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Preliminary Modeling of the Final Clean Power Plan

MSEER MEETING
LITTLE ROCK, ARKANSAS
OCTOBER 20, 2015

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"Phase I" Modeling Effort

"PHASE I" MODELING

- The "Phase I" modeling effort is intended to provide preliminary modeling results while updates to IPM are being made. These updates will allow us to model more features of the Final Clean Power Plan (CPP)

- "Phase I" runs can provide high-level insights into the impacts of the final rule

- "Phase I" results are focused on mass-based runs because IPM needed significant updates to represent the rate-based policy, including the national, technology-specific standard

- "Phase II" results will include the full suite of core and sensitivity modeling runs that we have discussed in the past

"PHASE I" MODELING

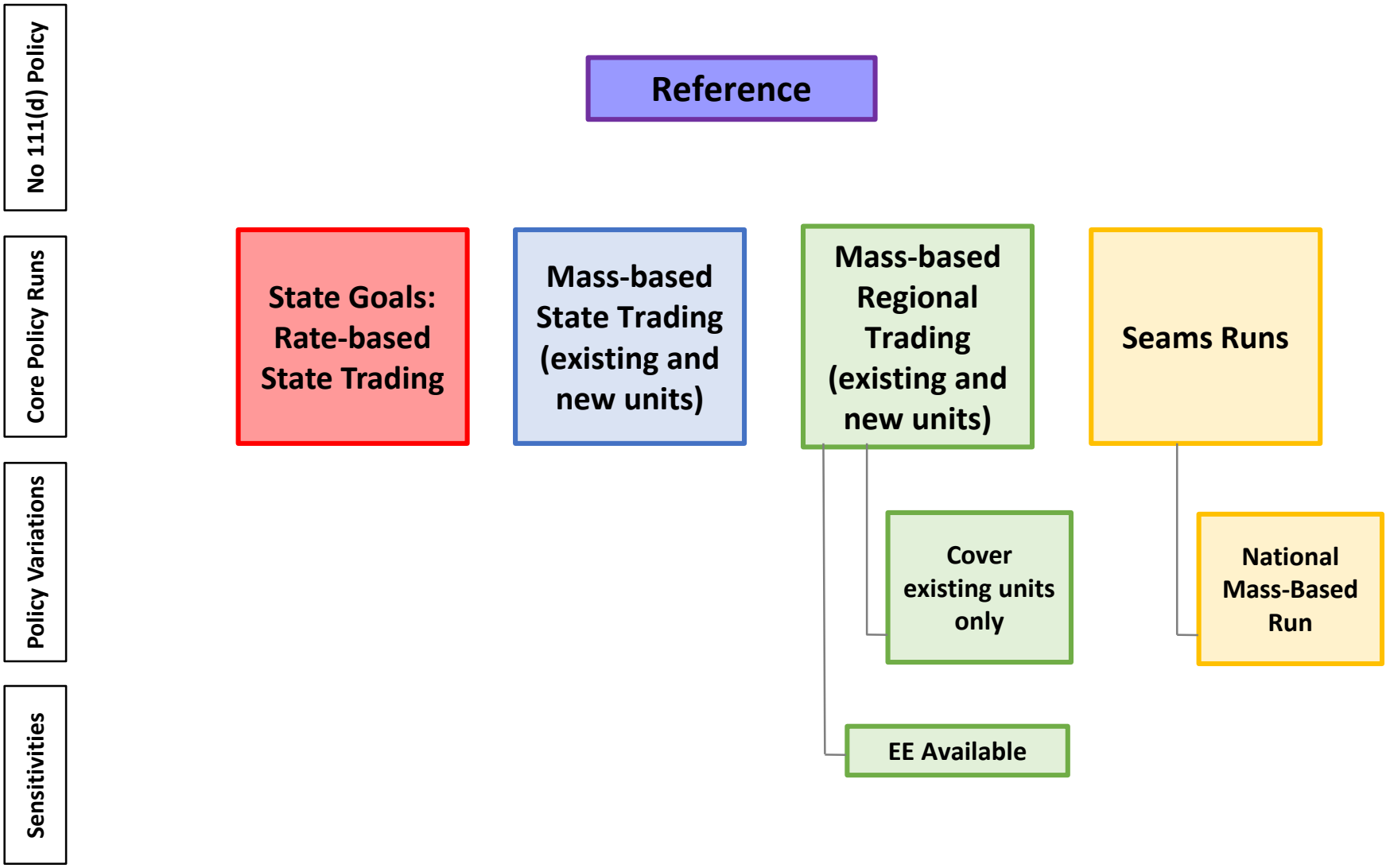
PHASE I

- Launched in September 2015
- Based on the same IPM modeling structure used for post-proposal modeling
- Models the new emission goals from the final CPP
- Incorporates many, but not all, updated modeling assumptions
- Includes limited core runs and sensitivities

PHASE II

- To be launched ASAP
- Based on a new IPM modeling structure designed to more accurately model the final CPP
- Models the new emission goals for the final CPP
- Incorporates all updated modeling assumptions
- Includes the full suite of core runs and sensitivities, including state and regional rate-based runs

"PHASE I" MODELING



* Note: We have also reviewed EPA's RIA modeling

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High-Level Insights

Key Insights

- The magnitude of impacts from the final CPP, including potential compliance costs, are dependent on state decisions yet to be made, as well as market factors, such as:
  - The availability of end-use energy efficiency (EE)
  - The treatment of new units
- There are benefits of multi-state collaboration and/or linked trading approaches
  - Adopting policy designs that allow access to emission reduction opportunities in other states tends to significantly lower the cost of compliance
- In all policy scenarios, coal and gas generation remain an important part of the generation and capacity mix

HIGH-LEVEL INSIGHTS

Key Insights continued…

- There is potential leakage when new units are not included under the mass-based goal.
  - Excluding new NGCC units:
    - Incentivizes the building of new NGCC units
    - Decreases the capacity factors of existing NGCC units.
- Including end-use efficiency (EE) as a compliance option decreased wholesale electricity price and cost impacts and decreased coal retirements.

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Preliminary Modeling Results

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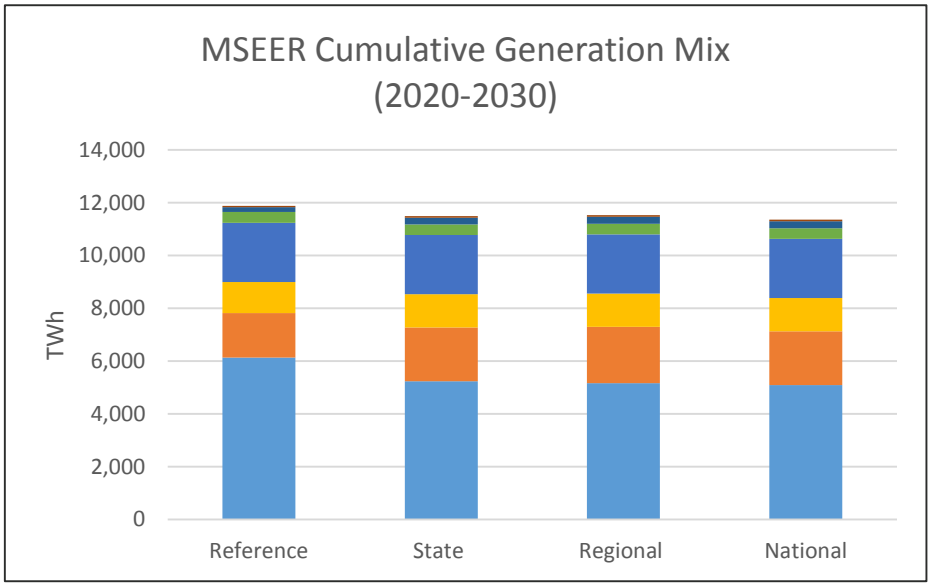
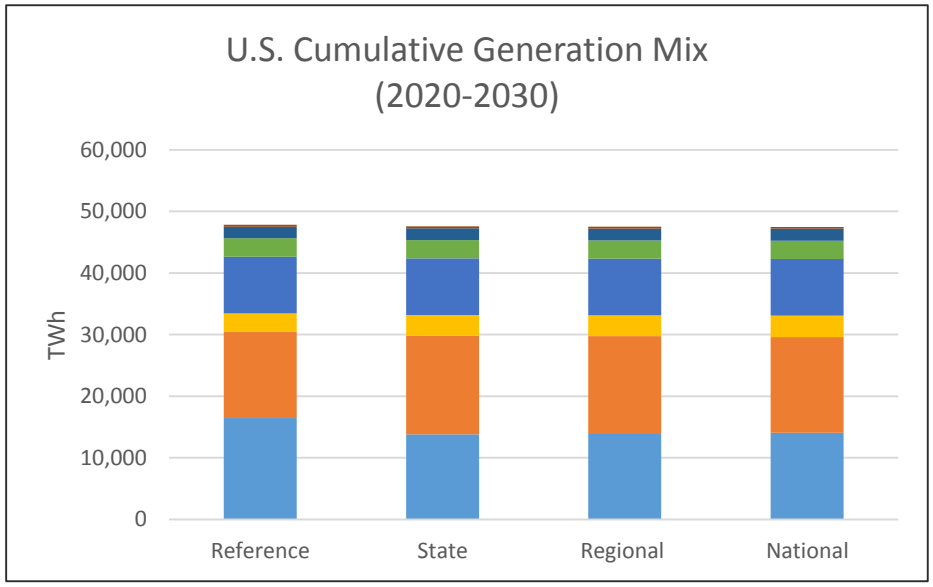
Generation/Capacity

GENERATION/CAPACITY

Cumulative Generation Mix

- In policy scenarios, coal and gas generation remain a key part of the generation mix
- As trading boundaries expand, renewable generation increases.
  - In MSEER, total renewables under state trading increase 13% over reference, regional trading increase 14%, and under national trading increase 15%.
  - In U.S., total renewable under state trading increase 9% over reference, regional trading increase 10%, and under national trading increase 13%.



