Minding the Gaps in US Climate Policy

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Attitudes to adopt for this talk

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Timeline of US GHG Regulation


Waxman-Markey passed in the US House of Representatives

Obama's Climate Action Plan foreshadows EPA's Clean Power Plan for existing power plants.

2007 — Jun 2009 — Jul 2010 — Jan 2011 — Jun 2013 — Jun 2014

2007: Supreme Court affirmed in *Massachusetts v. EPA* that greenhouse gases are covered by the CAA's definition of air pollutant

Jul 2010: Senate failed to take up WM climate bill

Cap and trade was declared dead.

Jan 2011: EPA issues new standards for motor vehicles and pre-construction permitting

Jun 2014: EPA Proposed Clean Power Plan under the Clean Air Act 111(d)

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Timeline of US GHG Regulation (continued)

EPA releases final version of Clean Power Plan and proposed Model Rule and Federal Plan. EPA also releases final standards for new generators.

US Supreme Court imposes stay on EPA enforcement of Clean Power Plan

EPA issues final NSPS for methane emissions from new oil and gas facilities and starts process toward regulating existing sources.

August 2015 | December 2015 | Feb 2016 | March 2016 | May 2016

COP 21 and Paris Accord Agreement for INDC national commitments approach to international climate policy

US submits its INDC to UN process; CPP plays major role

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A Few Gaps in US Climate Policy

- Timing Gap: we are late to the party
  - EU ETS took effect in 2005; no analogous national policy in US
  - Regional/state policies (RGGI, AB42, WCI)
    - Offer important lessons about policy design (topic for another talk)
- Coverage Gap: Silver Buckshot
  - Sector specific policies (CAFÉ, RFS, EE Standards, CPP)
  - No reallocation of effort across sectors to lower cost
  - Potential for emissions leakage due to different policies
  - *But* this approach has allowed for policy to move forward
    - Some analogies to the INDC approach that underlies Paris agreement
    - More policies likely needed to meet US INDC / Paris pledge

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A Few Gaps in US Climate Policy (cont'd)

- Stringency Gap
  - US federal government effort to measure social cost of carbon
    - Estimates are used in benefit cost analysis (RIAs) of new regulations
  - But, stringency of climate policy guided by technological assessment and by politics, not by internalizing marginal damage or equating MC to MB
  - Typically US policies that price carbon directly yield P < SCC
    - Policies could be more stringent with positive net benefit
    - Some tech focused policies yield high implicit MC of carbon reductions
- Policy Interaction (Understanding) Gap
  - Other market failures (knowledge spillover, learning by doing, EE gap) suggest role for other policies (R&D support, RPS/feed-in tariff, EERS)
  - Important interactions and unintended effects (Carolyn Fischer's work)
    - For example, renewables supports making room for coal
  - Issues of attribution of GHG emissions reductions

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Focus on the Electricity Sector

- Electricity sector responsible for 33% of US CO_2 emissions in 2013 and 47% of reductions from 2005 levels required to meet US Paris Pledge
- Regulation directed at this sector is the Clean Power Plan (CPP)
- Look at ***gaps associated with the CPP***
- Focus on three particular gaps
  - Energy Efficiency (EE) gap and EE *evaluation* gap
  - Geographic emissions leakage
  - Emissions leakage to new sources
- Contributing Features of the CPP
  - Design of *emission rate* policy option and issues with EE evaluation
  - Heterogeneous policy choices across states
  - Mass-based policy focused on existing sources only

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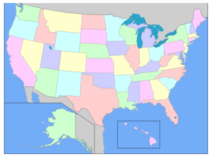
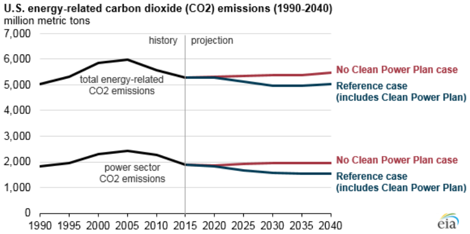
Overview of the Clean Power Plan

- Regulations issues by EPA under § 111(d) of the Clean Air Act
  - Sets **federal goals** for existing power plants
  - **State-based planning process** to achieve federal goals
  - Accompanying **proposed federal plan** (for recalcitrant states) and model rule



- Simultaneous release of final 111(b) emission rate standards for new fossil generators
- Expected 32% CO_2 emissions reduction from 2005 levels by 2030
- Intended timing
  - Final rule issued in August 2015
  - States have until 2018 to develop plans
  - Compliance begins in 2022



- *Supreme Court issues stay of the Clean Power Plan on Feb 9, 2016*
  - EPA cannot compel states to move forward with plans
  - Ultimate future of rule to be decided when Supreme Court rules
  - EPA still under obligation to regulate CO_2 emissions

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EPA’s CPP Emissions Guidelines

- Emissions Guidelines are built on Three Building Blocks (BB)
  - BB1: Heat rate improvements at existing coal-fired boilers
  - BB2: Substituting gas generation from existing NGCC plants for coal
  - BB3: Substitution of new renewables for existing fossil generation.
- Separate emissions rate standards for Fossil Boilers (Coal) and Natural Gas Combined Cycle (NGCC) units that get stricter over time

Table 2. Emission Performance Rates by Technology Category (lbs/MWh)

Category	Interim Rate (2022-2029)	Final Rate (2030 on)
Fossil Fuel-Fired Electric Steam	1,534	1,305
Combined Cycle Combustion Turbines	832	771

- Emissions rates translated into singled blended emissions rates at state level
  - Based on share of 2012 generation from NGCC and coal-fired boilers
  - Blended rates also translated into mass-based caps (tons)
  - New source complement if state chooses to include new sources under mass

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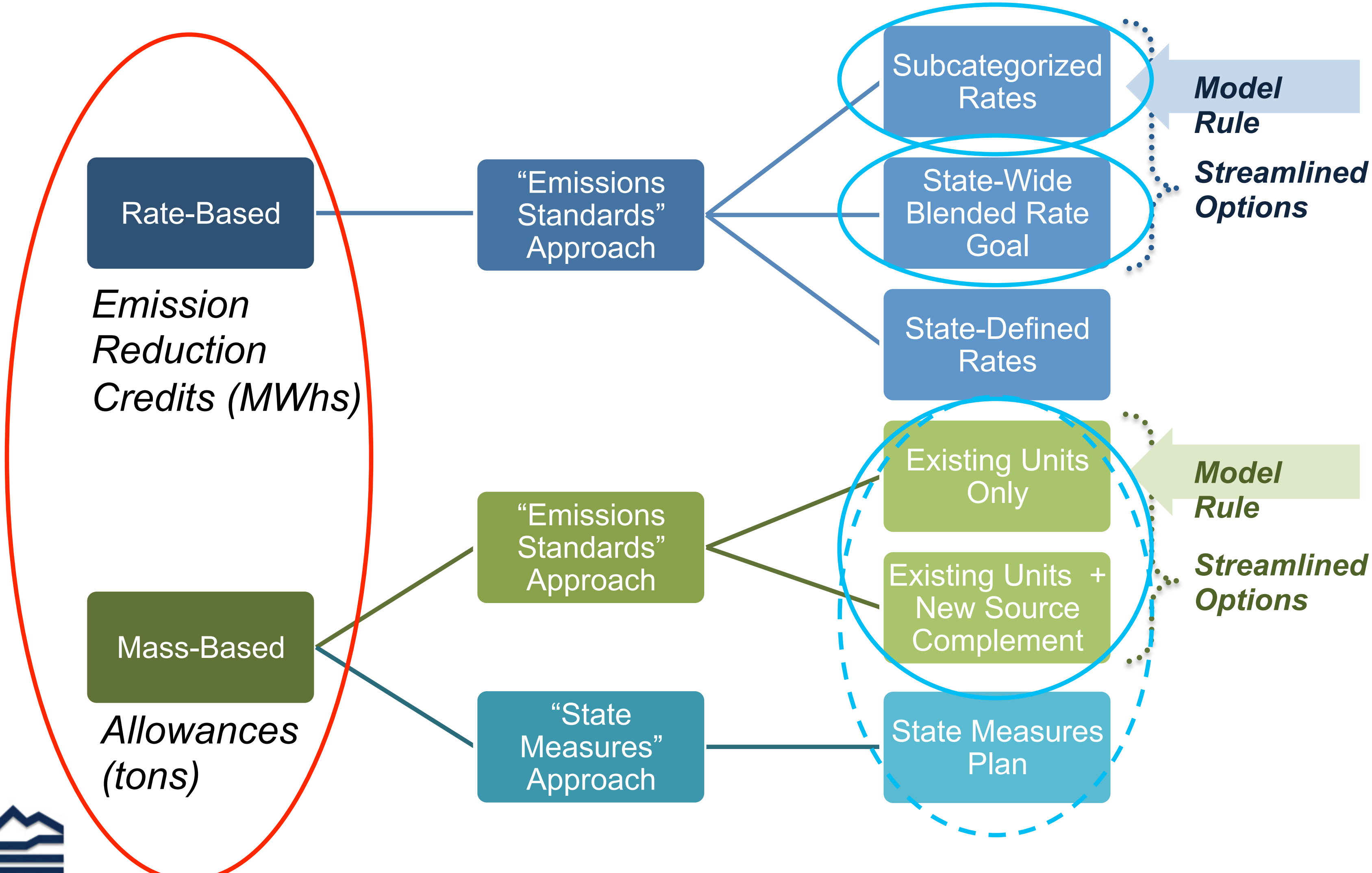
State Plan Options



