



**pennsylvania**  
DEPARTMENT OF ENVIRONMENTAL PROTECTION



# **IPM Modeling Results Discussion Reference Case and RGGI Policy Scenario**

**April 23, 2020**

**Tom Wolf, Governor**

**Patrick McDonnell, Secretary**

# Presentation Overview

- Panelist Introductions
- Overview of the IPM Power Sector Model
- Discuss Pennsylvania's Energy Sector & Historical Trends
- Presentation of Modeling Assumptions
- Analysis of IPM Modeling Results
- Review Timeline and Next Steps
- Questions & Answers

# Modeling Insights- PA RGGI Participation

- Significant Emissions Reductions Realized Over the Decade.
- Environmental Benefits Accrue in the near-term.
- Pennsylvania Remains a Leading Electricity Exporter.
- PA Generation Remains At Near Historical Levels.
- PA Wholesale Energy Prices Increase Slightly.
- Generation Mix Shifts as RGGI price impacts dispatch.
- RGGI Participation is critical to meeting GHG reduction goals.

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# Introduction of Panelists

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# Department of Environmental Protection



Krishnan Ramamurthy is DEP's Deputy Secretary for Waste, Air, Radiation and Remediation. He has over 40-years experience in environmental regulation focusing on air quality.



Jennie Demjanick is Counsel to DEP's Air Quality Program, primary author of DEP's CO<sub>2</sub> Budget Trading Program regulation, and key member of DEP's implementation team.



Hayley Book is DEP's Senior Advisor on Energy and Climate. She focuses on matters at the confluence of energy and environmental policy and leads the commonwealth's creation of a CO<sub>2</sub> Budget Trading Program.

# ICF Partners



Chris MacCracken is a Vice President, Energy Power Markets at ICF and manages its Advisory Power Team. He has 25 years of experience working on electricity and environmental markets and has supported electric sector analysis for the RGGI states since 2005.



Fiona Wissell is an Energy Markets Consultant in ICF's Advisory Power Team. She has supported electric sector analysis for the RGGI states since 2015.



# Overview of Modeling Partner - ICF



**energy +  
climate  
footprint**

ICF designs robust future-focused solutions in response to industry, policy, and environmental changes.



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# Integrated Planning Model (IPM<sup>®</sup>)

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# IPM- Power Sector Emission & Cost Changes



## Resource Supply

- Gas Supply
- Coal Supply
- Hydro Supply
- Biomass Supply
- Renewable Potential



## Existing Power Plant Variable Cost

- Fuel Transportation
- Fuel Costs
- Heat Rates
- O&M Costs



## New and Existing Power Plants

- Coal
- Oil & Gas Steam
- Combustion Turbine
- Combined Cycle
- Geothermal
- Nuclear
- Hydro
- Renewables
- Cogeneration

## Retrofit Technology

- SCR, SNCR, and new NO<sub>x</sub> control options
- Wet and Dry FGD
- ACI and Fabric Filter
- Cobenefits for Hg



## Transmission

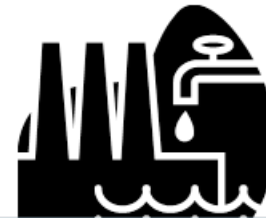
- New FERC Policies
- Long-term tradeoffs with Generation
- Grid operation

## Electric Demand

- Hourly Demand
- Peak & Energy Growth
- Reserve Margin
- Steam Demand

## Power Plant Dispatch and Grid Operation

- Economic dispatch



## Air Policy Specifications

- NO<sub>x</sub>, SO<sub>2</sub>, Hg and CO<sub>2</sub>
- MACT vs. Cap and Trade
- Banking and Progressive Flow Control
- National, Regional and State Programs
- Renewable Portfolio Standards
- Operation
  - Maintenance
  - Outages

OPTIMIZATION

## Projections

- Power Prices
- Fuel Prices
- Allowance Prices
- Asset Values
- Dispatch Decisions
- Capacity Build Decisions
- Emissions
- Compliance Costs
- Compliance Decisions
- Plant Retirement Decisions

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# Modeling Assumptions

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# Modeling Assumptions

- Generation Capacity Changes
  - Capacity Additions- New 'Firm' Generation Projects
  - Capacity Retirements
- Energy Efficiency Goals
  - PA meets Act 129 EE savings for Phase III
  - No consideration of Phase IV goals
- Renewable Portfolio Standards
  - Alternative Energy Portfolio Standard (AEPS)
  - PA meets 18% AEPS Goal by 2021 (8% Tier I, 10% Tier II)
- Waste Coal Set-Aside (9.3 million allowances annually)

--Full IPM modeling assumptions included in modeling results files available online--

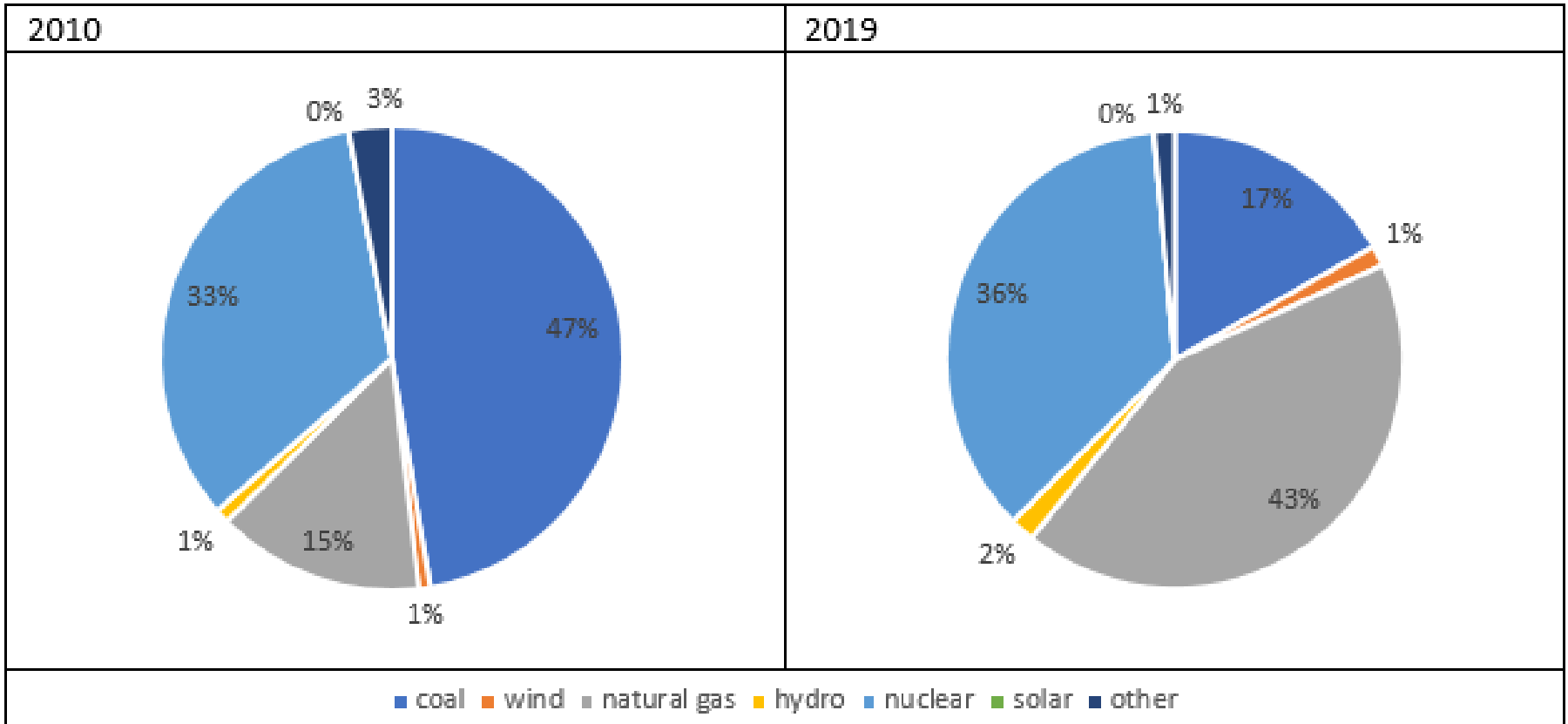
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# Pennsylvania's Power Sector

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# PA Energy Generation- Comparison

