Approaches to Address Potential CO_2 Emissions Leakage to New Sources under the Clean Power Plan

Technical Background for Public Comments to EPA

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Resources for the Future

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Introduction

EPA's Clean Power Plan (CPP) prescribes emissions rate standards covering most existing fossil electricity generating units (EGUs) and mass-based alternatives. States have the responsibility to adopt one approach. An important concern is the equivalence of a mass-based approach to emissions rate standards, in particular with respect to the expanded utilization of new fossil generating units and associated CO_2 emissions.

EPA has indicated that if a state uses a mass-based policy that covers new sources and includes the New Source Complement the policy would achieve equivalence. If only existing sources are covered under a mass-based policy then the state must demonstrate that it does not lead to expanded utilization of new fossil units.

The mass-based Proposed Model Rule distributes a portion of emissions allowances based on updating generation data to provide a production incentive for existing covered units intended to offset the incentives that otherwise exist to shift generation away from these units to new uncovered units. Another portion of allowances is allocated on an updating basis to new renewables. If finalized, this approach would be presumptively approvable as a design for state compliance plans.

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Updating the distribution of emissions allowances provides a production incentive to eligible units

EPA's proposed approach would distribute allowances based on recent information about an EGU's share of electricity generation (output) and update that information over time. Previous research indicates that this approach can provide an incentive that changes the utilization of facilities and affects the environmental outcome.

This research examines the expected performance of EPA's proposal and several alternatives using a highly parameterized capacity planning and operation model of the electricity system called Haiku.

We evaluate EPA's dual-rate emissions rate standard, the mass-based approach that covers all sources and includes the New Source Complements, and a representation of the Proposed Model Rule with updating distribution to new renewable sources and existing natural gas combined cycle (NGCC) units.

We also evaluate several variations of updating allocation, including expanding the portion of allowances allocated on an updating basis, pooling the set-asides for new renewables with the allocation for NGCC, applying various weights other than uniform across eligible technologies, expanding the set of eligible technologies to include coal and existing non-emitting units, and other special issues.

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Main Findings

- A **mass policy covering all sources** and including the new source complements yields emissions that are less than the options we consider for mass-based approaches that cover only existing sources.
- **Updating allocation is a potent approach** to reducing total emissions when new sources are not covered under a mass-based emissions cap. **EPA should consider expanding the portion of allowances allocated on an updating basis and the technologies eligible to earn them**.
- Designating all affected units (including coal) as eligible to receive updating allocation can be nearly as effective at reducing leakage to uncovered new fossil units as excluding coal from eligibility. This may have a policy or legal advantage in treating all affected sources symmetrically. In contrast, eligibility for existing non-emitting generators is not an effective leakage remedy.
- Some aspects of the model framework may amplify the leakage we identify. If newly constructed units were expected to be designated as existing units at a future date this would narrow the gap. Greater investment in effective programmatic energy efficiency also would narrow the gap. More EE would also lead to lower allowance prices and reduce the impact of any allowance allocation scheme.

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Summary of Model Results

1. The proposed model rule leaves an important gap in total emissions reductions compared to an approach covering all sources. EPA is right to be concerned about leakage.
2. Updating allocation is effective at reducing leakage to new sources compared to distributing allowances on an historic basis. Increasing the share of updating allocation beyond the ~10% proposed in the model rule can substantially reduce leakage.
3. Expanding eligibility for updating allocation to include all affected sources (including coal) only slightly increases emissions. This expansion would elevate allowance prices without necessarily raising average production costs for affected sources or retail electricity prices.
4. Expanding eligibility for updating allocation to include existing non-emitting generators is not an effective leakage remedy.
5. Pooling the allowances provided on an updating basis with those set-aside for renewables may yield slightly more new renewables and slightly greater emissions from new sources.
6. Weighting allocation based on the two different approaches that we modeled leads to more emissions than a uniform approach with eligibility to only gas or to all fossil generation.
7. National average retail electricity prices in 2030 typically increase by less than 3% compared to the Proposed Model Rule in scenarios that expand updating allocation to reduce leakage.

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Important Caveats

1. The model includes modest programmatic investment in energy efficiency beyond the *Annual Energy Outlook* baseline. We believe greater energy efficiency investment would directly reduce leakage.
2. We do not represent the Clean Energy Incentive Program (CEIP).
3. We do not report emissions or emissions changes from existing unaffected sources such as gas turbines.
4. The model assumes newly constructed units not covered by the existing source program would forever remain outside the program. However, statute indicates EPA should revise the performance standard for new sources every eight years, and can do so earlier. When EPA does so, newly constructed units are likely to be designated as existing and subject to regulation at that time. This model assumption likely exaggerates the role of new units.
5. We do not represent the 50% utilization threshold for allocation to existing natural gas combined cycle units that is in the proposed model rule. All generation from existing natural gas is eligible for allocation.
6. The set-asides for new renewables and existing NGCC units are always fully allocated to eligible units based on their shares of generation.
7. The updating allocation approach that we model assumes the allocation is coincident in time with when the allowances are used; in the proposed model rule updating allowances for NGCC are allocated based on generation in the recent past.
8. We model a national market for emissions allowances and do not model banking.

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Outline for the remainder of this report

- Defining leakage and equivalence
- Description of the Haiku model
- Addressing leakage by updating output-based allocation
  - Increasing the share of updating allocation
  - Alternative forms of eligibility
- Our “bottom line”

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EPA on Leakage and Emissions

- Leakage is "… the potential of an alternative form of implementation of the BSER* (e.g., the rate-based and mass-based state goals) to create a larger incentive for affected EGUs to shift generation to new fossil fuel-fired EGUs relative to what would occur when the implementation of the BSER took the form of standards of performance incorporating the subcategory-specific emission performance rates representing the BSER." ** Best System of Emissions Reduction*
- "… the EPA recognized that the statutory construction regarding the BSER is to reduce emissions.", "… leakage, where shifts in generation to unaffected fossil fuel-fired sources result in increased emissions, relative to what would have happened had generation shifts consistent with the BSER occurred, is contrary to this construction."

- Federal Register Vol. 80, No. 205, Pg. 64822

❑ EPA projects total emissions from implementation of BSER equal to emissions under mass-based policy that includes the New Source Complements.

Emissions Equivalence in 2030

CO_2 Emissions (million short tons)	Dual-Rate BSER	New Source Complements	Proposed Model Rule
Affected EGUs	1,342	1,427	1667
+ New NGCC	230	281	278
Total*	1,572	1,708	1,946

* Total does not include emissions from unaffected units other than new NGCC.

- RFF analysis, subject to our model assumptions including a lower level of energy efficiency than anticipated by EPA in its Regulatory Impact Analysis and other caveats, finds emissions from affected EGUs and new sources in 2030 do not reflect emissions equivalence between the Dual-Rate BSER, the New Source Complements and the Proposed Model Rule. We believe more programmatic efficiency would increase emissions under BSER and lower emissions under the Proposed Model Rule, with no effect on the published New Source Complements targets.
- Leakage under the Proposed Model Rule relative to the New Source Complements is 238 M short tons, which is less than 278 M tons of emissions from new NGCC under the model rule. The New Source Complements scenario is treated as the reference point for equivalence when measuring leakage in this modeling exercise.

