Clean Power Plan Compliance Analysis for Arizona

July 28, 2016

ASU LightWorks

ASU Energy Policy Innovation Council

Topics to be covered

- ASU's Work Plan
- Preliminary CPP Compliance Analysis

ASU Activities & Work Plan

- Preliminary Compliance Analysis
  - Completed for external review
- CPP Scenario Reliability Analysis
  - Expected completion in Fall 2016
- CPP Scenario Economic Analysis
  - Kickoff meeting in June 2016 (estimated)

CPP Scenario Reliability Analysis

- Partnership with Northern Arizona University (NAU)
- Key Tasks:
  - Baseline Modeling (March-July)
    - Production cost modeling (PLEXOS) using WECC Common Case w/ AZ focus
  - CPP Scenario Modeling (July-September)
    - Input from this group is welcome!
    - Key outputs: costs, emissions, water consumption, reliability metrics (e.g. unserved load, LOLE), etc.
    - Sensitivities: CO_2 price, fuel prices, etc.
  - Final Report (October)

CPP Scenario Economic Analysis

- Collaboration between ASU and researchers at Resources for the Future (Dallas Burtraw and colleagues)
- Key Tasks:
  - Computable general equilibrium model of AZ economy with detailed energy sector
  - Linked to power grid model and economic model of investment in generating capacity
  - Key outputs: cost, consumer impact, jobs, profit, economic growth

On hold until further notice

State Plan Requirements

- Reliability:
  - §VIII.G.2: "Therefore, we are requiring that each state demonstrate in its final state plan submittal that it has considered reliability issues in developing its plan."
- Economics:
  - §VIII.G.3: "States in designing their state plans should consider the effects of their plans on employment and overall economic development to assure that the opportunities for economic growth and jobs that the plans offer are manifest."

PRELIMINARY COMPLIANCE ANALYSIS

Caveats

- For discussion purposes only.
- Intended to be complementary to other analyses, not a replacement.
- Should not be interpreted as policy recommendations from ASU.
- Focus is on compliance. Does not assess reliability.
- ASU welcomes an open dialogue on ways to improve this analysis.

Guiding Questions

- How far along will AZ be towards meeting overall CPP compliance under a "baseline" or "business as usual" (BAU) scenario?
- Where do individual EGU owners fall?
- How do rate and mass options compare?
- What might "hypothetical" compliance costs/benefits look like for end users?

Approach to Analysis

- Analysis performed using publicly available CP3T Tool developed by Synapse Energy Economics:
  - http://www.synapse-energy.com/tools/clean-power-plan-planning-tool-cp3t
  - Some AZ-specific modifications added
- Builds on prior analysis provided by AUG/PACE Global
  - Assumptions mostly consistent with some revisions
- Four cases analyzed:
  - AZ Rate
  - AZ Mass
  - AZ + Navajo Rate
  - AZ + Navajo Mass
- Rate cases include ERCs for GS, RE, EE, and CEIP
- Mass cases do not include new source complement
- Mass allocation based on EPA's proposed model rules

Assumptions: Retirements

- Expected retirements included:
  - Apache 2: 2017 (repowered)
  - Cholla 2: 2015
  - Cholla 1, 3, 4: 2024
  - 4-Corners 1-3: 2014
  - Navajo 1: 2019
  - Sundt 4: 2017 (repowered)
- Consistent with PACE Global

Assumptions: Resource Additions

- If resource additions are needed (as indicated by PACE), what should be considered "BAU"?

Resource	Levelized Cost of Energy ($/MWh)
Wind	$49
Solar PV - Fixed	$54
Solar PV – Tracking	$70
New NGCC	$103
NG Reciprocating Engine	$135
Small Modular Nuclear	$145
Solar Thermal + Storage	$161

Source: TEP 2016 IRP

Assumptions: Resource Additions

+/- Difference from PACE Global

Total GWh	2025	2030
Wind	+1,200	+2,400
Solar PV	+2,400	+4,800
Other RE	0	0
New NGCC	-3,600	-7,200
Total	***0***	***0***

Total MW	2025	2030
Wind	+415	+830
Solar	+945	+1,890
Other RE	0	0
New NGCC	-517	-1,004

Capacity Factors: Wind = 33%, Solar PV = 29% (Source: TEP 2016 IRP)

