United States Environmental Protection Agency

# The role of non-traditional control measures in cost-effectively meeting state emission reduction targets

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# Introduction

| State Strategies Reducing Air Pollutants | |
|---|---|
| **Traditional Measures** | **Non-traditional Measures** |
| End-of-pipe control devices,<br>Fuel combustion changes | Fuel switching,<br>Improving energy efficiency,<br>Renewable energy,<br>End-use electrification,<br>Energy conservation,<br>Price-induced demand changes |

- Historically, air quality management has focused on traditional measures, which might not be sufficient to meet air quality goals.
- The fundamental research question:
  - To what extent can non-traditional control measures be used in designing an optimal strategy?
- This presentation is an incremental step to answer this question by introducing state-level "marginal abatement cost curves" for nitrogen oxides (NOx), which account for both traditional and nontraditional measures.

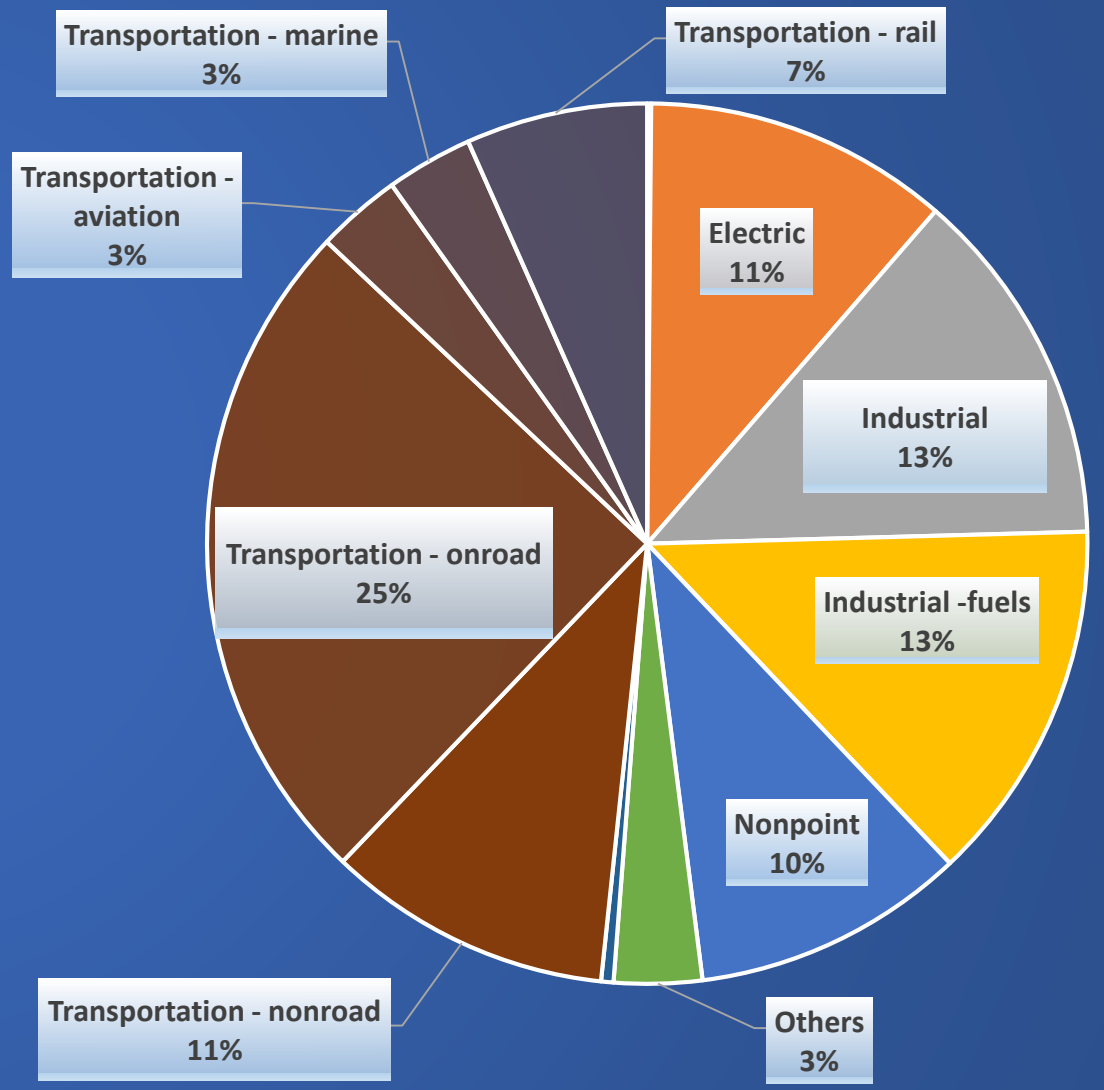
# Background: NOx

- NOx is emitted from combustion sources, including motor vehicles, power plants, and industrial processes.

- The reactions of NOx in the atmosphere can be harmful to human health and the environment.
  - With VOC under sunlight → Tropospheric Ozone ($O_3$)
  - Form $HNO_3$ → acid rain

- Traditional measures for reducing NOx:
  - Process changes for NOx burners
  - Applications of catalytic reduction devices