Policy Exercise

- We do not focus on the difference between a sub-categorized emissions rate approach (BSER) and the New Source Complements, recognizing that model differences and assumptions as described may be influential to the outcome.
- We examine emissions equivalence (among affected units and new NGCC) between mass-based policies that do not cover new sources and one that does cover new sources and includes the New Source Complements.
- This framework provides a laboratory to examine the effectiveness of various approaches for updating the distribution of emissions allowances to prevent leakage to new sources.

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RFF Modeling: Baseline

- Retail electricity prices and consumption, natural gas and coal prices calibrated to EIA's *Annual Energy Outlook 2013*.
- Clean Air Interstate Rule (CAIR) and Mercury and Air Toxic Standards (MATS)
- Regional Greenhouse Gas Initiative (RGGI) and California's AB32
- State renewable portfolio standard and mercury policies
- Federal and state renewable production and investment tax credits expire (recent policy changes are not represented).
- Programmatic energy efficiency achieves about 3.4% cumulative demand reduction by 2025 and is maintained thereafter (roughly half the level anticipated by EPA).

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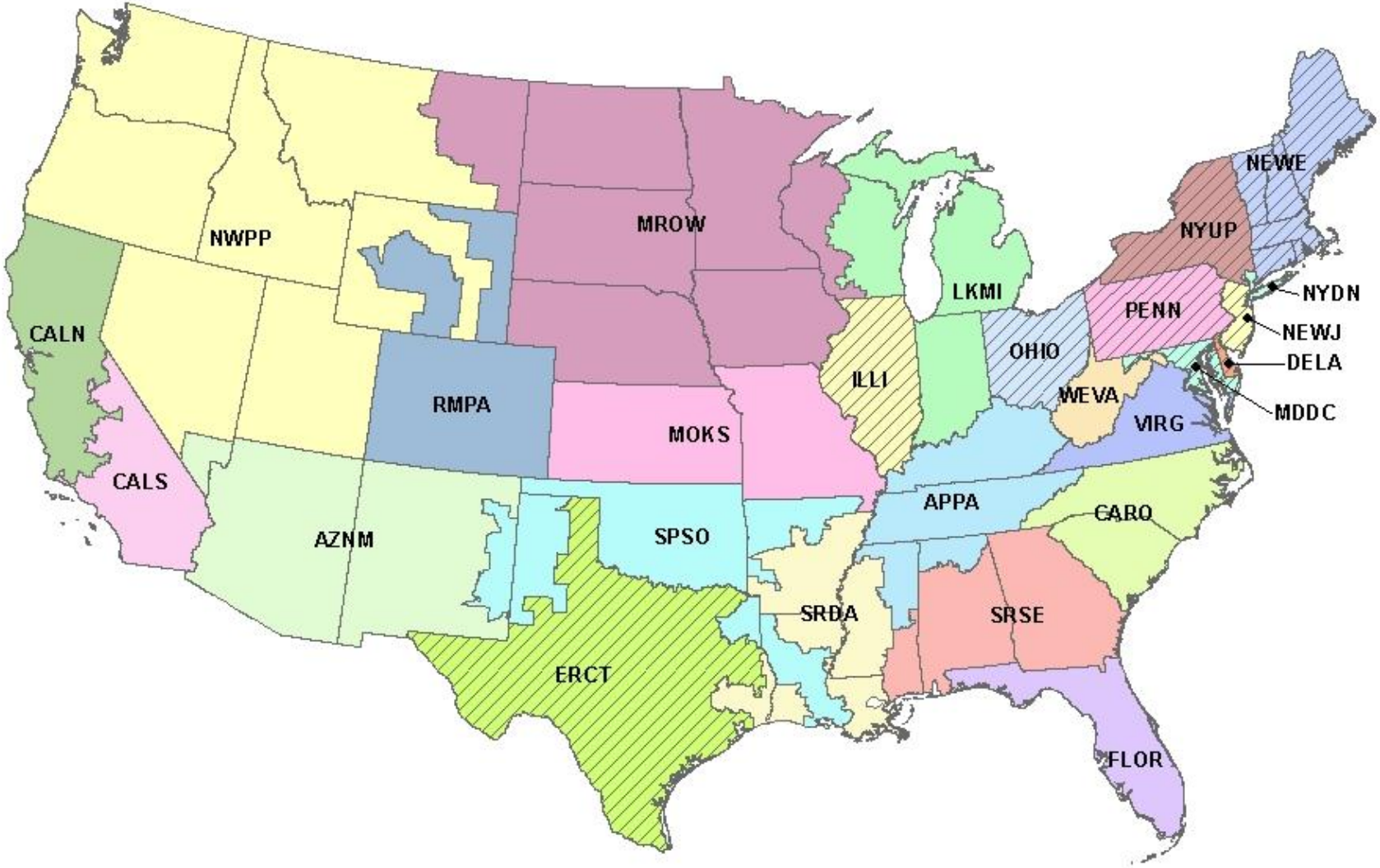
Model Regions



Competitive Cost Regions

RFF Modeling of the Clean Power Plan

- National allowance trading
- No CEIP
- A mass-based policy with the New Source Complements is the reference point for leakage.
- We study alternative methods of updating allowance allocation under mass-based policies without the new source complements for their effectiveness at eliminating leakage.
  - Allocate up to 100% allowances by updating allocation?
  - Instead of 50/50 split between existing NGCC and new renewables, is another share more effective? Include existing coal boilers in the scheme?
  - Instead of set of set-asides, would pooling technologies be more effective?
  - Should all eligible generators receive the same allocation per MWh of production or should different technologies get different allocation weights?
  - Other special issues.

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RFF Modeling of Bookend Scenarios

Six scenarios are described on the next page.

- Proposed Model Rule
  - New sources not covered under the cap (New Source Complements are not adopted). Shares of allowances are set aside for new renewables (5%) and existing NGCC (~5%) to be distributed according to updated shares of generation (output based allocation). Remaining allowances (~90%) are allocated based on historic emissions (grandfathering).
- 100 Percent Updating Allocation without New Source Complements
  - Four scenarios are similar to the Proposed Model Rule scenario with the share of allowances that is allocated by updating output-based allocation increased to 100%. The scenarios vary by the technologies eligible to earn allowances and by the existence of technology-specific set-asides vs. combining eligible technologies within a single allowance pool.
- New Source Complements
  - Cover all affected and new NGCC units and include New Source Complements. All allowances are allocated based on historic emissions (grandfathering).