Adapted from Georgetown Climate Center and other sources

Gap Number 1

The Energy Efficiency (EE) and Energy Efficiency Evaluation (EEE) Gaps

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Features of a Rate-Based Approach to CPP

- Compliance instrument is Emission Reduction Credit (ERC) earned for a MWh of generation by eligible generators
- For compliance: (CO_2 emissions/ERCs) < standard (tons/ MWh).
- Ability to earn ERCs provides **production incentive**
  - low emitting generators produce more electricity to earn ERCs
  - which lowers market clearing price of power (relative to CO_2 tax)
  - which, in turn, mutes incentives to reduce consumption
- To restore incentive to conserve, CPP allows energy savings from EE programs/policies to earn ERCs
- EPA's Clean Energy Incentive Program awards **two ERCs** for savings from early low-income EE (pre 2022)
- Question: **are energy savings real and additional?**

If savings are not real or additional, EE ERCs can make room for more emissions, reducing CPP effectiveness.

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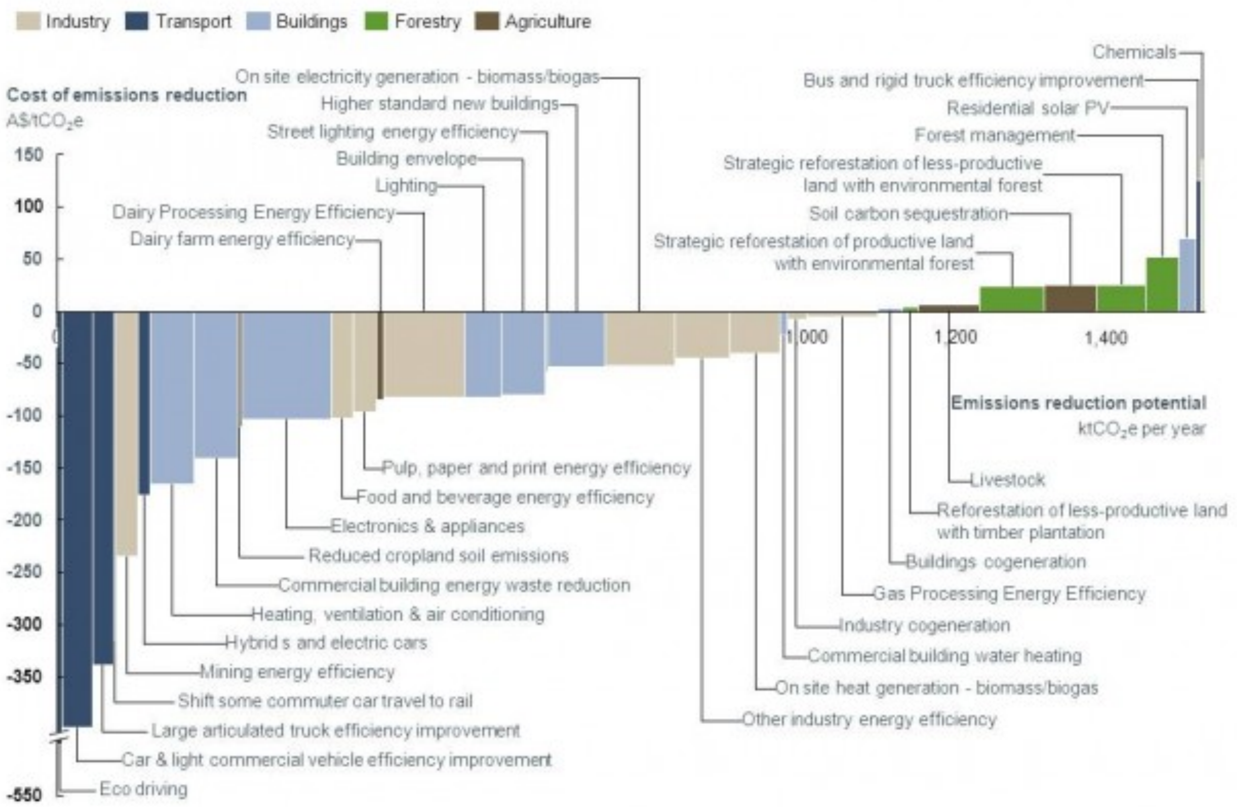
And then there's the Energy Efficiency Gap



EEGap: the observation that households and businesses fail to make energy efficiency investments that seem to pay for themselves in the discounted stream of energy savings.

The EE Gap provides another potential justification for policy. Appropriate type of policy depends on causes of the gap (see Gillingham and Palmer 2014).

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Making effective policy to address the EE Gap also requires **good evaluation**.

Issues with EE Evaluation, Measurement and Verification (EM&V)

- Currently lots of variation in evaluation approaches and findings for similar/identical interventions across states
- Lots of uncertainty about energy savings.
- Reasons to be skeptical of current state of the art:
  - Focus on verifying installations
  - Energy savings based on engineering calculations or look-up tables
  - Measurements of in situ performance and effects on consumption are rare
  - Behavior element is handled by assumptions
  - Assessment of infra marginal participation is weak
  - Measure interaction (e.g. lighting and cooling/heating) may be assumed
- Review of current practice suggests an energy efficiency evaluation gap.

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An Alternative Approach: Empirical Analysis of Energy Demand

- How do you know if an intervention saves energy?
  - Need a reliable assessment of the baseline
  - Consumption before the efficiency measure is not sufficient
  - Comparisons to non-participants can confound multiple effects
- Use experimental or statistical techniques
  - Where possible use randomized control trials or randomized encouragement
  - Quasi experimental methods (eligibility criteria, waiting lists) facilitate evaluation
  - Explain participation with IV methods or use matching to identify controls
- Estimate econometric equation to explain energy consumption
  - Use a panel of customer-level data on actual consumption
  - Nothing but net: method identifies policy induced savings

- Best if evaluation is done by a neutral party
  - Make data available for replication
  - Develop data base of “revealed” savings
- How do empirically estimated savings compare with engineering estimates?