**2023 NOx Emissions by Sector**



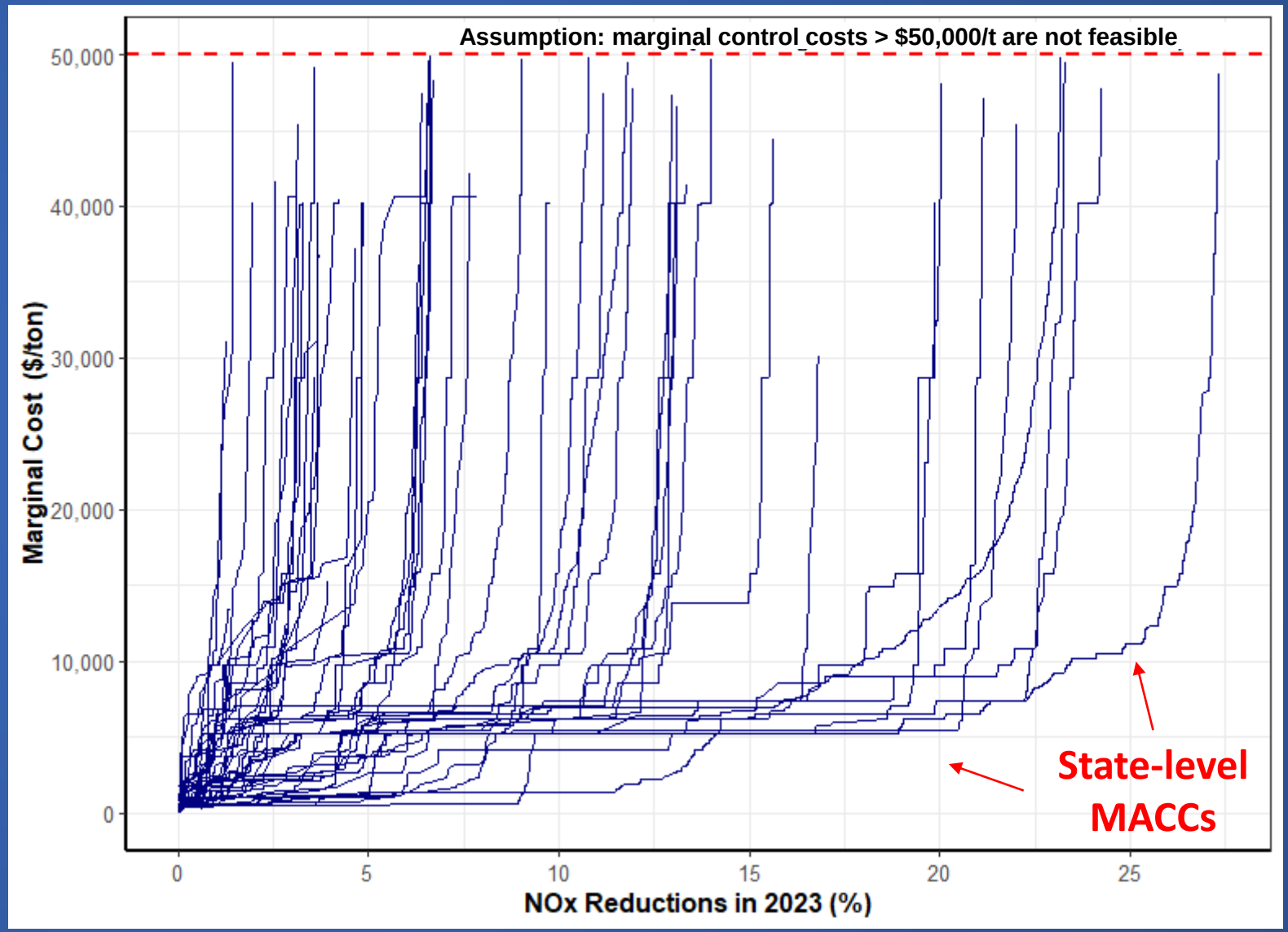

Data Source: 2016 EPA Modeling Platform

# Background: Traditional NOx Measures

NOx controls in 2023 From EPA's Control Strategy Tool (CoST)

***Marginal Abatement Cost Curve (MACC):***

- Represents the relationship between reductions and the abatement costs for one additional unit of emissions
- Reduction costs increase as sources get more expensive to control

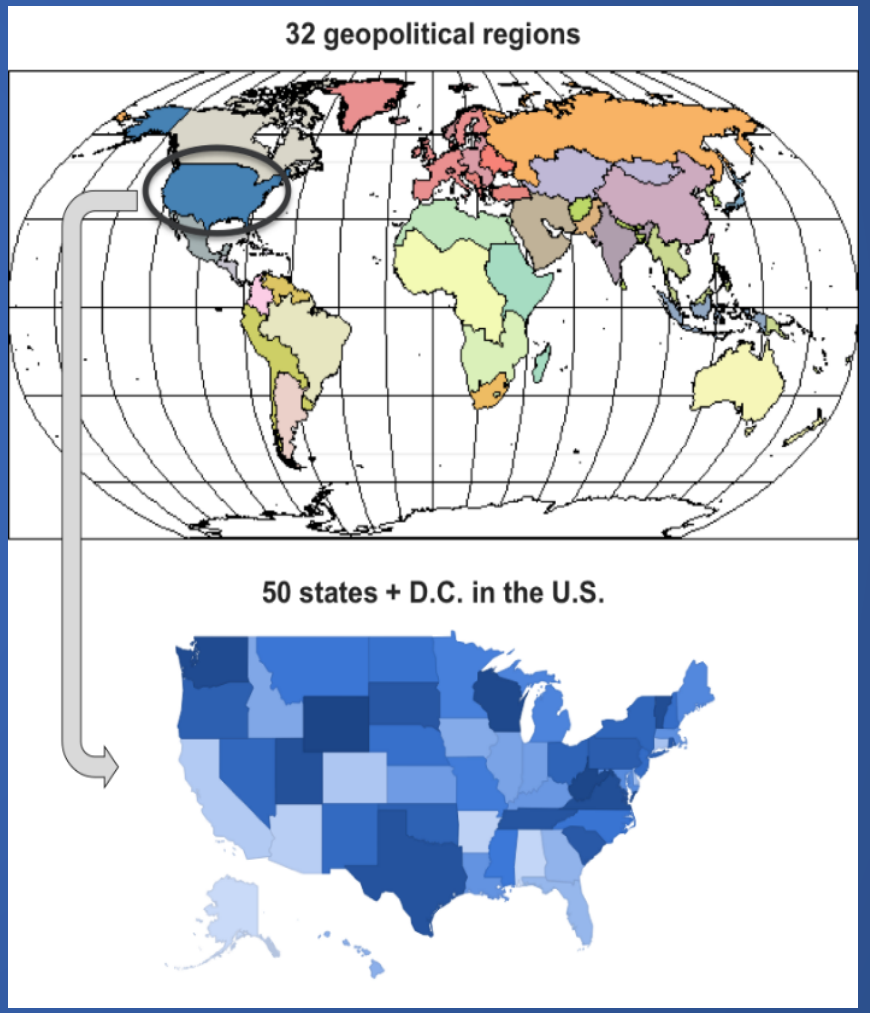


# Hypotheses

- Non-traditional measures are cost-competitive with many traditional measures
- Non-traditional measures can increase emission reduction potential beyond what traditional measures can achieve alone
- The optimal mix of traditional and non-traditional measures differs by state and reduction target