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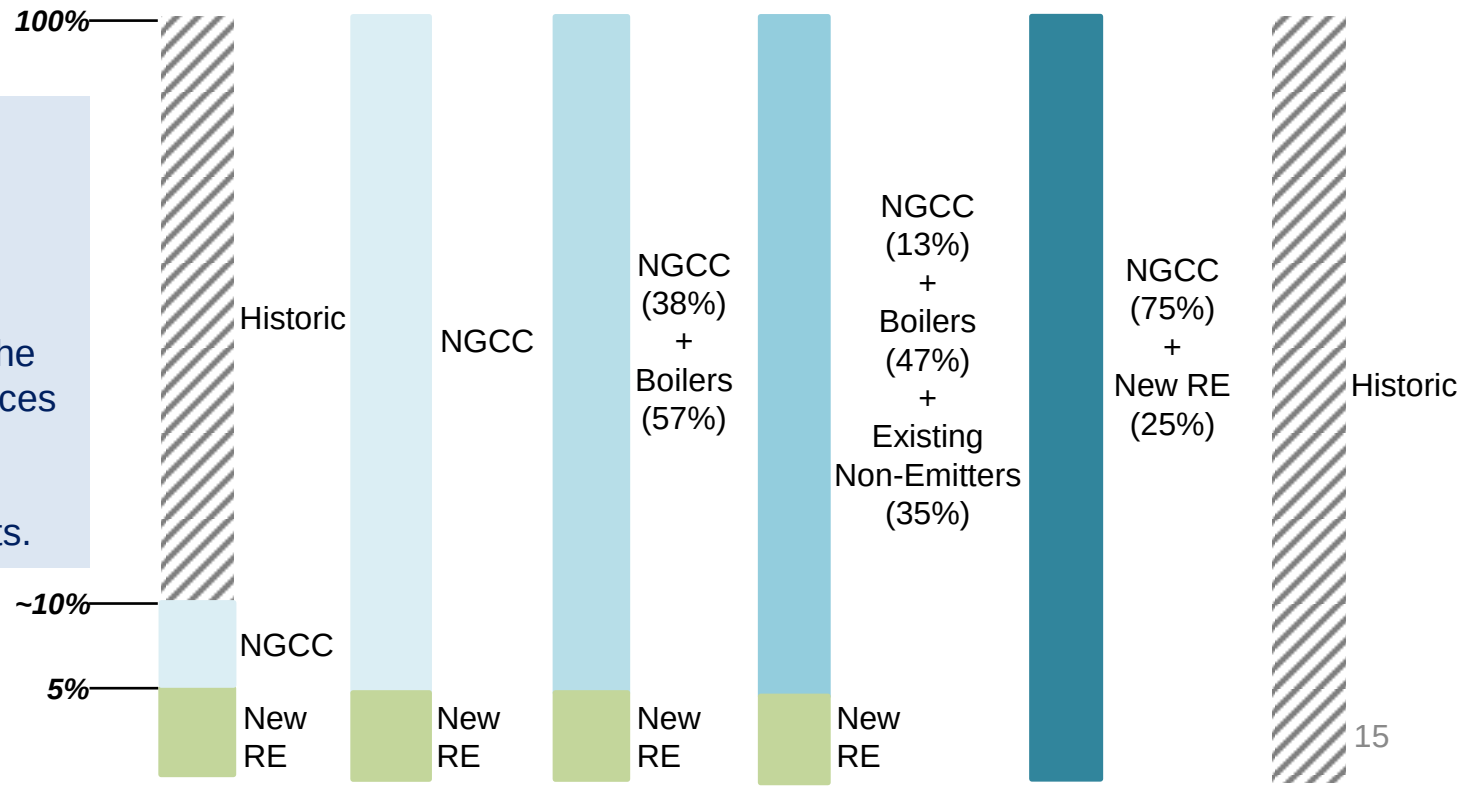
100 Percent Updating Allocation Scenarios (2030)

	Proposed Model Rule	Alternative Updating Approaches				New Source Complements
Covered Sources:	Existing NGCC & Boilers					All NGCC & Boilers
Updating Share:	~10%	100%				0%
New Renewables:	5% Set-Aside				Pooled	
Existing Sources Eligible for Allocation:	NGCC	NGCC	Affected EGUs	All	NGCC	

Solid colored bars represent updating allocation.

Percentages (in parentheses) indicate the fraction of total allowances earned by each technology. These are model results, not inputs.



Results for 100 Percent Updating Allocation (2030)

		Proposed Model Rule	Alternative Updating Approaches				New Source Complement
	Covered Sources:	Existing NGCC & Boilers					All NGCC & Boilders
	Updating Share:	~10%	100%				0%
	New Renewables:	5% Set-Aside				Pooled	
	Existing Sources Eligible for Allocation:	NGCC	NGCC	Affected EGUs	All	NGCC	
Generation (TWh)	Existing Boilers	1,405	1,205	1,253	1,410	1,249	1,148
	Existing NGCC	469	965	870	455	860	573
	New NGCC	735	337	385	732	384	742
	New Wind	147	203	220	160	241	206
Emissions (M tons)	Existing Boilers	1,464	1,244	1,290	1,470	1,293	1,180
	+ Existing NGCC	203	422	377	197	373	247
	= Affected EGUs	1,667	1,667	1,667	1,666	1,666	1,427
	+ New NGCC	278	128	146	277	146	281
	= Total	1,946	1,794	1,812	1,943	1,812	1,708
	Leakage (M tons)	238	86	104	235	104	-
	Leakage Reduction ()	-	64%	56%	1%	56%	-
	Allowance Price ($/ton)	4	7	20	4	5	17
	Electricity Price ($/MWh)	102	105	104	102	104	106

Leakage Reduction is percent reduction from Leakage under Proposed Model Rule compared to coverage of existing affected and new sources using the New Source Complements.

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Updating Allocation Mitigates Leakage (2030)

All 100% updating scenarios reduce total emissions compared to the Proposed Model Rule (10% updating, 90% historic). Given our model assumptions, leakage mitigation is 1%-64%.

None of these allowance allocation schemes completely achieve emissions equivalence.

As noted elsewhere, other policy measures (such as programmatic energy efficiency) can further mitigate leakage.

		Proposed Model Rule	Alternative Updating Approaches				New Source Complement
	Covered Sources:	Existing NGCC & Boilers					All NGCC & Boilders
	Updating Share:	~10%	100%				0%
	New Renewables:	5% Set-Aside				Pooled	
	Existing Sources Eligible for Allocation:	NGCC	NGCC	Affected EGUs	All	NGCC	
Generation (TWh)	Existing Boilers	1,405	1,205	1,253	1,410	1,249	1,148
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Existing/New NGCC Substitution (2030)

The primary leakage mitigation pathway is substituting generation from existing NGCC for new NGCC.

Inclusive approaches, when boilers are eligible or when new RE is pooled with NGCC, are nearly as effective at mitigating leakage as making only NGCC eligible for non-set-aside allowances.

Eligibility also for existing non-emitting ("All") is less effective because those sources[1] are not responsive to the incentive from updating allocation. This approach waters down the incentive directed to other technologies.