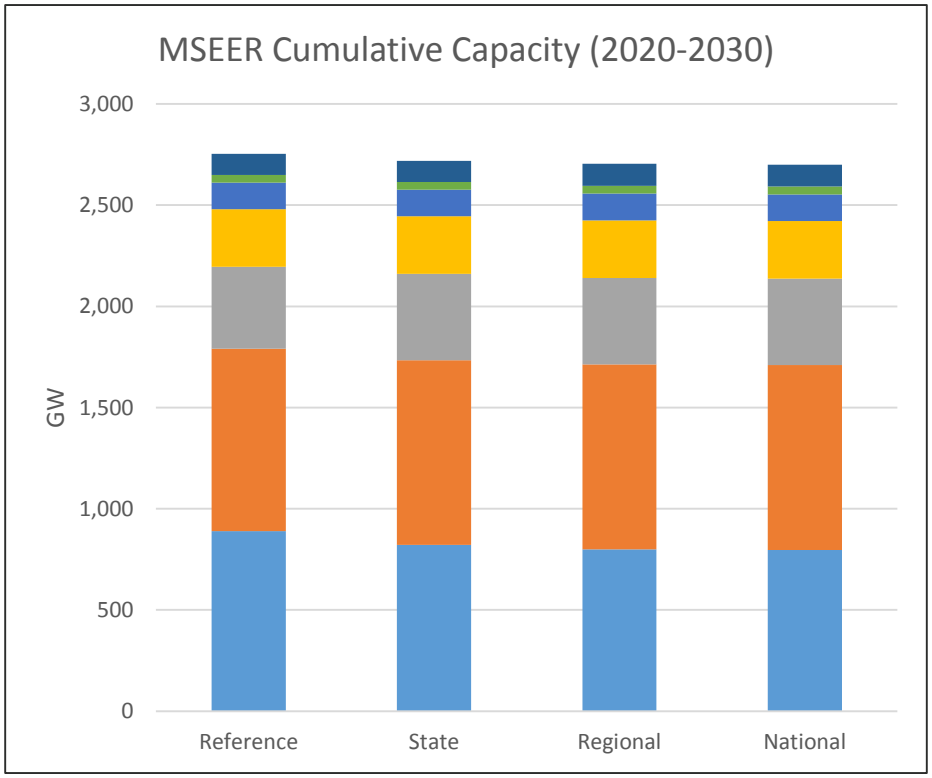


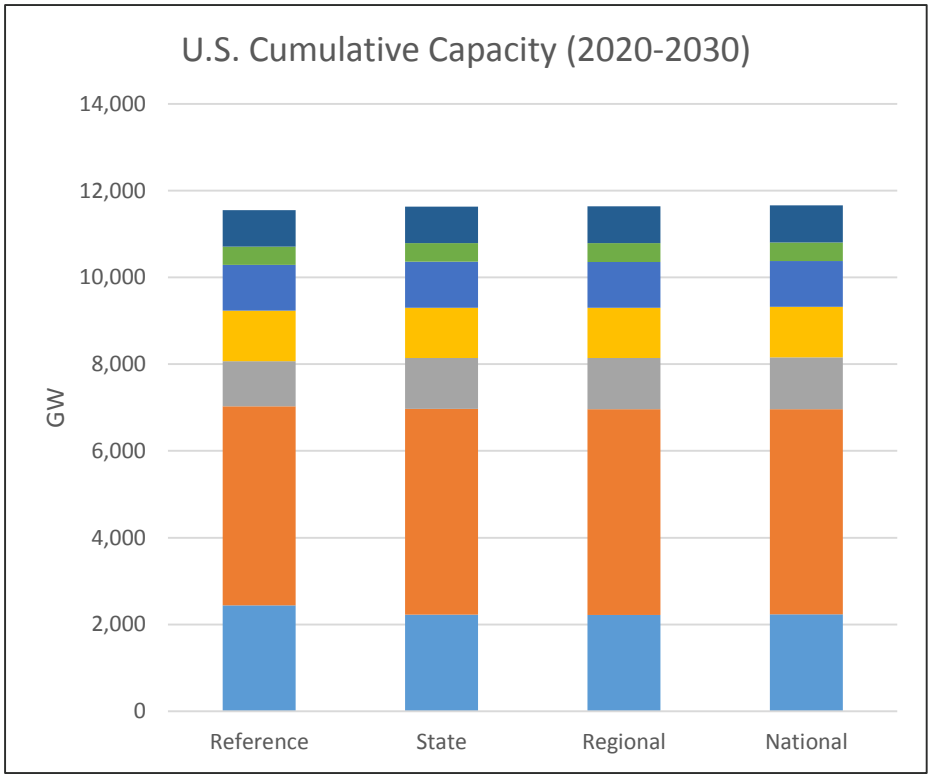
Coal Gas EE Wind Nuclear Hydro Other RE Other

GENERATION/CAPACITY

Cumulative Capacity Mix

- Capacity trends mirror trends in generation





Coal Gas Wind Nuclear Hydro Other RE Other

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Costs/Prices

COSTS

Components of Total Adjusted Cost (TAC):

- Total System Cost (TSC): Includes all costs associated with generation, such as new capacity, fuel, and other operating & maintenance costs, as well as compliance costs such as the utility portion of end-use energy efficiency. For a state, this includes in-state generation only.
- EE Participant costs: We assume 55% of the total resource cost of an end-use energy efficiency measure is born by the utility and 45% of the cost is paid by the consumer/participant. While the utility portion is included in TSC, and thus impacts wholesale electricity costs, the participant portion is a separate line item.
- Import/export adjustment: Some scenarios result in generation shifts between states/regions so that the cost of in-state generation may go down, while the cost of importing power goes up (or vice versa). To better account for total costs to deliver energy, this adjustment estimates the cost associated with changes in net electricity imports/exports. Because IPM uses regional (rather than state-level) electricity demand, state-level imports are estimated compared to the reference case.
- Net allowance/credit cost: The value of the net position in emission credits or allowances (i.e., to what degree is state a net buyer or seller of credits/allowances in a regional trading program). For state implementation, credits don't cross borders; thus this cost is zero. For regional scenarios, this nets to zero at the regional level.

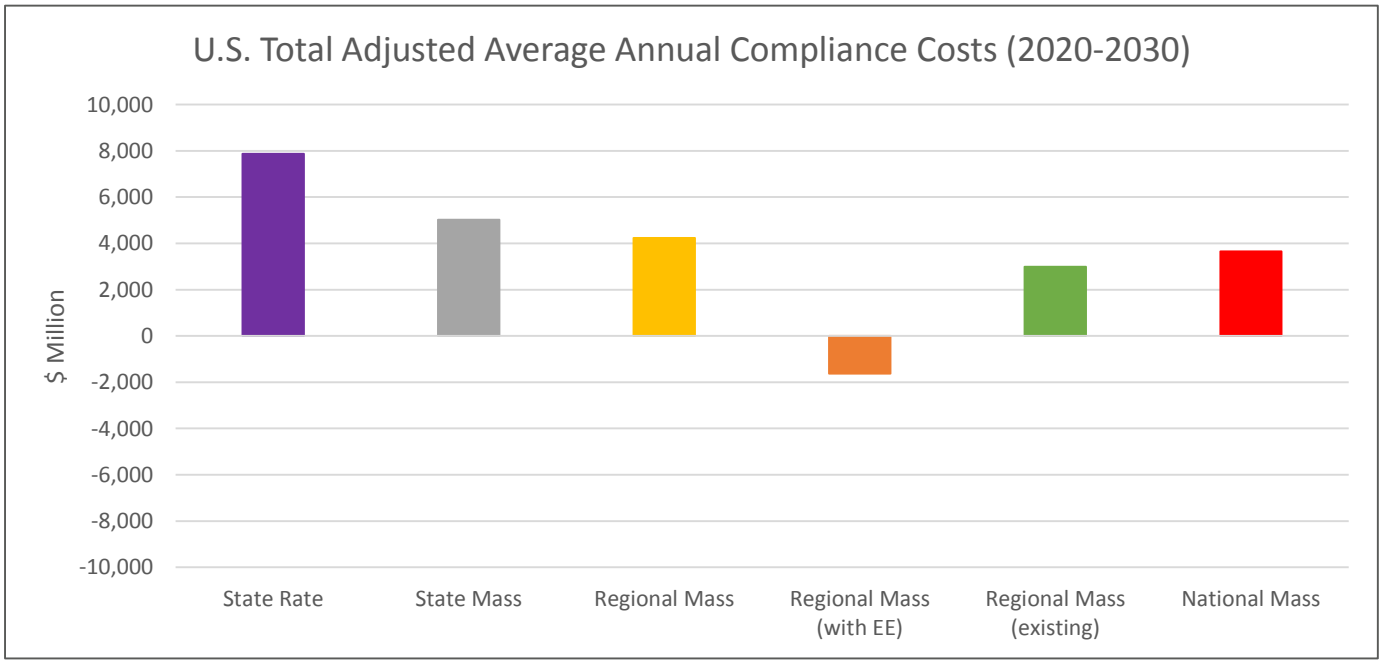
COSTS

Total Compliance Cost Cumulative for U.S.*

- Projected compliance cost in regional mass-based policy scenario *without end-use energy efficiency*:

  $5.1 Billion in 2025 and **$9 Billion in 2030** annually

- Wide range of costs predicted across scenarios depending on assumptions
  - With some negative costs depending on the treatment of end-use energy efficiency