**2010 PA Total Generation - 233,100 GWh**



**2019 PA Total Generation - 231,245 GWh**

# PA Historical Energy Generation

## 2019 PA Total Generation - 231,245 GWh



**Natural Gas**  
42%



**Nuclear**  
36%



**Renewable**  
5%



**Coal**  
17%

## 2010 PA Total Generation - 233,100 GWh



**Natural Gas**  
14%



**Nuclear**  
34%



**Renewable**  
5%



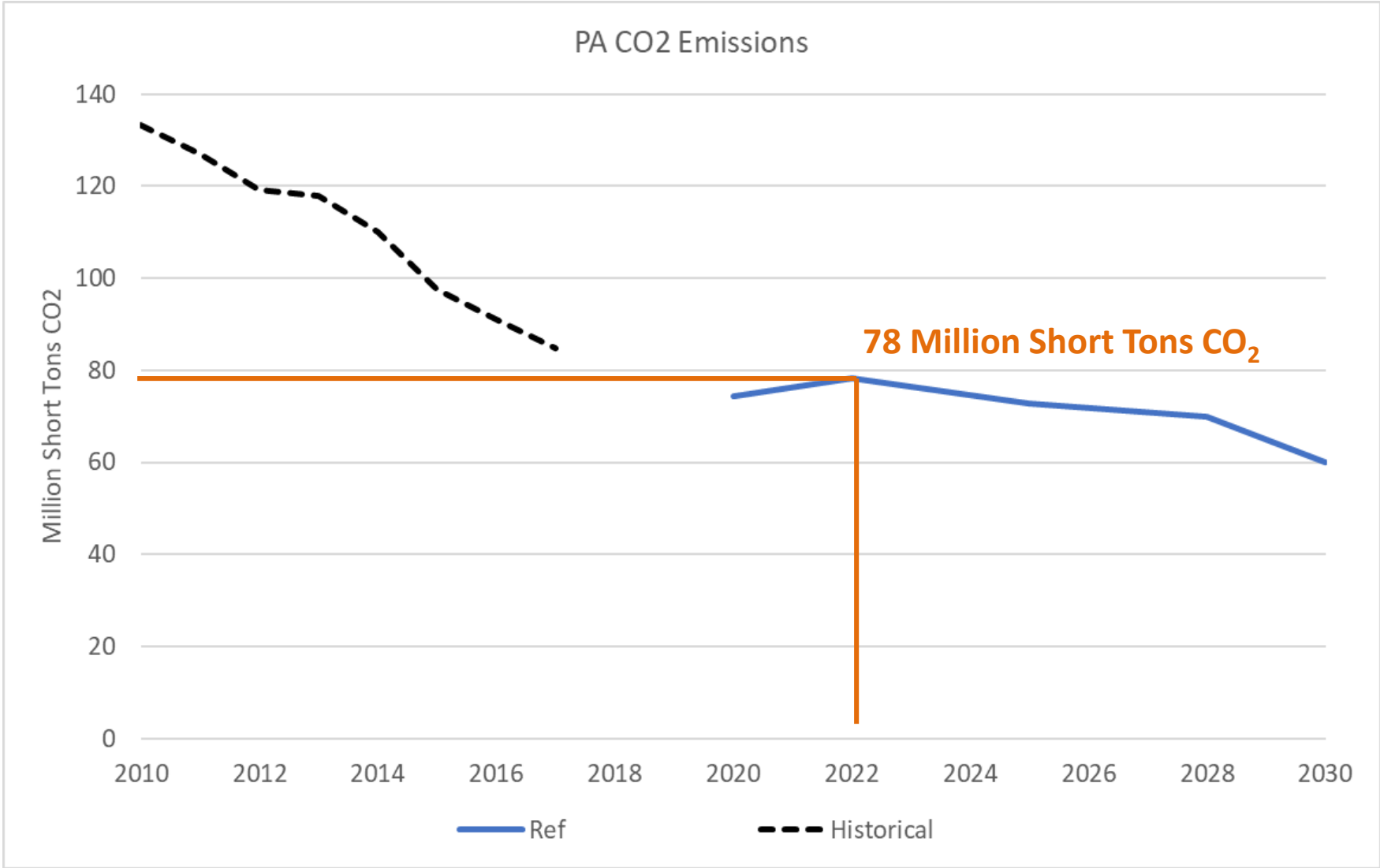
**Coal**  
47%

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# Reference Case (Ref)

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# PA Starting CO<sub>2</sub> Allowance Budget



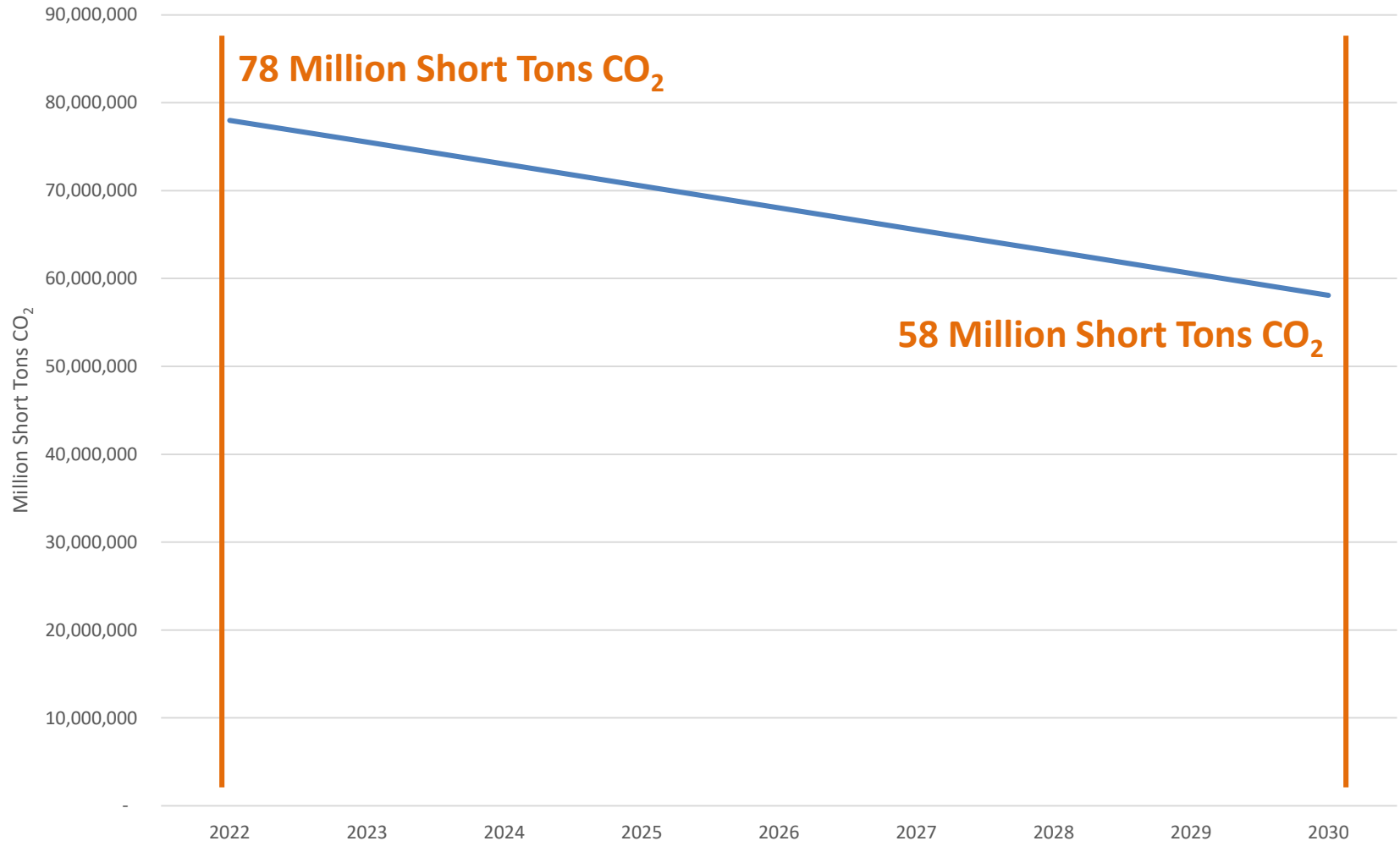


# Calculating Allowance Budget Trajectory

Year	Budget	Decline (Tonnage)	Annual Decline (Percentage)
2020			
2021			
2022	78,000,000		
2023	75,510,630	2,489,370	-3.19%
2024	73,021,260	2,489,370	-3.30%
2025	70,531,890	2,489,370	-3.41%
2026	68,042,520	2,489,370	-3.53%
2027	65,553,150	2,489,370	-3.66%
2028	63,063,780	2,489,370	-3.80%
2029	60,574,410	2,489,370	-3.95%
2030	58,085,040	2,489,370	-4.11%
<b>2022-2030 Total Reduction:</b>		<b>19,914,960</b>	<b>-25.532%</b>
<b>25.532% reduction from 2022:</b>	<b>58,085,040</b>		
<b>Total tonnage reduction:</b>	<b>19,914,960</b>		
<b>Annual tonnage reduction:</b>	<b>2,489,370</b>		

