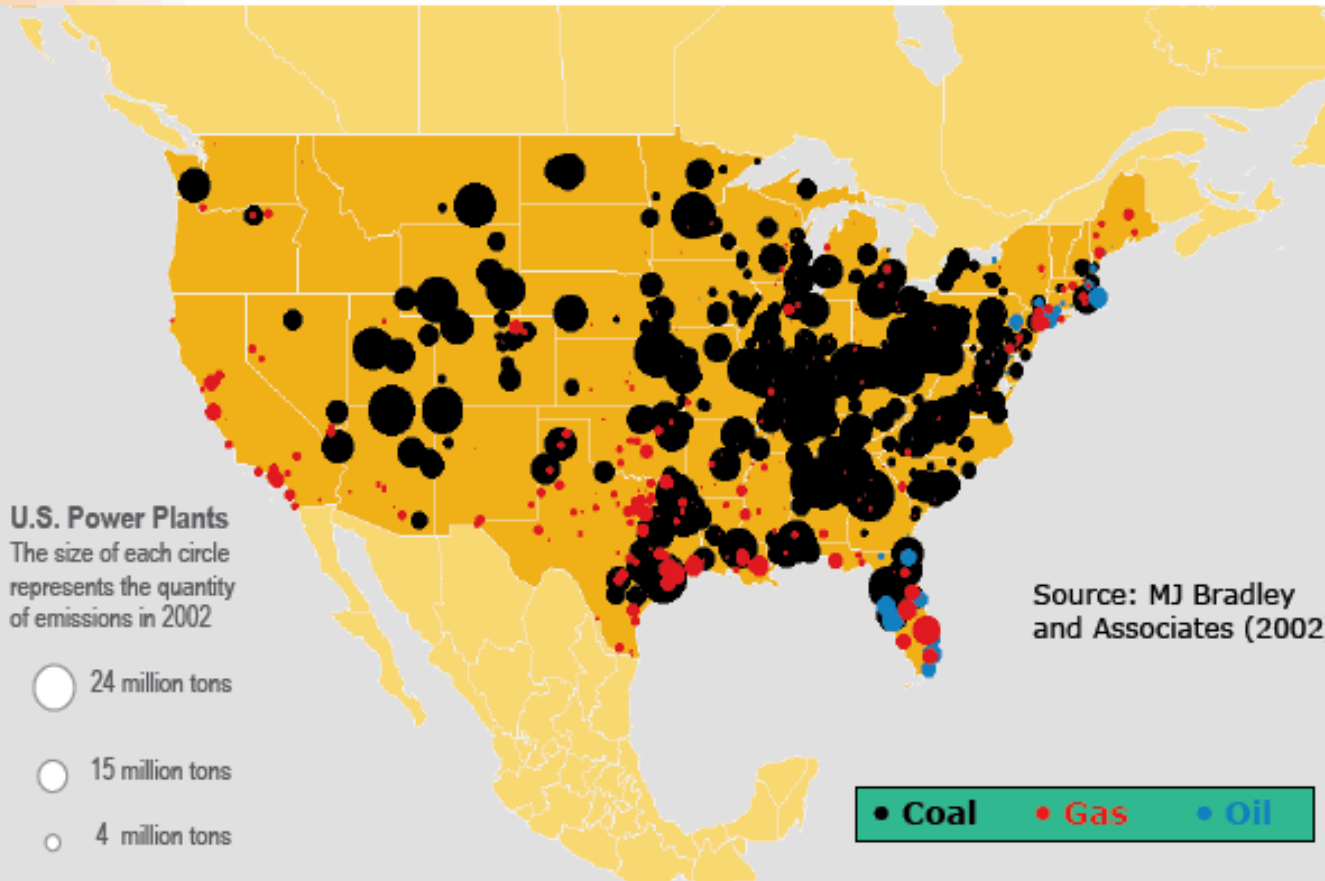
Carbon Regulation: Thinking Globally but Regulating Locally