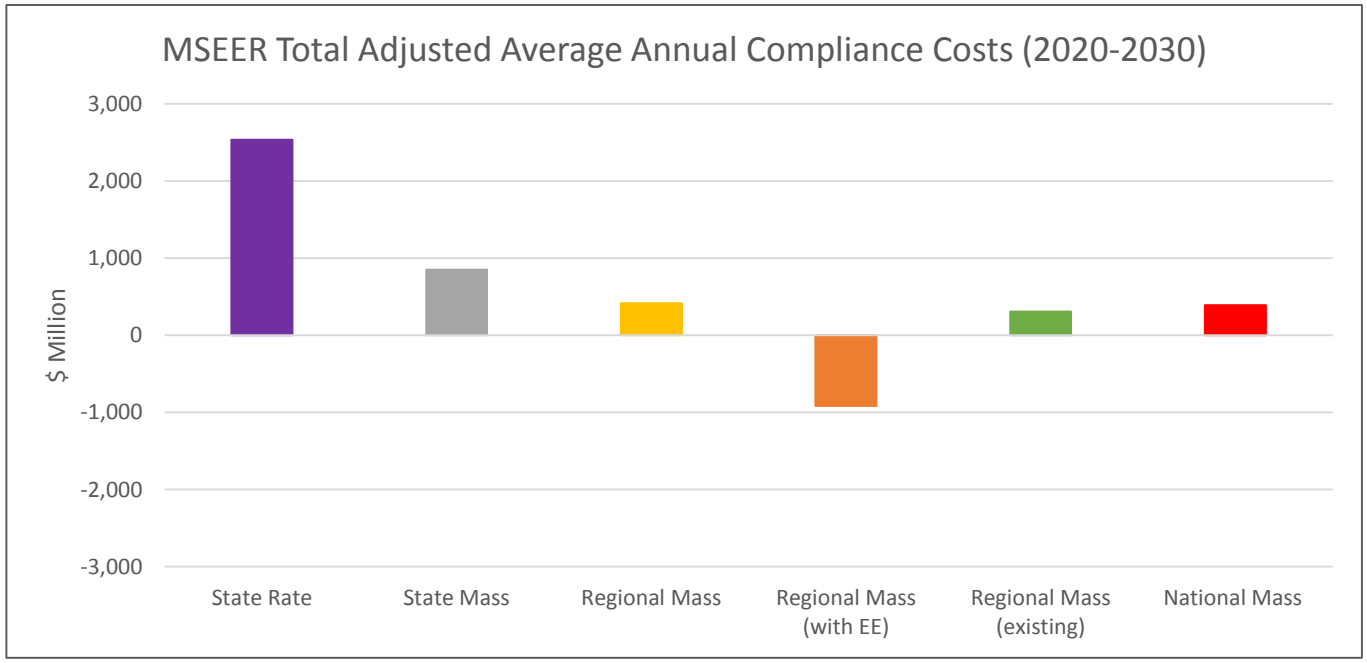
* IPM includes the continental U.S.; costs noted in the graph do not include Alaska and Hawaii

Total Compliance Cost Cumulative for MSEER

- Projected compliance cost in regional mass-based policy scenario *without end-use energy efficiency*:

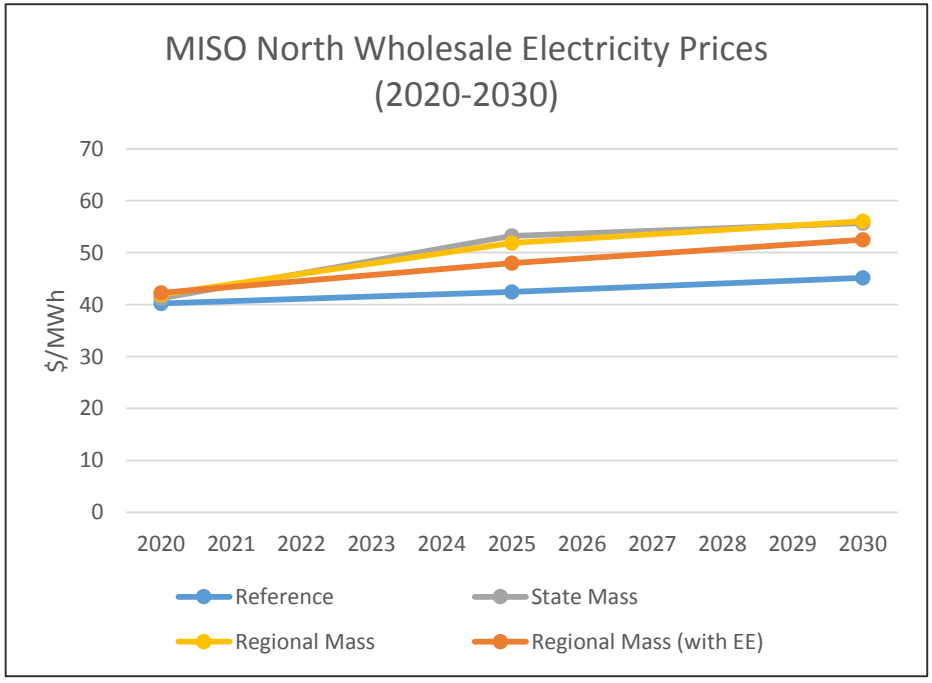
  $0.5 Billion in 2025 and **$1.5 Billion in 2030** annually

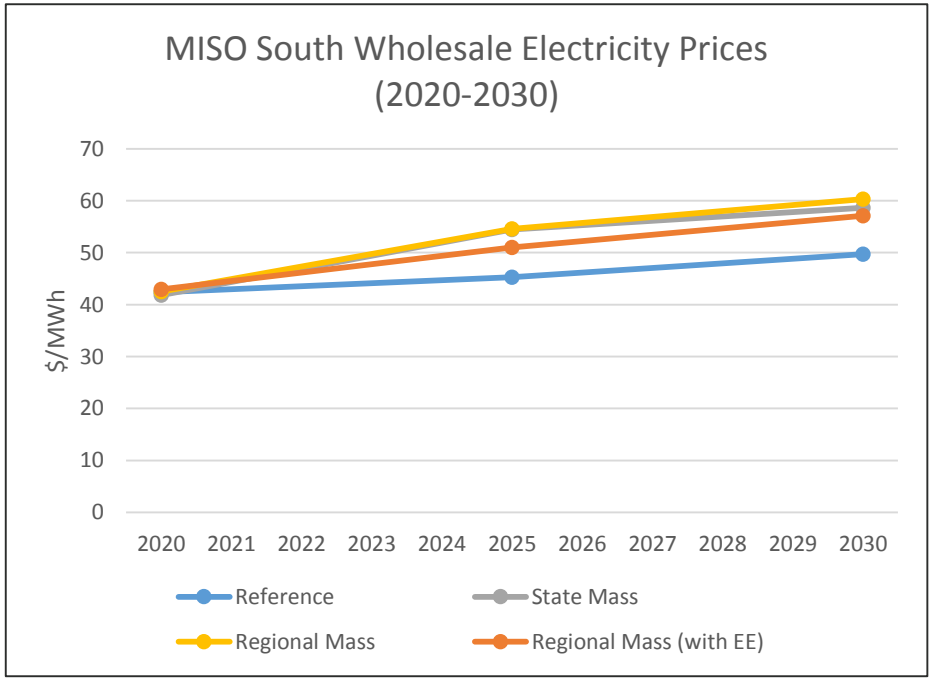
- Wide range of costs predicted across scenarios depending on assumptions
  - With some negative costs depending on the treatment of end-use efficiency



WHOLESALE ELECTRICITY PRICES

- Wholesale electricity prices in MISO North increase by 16%-24% in 2030 as compared to the Reference Case. MISO South prices increase by 15%-21%
  - Because other costs are included in retail rates, retail impacts are not expected to be as much
- The smallest price increase occurs in the regional mass case with EE
- Trends in MISO North and South mirror those seen in aggregate across the country





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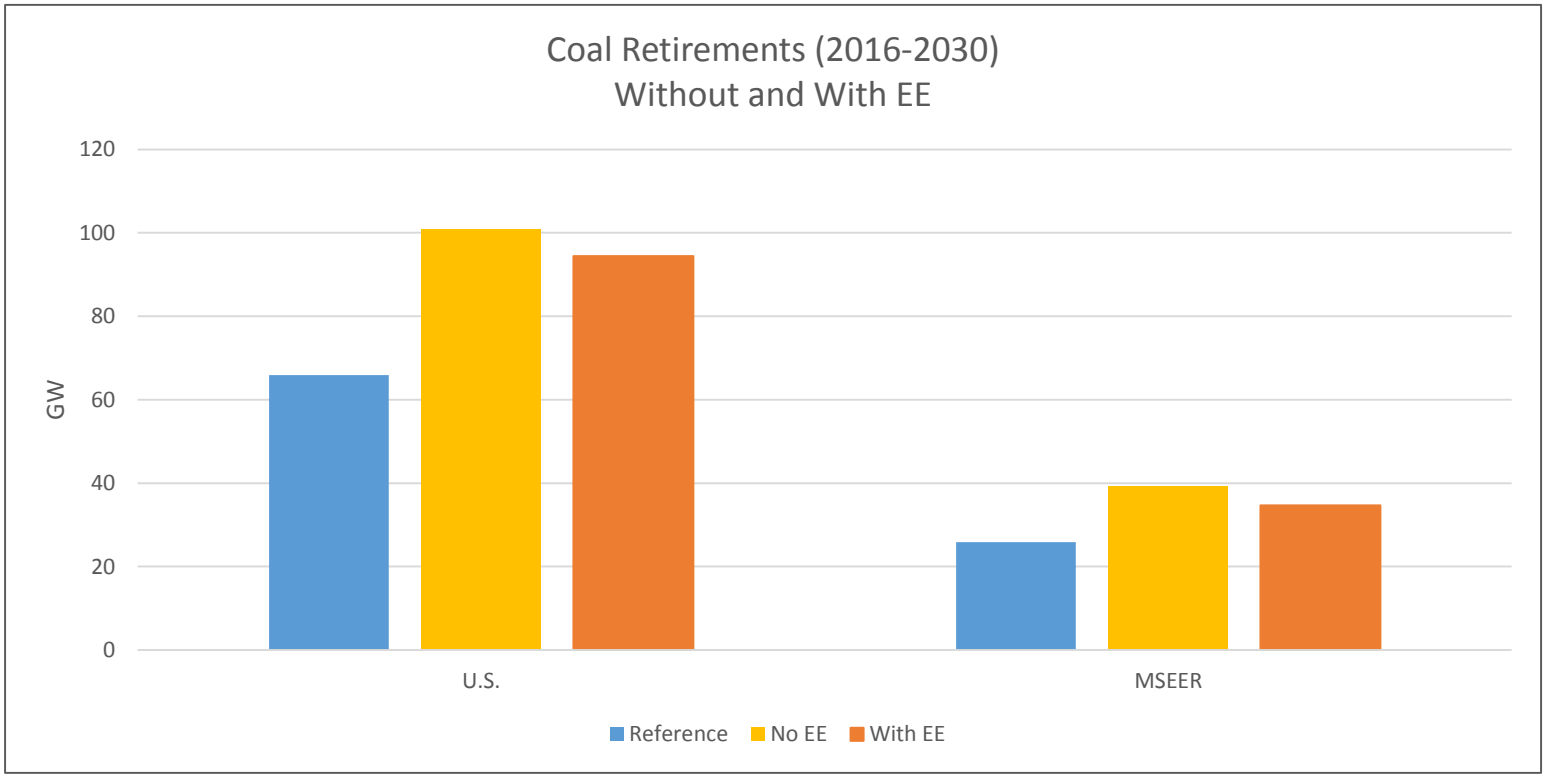
Energy Efficiency