		Proposed Model Rule	Alternative Updating Approaches				New Source Complement
	Covered Sources:	Existing NGCC & Boilers					All NGCC & Boilders
	Updating Share:	~10%	100%				0%
	New Renewables:	5% Set-Aside				Pooled	
	Existing Sources Eligible for Allocation:	NGCC	NGCC	Affected EGUs	All	NGCC	
Generation (TWh)	Existing Boilers	1,405	1,205	1,253	1,410	1,249	1,148
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	Leakage Reduction ()	-	64%	56%	1%	56%	-
	Allowance Price ($/ton)	4	7	20	4	5	17
	Electricity Price ($/MWh)	102	105	104	102	104	106

1. Our modeling finds no nuclear plant retirement even in the baseline. If they would retire in the absence of the CPP, then an updating allocation to nuclear plants could prevent that retirement.

Electricity and Allowance Prices (2030)

Electricity prices rise as leakage is mitigated, but by less than 3% compared to the Proposed Model Rule.

Allowance prices are elevated when boilers are eligible, but electricity prices are not. This is because all of the allowance value, which is highest when boilers are eligible, is returned to the power sector. This offsets the cost of an elevated price on emissions.

		Proposed Model Rule	Alternative Updating Approaches				New Source Complement
	Covered Sources:	Existing NGCC & Boilers					All NGCC & Boilders
	Updating Share:	~10%	100%				0%
	New Renewables:	5% Set-Aside				Pooled	
	Existing Sources Eligible for Allocation:	NGCC	NGCC	Affected EGUs	All	NGCC	
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	Allowance Price ($/ton)	4	7	20	4	5	17
	Electricity Price ($/MWh)	102	105	104	102	104	106

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Summary of 100 Percent Updating Approaches

1. Updating allocation is effective at reducing leakage to new sources compared to distributing allowances on an historic basis.
2. Expanding eligibility for updating allocation to include all affected sources (including coal) only slightly increases emissions. This expansion would elevate allowance prices without necessarily raising average production costs for affected sources or retail electricity prices.
3. Expanding eligibility for updating allocation to include existing non-emitting generators is not an effective leakage remedy.
4. Pooling the allowances distributed on an updating basis to existing fossil and new renewables generating units may yield slightly more new renewables and slightly greater emissions from new fossil sources.
5. National average retail electricity prices in 2030 increase typically by less than 3% from the Proposed Model Rule in all scenarios that expand updating allocation to reduce leakage.

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An Expanded Set of Scenarios

- In this section **we consider a range of updating allocation shares** under both the pooled and set-aside approaches described above to study the effects of incremental changes in the number of allowances being allocated through updating to existing natural gas units.
- We also explore the consequences of **weighted allocations** where the number of allowances awarded per MWh of generation differs across technologies in a way that tries to map to the incentives under BSER.
  - The first approach uses the BSER emission rate goals for coal, gas and non-emitting as inverse weights to yield the following allocation weights in 2030:
    - RE: 1
    - Gas: Interim – (1534-832)/1534=0.458 Final – (1305-771)/1305=0.409
    - Coal: 0.
  - The second approach takes the production incentive outcomes from the dual-emissions rates BSER scenario, in the form of emissions allowances earned per MWh, which vary according to individual generator's emissions rates to define the following allocation weights in 2030:
    - RE: 0.57. (The allowances earned by a new MWh of non-emitting generation.)
    - Gas: 0.34-0.42. (This accounts for gas shift ERCs awarded to existing gas generation).
    - Coal: 0.69-0.72.
- Note the Proposed Model Rule sets aside allowances for existing NGCC and new renewables but applies no weighting otherwise. The weighting considered here would introduce another difference from the proposal.

Expanded Scenario Specifications

We model 20 scenarios, described in four rows and five columns below, that vary the magnitude and form of updating allocation with the following characteristics:

1. Set asides for existing NGCC and new RE, pooled eligibility , included eligibility for boilers and 2 versions of weighting.
2. Share of allowances allocated by updating varies : 10%, 23%, 70%, 100%, 100%.

In previous results we described the 10% and 100% cases. Here we present intermediate outcomes and other observations.

Updating Share:	10%	23%	70%	100%	
Set-Asides	5%: RE 5%: NGCC *90%: Historic*	5%: RE 18%: NGCC *77%: Historic*	5%: RE 65%: NGCC *30%: Historic*	5%: RE 95%: NGCC *0%: Historic*	5%: RE 95%: NGCC, Boilers *0%: Historic*
Pooled Eligibility w/ Uniform Weights	10%: RE, NGCC *90%: Historic*	23%: RE, NGCC 77%: Historic	70%: RE, NGCC *30%: Historic*	100%: RE, NGCC *0%: Historic*	100%: RE, NGCC, Boilers *0%: Historic*
Weights 1: (BSER Goals)	10%: RE, NGCC *90%: Historic*	23%: RE, NGCC 77%: Historic	70%: RE, NGCC *30%: Historic*	100%: RE, NGCC *0%: Historic*	N/A
Weights 2: (BSER Outcomes)	10%: RE, NGCC *90%: Historic*	23%: RE, NGCC 77%: Historic	70%: RE, NGCC *30%: Historic*	100%: RE, NGCC *0%: Historic*	100%: RE, NGCC, Boilers *0%: Historic*

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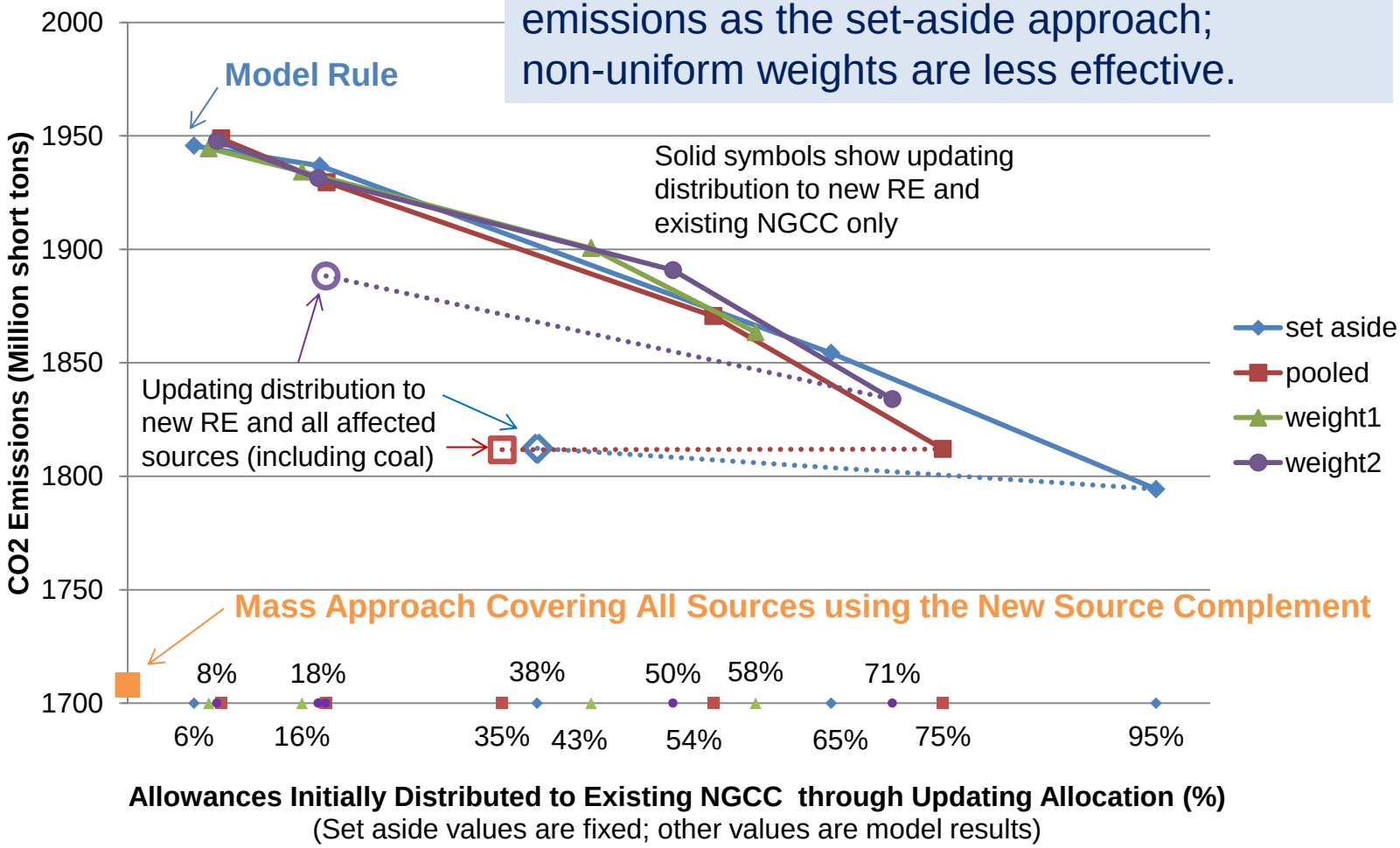
CO_2 Emissions from Affected EGUs + New NGCCs (2030)