# Model - GCAM-USA

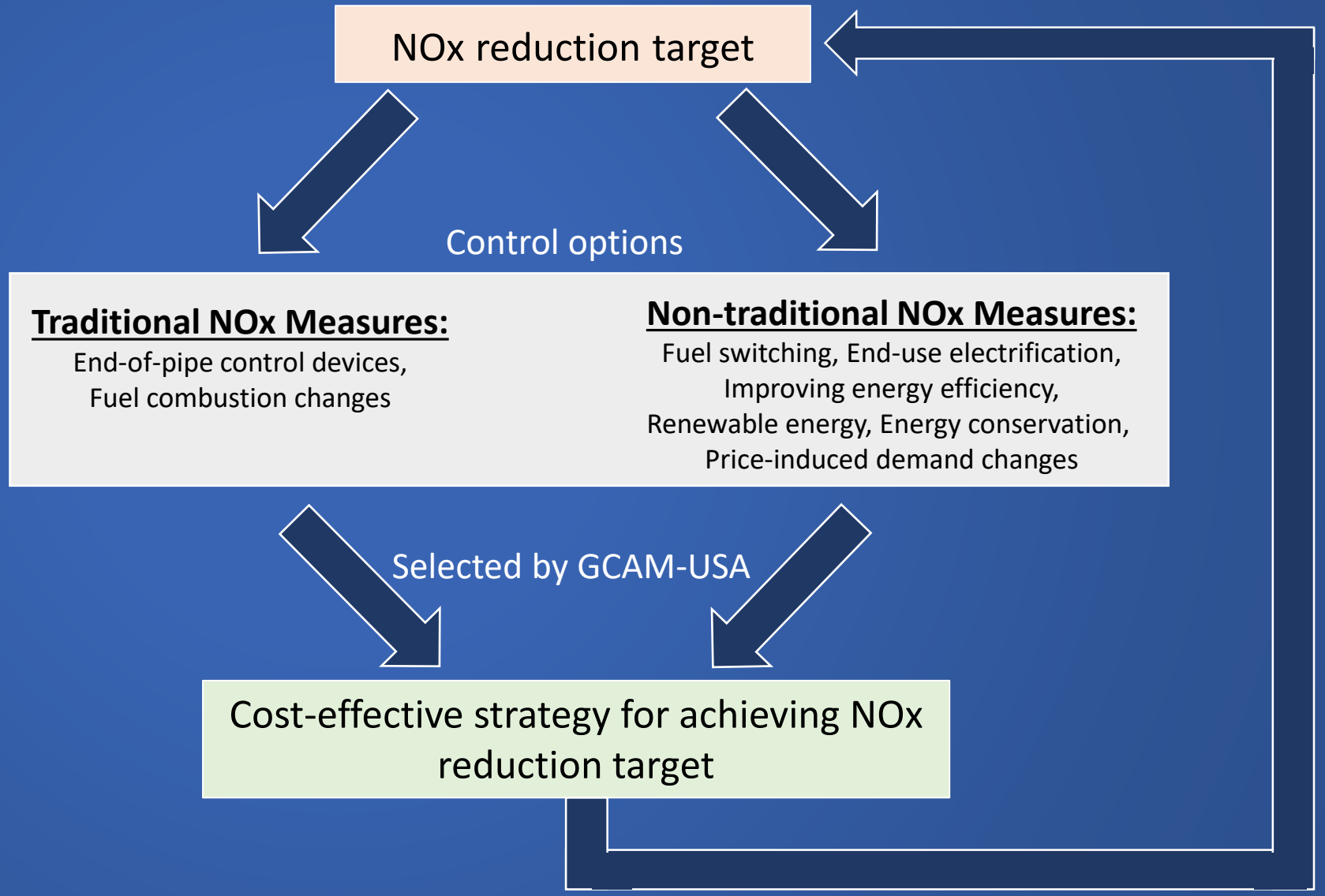
- GCAM-USA:
  - Global Change Analysis Model with state-level resolution
  - Simulates the co-evolution of human and earth systems for various scenarios
  - Includes energy, water, agriculture, land and climate systems
  - Tracks greenhouse gas and air pollutant emissions
  - Represents many U.S., regional, and state policies:
    - Cross State Air Pollution Rule
    - Corporate Average Fuel Economy standards
    - Various pollutant New Source Performance Standards
    - Zero Emission Vehicle state targets
    - Regional Greenhouse Gas Initiative
  - Supports analysis of alternative policy scenarios
    - Pollutant caps, taxes, emission standards, efficiency standards