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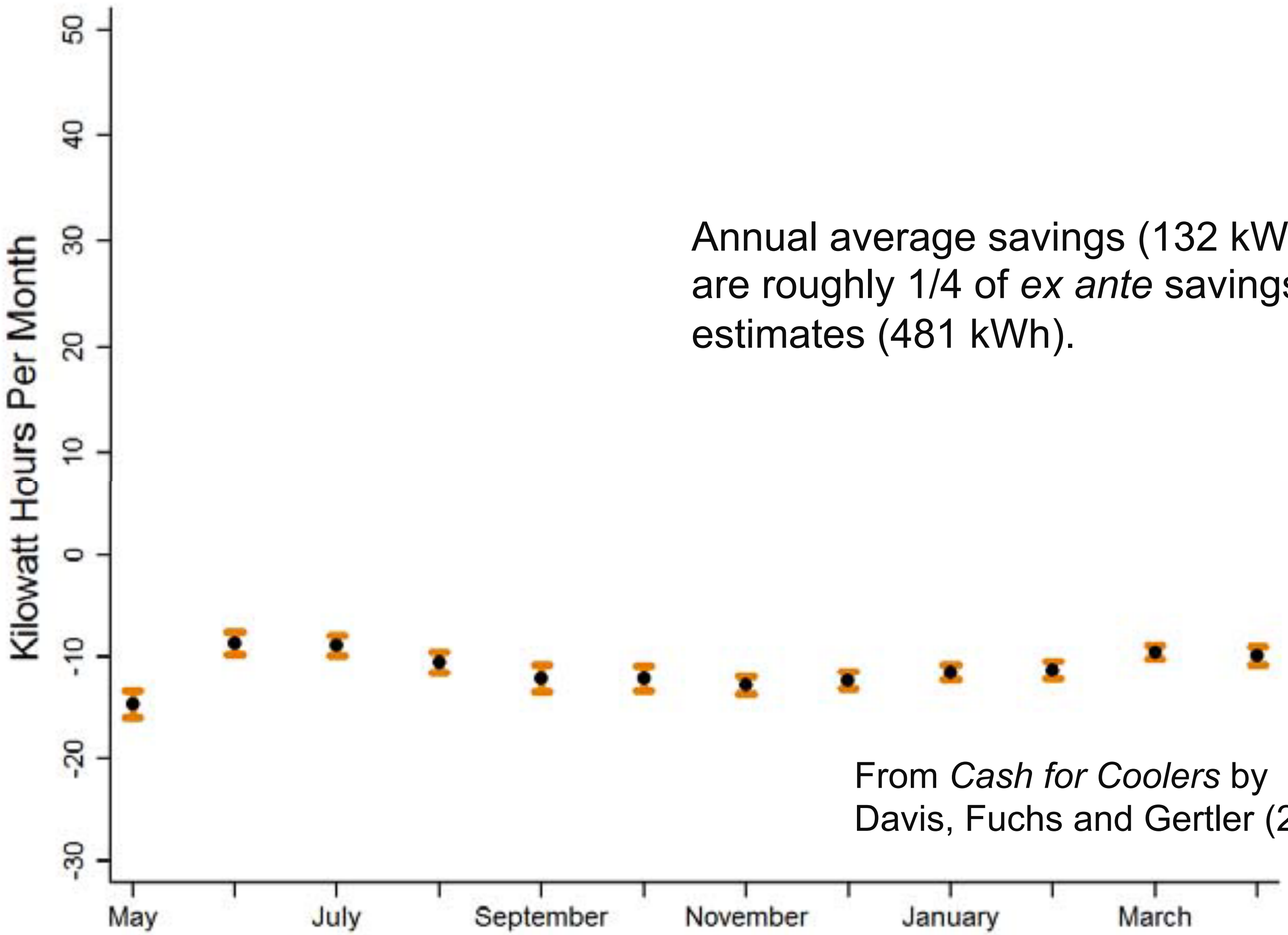
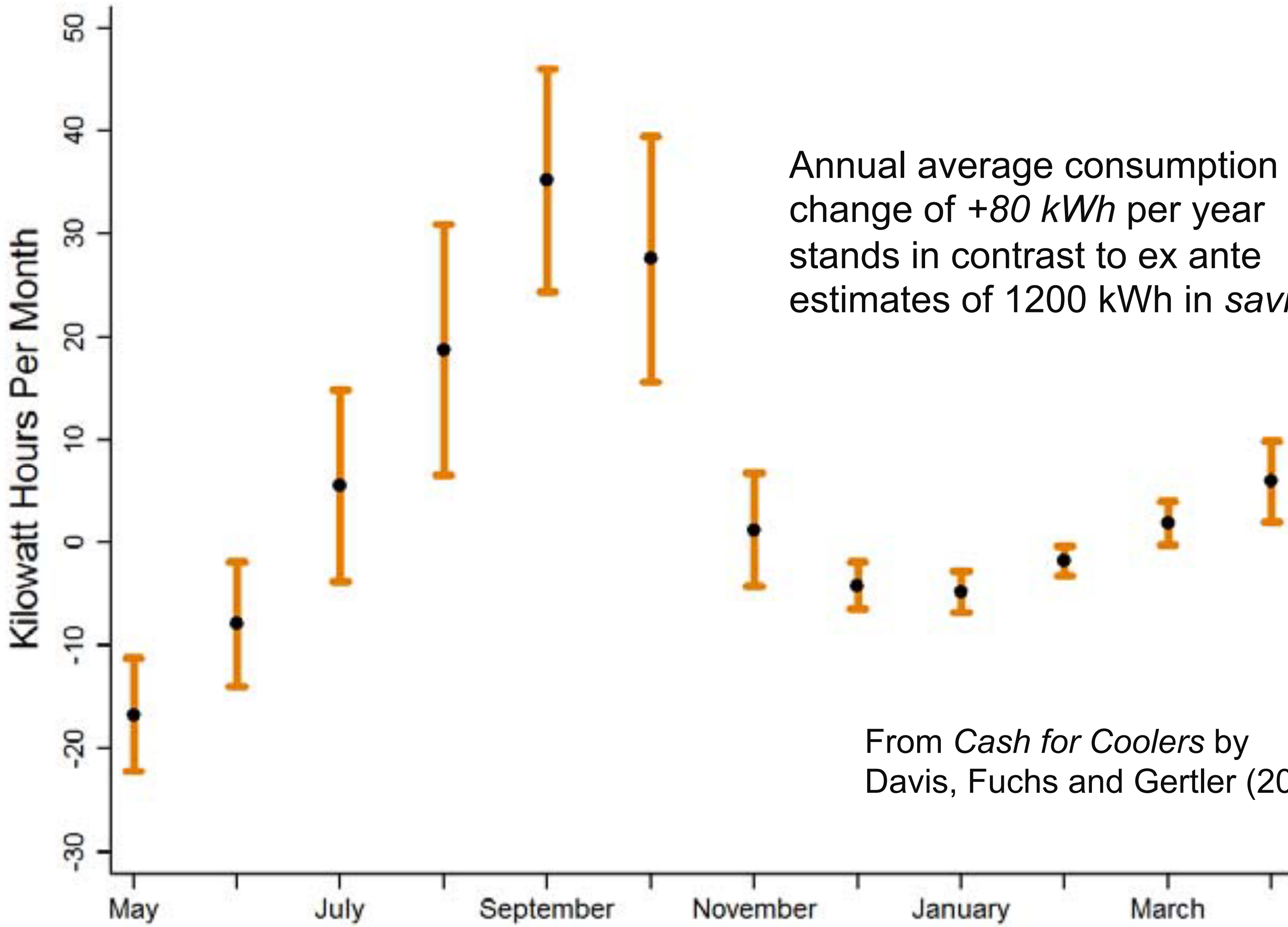
Impact of Mexican EE Refrigerator Subsidies on Energy Use



Annual average savings (132 kWh) are roughly 1/4 of *ex ante* savings estimates (481 kWh).

From *Cash for Coolers* by Davis, Fuchs and Gertler (2012)

Impact of Mexican EE Air Conditioner Subsidies on Energy Use



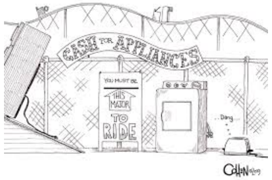
Annual average consumption change of *+80 kWh* per year stands in contrast to ex ante estimates of 1200 kWh in *savings*.