Part II

US Regions with GHG Caps or Standards



Electric Generating Sector GHG Footprint



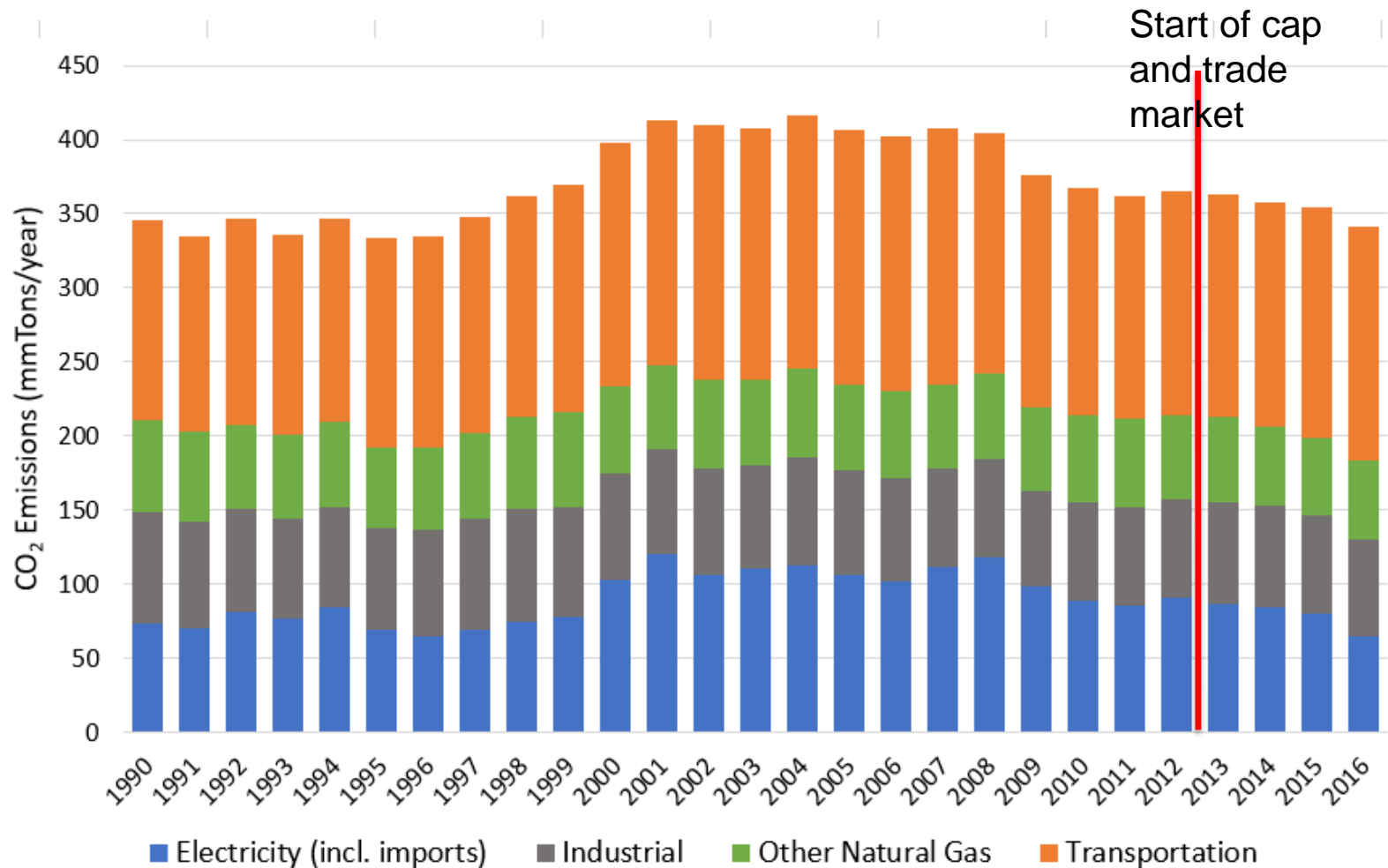
Carbon Regulations: Some Jargon

- Upstream = “source”
 - Regulates smokestack or fuel source
- Concerns are “leakage” and ineffectiveness
 - Reduce output from local source, import more from a source outside of jurisdiction
 - Some climate policies subsidize “medium” carbon sources, rather than tax “high” carbon sources, complicating import/export calculations
 - Was a big concern with clean power plan
 - Ineffective if local policies don’t cover many sources