# Method

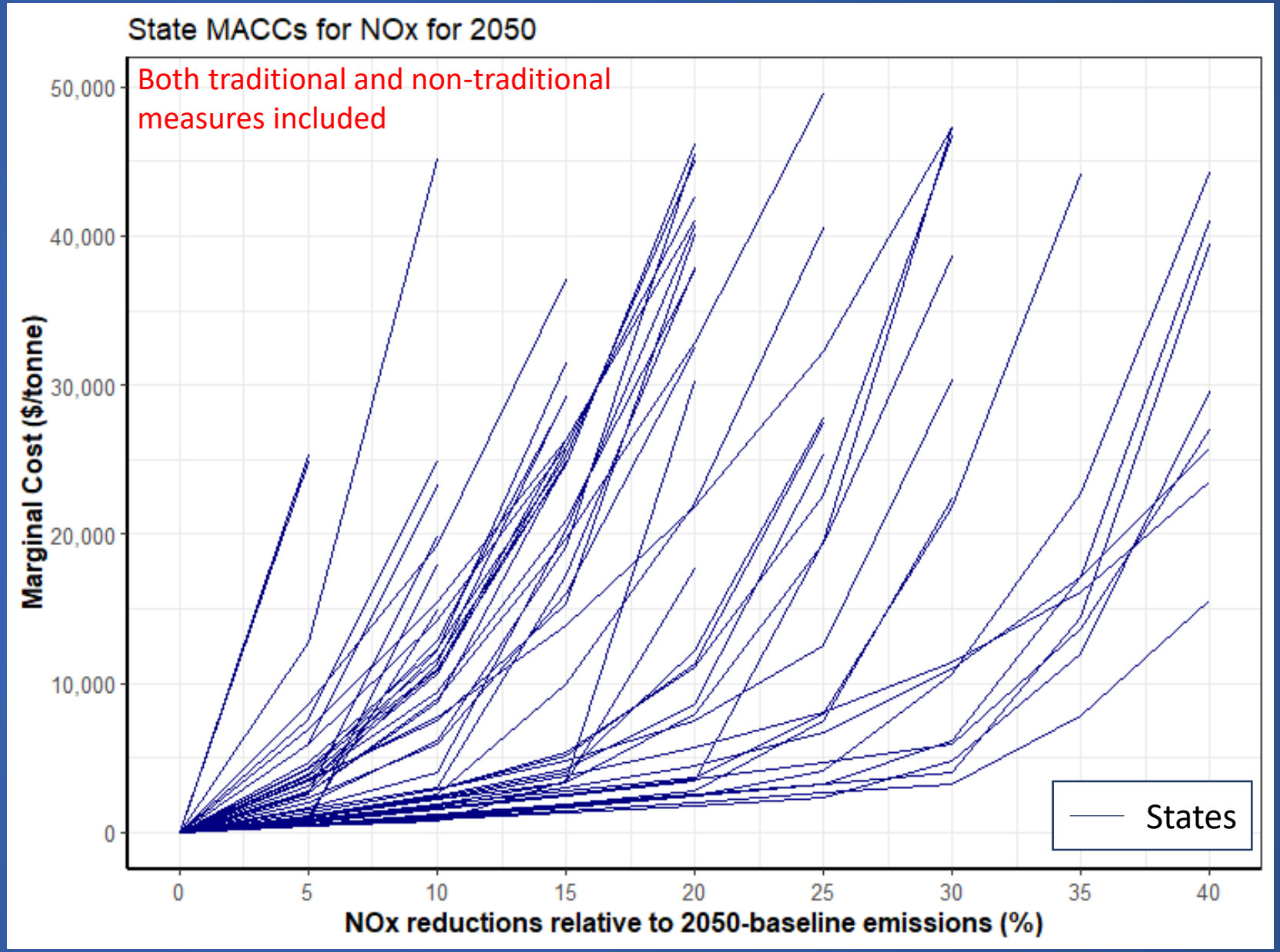
- Incrementally tighten NOx abatement targets (%) for lower-48 states
- For each % target, run GCAM-USA
  - Record the marginal costs
  - Identify the optimal mix of traditional and non-traditional measures

Note: for any particular state, the NOx abatement target incrementation is stopped when a $50,000/t marginal cost is reached.



# Results

- State-level MACCs vary greatly from one state to another

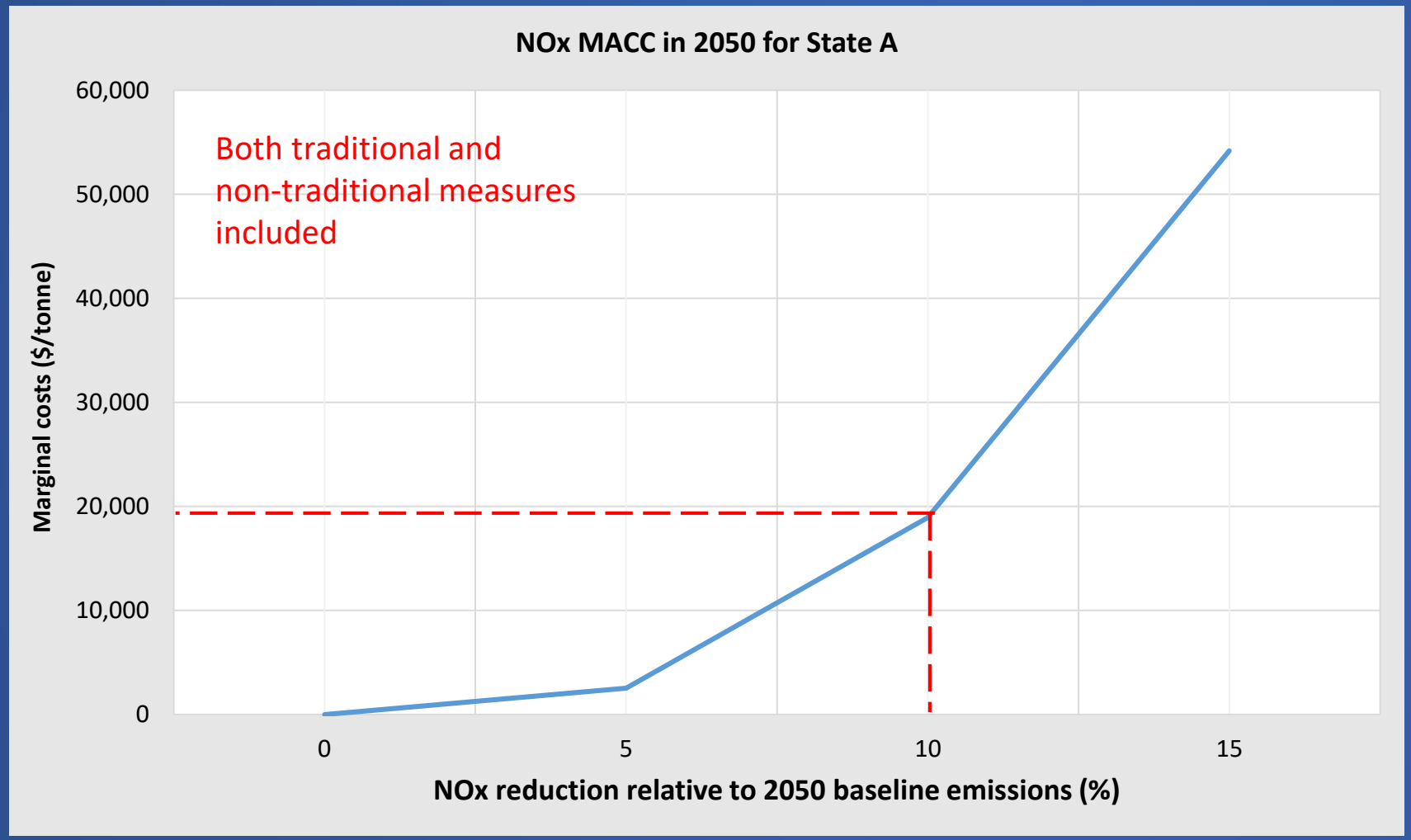





Draft results

# Results – State-level MACCs

**Sample state A: a state with heavy demands on fossil fuels located in the Midwestern region**




Analyzing the MACC for a particular state:

- A 10% reduction target can be achieved with measures that have a marginal cost of $19k/t or less

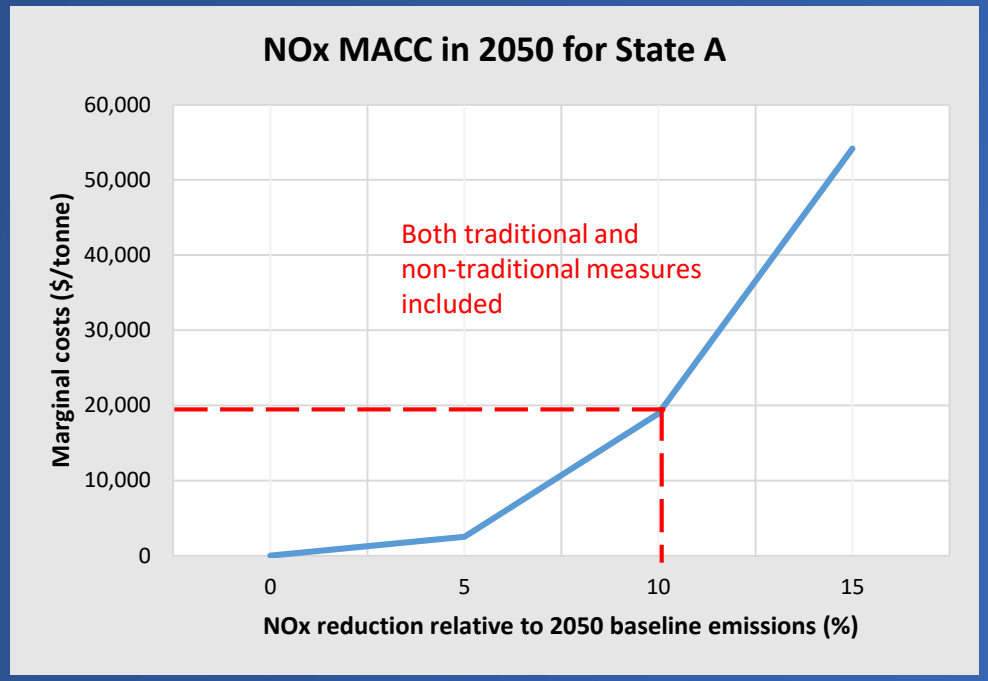
**Abatement cost at each reduction level**