From *Cash for Coolers* by Davis, Fuchs and Gertler (2012)

Some EE Programs Defy Engineering Assessment

- Behavioral programs that use nudges
  - Opower experiments (RCTs) comparing my energy use to neighbors have been shown to reduce energy consumption by roughly 2% (Allcott 2012)

- Information programs
  - Responses to Energy Star program are very heterogeneous across consumers (Houde 2014)
  - Experiments can inform better information provision through appliance labeling (Newell and Siikamaki 2014)
  - Program interactions can also be assessed with statistical techniques and data: “Cash 4 Appliances” subsidies for Energy Star appliances produced little incremental energy savings (Houde and Aldy 2014)



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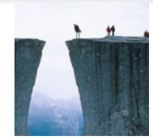
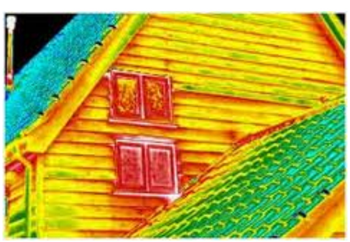
Filling the Energy Efficiency Evaluation Gap

- Two ingredients to fill the gap
  - Design efficiency programs for good evaluation
  - Provide researchers/evaluators with access to customer level data for participants and controls before and after program intervention

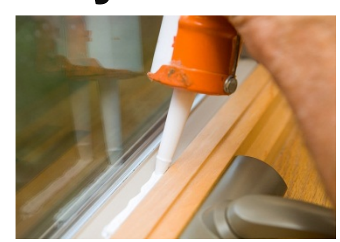


- Development of state plans for CPP compliance creates an opportunity
  - Compliance starts in 2022 so time for experimentation
  - Can build a knowledge base to:
    - enable better forecasting of future energy savings
    - help to target future efficiency policies and program $

More EE policy experimentation + Rigorous EE policy evaluation =



Better understanding and more effective policy



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Gap Number 2

Heterogeneous State Policies and Geographic Emissions Leakage

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The Coordination Challenge

Different state policies

- States can adopt either a rate-based or a mass-based policy, so could be a mix of both types across the states
- Bushnell et al. (2016) finds substantial leakage and economic disadvantage in states that transition to mass
- Our work validates the possibility for leakage
- But, we also demonstrate that states can use updating allocation of emissions allowance value to mimic the production incentive of original emission rate target

⇨ Leakage does not necessarily result from the choice of a mass-based policy. Negative leakage is possible.

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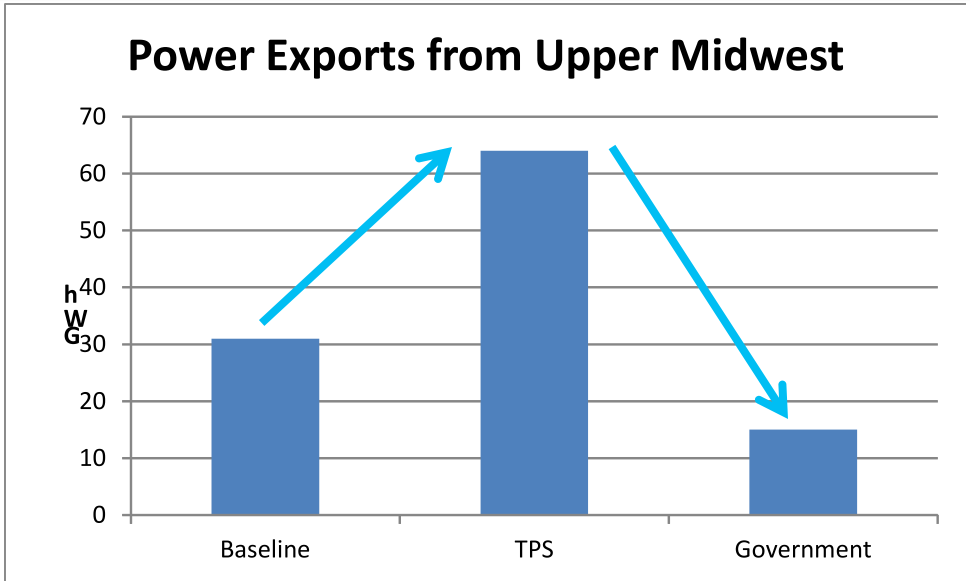
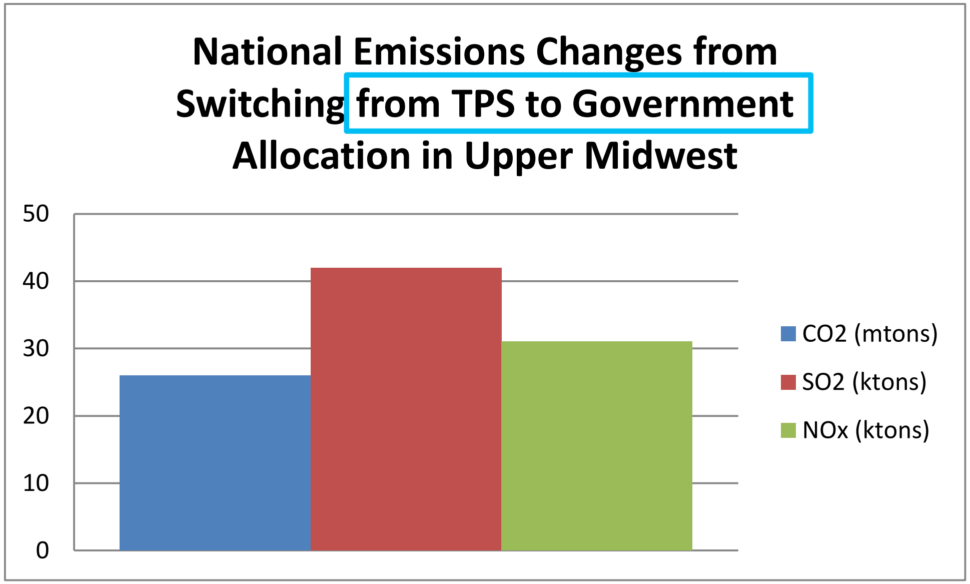
Leakage under Mass-Based Policy

Mass-based policy with allowance value to government (auction) in upper Midwest reduces power exports from region





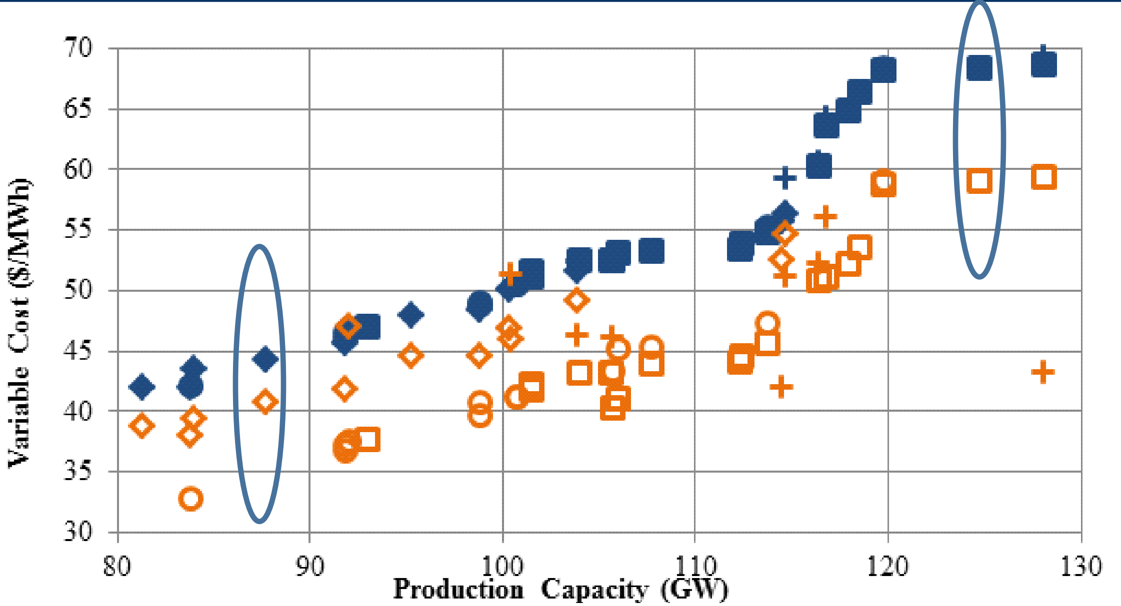
National emissions of CO_2 and criteria pollutants are higher as a result