Pooling can be nearly as effective at reducing emissions as the set-aside approach; non-uniform weights are less effective.



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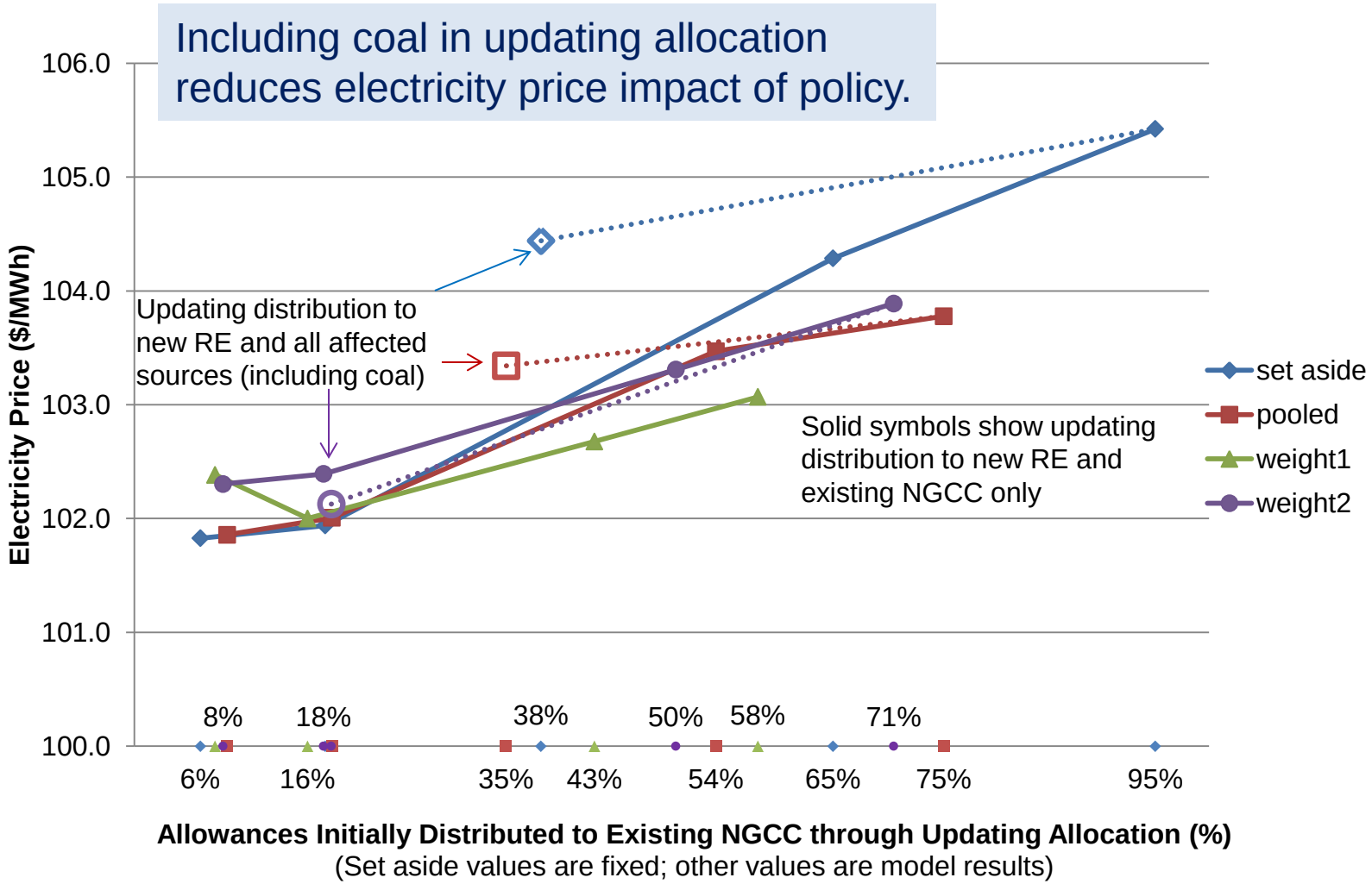
Electricity Price (2030)