# PA CO<sub>2</sub> Allowance Budget Trajectory

PA Allowance Budget Trajectory



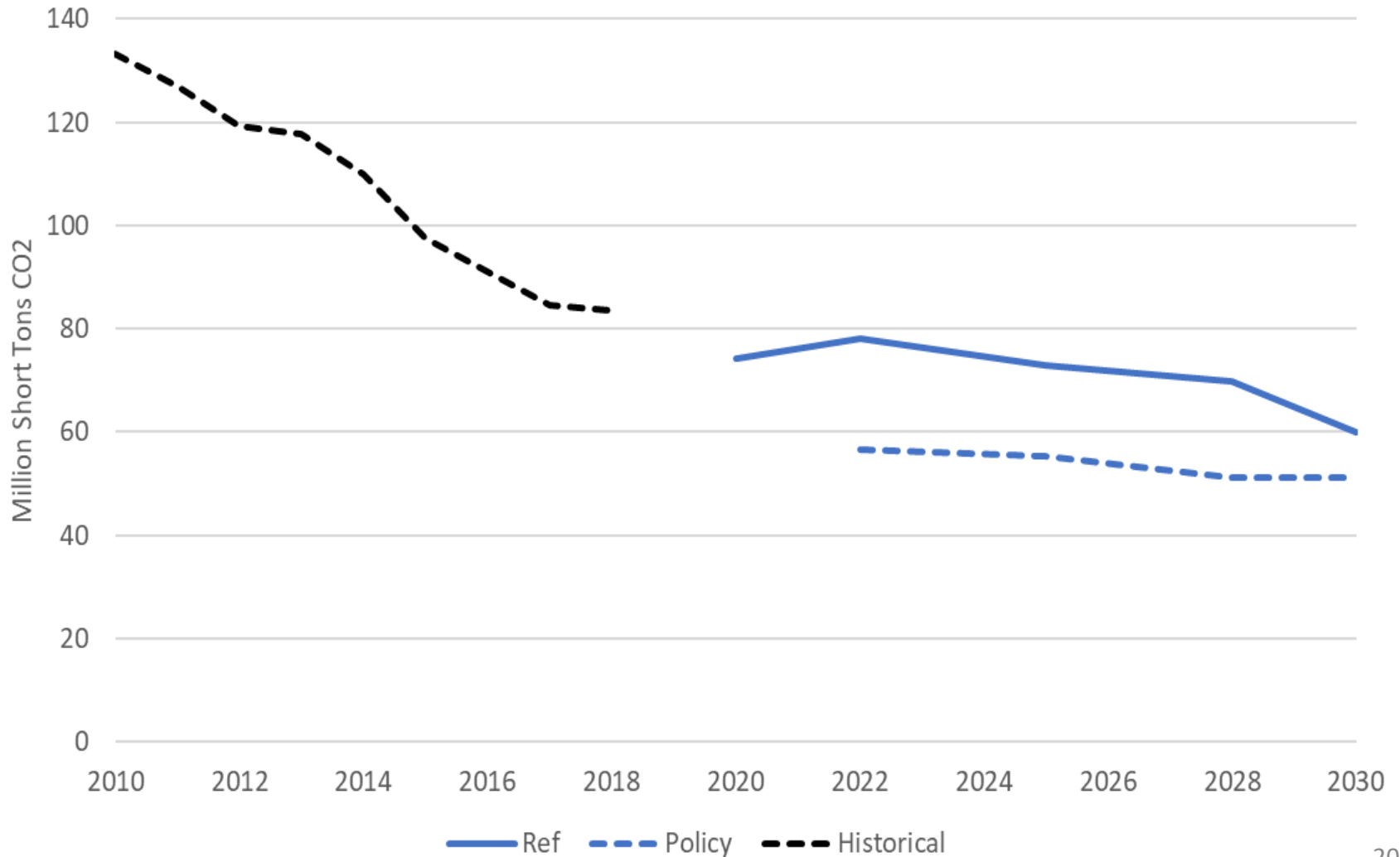
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# Comparison of Modeling Results

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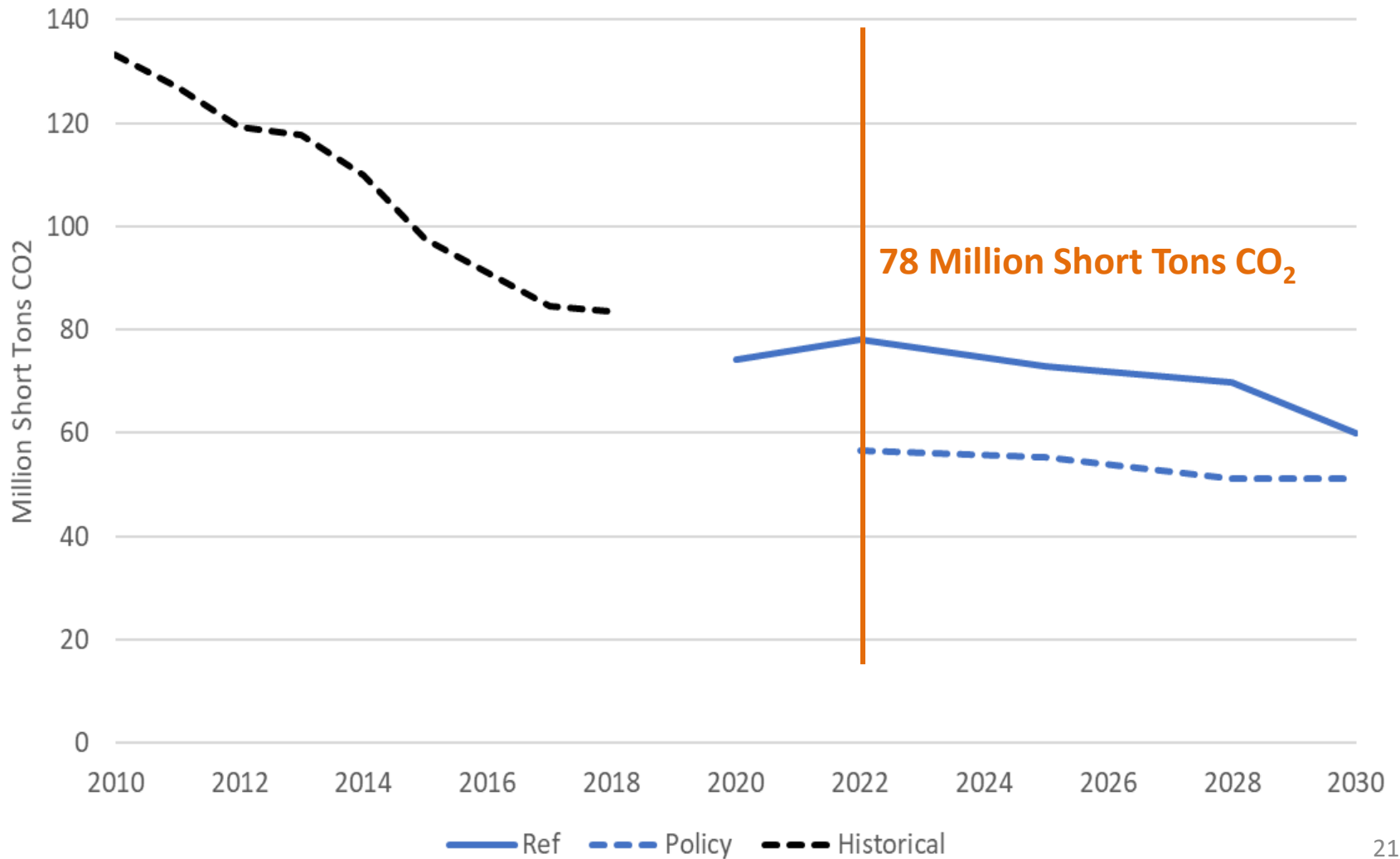
# PA Power Sector CO<sub>2</sub> Emissions