Key:
TPS = Rate-based policy
Government = mass-based with auction

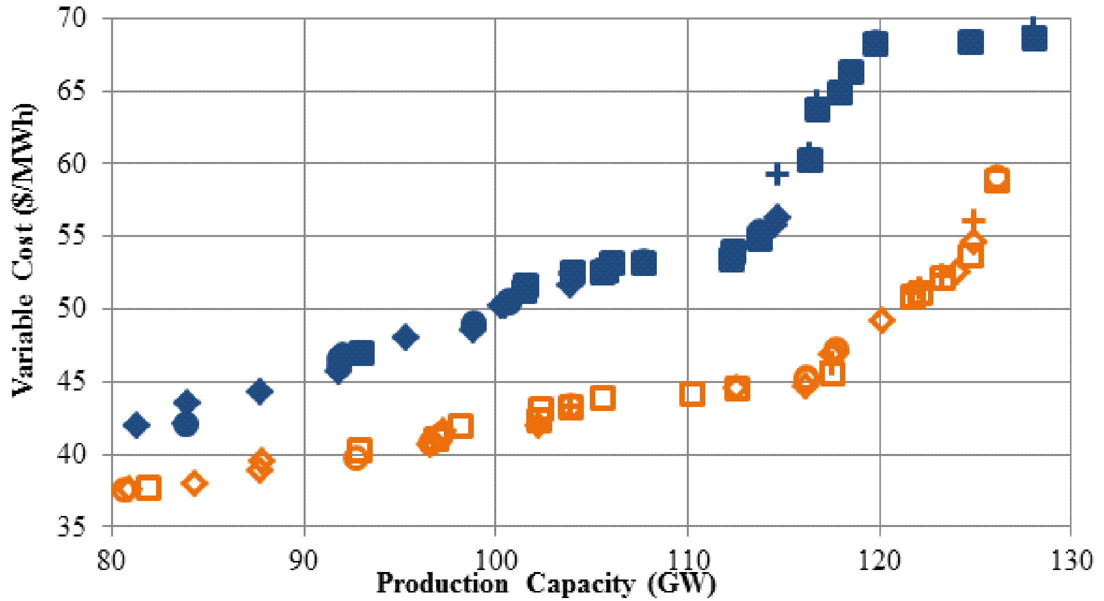
Production incentive in the merit order dispatch

Government (Auction) compared with Updating OBA-excluding coal

- Before reordering



- After reordering



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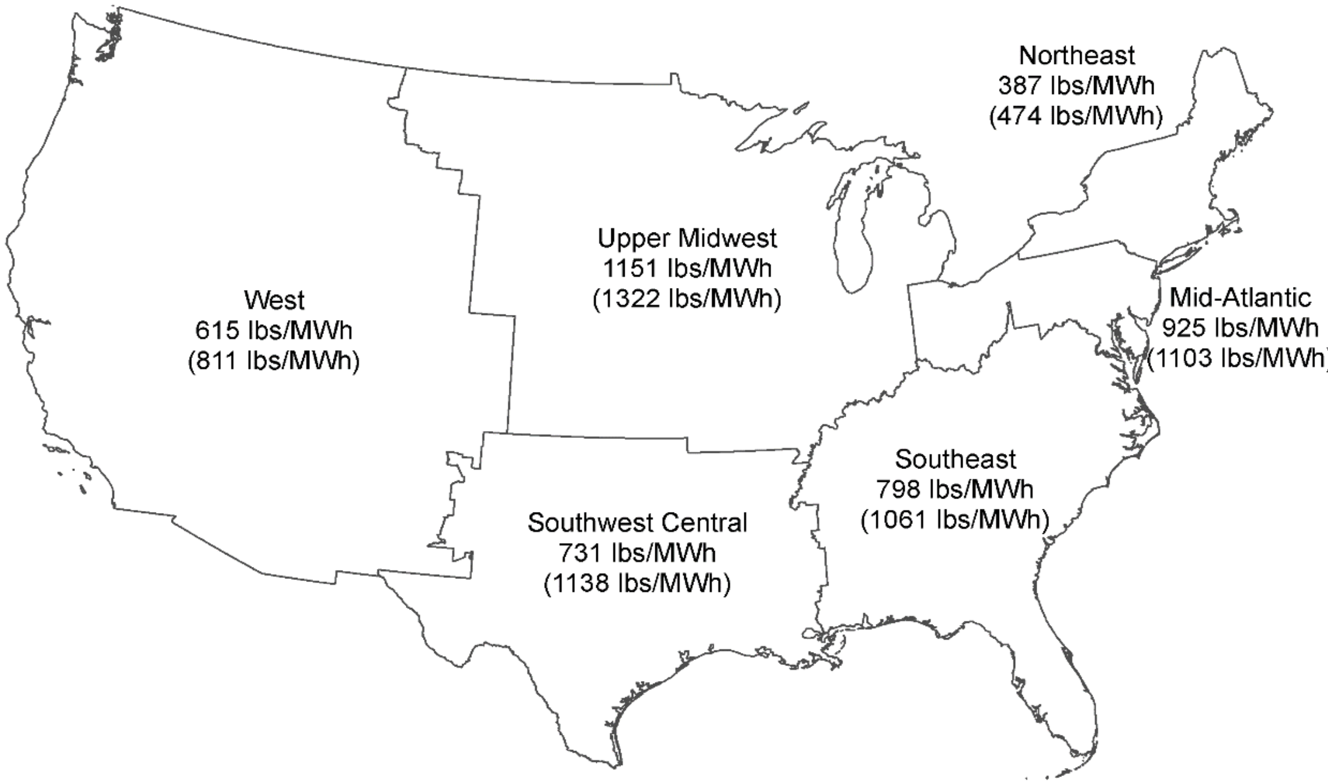
Modeled six regions



- Autonomous regional programs
- Several alternative forms of mass-based policy in Upper Midwest
- Rest of nation has tradable emissions rate standards (denoted TPS)

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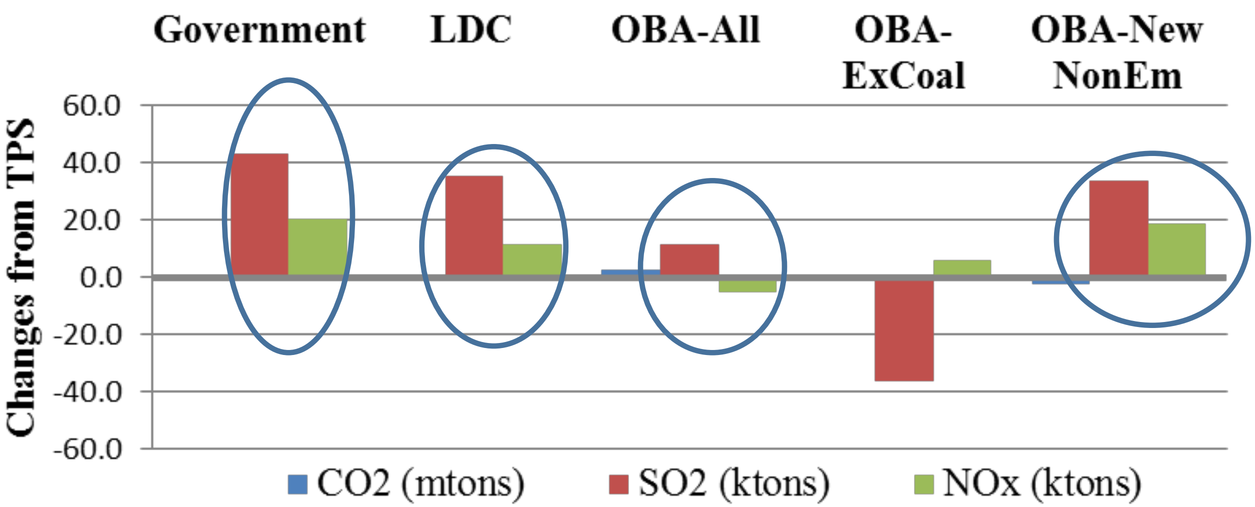
Policy Scenarios