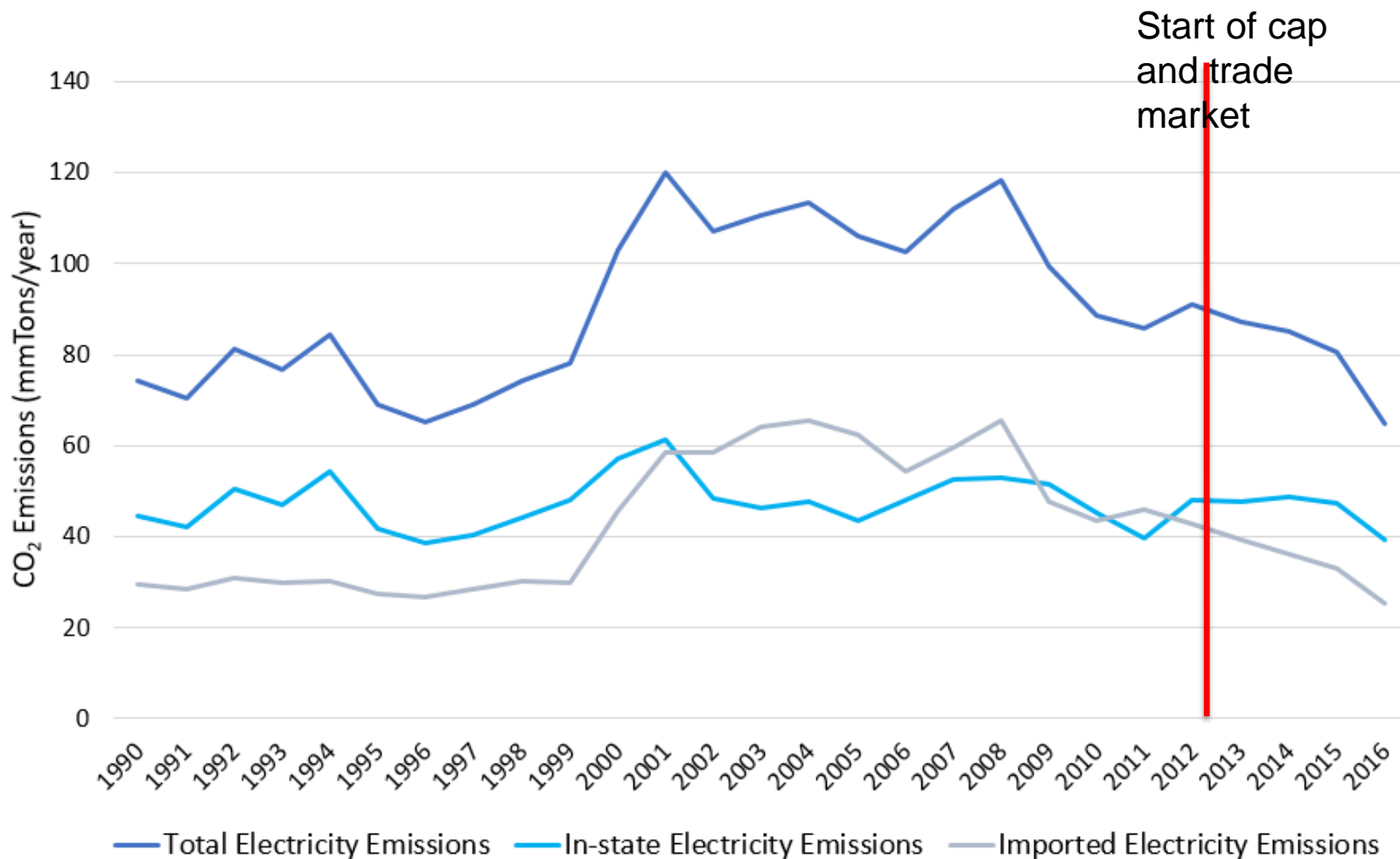
Carbon Regulations: Some Jargon

- Downstream = “importer” = “first deliverer”
 - Regulates consumer/importer
 - Must trace emissions back to some source
 - Raises issues for “pool” based markets
- Concerns are “reshuffling” and “relabeling”
 - Relabel dirty import source as generic (unspecified) source
 - Only appealing if generic is considered cleaner
 - Reshuffle import by swapping sources with some external (unregulated) customer
 - Emissions don’t change, only source destination pairs
 - Strick enforcement of one concern can incentivize the other