Impact of EE on Coal Retirements

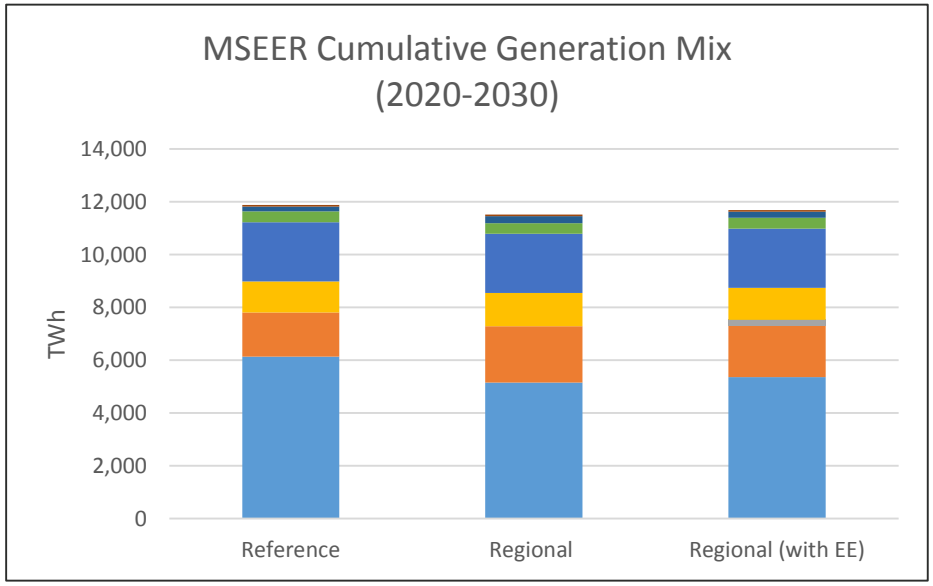
- Given availability/cost assumptions, policies that incentivize additional end-use energy efficiency are projected to lead to:
  - cost savings in the U.S. & MSEER.
  - fewer coal retirements in the U.S. and MSEER.

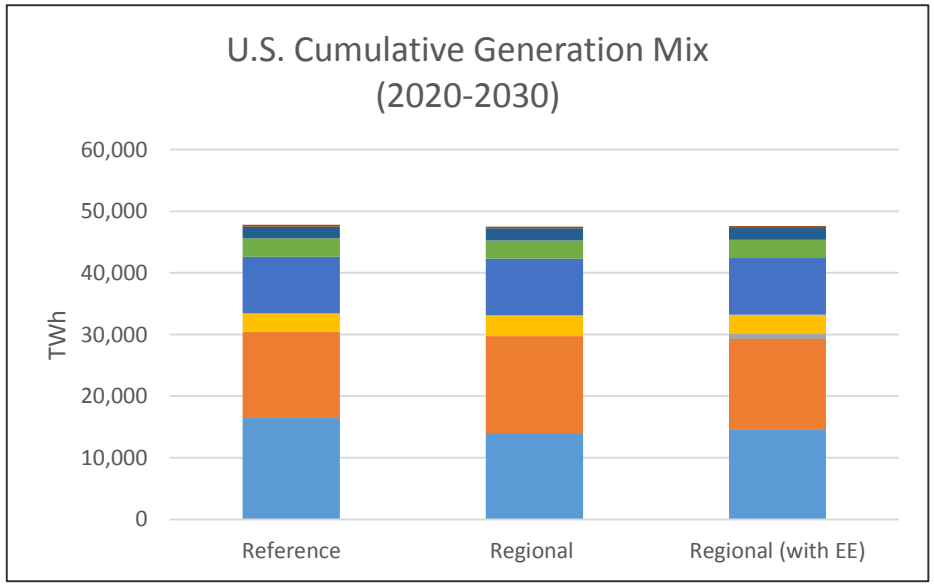


Scenarios shown above use regional mass-based goal and include new NGCC.

Cumulative Generation Mix

- Inclusion of policies that incent cost-effective EE influences the generation mix
  - While coal-fired generation in all policy cases is lower than reference case levels, more coal-fired generation occurs in scenarios that allow for additional end-use EE
  - More gas generation occurs in scenarios that restrict investment in additional EE
  - Due to increased gas demand, in 2030, Henry Hub gas prices are 4% higher in the run without end-use EE, as compared to the run with end-use EE.
  - Both state and regional scenarios have more renewable energy than Reference, with slightly more renewable energy in the MSEER and U.S. regional run



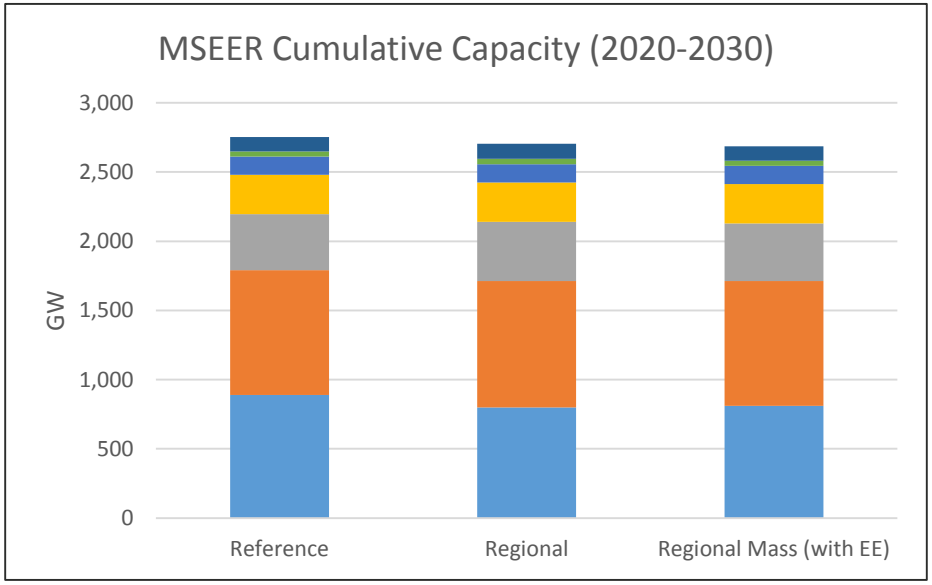


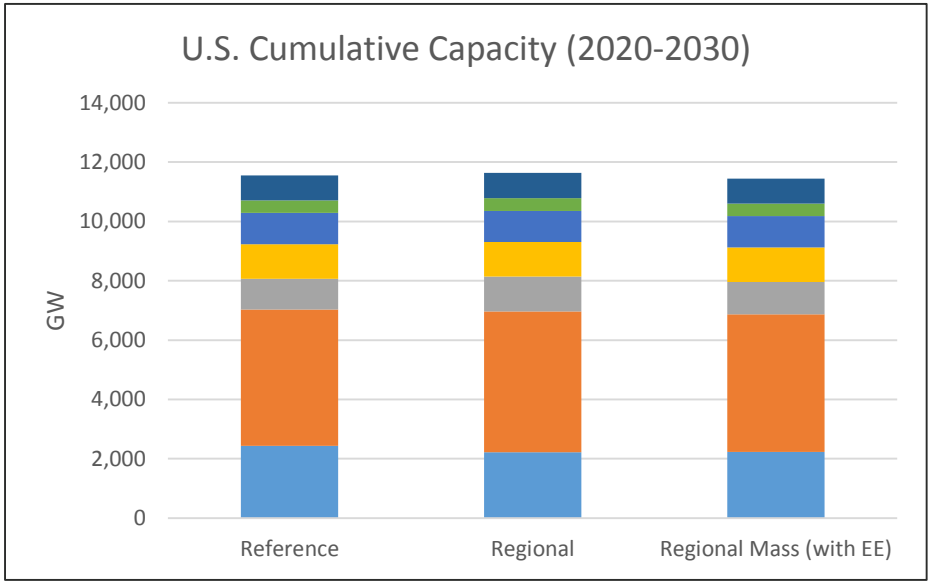
Coal Gas EE Wind Nuclear Hydro Other RE Other

ENERGY EFFICIENCY

Cumulative Capacity Mix

- Capacity trends mirror trends in generation
- When end-use EE investments are offered, capacity needs are reduced
- Compared to other policy scenarios, there is slightly more coal capacity, less gas capacity, and less wind capacity in the policy scenario that allows for additional investment in end-use EE





Coal Gas Wind Nuclear Hydro Other RE Other

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New Units

NEW UNITS

Leakage

- The final rule requires all mass-based plans to account for leakage, or the possibility of shifting generation from existing fossil units that are covered by the policy to new fossil units that are not covered by the policy

- EPA allows states to address in several ways

1. Including new sources in the program using EPA's "new source complement" budgets (based on AEO 2015 demand growth and NSPS emission rate for new NGCC)

2. Including new sources in the program using an alternate "new source complement" budget based on state growth projections

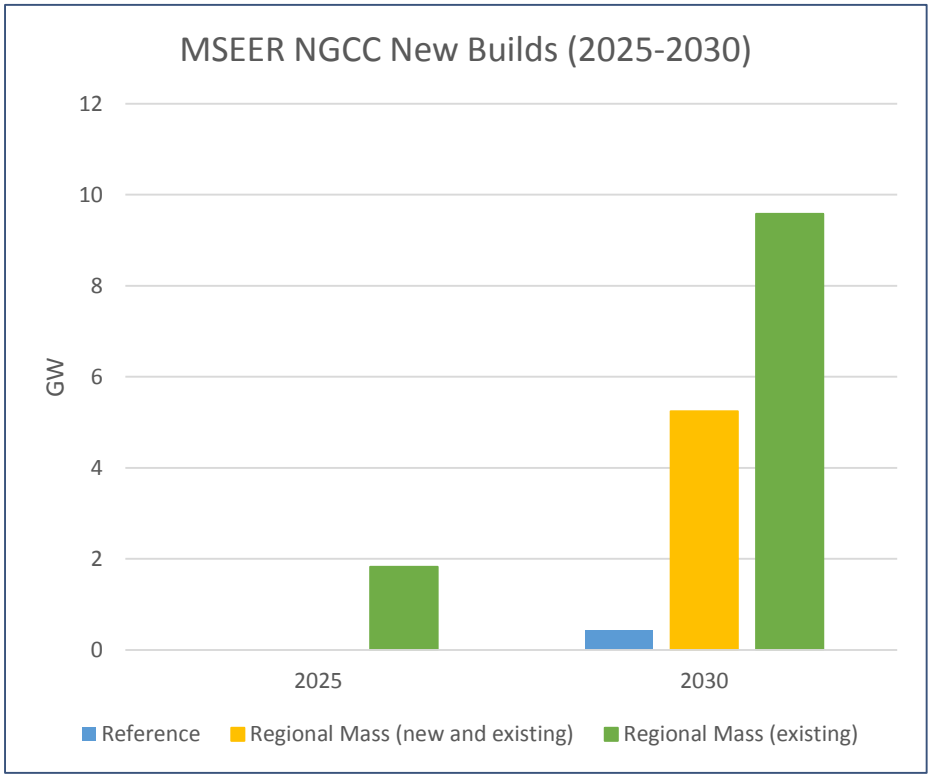
3. Accounting for leakage using an allocation method, such as updating output-based allocation for NGCC and an allowance set aside that targets RE