Assumptions: Load & Demand-side Resources

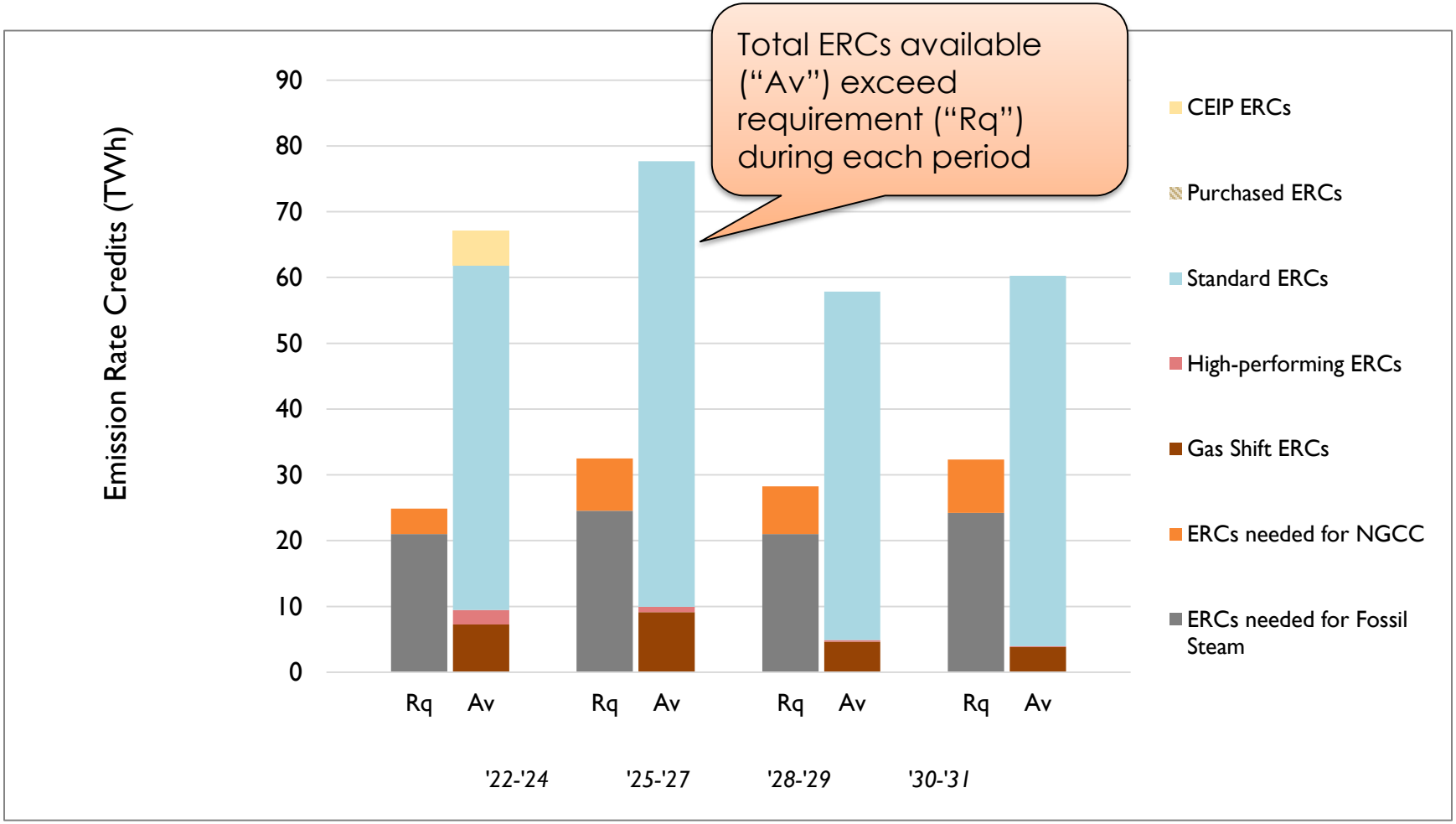
- Adopted PACE average annual load growth rate (prior to EE/DG)
- Adjusted annual incremental savings from EE from <1% to 1.5%.