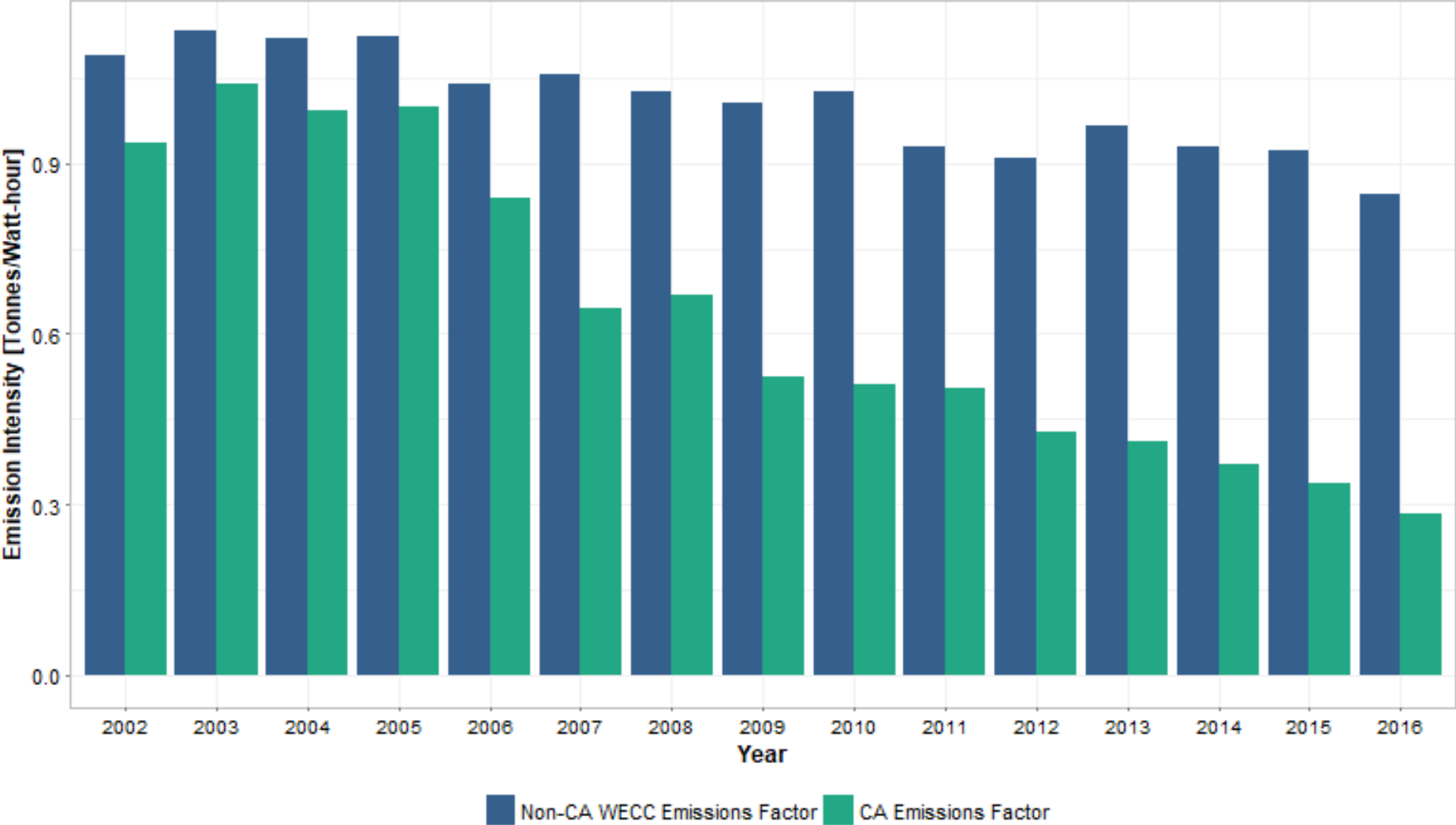
Cap-and-Trade covered GHG emissions have declined below 1990 level