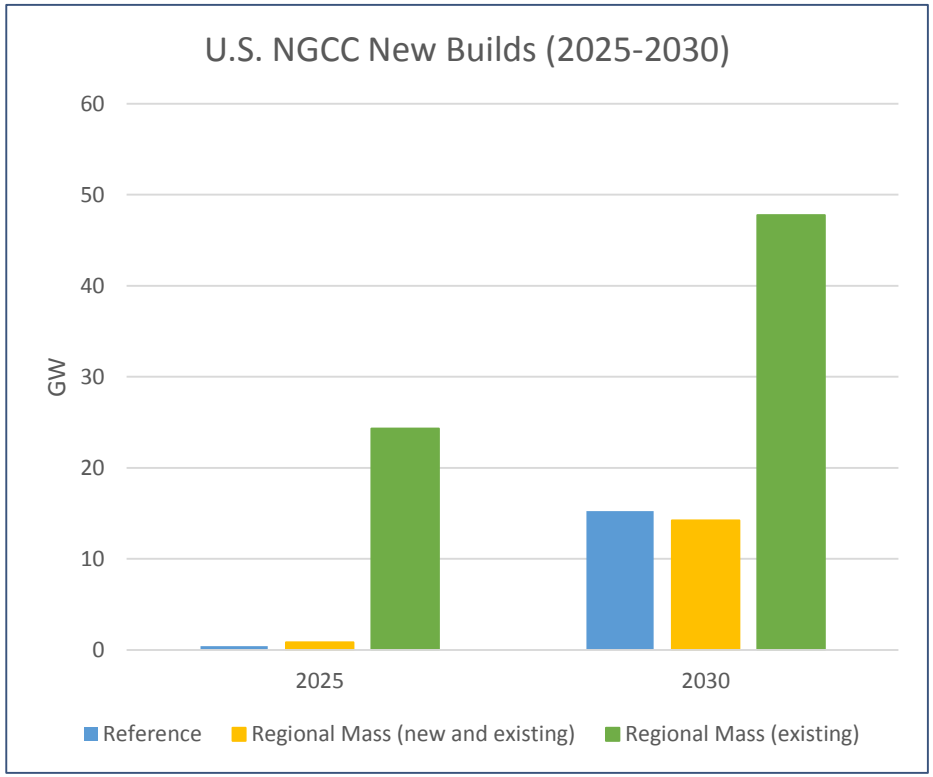
4. Demonstrating that leakage is unlikely to occur in a given state due to unique factors

NEW UNITS

New Builds

- In the regional mass-based run with only existing units covered by the policy, there are more new NGCC units built than in the regional mass-based run with both existing and new units covered by the policy.

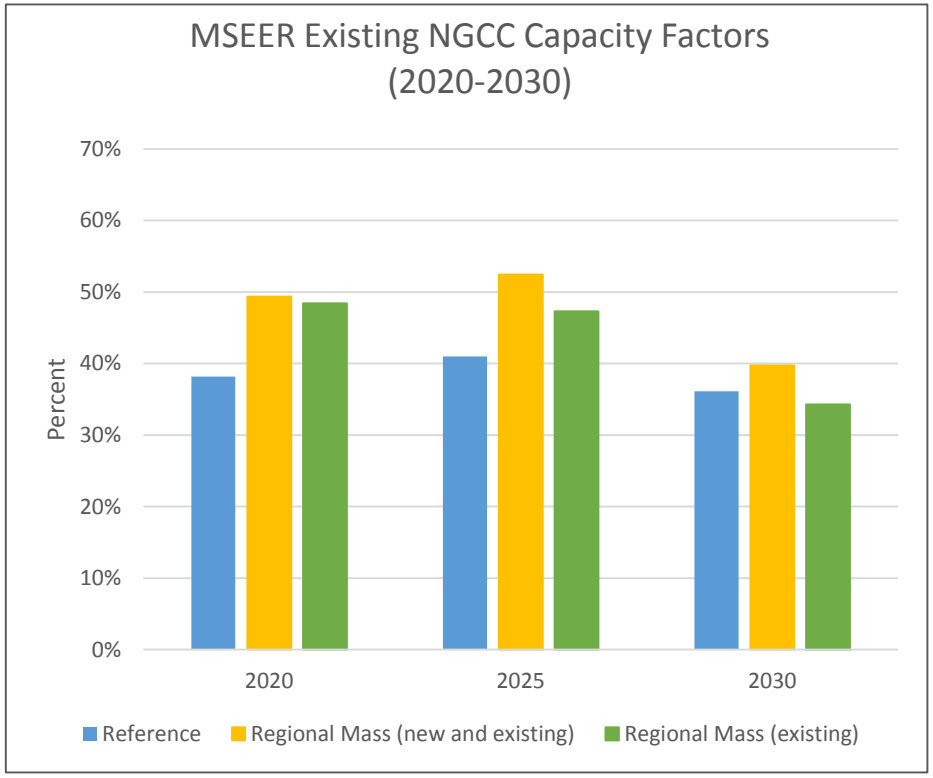


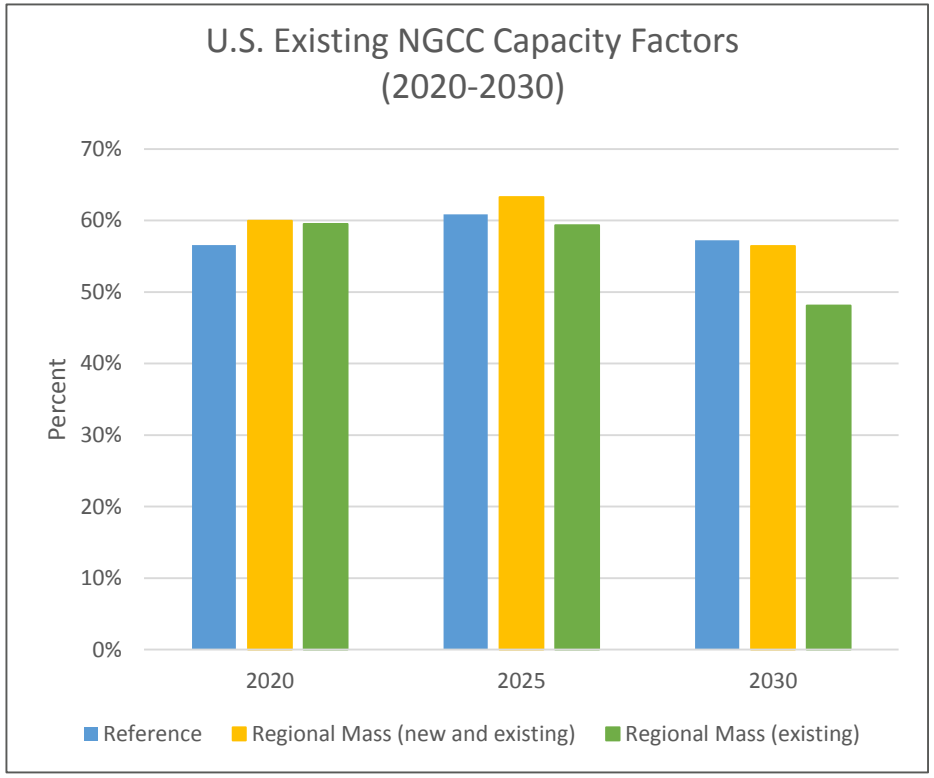


NEW UNITS

Capacity Factors of Existing NGCC

- In the regional mass-based run with only existing units covered by the policy, existing NGCC units have lower capacity factors than in the regional mass-based run with both existing and new 111(b) units covered by the policy.