PA CO2 Emissions



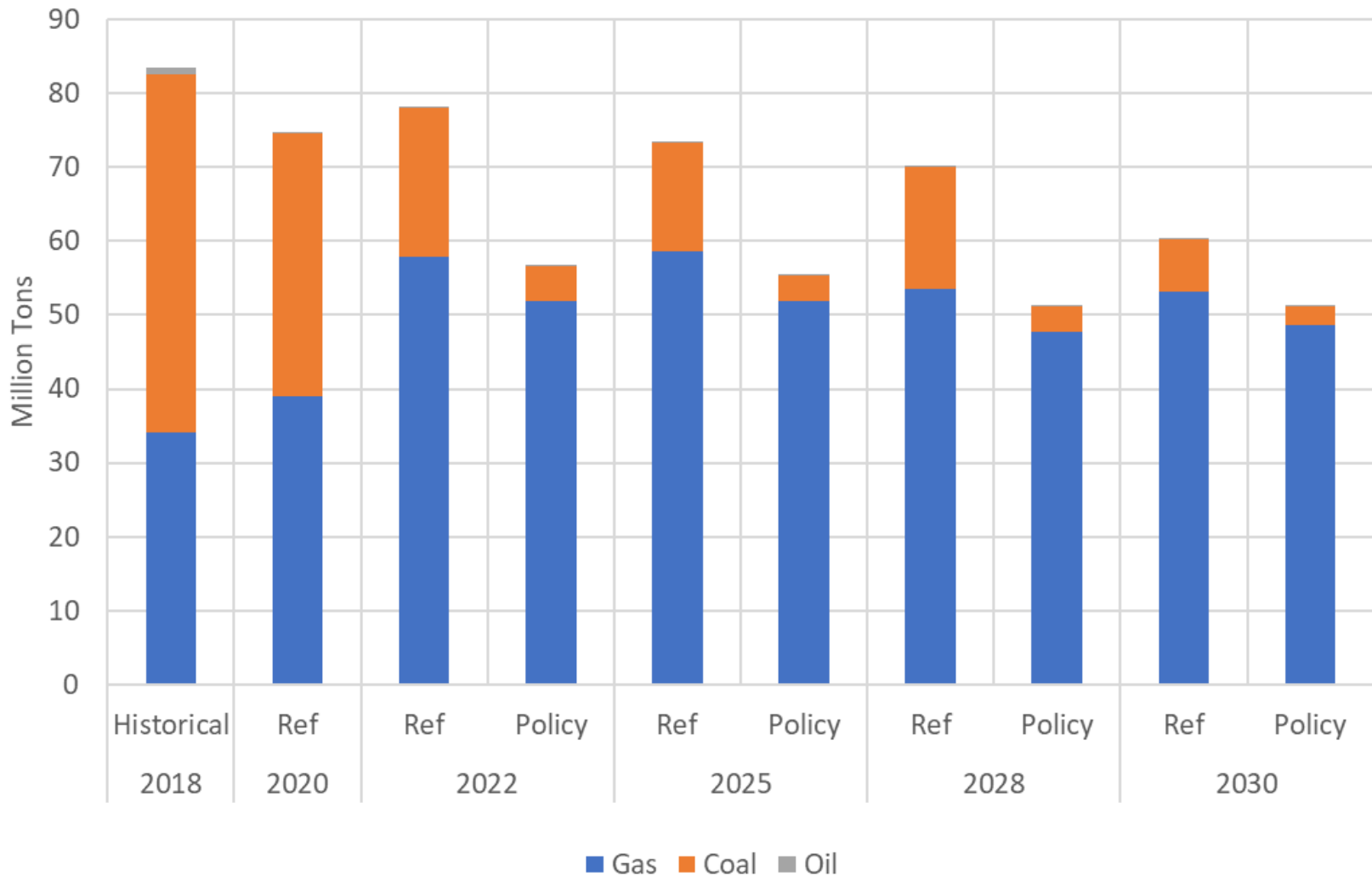
# PA Starting CO<sub>2</sub> Allowance Budget