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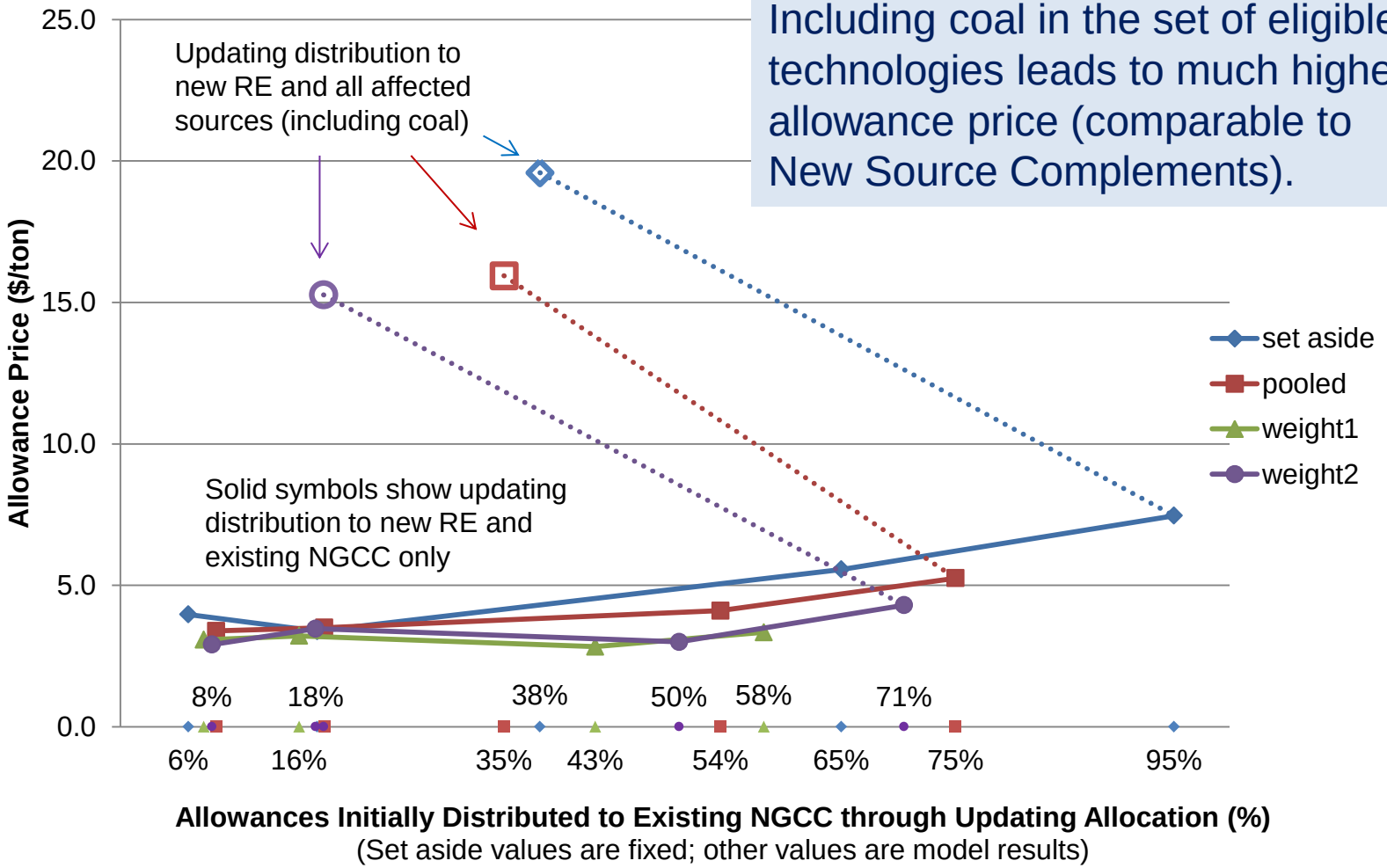
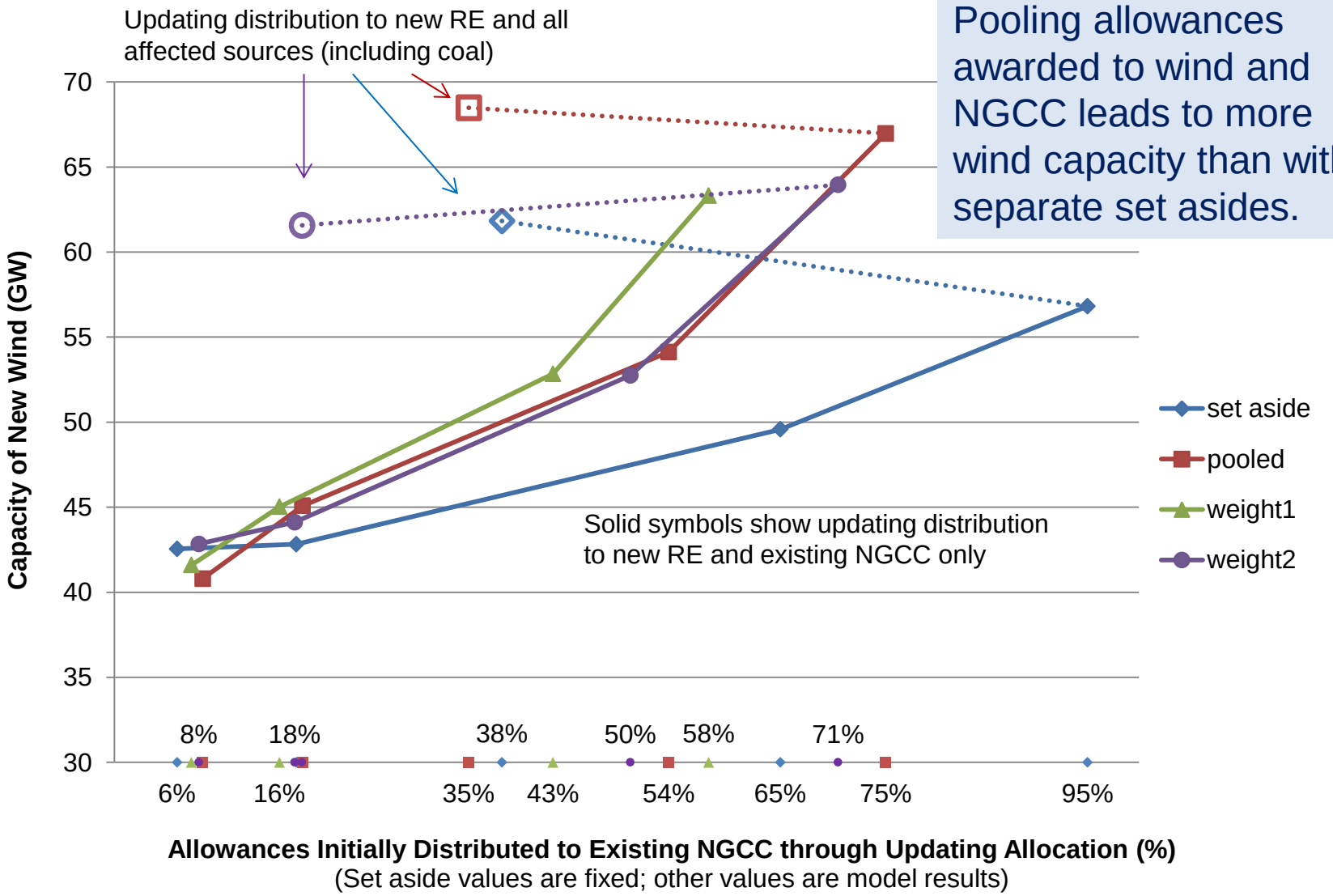
Allowance Price (2030)

Including coal in the set of eligible technologies leads to much higher allowance price (comparable to New Source Complements).



Capacity of New Wind (2030)



Pooling allowances awarded to wind and NGCC leads to more wind capacity than with separate set asides.