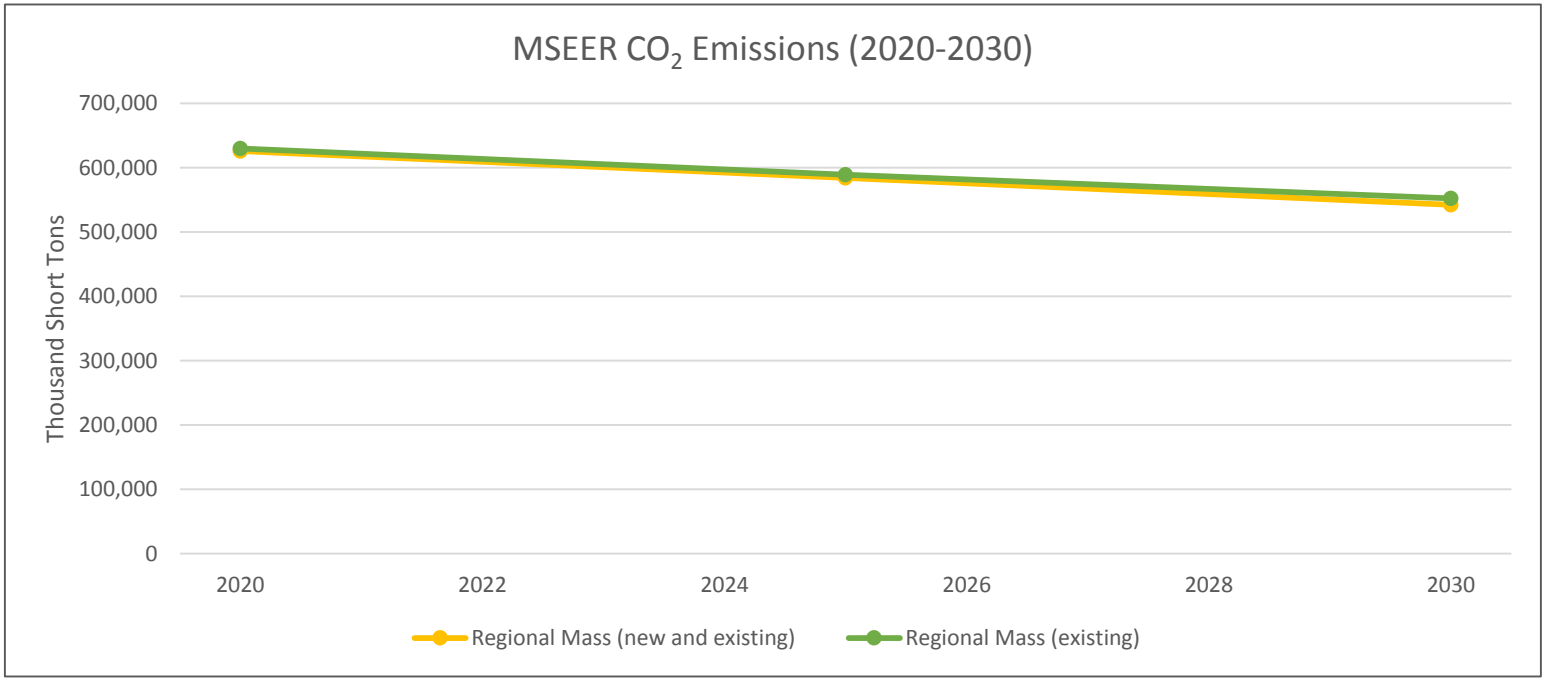




NEW UNITS

CO_2 Emissions

- CO_2 emissions in MSEER are higher when new units are not included under the mass-based program.
  - In 2030, emissions are 2%, or 10,143 short tons, higher in the regional mass-based run with only existing units covered by the policy as compared to the regional mass-based run with both existing and new 111(b) units covered by the policy.



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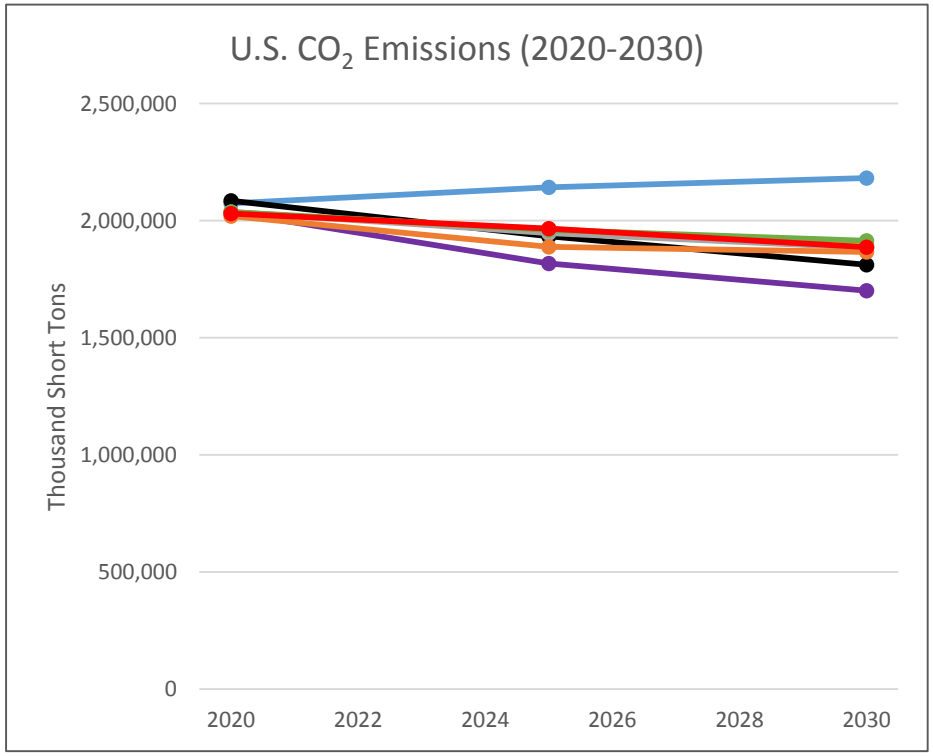
CO_2 Emissions

CO_2 EMISSIONS

- All policy scenarios see a decrease in CO_2 emissions as compared to BAU
- However, the stringency/results of the policy vary depending on the policy scenario
  - Ability to bank allowances contributes to different CO_2 levels per scenario
- State rate run (with no out of state RE/EE) has lowest emissions and is more stringent than EPA's state rate run

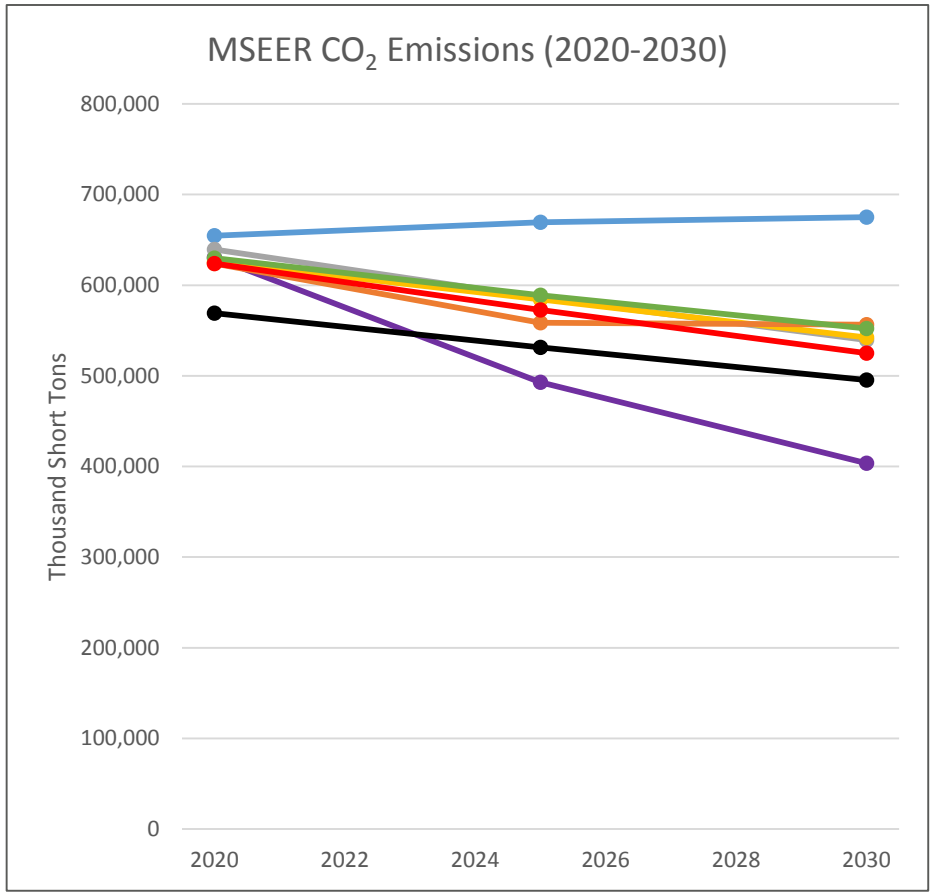


Scenario	Percent Difference from Reference (2025-2030)
State Rate	-18.5%
State Mass	-11.4%
Regional Mass	-10.8%
Regional Mass (EE)	-13.2%
Regional Mass (Existing)	-10.4%
National Mass	-10.9%

CO_2 EMISSIONS

MSEER CO_2 Emissions

- Trends in MSEER are similar to trends in the U.S.



Scenario	Percent Difference from Reference (2025-2030)
State Rate	-33.3%
State Mass	-16.3%
Regional Mass	-16.2%
Regional Mass (EE)	-17.1%
Regional Mass (Existing)	-15.1%
National Mass	-18.4%

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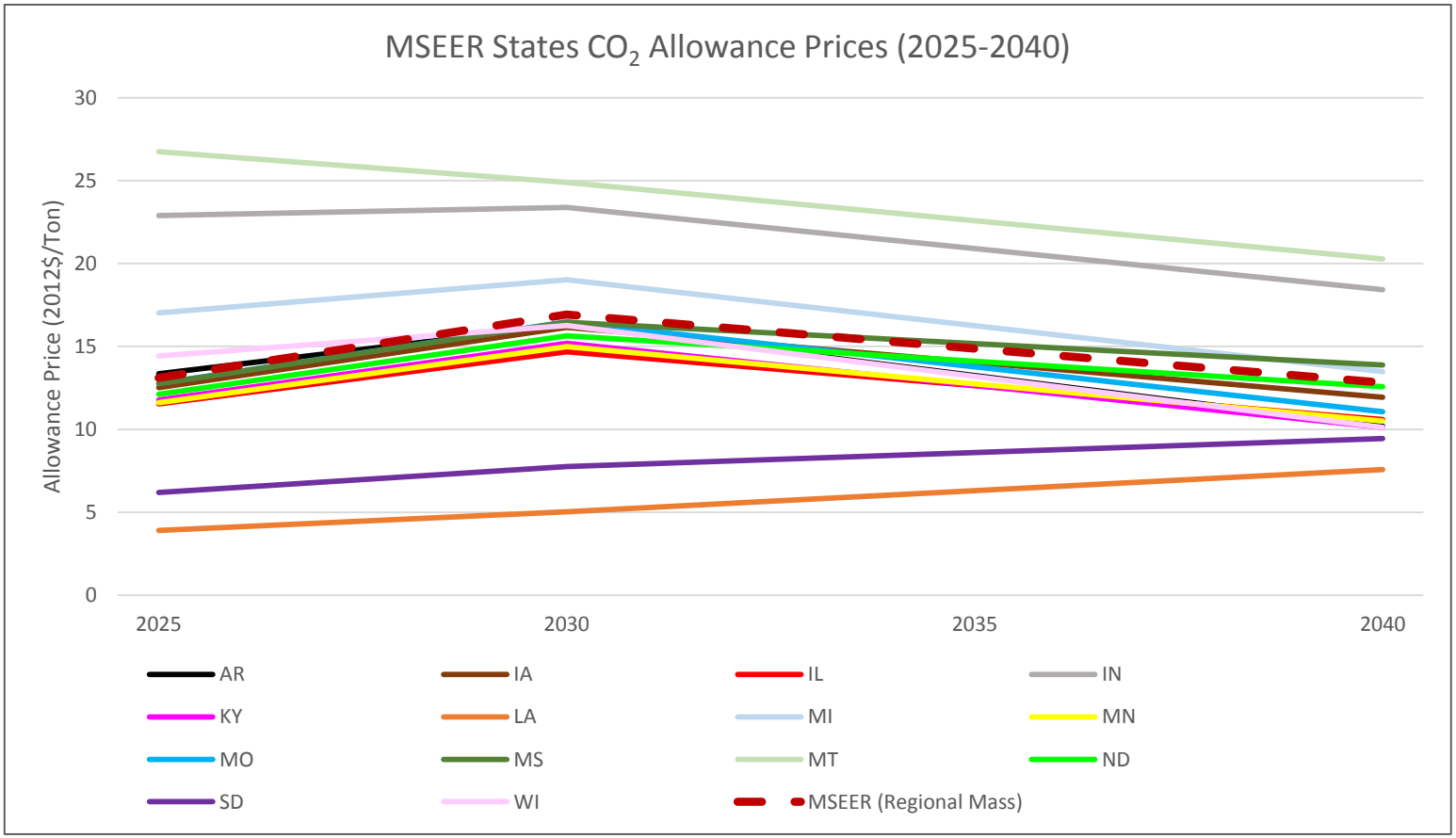
Allowance Prices