Generator Type		Covered Sources	Production Eligible for Allowance Allocation				
			Rate-based Policy (TPS)	Govern-ment (auction)	OBA-All	OBA-ExCoal	OBA-New NonEm
Fossil	Coal	X	X		X		
	Gas	X	X		X	X	
	Oil	X	X		X	X	
Renew.	Ex Wind	X	X		X	X	
	Other Ex	X	X		X	X	
	New	X	X		X	X	X
Nuclear	Existing				X		
	New	X	X		X	X	X
	At Risk	X	X		X	X	X
Hydro					X		
Efficiency		X					

OBA = updating output-based allocation

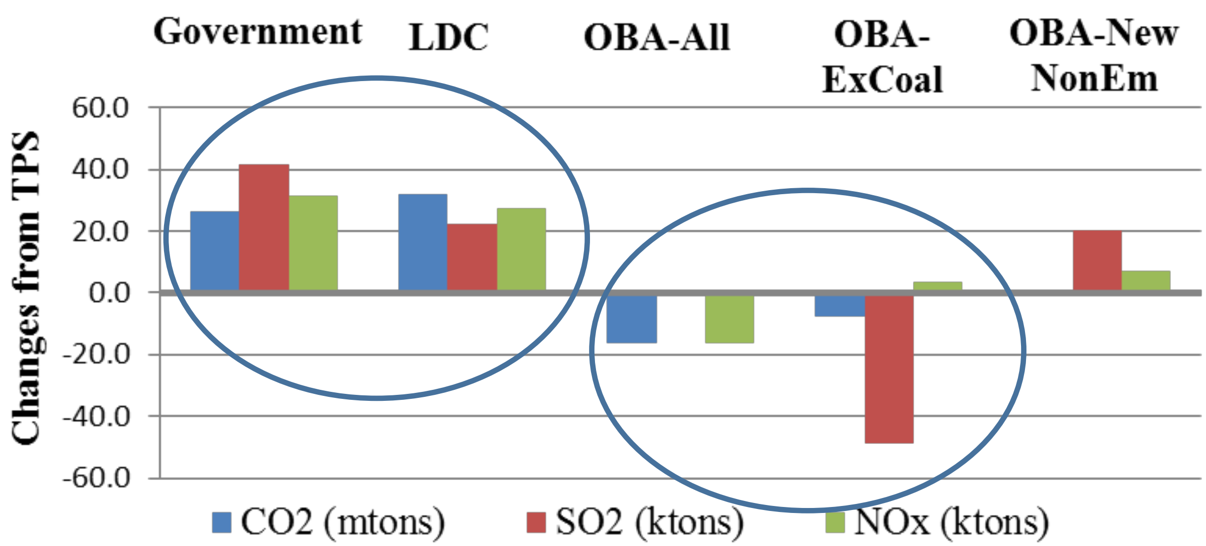
Or you could have a consumption incentive: LDC Allocation.

Emissions Changes from Rate-Based (TPS)



Emissions in Upper Midwest

National Emissions



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Bottom lines on dealing with geographic leakage

1. State policy flexibility in CPP invites strategic behavior and policy interaction could increase emissions and degrade air quality.

2. Updating output-based allocation with mass-based policy can restore production incentive and may lead to negative leakage.

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Gap Number 3

Incomplete Policy and Emissions Leakage to New Sources

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CPP Treatment of New Sources

- EPA's Clean Power Plan (CPP) prescribes emissions rate standards as the *Best System of Emissions Reduction* (BSER), and allows mass-based alternatives for existing fossil EGUs.
- EPA cannot compel states to cover new sources.
- The treatment of sources in different ways could result in artificial economic signals affecting operation and investment outcomes.

➢ **Leakage…**

- If a mass-based policy covers only existing units then the state must demonstrate that the policy does not lead to emissions leakage to uncovered sources.

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Leakage

- State plans should be "equivalent" to BSER.
  - Equivalence probably means the emissions outcome, but it could mean incentives for operation.
  - The outcome under an emissions rate approach is model dependent
- EPA defines a mass-based approach covering all sources as equivalent. We compare to this benchmark (emissions cap).

CO_2 Emissions (million short tons)	Mass-Based - All Sources w/ New Source Complements	Proposed Mass-Based Existing Source Only Model Rule
Affected EGUs	1,427	1667
+ New NGCC	281	278
Total	1,708*	1,946

* The Total for New Source Complements is EPA's target and does not include unaffected existing units (gas turbines, MSW). Other values are modeling results.

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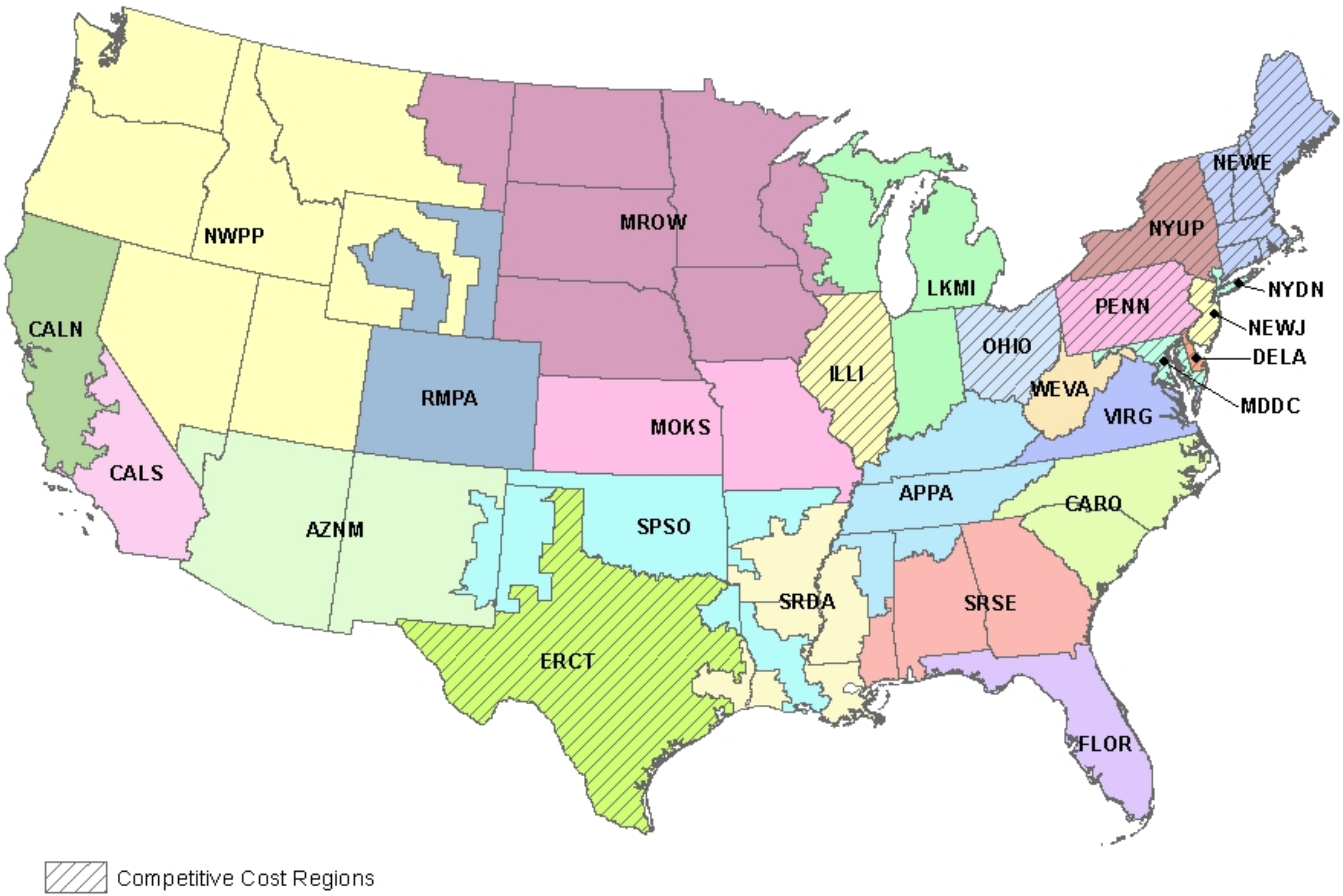
Model Regions



Main Findings

Findings are contingent on our specific version of the model and policy assumptions!