EE-ERCs in 2022 (GWh, PACE Forecast)	Cumulative EE Savings 2014-2022 (Utility Planned)	% of forecast (expected by 2022)
5,796	8,413	145%

DG-ERCs in 2022 (GWh, PACE Forecast)	Est. MWh/yr from AZ DG installed in 2015	% of forecast (achieved to date)
1,019	215	21%

Sources:
APS 2014 IRP: 4,054 GWh cumulative savings, 2014-2022
TEP 2014 IRP: 1,100 GWh cumulative savings, 2014-2022
SRP FY14 EE Report 3,259 GWh cumulative savings, FY15-20
SEIA Solar Spotlight - Arizona: 129 MW Solar DG installed in 2015. Assumed capacity factor of 19%)

Results: AZ, Rate



Results: AZ, Rate

Balance of ERCs (GWh, annual)

EGU Owner (before CEIP/RE/EE)	1st Period (2022-2024)	2nd Period (2025-2027)	3rd Period (2028-2029)	Final Period (2030-2031)
AEPCO	-331	-506	-654	-758
APS	-62	484	28	-188
IPP	115	-443	-1,230	-1,595
PAC	-724	0	0	0
SRP	-2,062	-3,669	-5,328	-6,369
TEP	-1,461	-2,407	-3,213	-3,761
TSGT	-611	-979	-1,289	-1,507
ERCs from CEIP/EE/RE				
CEIP	5,264	0	0	0
RE-ERCs	6,759	10,483	13,762	14,989
EE-ERCs	10,685	12,091	12,710	13,148
Statewide Total	**17,573**	**15,054**	**14,787**	**13,960**

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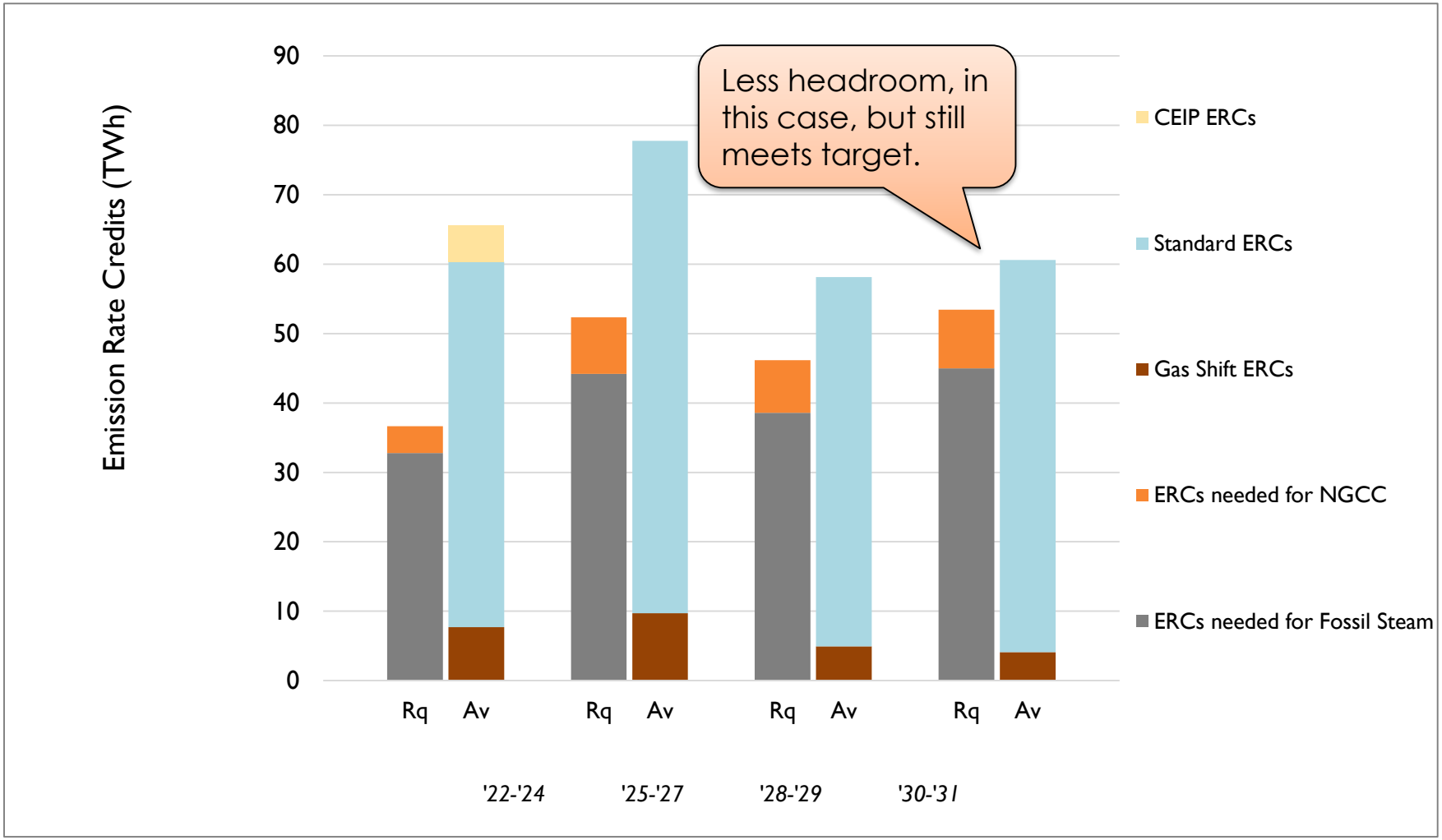
ERCs generated by EGU owners (e.g. to meet RES/EERS/SPP) can offset the deficit above.