**Draft results**

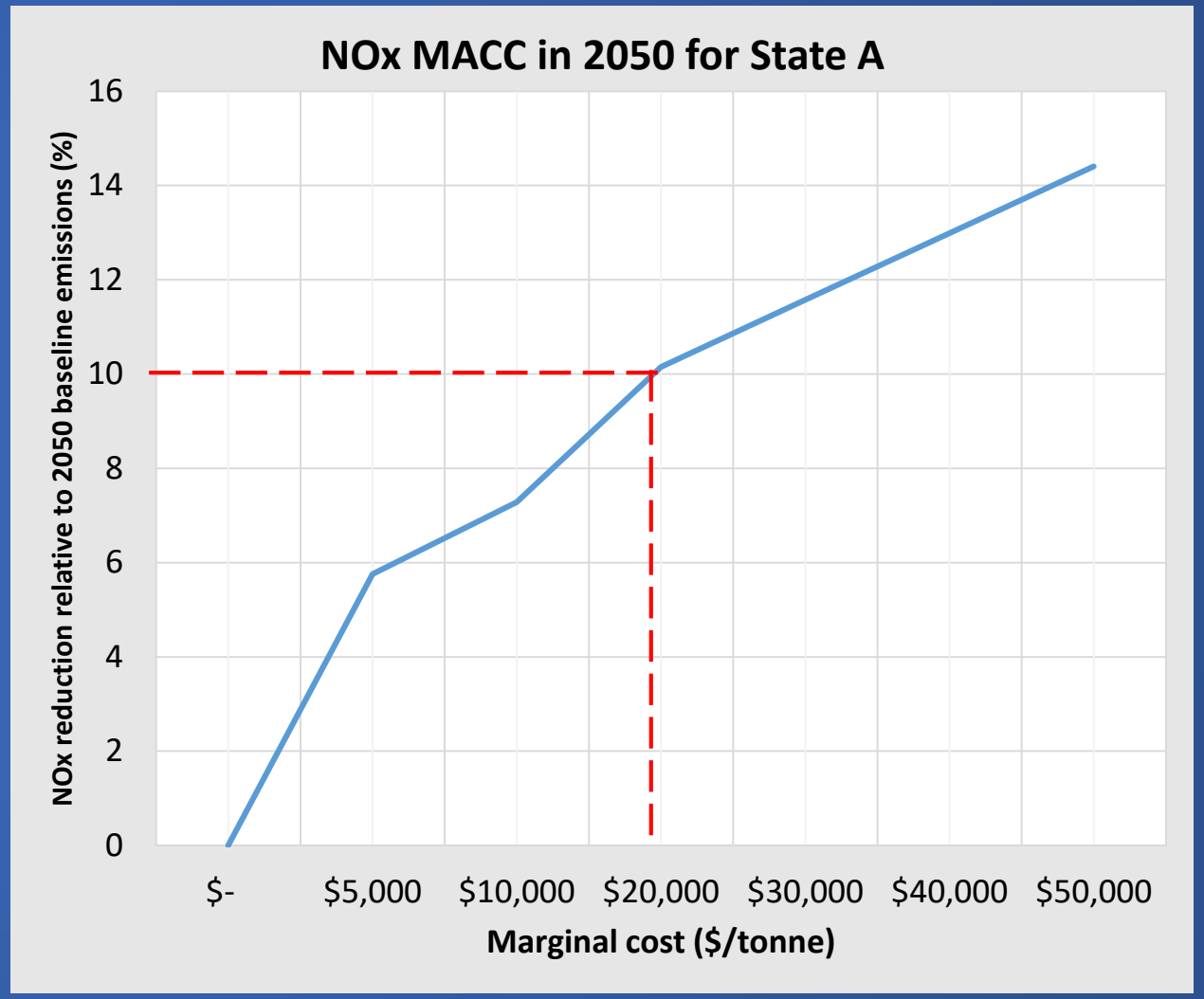
# Results – State-level MACCs

Sample state A: a state with heavy demands on fossil fuels located in the Midwestern region




Abatement cost at each reduction level

Axes switched




Potential NOx reductions at each cost level

- It can be useful in analyzing the MACCs to transpose the axes
  - Using measures with a marginal cost of $19k/t or less, a 10% reduction can be achieved



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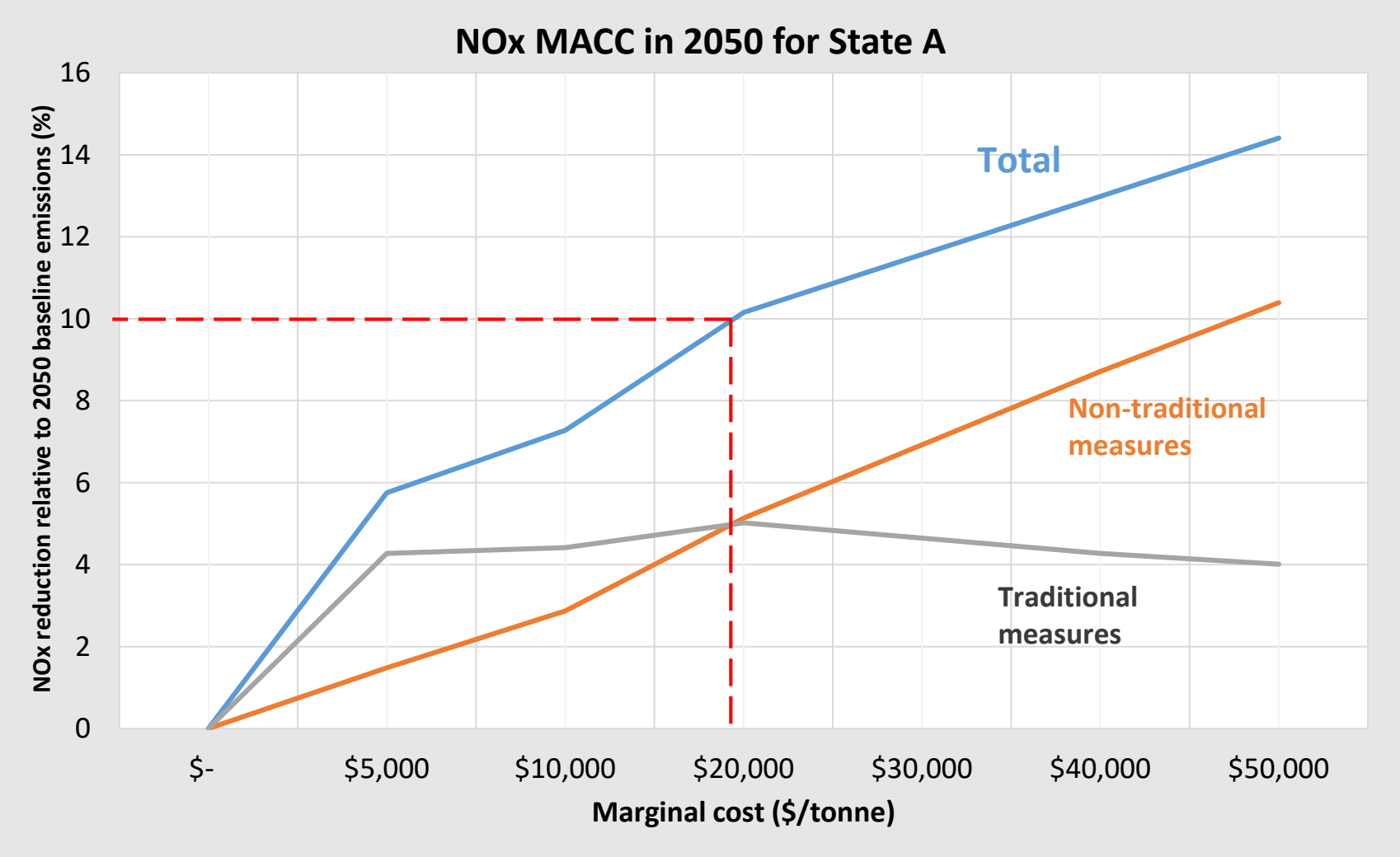
# Results – State-level MACCs

**Sample state A: a state with heavy demands on fossil fuels located in the Midwestern region**




Potential NOx reductions at each cost level

- Decomposition of the contribution of traditional and non-traditional measures
- For < $19k/t, reductions from traditional measures dominate
  - However, non-traditional contributions are 1/3 of total at $5k/t
- At $19k/t, traditional and non-traditional contributions are roughly equivalent
- If State A is willing to pay more than $19k/t, or must reduce more than 10% in this state, non-traditional measures dominate