PA CO<sub>2</sub> Emissions

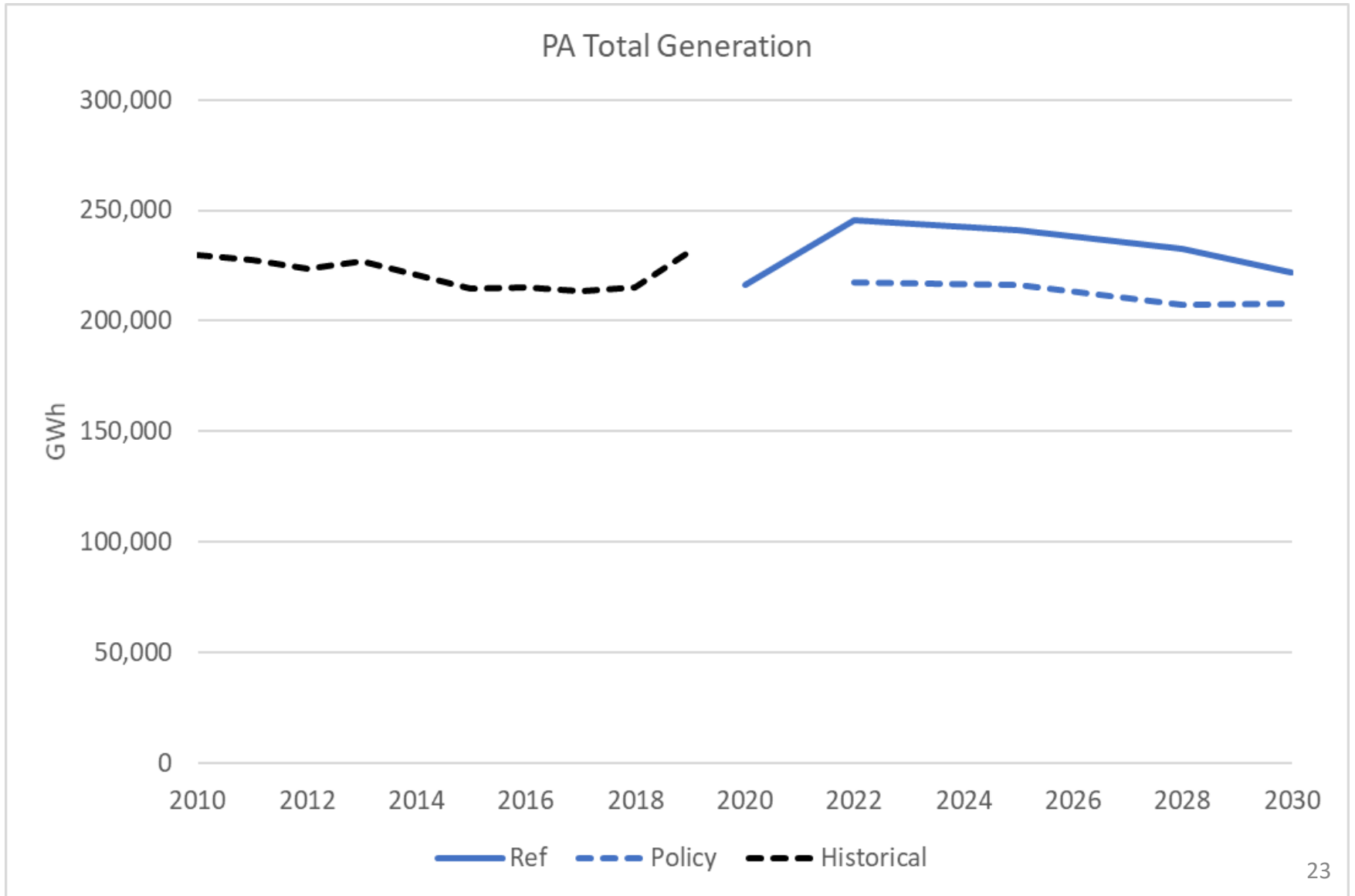


# PA Power Sector CO<sub>2</sub> Emissions

PA Emissions by Type

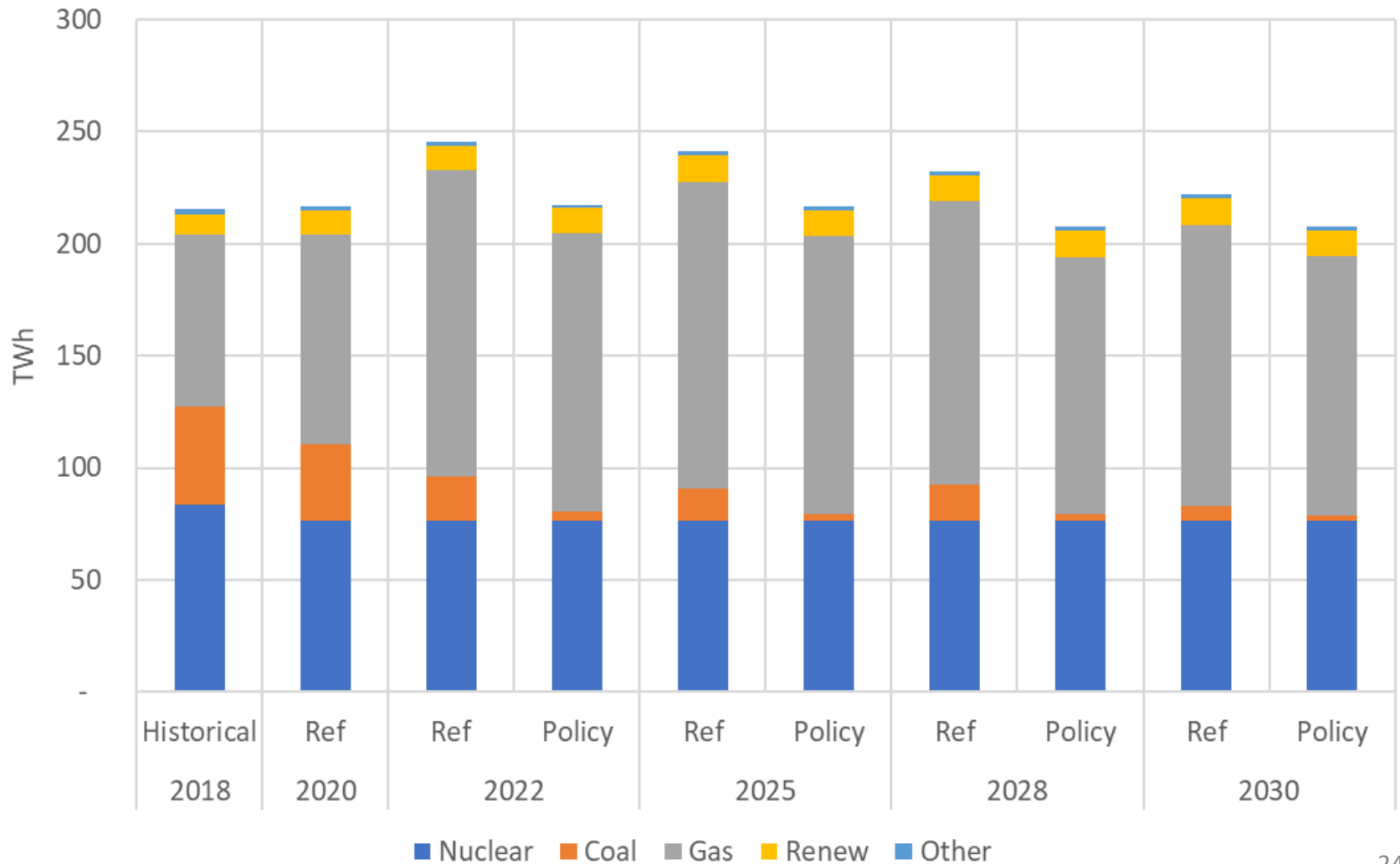


# PA Total Generation



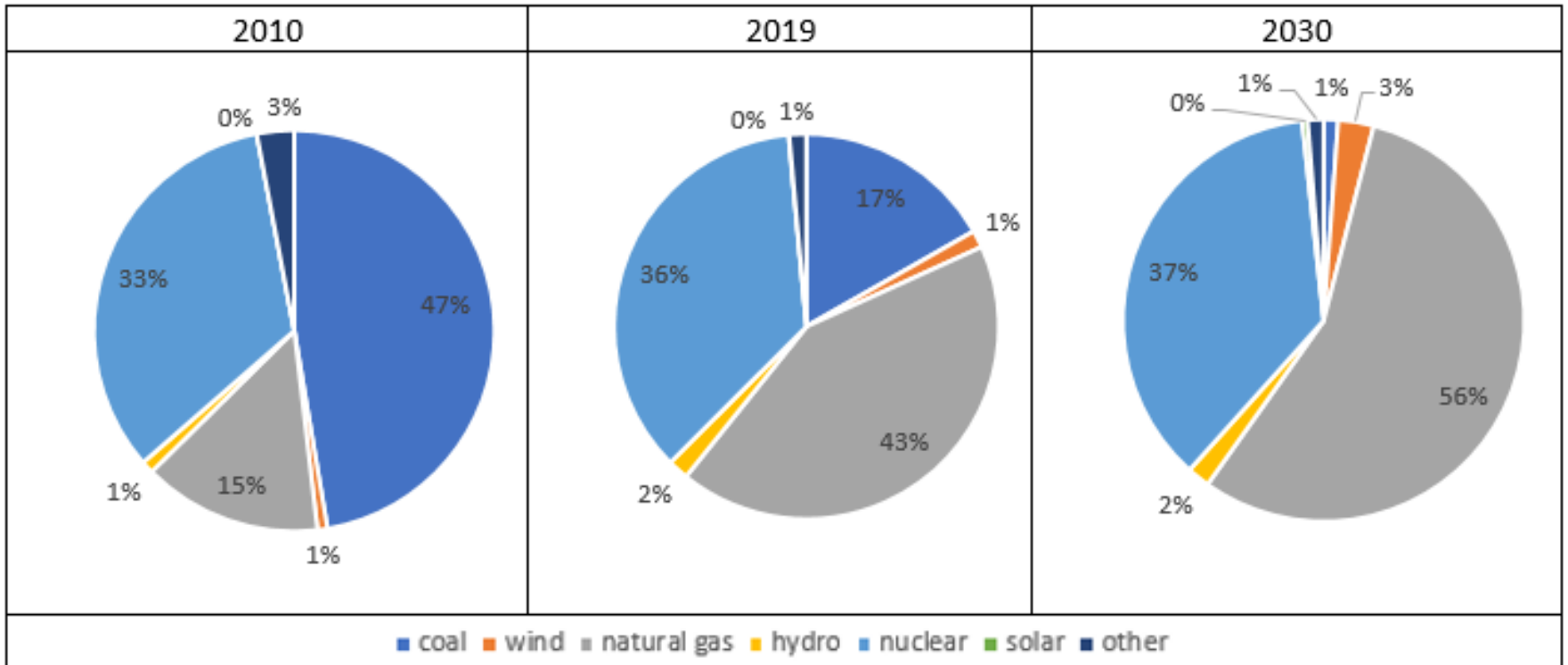
# PA Generation Mix

PA Generation Mix Comparison