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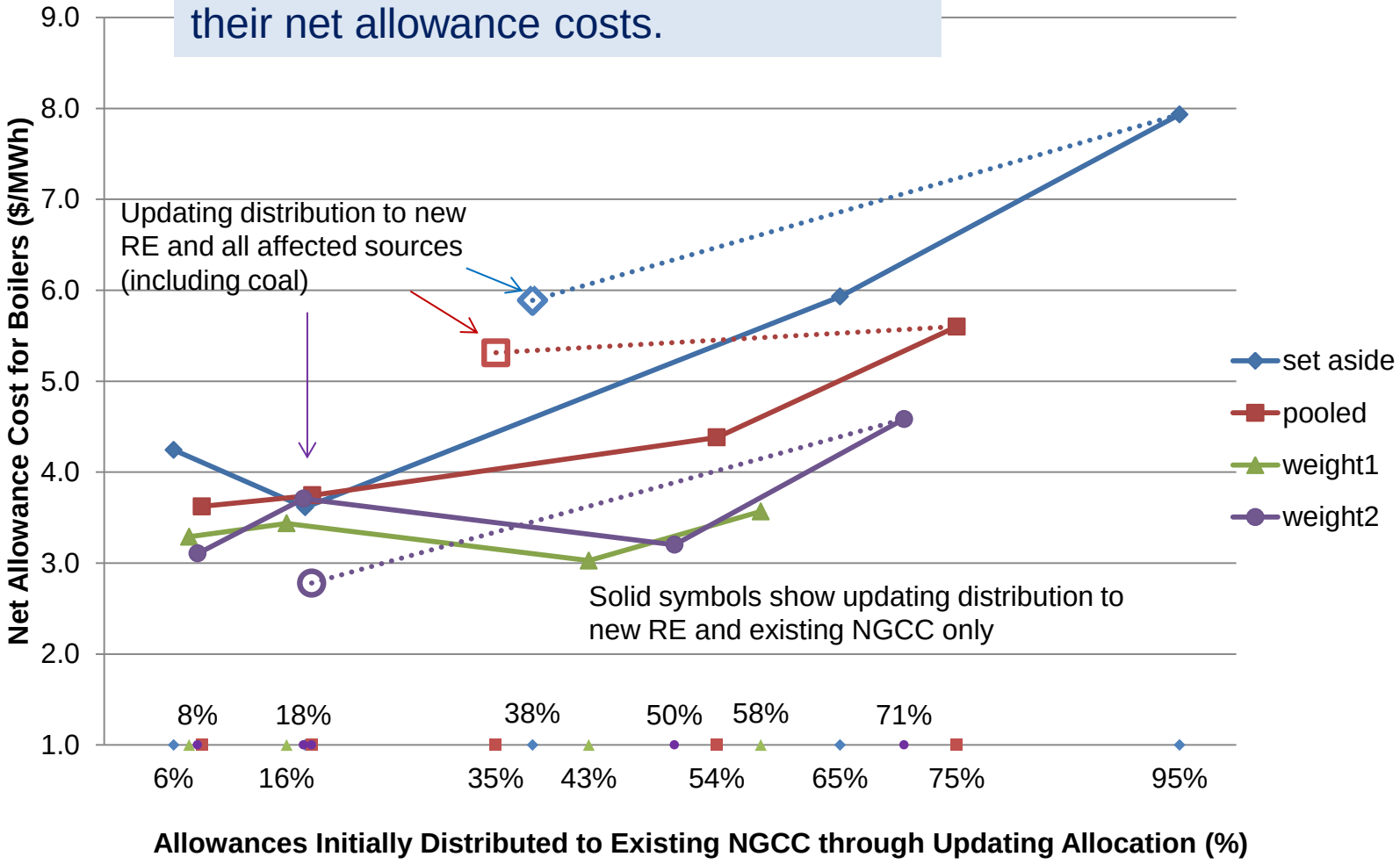
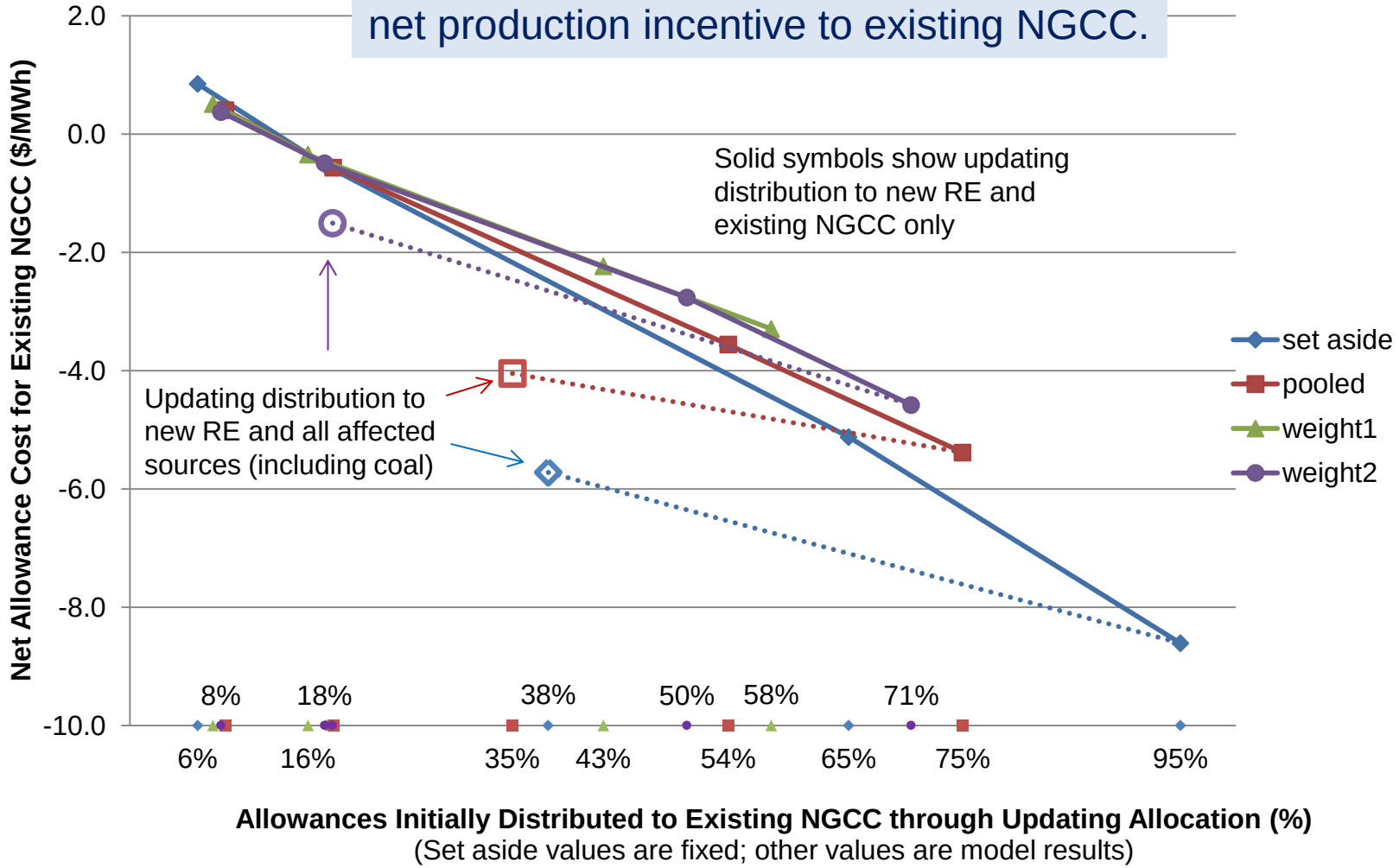
Net Allowance Cost for Boilers (2030)

Allocating allowances to coal reduces their net allowance costs.