ALLOWANCE PRICES

Allowance Prices

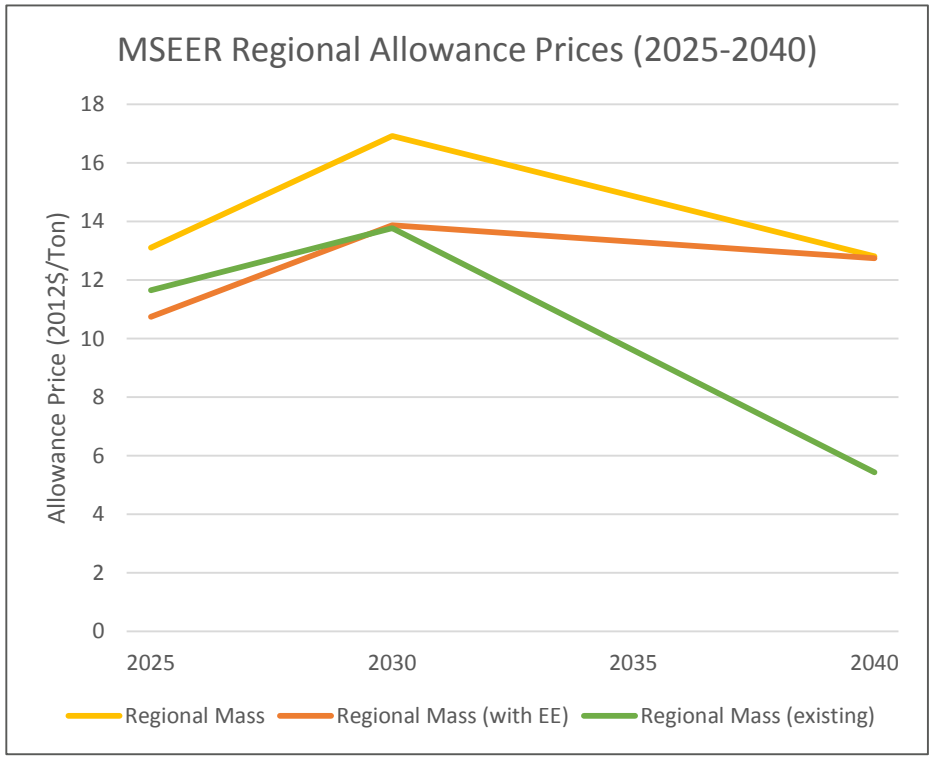
- Allowances prices in MSEER in the state mass scenario range from $5.03/Ton in Louisiana in 2030 to $24.89 in Montana.

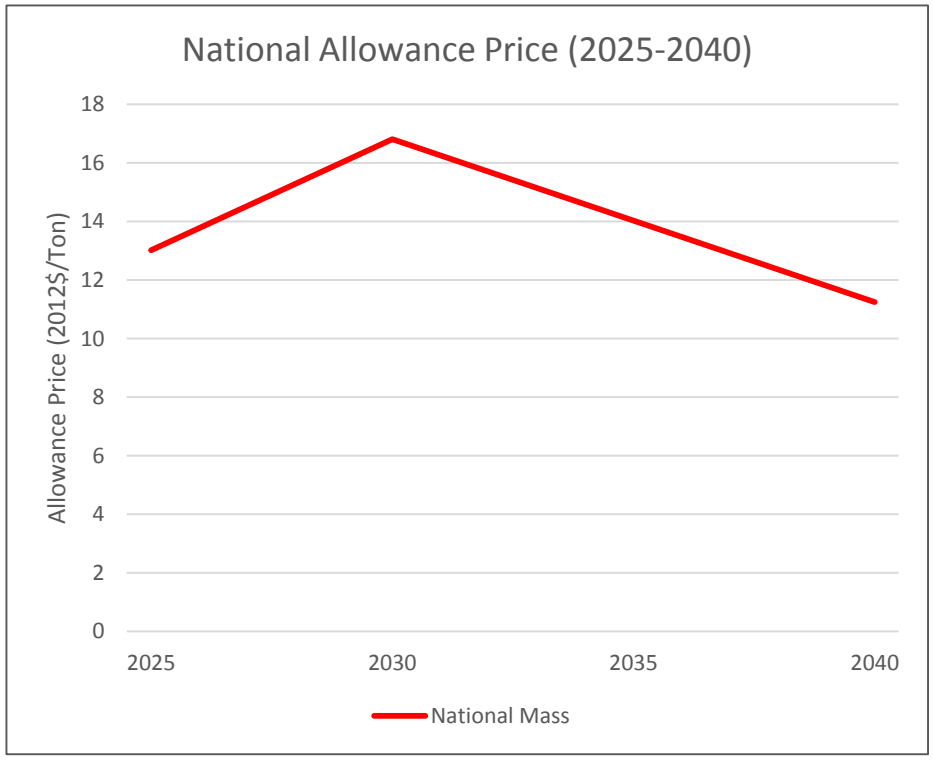


ALLOWANCE PRICES

Allowance Prices

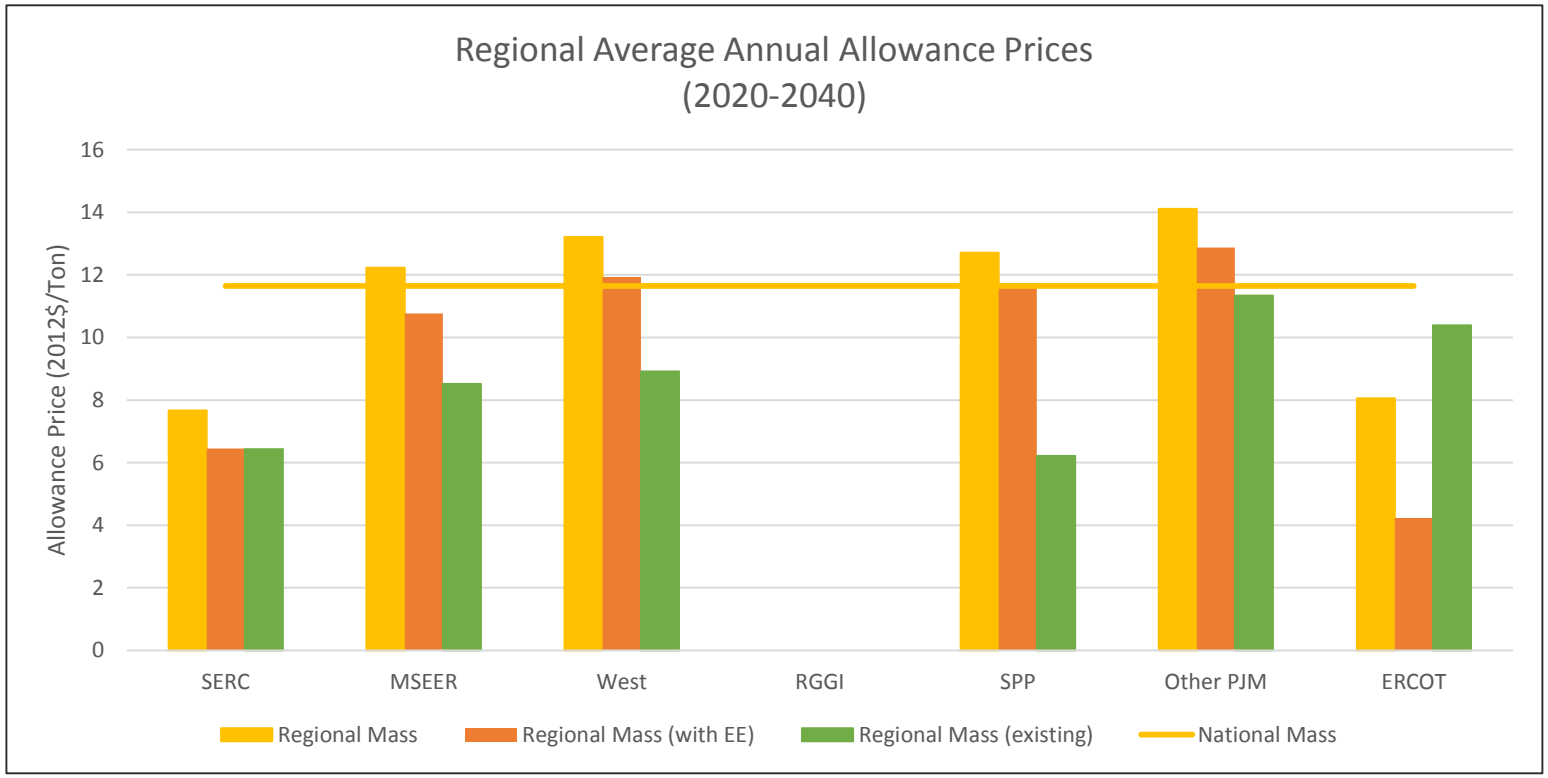
- The MSEER allowance price under the regional mass scenario is similar to the U.S. allowance prices under the national mass run. In 2030, the MSEER allowance price is $16.92/Ton. The U.S. allowance price is $16.80/Ton.
- The scenarios with EE and with existing units only have significantly lower allowance prices.





ALLOWANCE PRICES

Allowance Prices



- Note: The National Mass run is equivalent to the Regional Mass run in all assumptions except for trading boundaries.