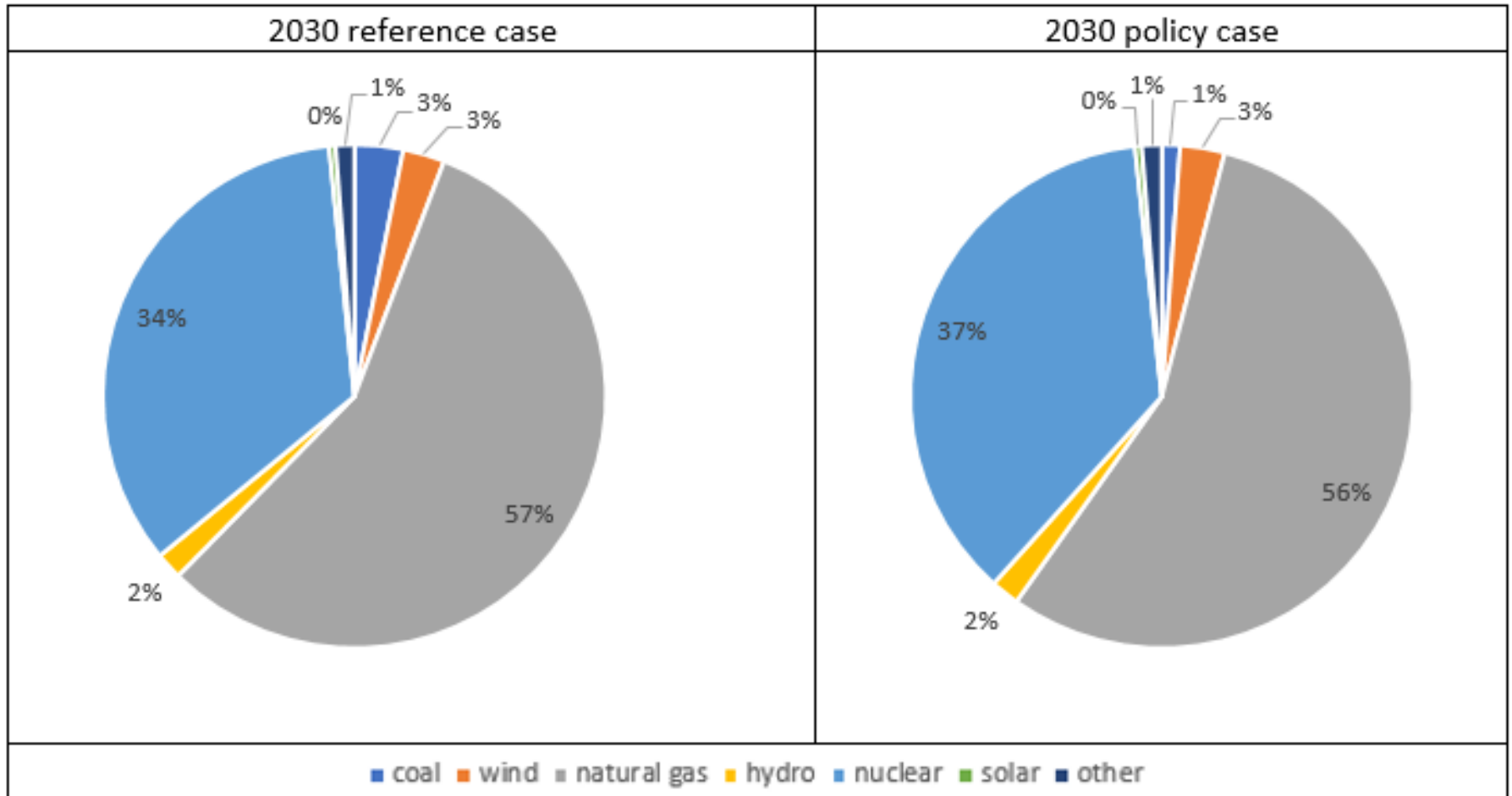


# PA Energy Generation- Comparison



**2030 PA Policy Scenario**

# 2030 Generation - Reference vs. Policy

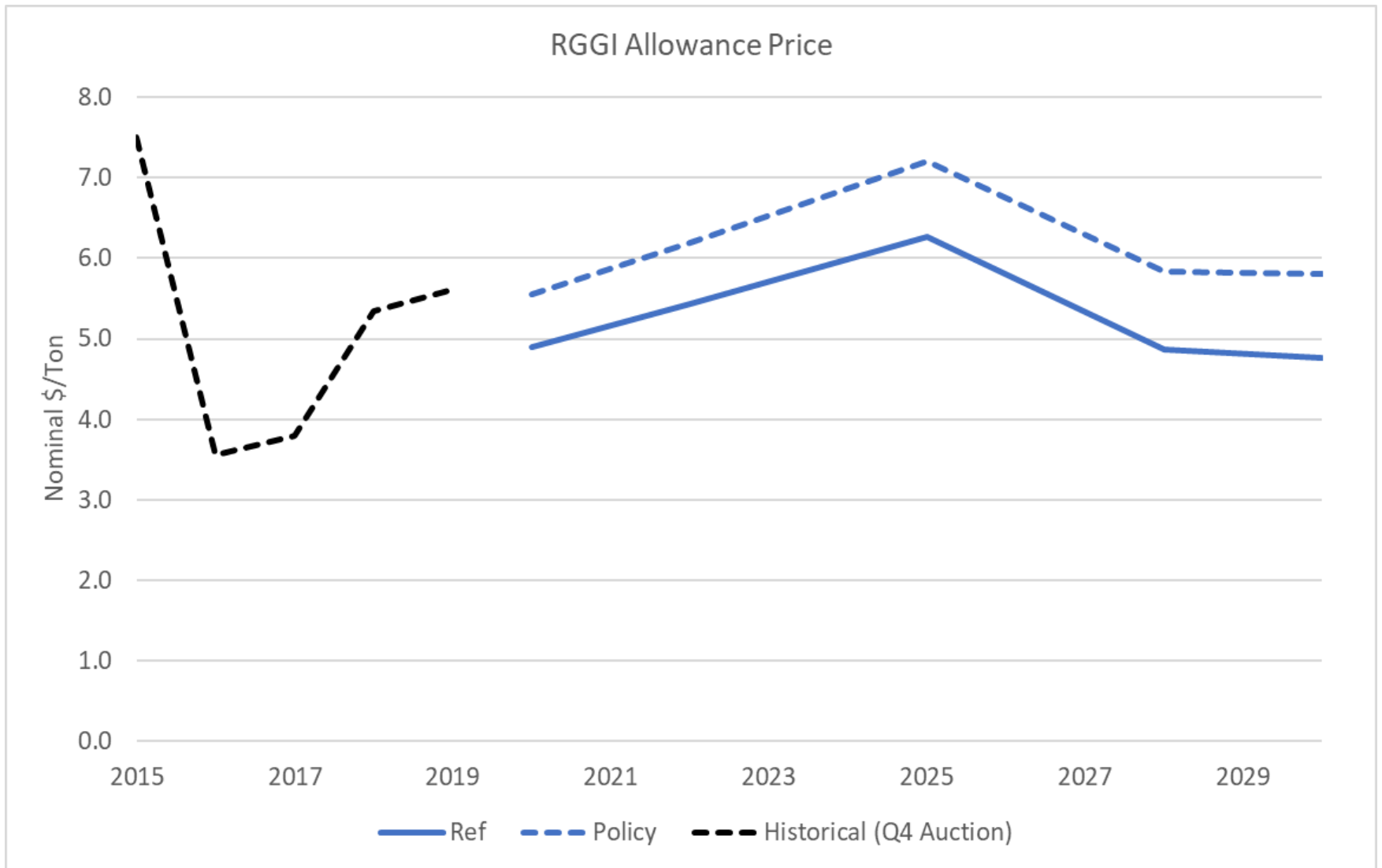


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# Regional Greenhouse Gas Initiative