Net Allowance Cost for Existing NGCC (2030)

Allocating allowances to coal reduces the net production incentive to existing NGCC.



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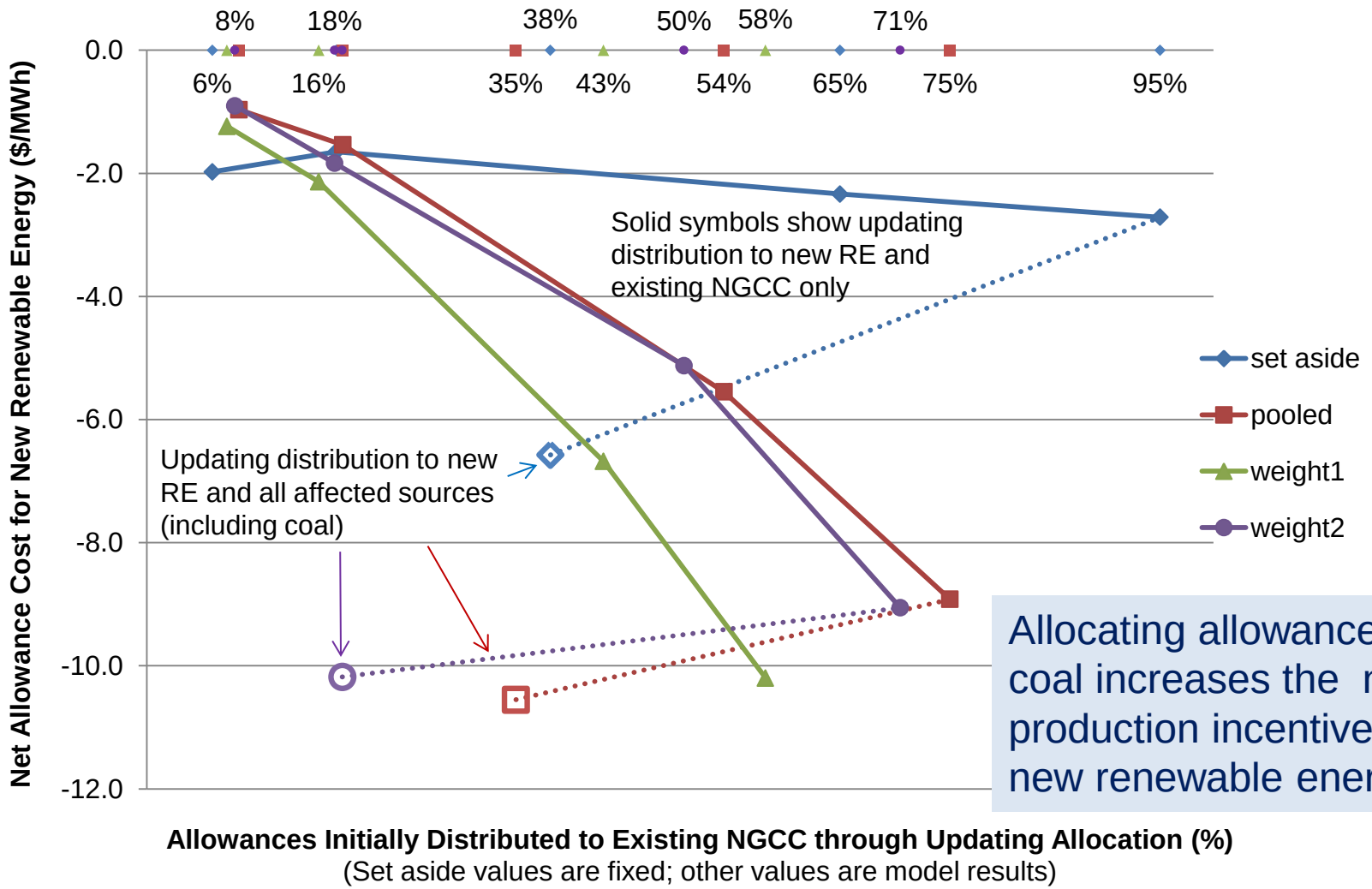
Net Allowance Cost for New Renewable Energy (2030)



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Additional Scenarios (1)

We have explored several other approaches:

- Expanded eligibility to include existing non-emitting units
  - A) 5% Set aside for new RE; 95% pooled for all existing generation.
  - B) Pooled 100% to new RE and all existing generation.
  - ❖ In both cases this approach diverts a significant share of allowance value to technologies that have little opportunity to change utilization (hydro, existing wind and nuclear). This approach has an effect on the profitability of these technologies, but the technological outcome is similar to grandfathering the same portion of allowances to any group of generators.
  - ❖ Note that existing non-emitting sources receive an effective production subsidy under the program even if they do not receive a share of emissions allowances. The anticipated change in the national average retail price of $2-3/MWh is an increase in revenue to these sources without an associated increase in cost.

Additional Scenarios (2)

- Greater Level of Energy Efficiency
  - This approach reduces the financial return to new natural gas units and results in lower emissions.
- Allocation to Local Distribution Companies
  - This approach directs allowance value that was grandfathered in another scenario to consumers. In cost-of-service regions this is almost exactly the same as grandfathering, however it leads to a noticeably different outcome with lower retail electricity prices in competitive regions resulting in slightly greater demand and leakage.
- Delay in Awarding Allowances
  - A delay between the generation activity that earns an allocation and the receipt of an allowance lowers its value as a production incentive, leading to less generation from existing NGCC and more generation from new NGCC. Although not considered in our model, it also introduces uncertainty about the value of the allowance and further lowers the incentive to generate.

Our Bottom Line (1)

What recommendations would we give to EPA to address leakage?

1. Include the New Source Complements in the model rule.

Otherwise,

2. Expand the portion of allowances distributed through updated information about a unit's share of generation.
3. Reconsider the definition of sources eligible to receive allocation using updating. For example, including eligibility for all existing affected and new non-emitting units has a small effect on emissions and may have a policy or legal advantage by treating all affected sources symmetrically.

Our Bottom Line (2)

Additional recommendations to address leakage and improve the implementation of the Clean Power Plan.

If the mass-based model rule does not require inclusion of new sources:

4. Consider programmatic energy efficiency in state compliance plans as a measure to reduce leakage.
5. Affirm the agency's commitment to timely re-evaluation of the new source performance standard according to the schedule described in statute or sooner, based on technological developments.
6. Reduce the delay when using allocation based on updated information about generation shares.
7. For any allowances not based on updated information about generation shares, a distribution to local distribution companies rather than generators would protect consumer interests in competitive regions.
8. In separate analysis we recommend a requirement for revenue-neutral consignment sales of allowances that are distributed based on historic generation shares to ensure equal access to allowances for all affected sources.