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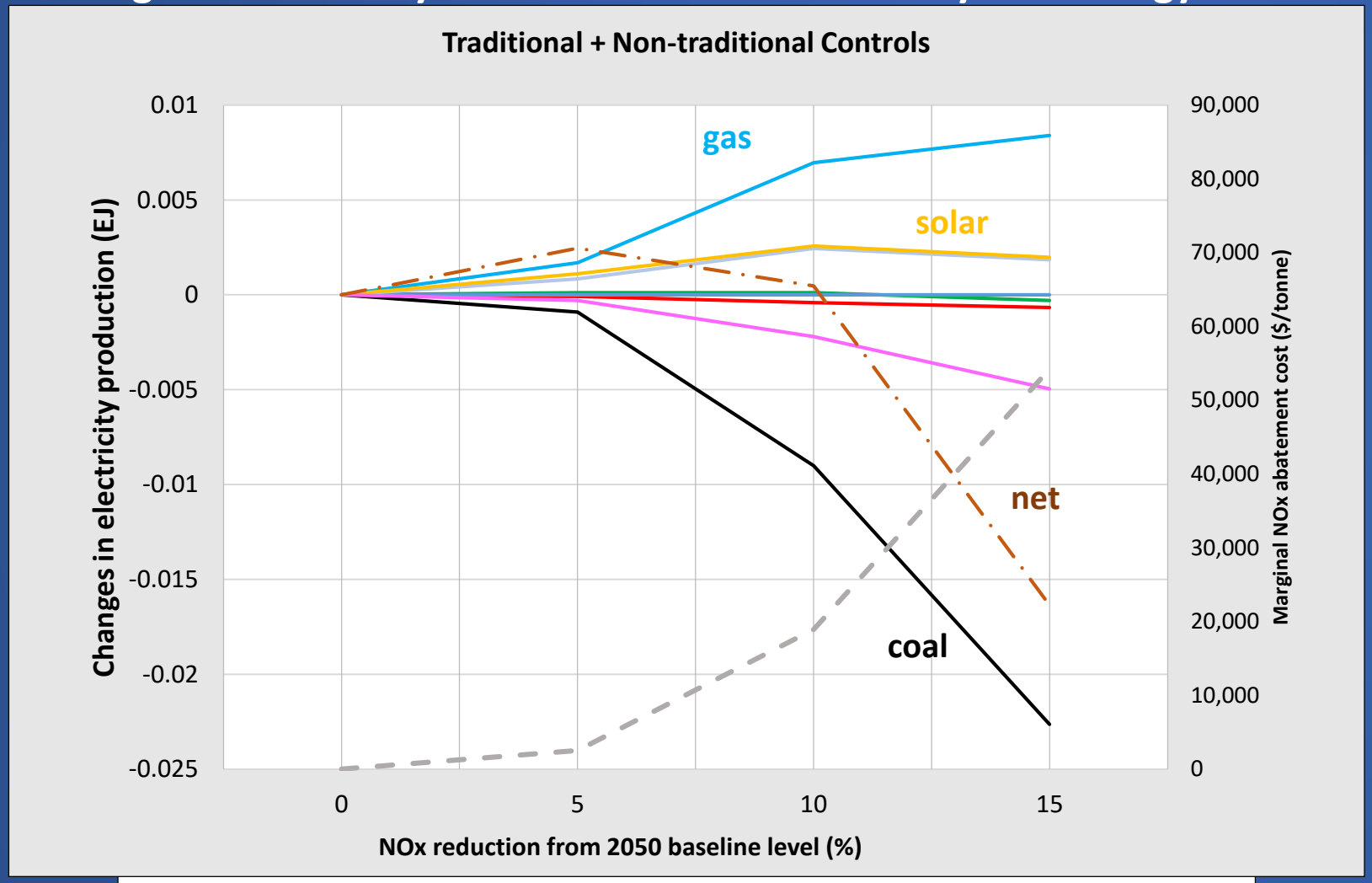
# Results – Changes in Electricity Generation