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# RGGI Allowance Price

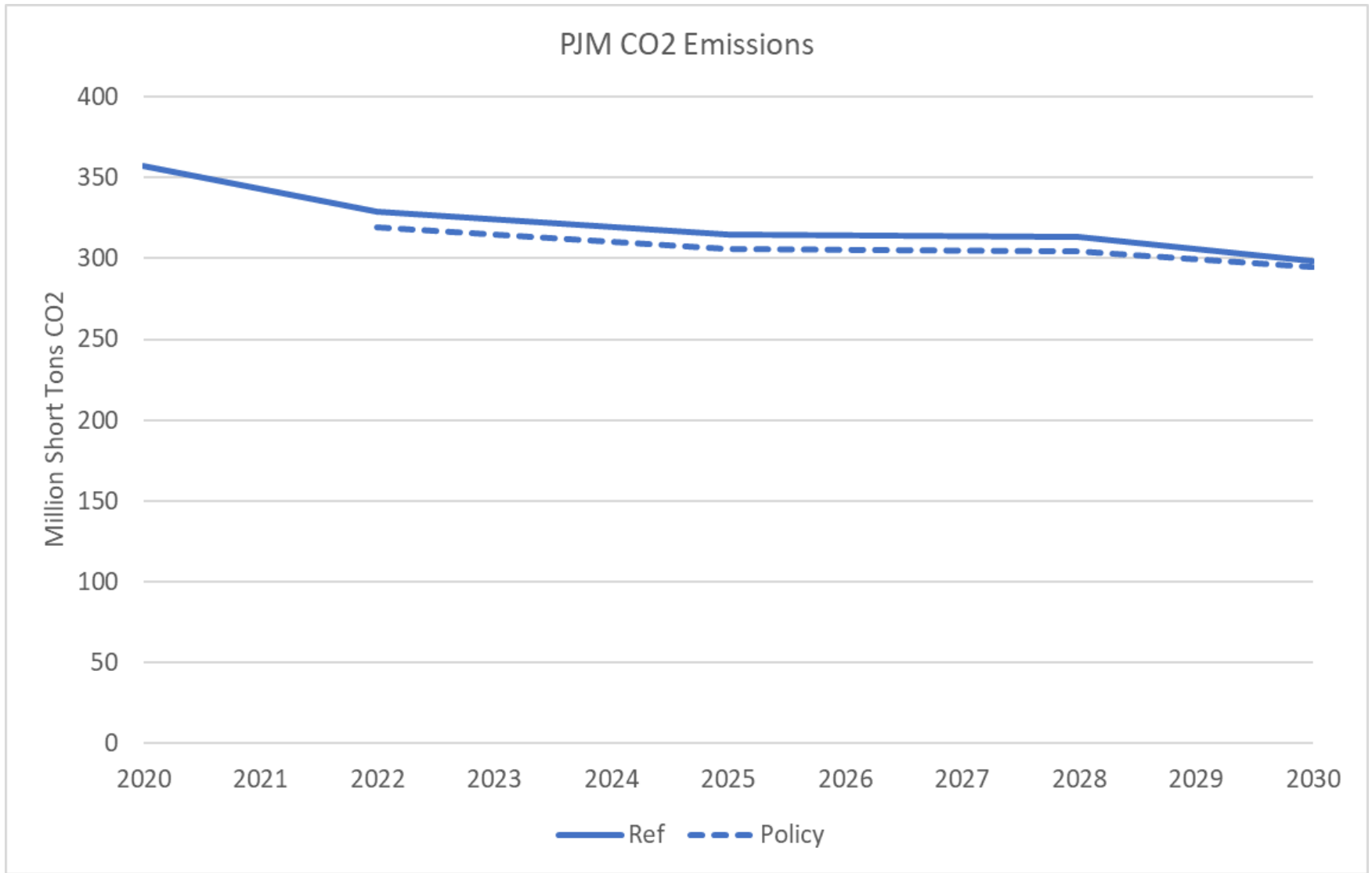


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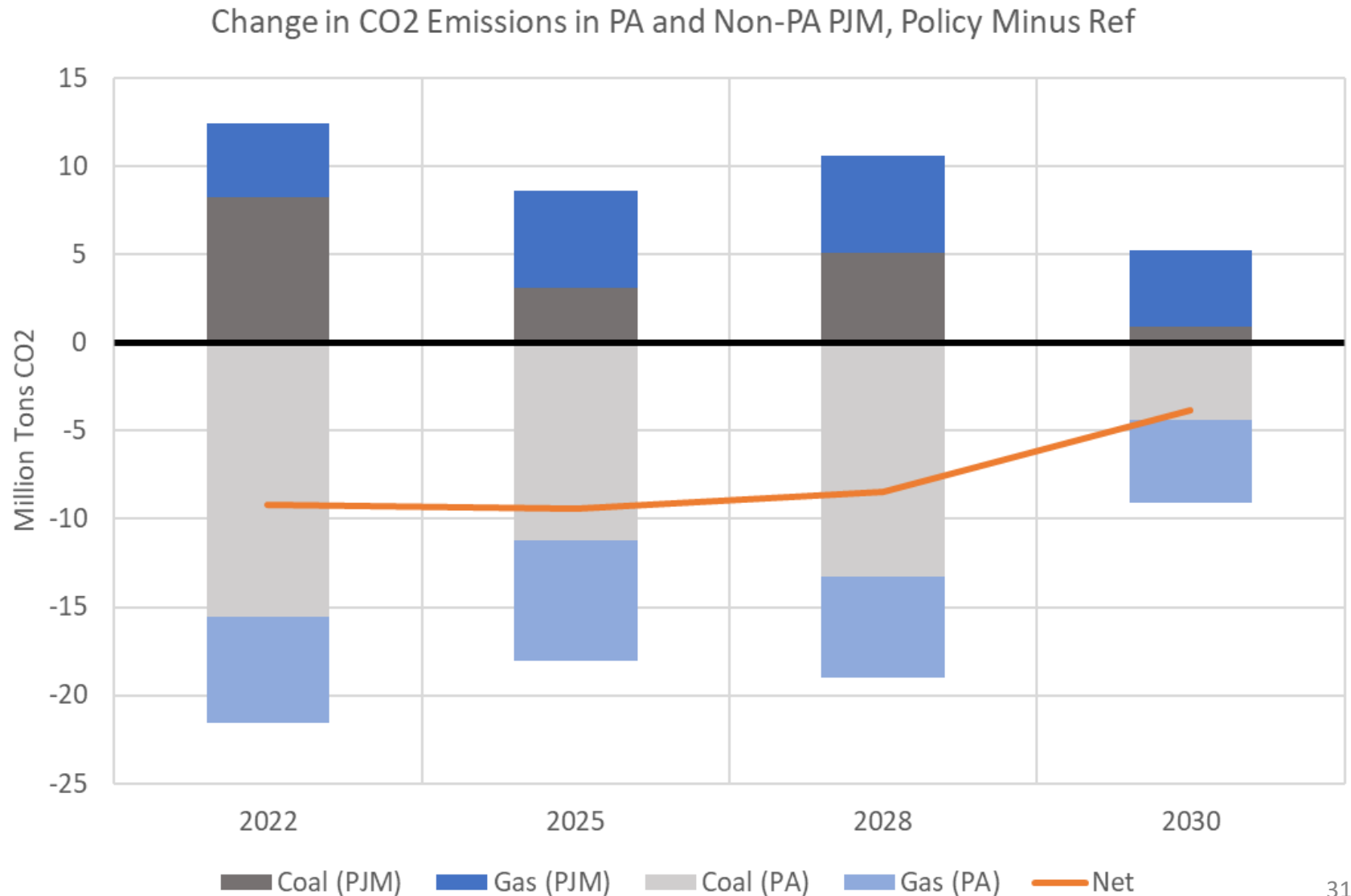
# Regional Power Sector Impacts

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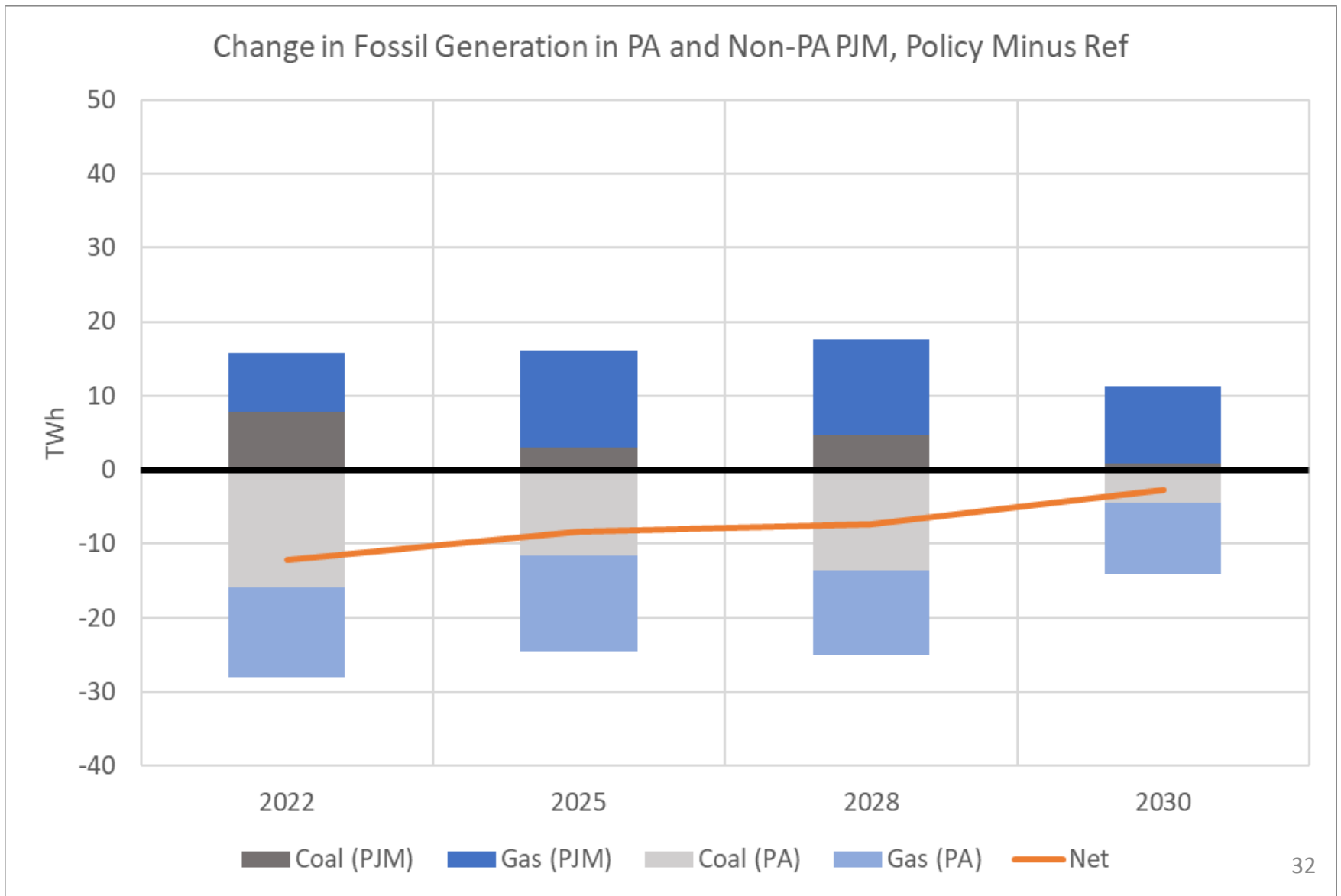
# PJM Power Sector CO<sub>2</sub> Emissions