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Appendix

APPENDIX

Summary of Key Assumptions

	Phase I Assumption	Phase II Assumption	Proposal Assumption
Unit-level characteristics	AEO 2015 & NEEDSv.5.13	AEO 2015 & NEEDSv.5.15	AEO 2014 & NEEDSv.5.13
Natural Gas Supply & Costs	ICF's 2015 Integrated Gas Module	ICF's 2015 Integrated Gas Module	ICF's 2014 Integrated Gas Module
Renewable Energy Cost	ICF Market Research	ICF Market Research	AEO 2014 & LBNL Wind Costs
Energy Efficiency Costs	3-step cost curve (2.3-3.2 cents/KWh)	3-step cost curve (2.3-3.2 cents/KWh)	3-step cost curve (2.3-3.2 cents/KWh)
Energy Efficiency Supply	Synapse Study (2011)	EE supply from EPA	Synapse Study (2011)

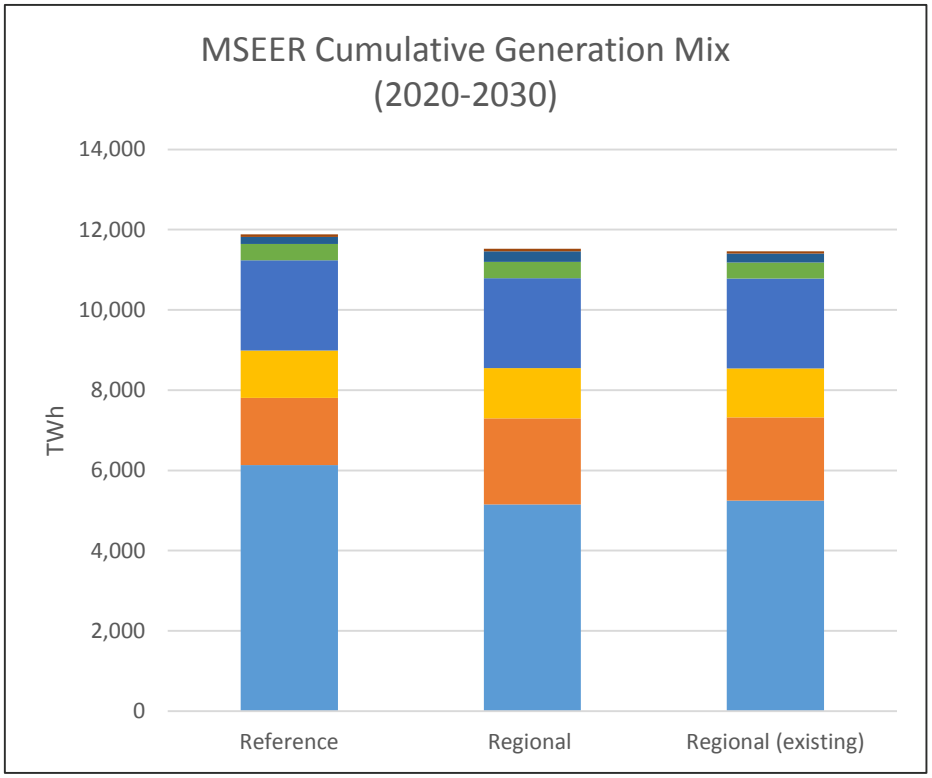
APPENDIX

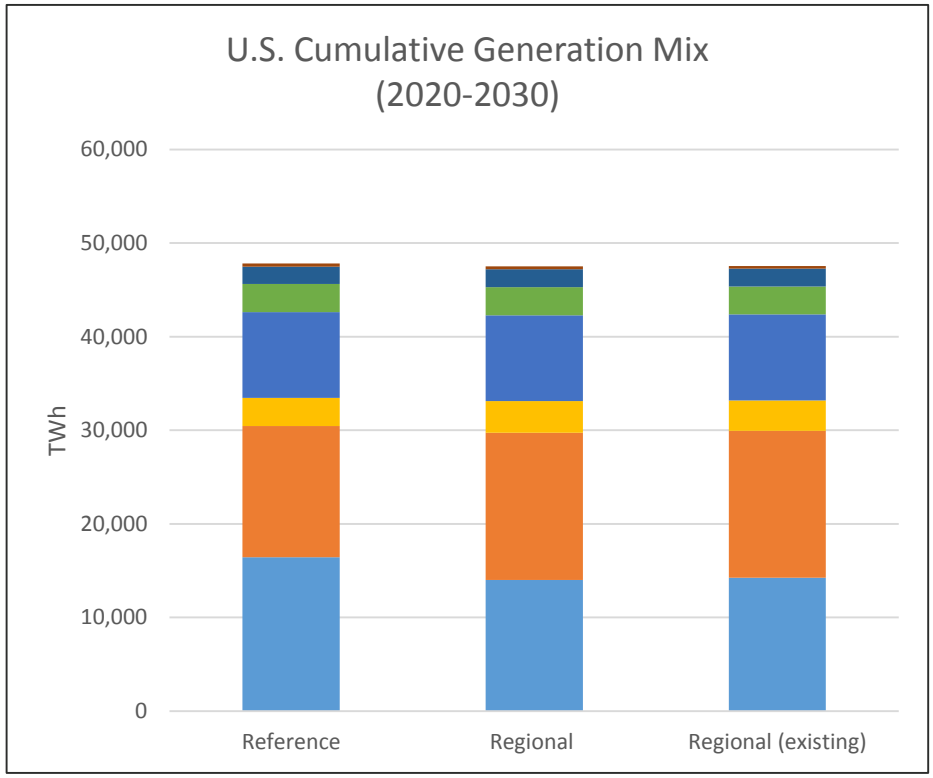
- In policy scenarios that allow EE, end-use EE is available to serve electricity demand using an assumed three-step supply curve with cost increasing as the supply available at each step is exhausted. In 2020, costs are: 2.3, 2.6, and 3.2 cents/KWh. Costs in each block increase by .3 cents/KWh starting in 2021. An assumed participant portion (45% of the total resource cost of EE) is added separately to the compliance cost.

2020 EE Cost	Units = Cents/KWh			Units = $/MWh		
	Step 1	Step 2	Step 3	Step 1	Step 2	Step 3
Utility Portion	2.3	2.6	3.2	23	26	32
Participant Portion	1.9	2.1	2.6	19	21	26
Total Resource Cost	4.2	4.7	5.8	42	47	58

APPENDIX

Influence of New Source Complement on Generation Mix

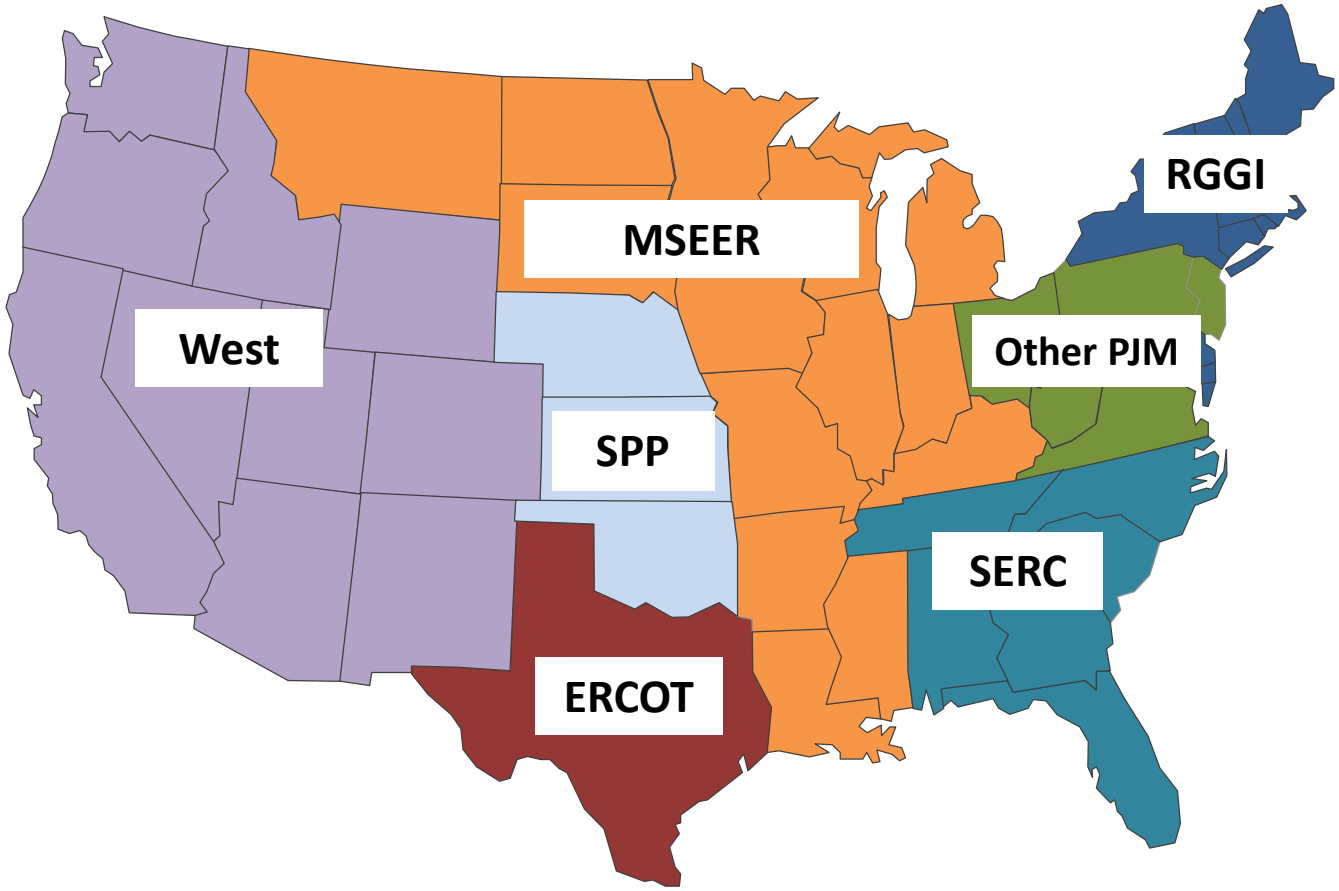




Coal Gas EE Wind Nuclear Hydro Other RE Other

APPENDIX

Policy Regions



Note: Regional scenarios require assumptions about how states/regions are implementing the final Clean Power Plan. For purposes of modeling regional implementation, all EGUs in a state are grouped together in a single region as shown above for policy purposes. However, EGUs continue to be dispatched according to electricity markets with represented transmission bottlenecks.

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