- Nationwide trading with modest energy efficiency (1/2 EPA's assumptions)
- Old renewable data, no PTC/ITC extenders
- Contemporaneous updating allocation (not delayed to a subsequent period)

- A **mass policy covering all sources** yields fewer total emissions than mass-based approaches that cover only existing sources.
- **Updating allocation is a potent approach** to reducing total emissions when new sources are not covered.
  - About 2/3 of emissions leakage to new sources can be remedied.
  - (Notably, there are other ways EPA could affect investment behavior and reduce leakage to new sources such as just acknowledging the schedule suggested in the Clean Air Act for revising the rule at which time newly constructed units would likely be deemed "existing.")

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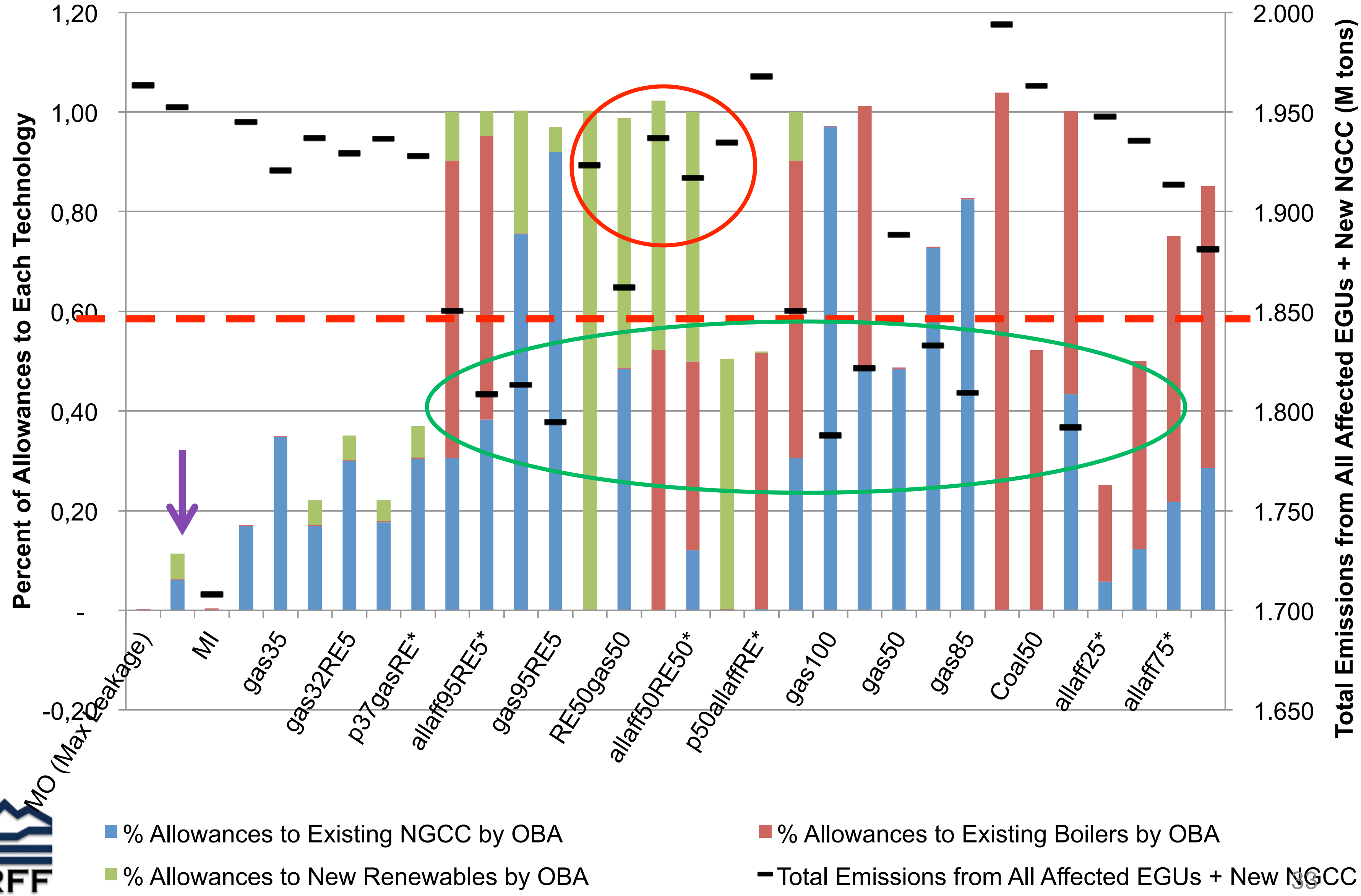
General Results Overview



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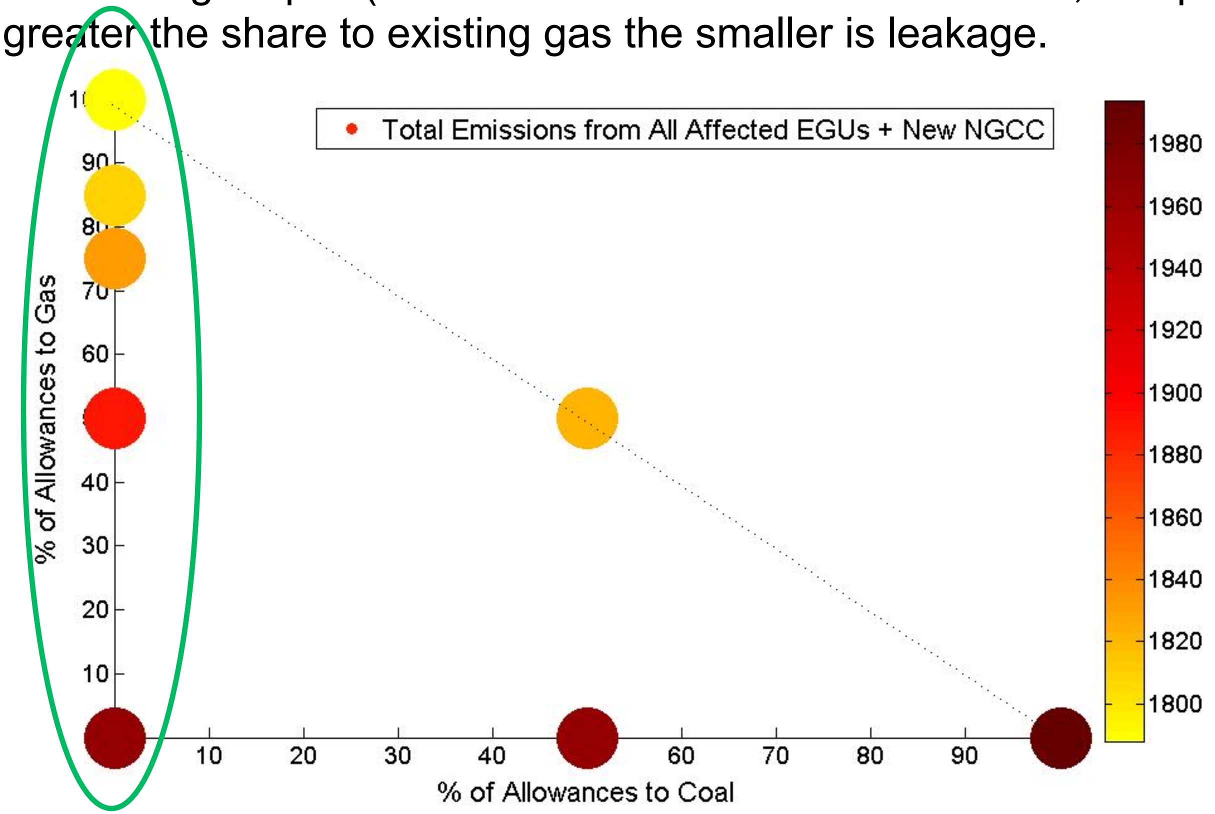
Main Findings: Set Asides by Technology

First consider a **set aside allocation rule**: generation share to each eligible technology, by state, with single national trading market.