# Regional Changes in CO<sub>2</sub> Emissions

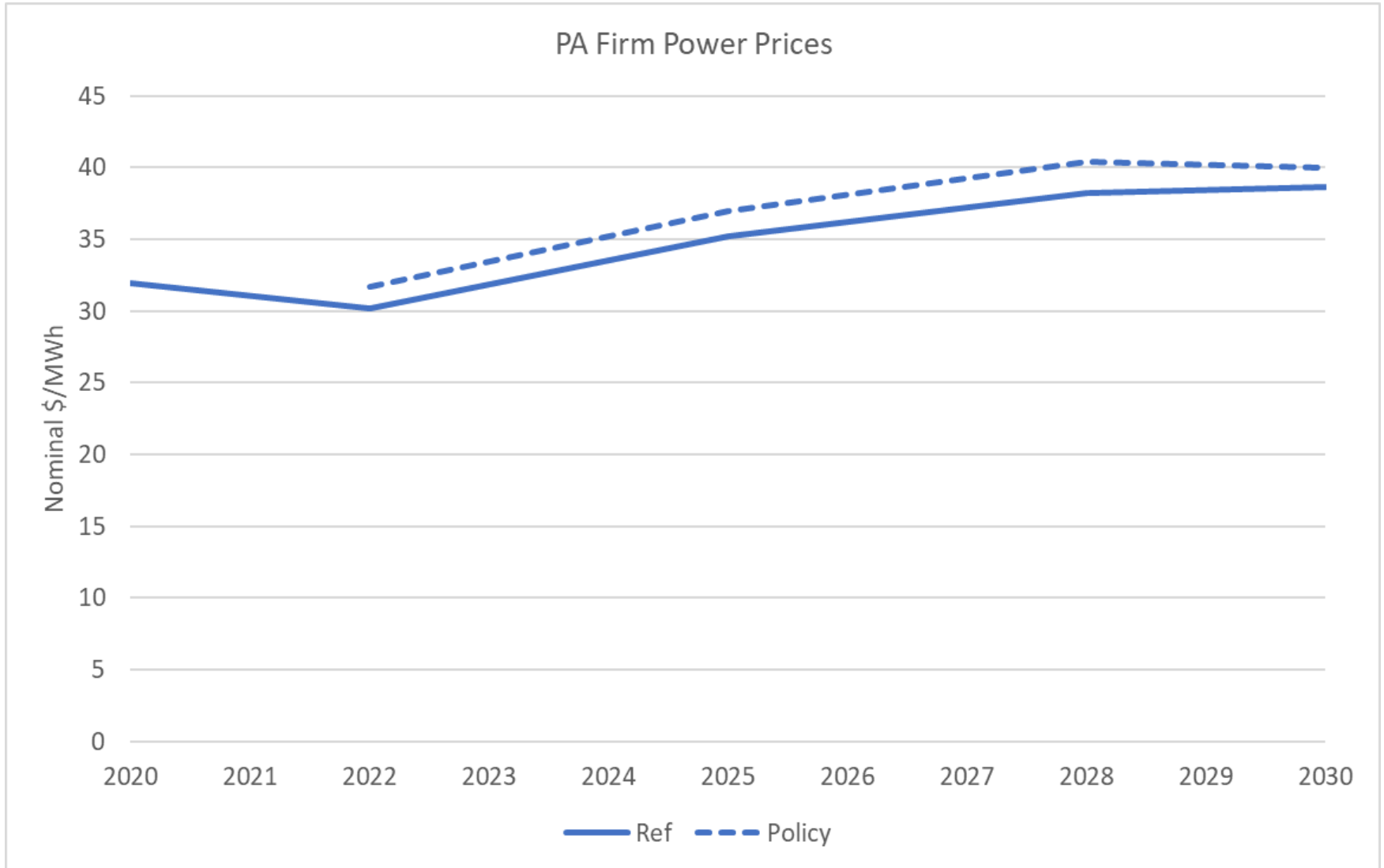


# Regional Changes in Fossil Generation





# Energy Price Comparisons



# RGGI Energy Price Comparisons

## Energy Prices (Nominal \$/MWh)

	2020	2022	2025	2028	2030
MA	\$ 44.5	\$ 40.5	\$ 40.8	\$ 46.4	\$ 49.3
CT	\$ 39.4	\$ 36.1	\$ 37.8	\$ 40.5	\$ 41.0
ME	\$ 39.2	\$ 35.1	\$ 38.1	\$ 41.8	\$ 41.8
NH	\$ 39.8	\$ 35.4	\$ 36.7	\$ 41.4	\$ 41.9
RI	\$ 44.6	\$ 41.1	\$ 43.0	\$ 49.1	\$ 50.7
VT	\$ 43.7	\$ 38.7	\$ 42.1	\$ 46.5	\$ 47.5
NY	\$ 35.8	\$ 31.6	\$ 32.7	\$ 34.2	\$ 34.0
DE	\$ 34.8	\$ 28.8	\$ 30.0	\$ 34.8	\$ 35.8
MD	\$ 31.6	\$ 28.7	\$ 29.9	\$ 34.0	\$ 34.9
9-state RGGI	\$ 37.3	\$ 33.2	\$ 34.3	\$ 37.1	\$ 37.7
VA	\$ 29.7	\$ 28.3	\$ 29.4	\$ 33.0	\$ 34.0
NJ	\$ 34.1	\$ 30.3	\$ 31.2	\$ 34.2	\$ 34.2
PA	\$ 27.8	\$ 25.8	\$ 27.8	\$ 31.8	\$ 32.8

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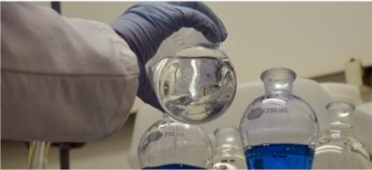
# Next Steps

## Revised Regulatory Timeline- Draft Proposed CO<sub>2</sub> Budget Trading Program Regulation

- April 16<sup>th</sup> Air Quality Technical Advisory Committee Meeting- Update & Timeline Discussion
- April 21<sup>st</sup> Citizens Advisory Council Meeting- Update & Timeline Discussion
- April 23<sup>rd</sup> Joint Informational Modeling Webinar- AQTAC & the Citizens Advisory Council  
Draft Proposed Annex Posted Online- PA CO<sub>2</sub> Budget Trading Program
- May 7<sup>th</sup> Air Quality Technical Advisory Committee Meeting- CO<sub>2</sub> Budget Trading Program Regulation**
- May 19<sup>th</sup> Citizen's Advisory Council Meeting- CO<sub>2</sub> Budget Trading Program Regulation
- July 7<sup>th</sup> Draft Proposed Annex Posting to EQB Website
- July 21<sup>st</sup> Environmental Quality Board Meeting- CO<sub>2</sub> Budget Trading Program Regulation  
\*Meets deadline as established in Executive Order 2019-7
- Sep 2020 – Comment Period Opens & Public Hearings are Held Across the State

# Questions & Answers





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DEPARTMENT OF ENVIRONMENTAL PROTECTION



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