Most of the decline has been in electricity, much of that from imports

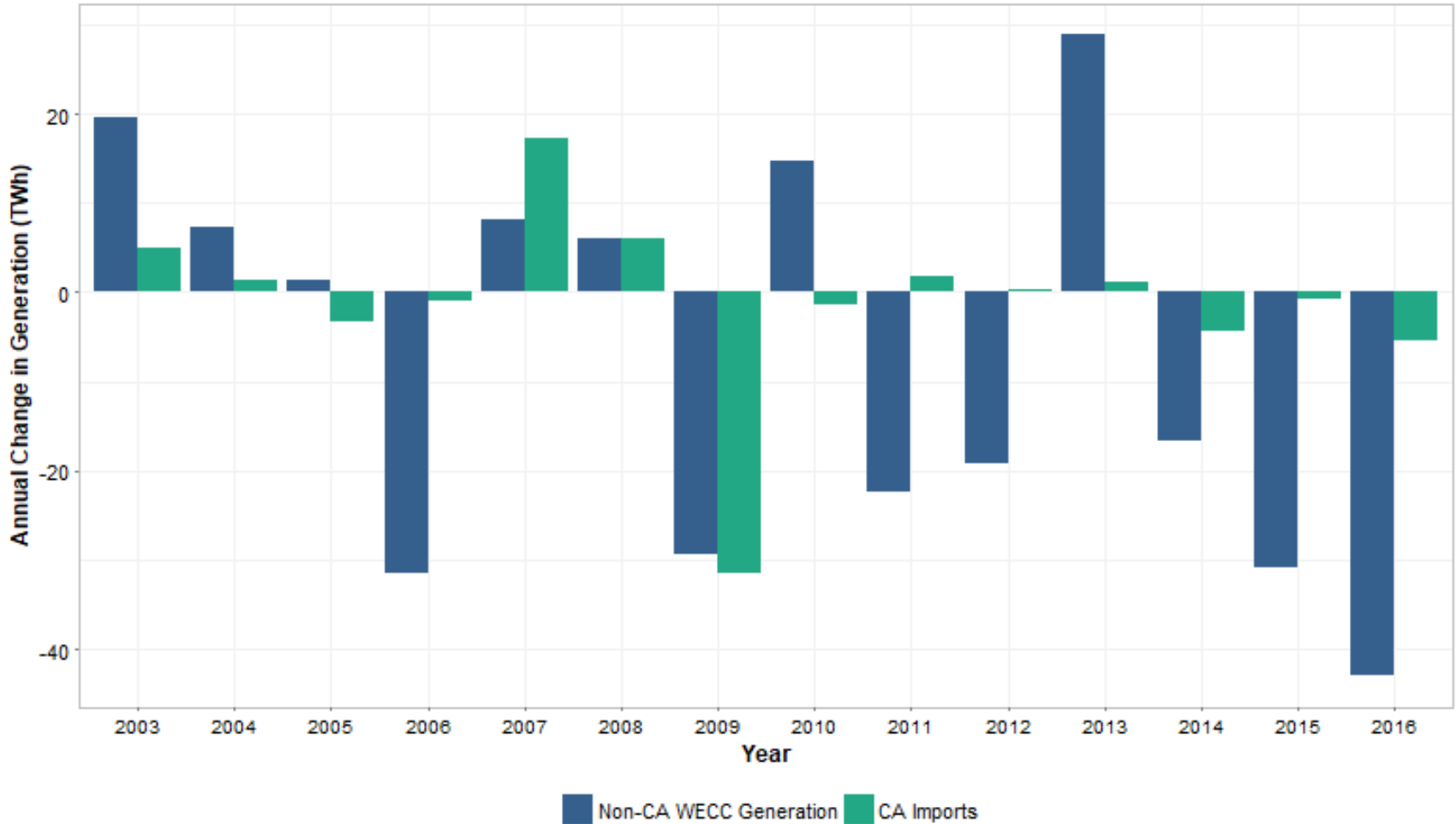


Emission Intensities: CA Imports and Non-CA WECC Generation



Coal Output Declining Faster in WECC than in CA Imports

Annual Changes in Non-CA WECC Generation and CA Specified Coal Imports



Policy Observations

- There is no perfect way to regulate external emissions!
 - Reducing efficiency benefits to combat import problems will be long-run counter productive
 - Isolation can reduce influence
- EIM makes import substitution more transparent and reduces frictions
 - But most vast majority of import transactions (and emissions reductions) outside of CAISO market
 - Day-ahead schedules vs. EIM optimized dispatch
- Precise regulation of one import problem (e.g. shuffling/labeling can push activity to the other

Thank You