Results: AZ + Navajo, Rate



Results: AZ + Navajo, Rate

Balance of ERCs (GWh, annual)

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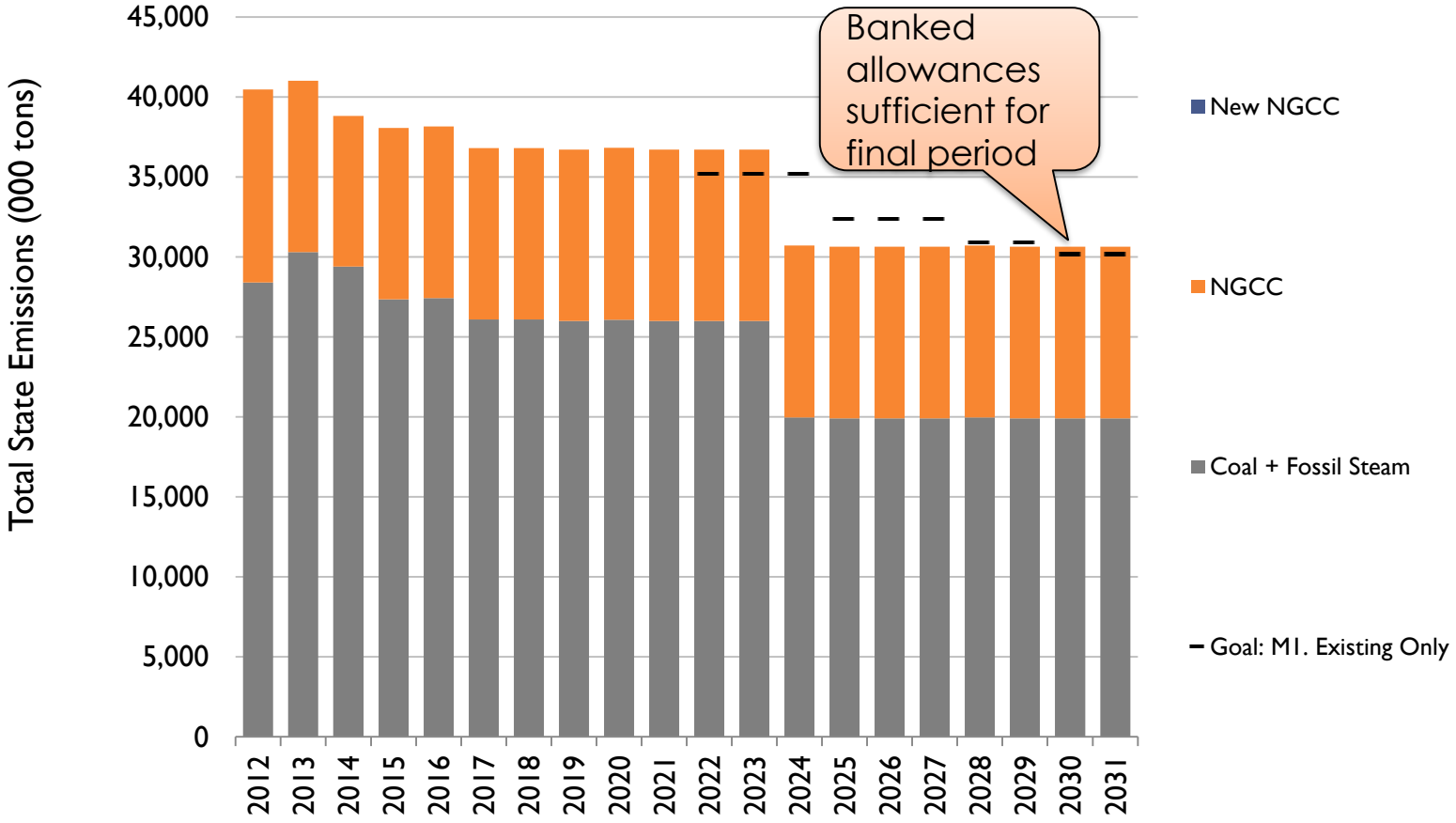
AEPCO	-332	-504	-652	-755
APS	-1,521	-1,995	-3,326	-4,158
BOR	-587	-968	-1,294	-1,522
EPE	-124	-213	-289	-342
IPP	303	-316	-1,213	-1,630
PAC	-728	0	0	0
PNM	-230	-395	-536	-636
SRP	-3,283	-5,668	-8,005	-9,524
TEP	-1,512	-2,458	-3,271	-3,824
TSGT	-613	-975	-1,285	-1,502
ERCs from CEIP/EE/RE				
CEIP	5,270	0	0	0
RE-ERCs	6,759	10,483	13,762	14,989
EE-ERCs	10,769	12,190	12,819	13,259
Statewide Total (incl. Tribes)	**14,173**	**9,180**	**6,710**	**4,355**