For State A

## Changes in Electricity Generation from Baseline by Technology in 2050

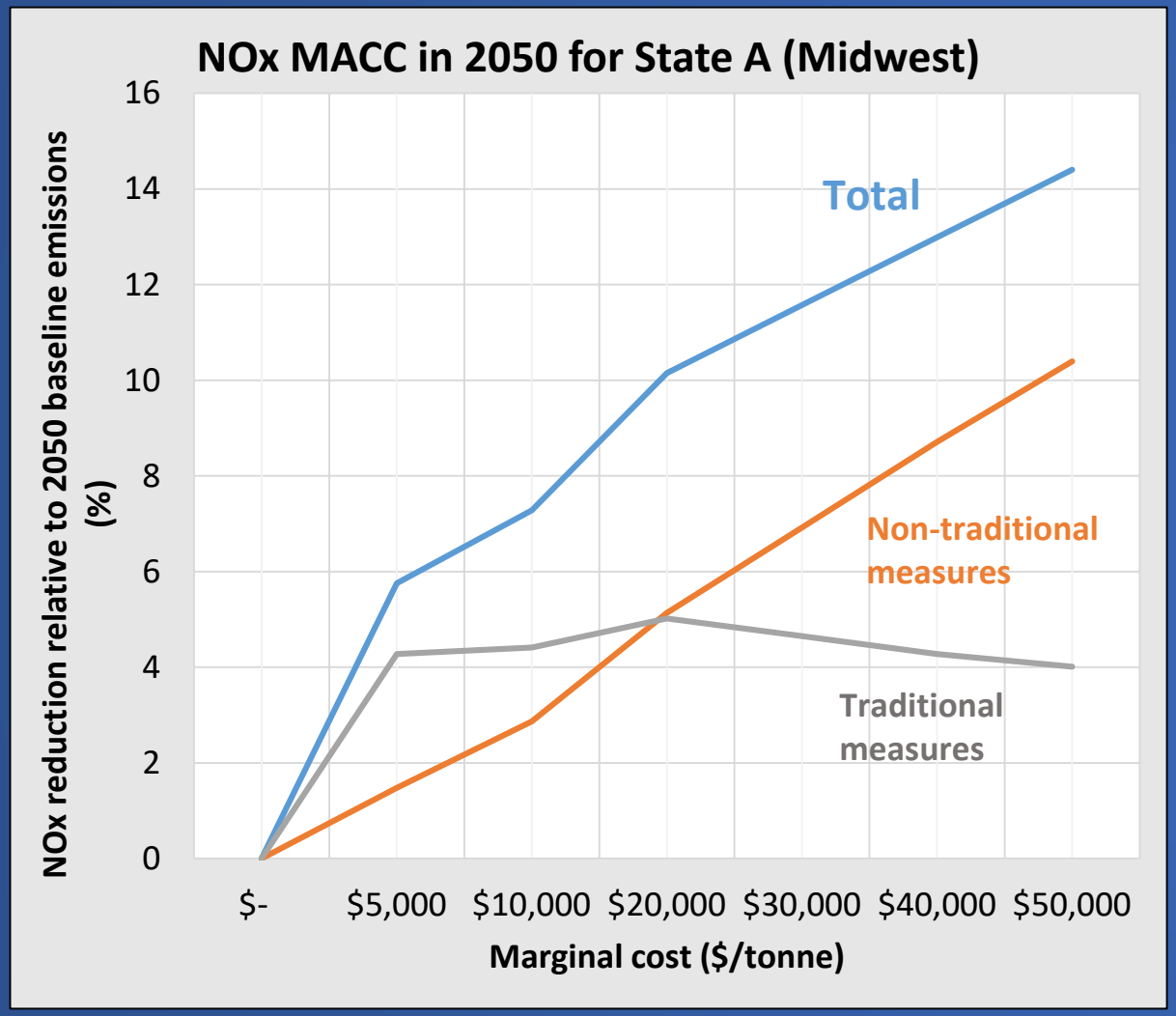


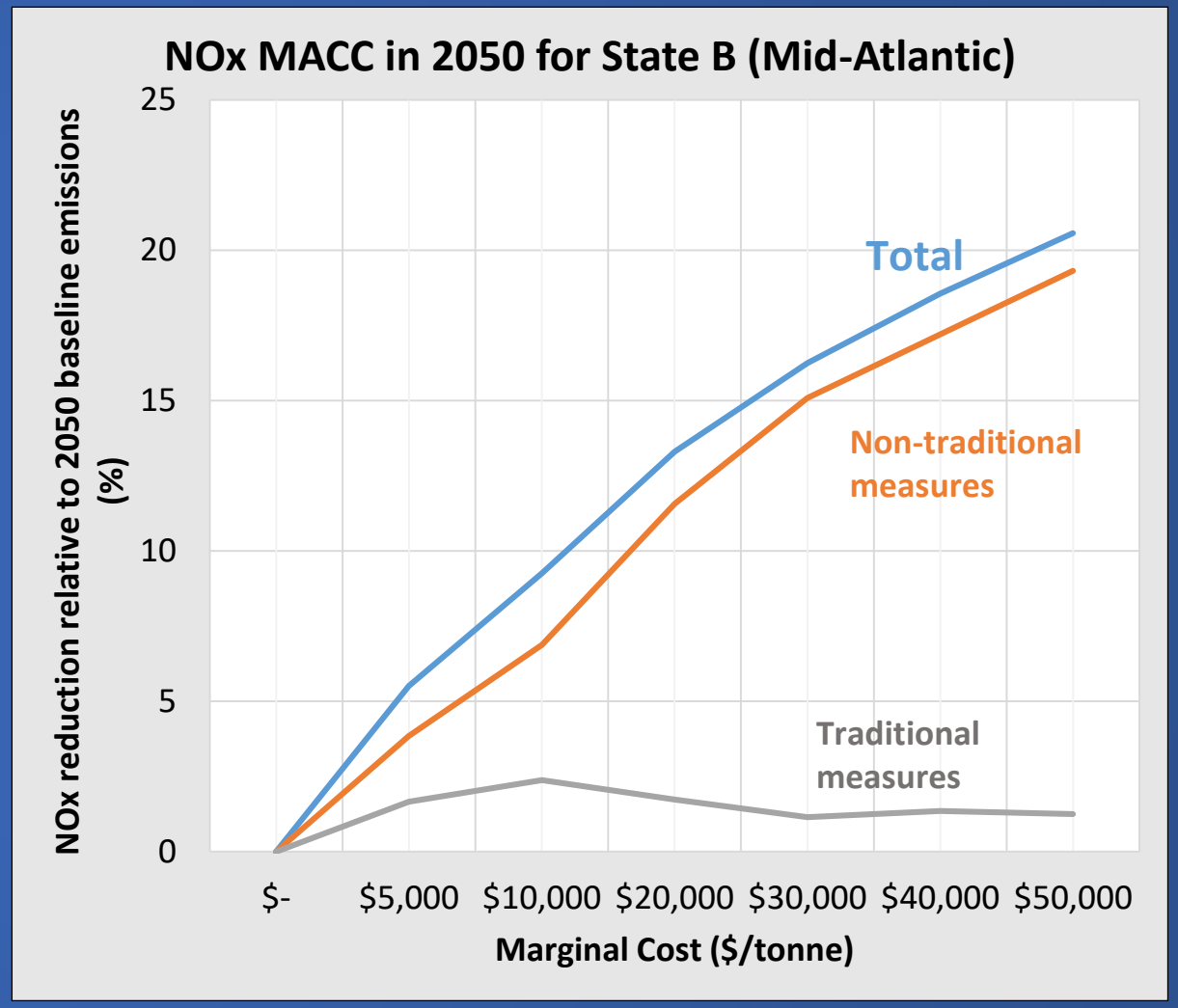

- Characterize the NOx reduction targets and costs at which specific non-traditional measures are used.
- In the electric sector:
  - At a 5% reduction target:
    - Coal output decreases
    - Gas, solar and wind increase
    - End-uses electrify, resulting in the increased net generation
  - At a 10% reduction target:
    - Coal output is lower
    - Gas, solar and wind increase
    - Net generation is lower



Draft results

# Results – State Comparisons




- MACCs trace out the dynamics of measures in an optimal control option.
- The role of non-traditional measures can differ greatly by state and target.

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# Summary

- We demonstrated an approach for examining the role of non-traditional measures in reducing NOx emissions
- Non-traditional measures were shown to:
  - Be cost-competitive with traditional measures
  - Increase the amount of NOx that could be reduced
  - Have a different role from one state to another

# Future Work

- Update industrial control data from latest CoST
- Integrate GCAM-USA's new industrial sector
  - Differentiates industrial technologies by fuel, use, and industrial sector
- Characterize state-level differences in more detail
- Explore how to account for the multi-pollutant co-benefits of non-traditional measures in determining optimal utilization