1. The most potent approach is allocation to existing **gas**.
   - Other things equal (such as allocation to other resources, fuel prices, etc.) the greater the share to existing gas the smaller is leakage.



Axes represent set aside share of allowances to gas and coal. Allowances are earned by a units share of generation in each group within each state.

Main Findings: Set Asides by Technology

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1. The most potent approach is allocation to existing **gas**.
   - Other things equal (such as allocation to other resources, fuel prices, etc.) the greater the share to existing gas the smaller is leakage.
2. Allocation to **RE** is (much) less effective (under our assumptions!)
3. Allocation to **existing nonemitting** has no effect (at-risk nuclear?)
4. Allocation to **coal** increases emissions if it comes at expense of allocation to gas.

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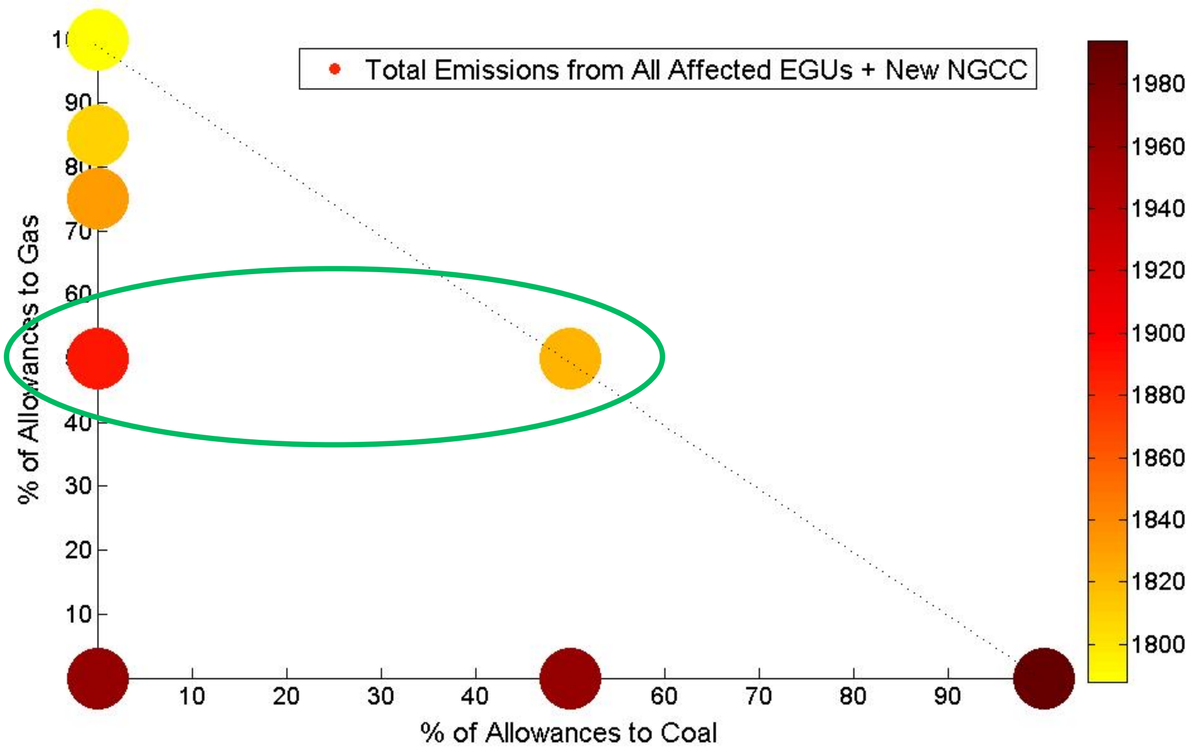
Main Findings: Set Asides by Technology

5. Allocation to **coal** can decrease emissions if it comes from grandfathered allowance set aside. Why?



Axes represent set aside share of allowances to gas and coal. Allowances are earned by a units share of generation in each group within each state.

5. A Set Aside to Coal Can Reduce Emissions. Why?

A. Greater allocation to fossil resources will increase allowance price.

B. Driving the outcome is *relative* net subsidy from the cost of surrendering allowances and the value of the production incentive.

- Increasing the allowance price will affect both.
- A resource is advantaged (a) if its position (per MWh) is long (goal > actual emissions rate) and/or (b) by its net subsidy relative to other resources.

C. The set aside rule yields different allocation rates (lbs/MWh) by state.

- The availability of a production incentive to coal may correspond with a large market opportunity (willingness to pay for allowances) in some states, driving up allowance price nationally, which negatively affects coal generation in other states.

Net tax = [(Compliance Tons – Production Incentive)/MWh] * Allowance Price

2030	Net Tax Gas ($/MWh)	Net Tax Coal ($/MWh)	Difference (Coal-Gas)	Emissions (tons)
Gas 50%	-3.6	4.9	8.5	1894
Gas50%/Coal50%	-8.9	6.7	15.6	1822

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Main Findings: Pooled Eligibility Across Technologies

6. Designating **all affected units** (gas *and* coal) as eligible to receive updating allocation can be nearly as effective at reducing leakage to uncovered new fossil units as allocating only to gas.
   - As noted, redirecting allocation away from gas to any technology will increase leakage, but eligibility for coal is a two-edged sword as allowance price increases!!
   - There may be policy and legal advantages to treating affected sources symmetrically!

2030	Net Tax Gas ($/MWh)	Net Tax Coal ($/MWh)	Difference (Coal-Gas)	Emissions (tons)
Gas 100%	-9.9	9.0	18.9	1789
Gas&Coal 100%	-8.6	7.9	16.5	1793

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Advice for EPA on Dealing with Leakage to New Sources

(Findings are contingent on model construction and assumptions!)

- EPA could consider/impart further advantages for states that include the New Source Complements in their plans.

Otherwise, EPA could consider:

- Expanding the portion of allowances distributed through updating.
- Changing the set of sources eligible to receive allocation using updating.
  - Eligibility for all existing affected sources has a small effect on emissions and may have policy or legal advantage by treating sources symmetrically.
  - Pooling eligibility (vs. set-asides) among all affected (or also plus new renewables) will lead to smaller power market distortions and lower electricity prices.
- A carbon price yields the first best result. But given the hand we are dealt, updating allocation implemented carefully can provide a useful second-best approach to introducing economic incentives in the power sector.

Can we eliminate the gaps?

Prospects for Comprehensive Greenhouse Gas Regulation in the US.

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Dreaming of other ways to address the gaps

Is a more comprehensive approach to US Climate Policy possible? Likely?

Two options under discussion (at least in some circles)

- Taxing carbon emissions economy-wide to help improve the efficiency of the tax system and address deficits
  - Senators Whitehouse, Delany and Sanders have each introduced carbon tax bills
  - But the US House of Representatives recently passed an anti-carbon tax resolution
- Section 115: A different approach to regulations by US EPA
  - Some environmental law scholars believe if CPP is over turned by Supreme Court EPA could use Section 115 of the Clean Air Act to regulate CO_2 emissions.
  - Section 115 empowers EPA to address international emissions issues that other countries are also addressing
  - Not a sector-specific approach (like 111) but cross sectoral and cross vintage
  - Could conceivably allow for economy-wide cap and trade and efficient regulation
  - Would face political hurdles given large opposition to cap-and-trade but EPA is required to regulate CO_2 under current law and this is another, more elegant option.

Conclusions

1. Design EE policy with evaluation in mind to learn about the EE gap and fill the EE evaluation gap.
2. Updating OBA allowance allocation can eliminate inter-state emissions leakage in a mixed policy world.
3. Updating allowance allocation to existing emitting sources can also address leakage to uncovered new sources.
4. As evidence mounts, eventually, comprehensive climate policy will win the day in the US and the gaps will be fewer and smaller.