Results: AZ, Mass



Results: AZ, Mass

Balance of CO_2 Allowances (000 tons, annual)

EGU Owner (before set-asides)	1st Period (2022-2024)	2nd Period (2025-2027)	3rd Period (2028-2029)	Final Period (2030-2031)
AEPCO	-88	-287	-340	-364
APS	652	1,858	314	236
IPP	2,997	1,748	1,403	1,239
PAC	-400	1,373	0	0
SRP	-3,719	-5,217	-5,622	-5,800
TEP	-2,592	-3,229	-3,422	-3,506
TSGT	-946	-1,239	-1,317	-1,351
Set-Asides				
CEIP	1,720	0	0	0
OBA	0	4,198	4,198	4,198
REA	2,856	2,537	5,021	4,888
Statewide Total	**480**	**1,742**	**234**	**-460**

Note: This assumes allowances are allocated according to EPA's proposed model trading rules (updated from 5/12/16 presentation to reflect proposal for retirements: Cholla, Navajo, 4-Corners)

Results: AZ, Mass

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AEPCO	-88	-287	-340	-364
APS	652	1,858	314	236
IPP	2,997	1,748	1,403	1,239
PAC	-400	1,373	0	0
SRP	-3,719	-5,217	-5,622	-5,800
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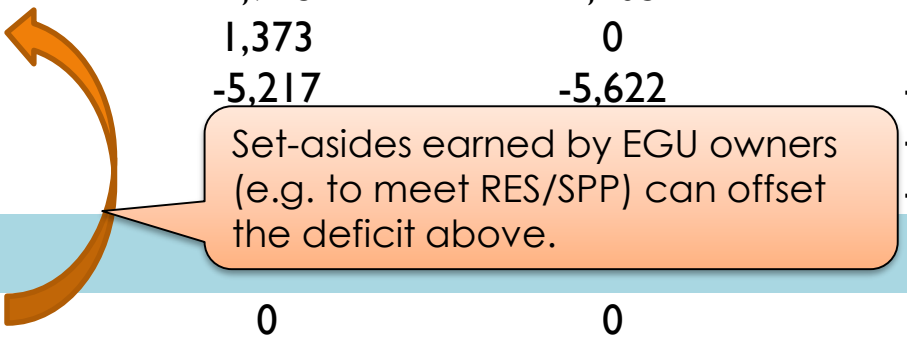
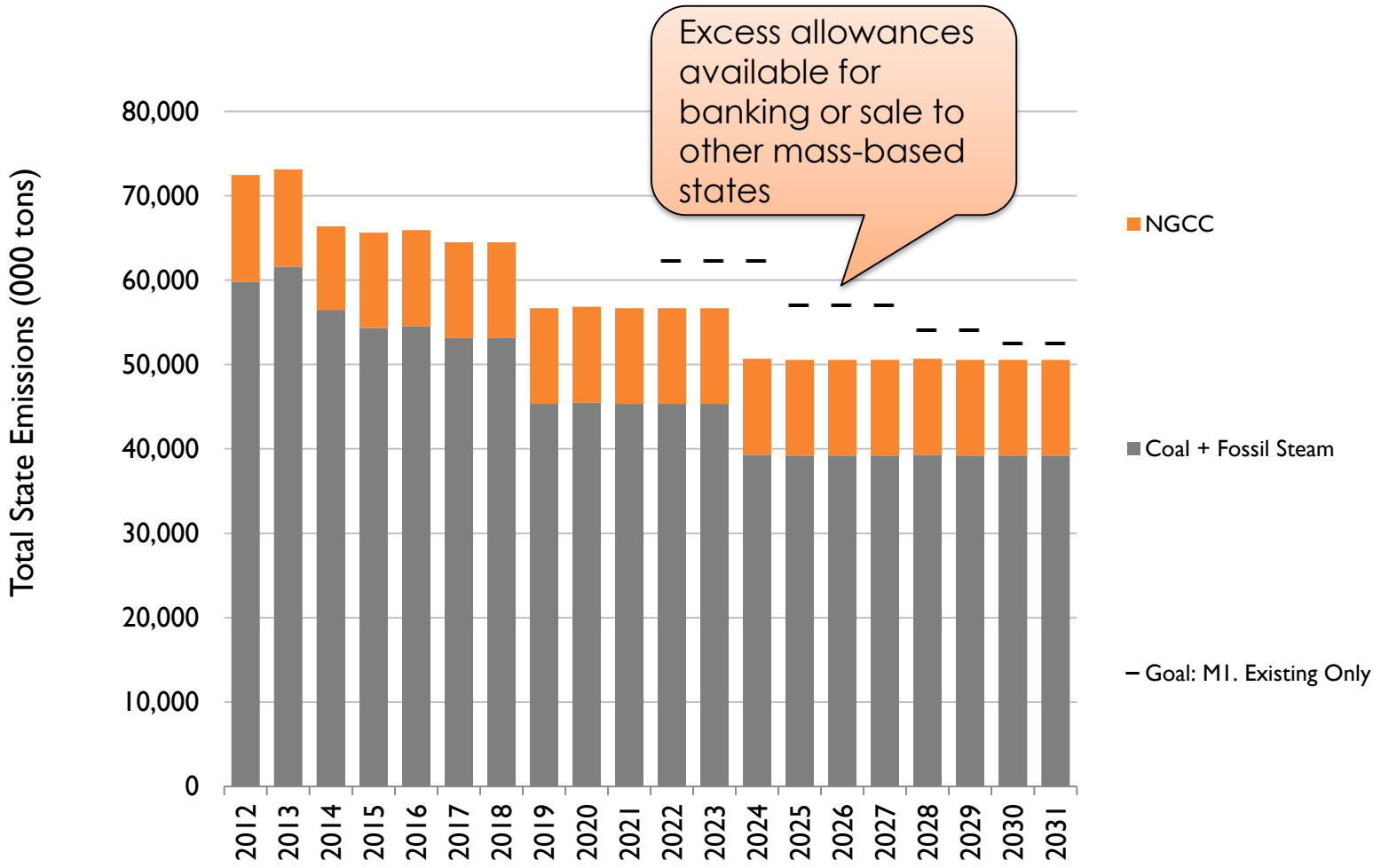


Results: AZ + Navajo, Mass



Results: AZ + Navajo, Mass

Balance of CO_2 Allowances (000 tons, annual)

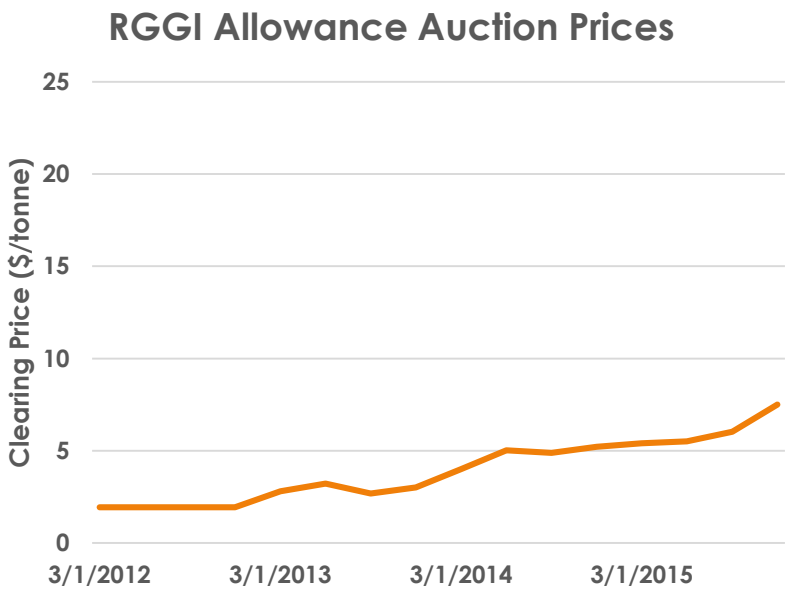
EGU Owner (before set-asides)	1st Period (2022-2024)	2nd Period (2025-2027)	3rd Period (2028-2029)	Final Period (2030-2031)
AEPCO	-91	-283	-336	-360
APS	-2,582	-1,488	-3,287	-3,501
BOR	-678	-738	-863	-931
EPE	-645	-645	-646	-645
IPP	2,967	1,441	1,084	921
NVE	968	939	883	849
PAC	-411	1,373	0	0
PNM	-1,198	-1,197	-1,199	-1,197
SRP	-5,854	-7,406	-8,033	-8,331
TEP	-1,983	-2,653	-2,884	-2,990
TSGT	-953	-1,231	-1,309	-1,342
Set-Asides				
CEIP	3,349	0	0	0
OBA	0	4,446	4,446	4,446
REA	16,139	15,338	17,055	16,465
Statewide Total (incl. Tribes)	**9,027**	**7,897**	**4,911**	**3,385**

Results: Summary

	2022-2024	2025-2027	2028-2029	2030-2031
AZ Rate	✓	✓	✓	✓
AZ + Navajo Rate	✓	✓	✓	✓
AZ Mass	✓	✓	✓	*
AZ + Navajo Mass	✓	✓	✓	✓

✓ = baseline scenario is compliant (statewide)
* = compliance can be met through banked allowances

Historic Allowance Prices



Hypothetical Costs: AZ+Navajo, Mass

Annual Cost (Benefit) $M

EGU Owner (before set-asides)	1st Period (2022-2024)	2nd Period (2025-2027)	3rd Period (2028-2029)	Final Period (2030-2031)
AEPCO	$1	$4	$4	$5
APS	$34	$19	$43	$46
BOR	$9	$10	$11	$12
EPE	$8	$8	$8	$8
IPP	-$39	-$19	-$14	-$12
NVE	-$13	-$12	-$11	-$11
PAC	$5	-$18	$0	$0
PNM	$16	$16	$16	$16
SRP	$76	$96	$104	$108
TEP	$26	$34	$37	$39
TSGT	$12	$16	$17	$17
Set-Asides				
CEIP	-$44	$0	$0	$0
OBA	$0	-$58	-$58	-$58
REA	-$210	-$199	-$222	-$214
Statewide Total (incl. Tribes)	-$117	-$103	-$64	-$44

Notes:

- Assumes an allowance price of $13/ton in each compliance period.
- EGU owner costs above do not include any set-asides that would be obtained under BAU. Including these would have the effect of lowering annual costs.

Hypothetical Costs: AZ+Navajo, Mass

Illustrative monthly bill impact for selected AZ utilities, 2022-onwards (average residential customer)

EGU Owner (before set-asides)	Allowance price @ $13/ton (EPA's estimate)	Allowance price @ $20/ton (high case)
AEPCO	$0-1	$1-2
APS	$1-2	$2-3
SRP	$3-5	$5-7
TEP	$2-3	$3-5

Notes:

- Assumes allowance prices are similar in each compliance period.
- Assumes EPA's proposed allowance allocation method is used.
- Assumes compliance is met solely through purchase of allowances.
- Assumes compliance costs are allocated based on residential portion of each utility's total retail sales.
- Does not include the effects of any set-asides or other allowances that could be obtained under BAU. Including these would have the effect of lowering customer bill impacts.

Conclusions

- Both rate or mass options appear feasible for AZ.
- Overall, Arizona stands to benefit from an excess of ERCs or allowances, however each EGU owner's situation is unique.
- Incremental EE and RE considered in "baseline" is important.
- Combining AZ + Navajo unlocks large number of allowances under a mass approach.

Thank You!

Please contact us with questions, comments, feedback, etc.

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