

Reasonable Progress for Class I Areas in the Northern Midwest – Four-Factor Analysis

Regional Air Quality Workshop
March 21-22, 2007

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Prepared for: Lake Michigan Air Directors Consortium
Minnesota Pollution Control Agency



Outline

- Objectives
- Background
- Methodology
- Analysis of “on-the-books” measures
- Analysis of potential future control measures



Objectives

- Develop a methodology for addressing the reasonable progress factors of the Regional Haze Rule
- Apply the methodology for several possible control strategies for improving visibility in northern Midwest Class I areas
 - Boundary Waters Wilderness Area
 - Voyageurs National Park
 - Isle Royale National Park
 - Seney Wilderness Area



Northern Midwest Class I Areas



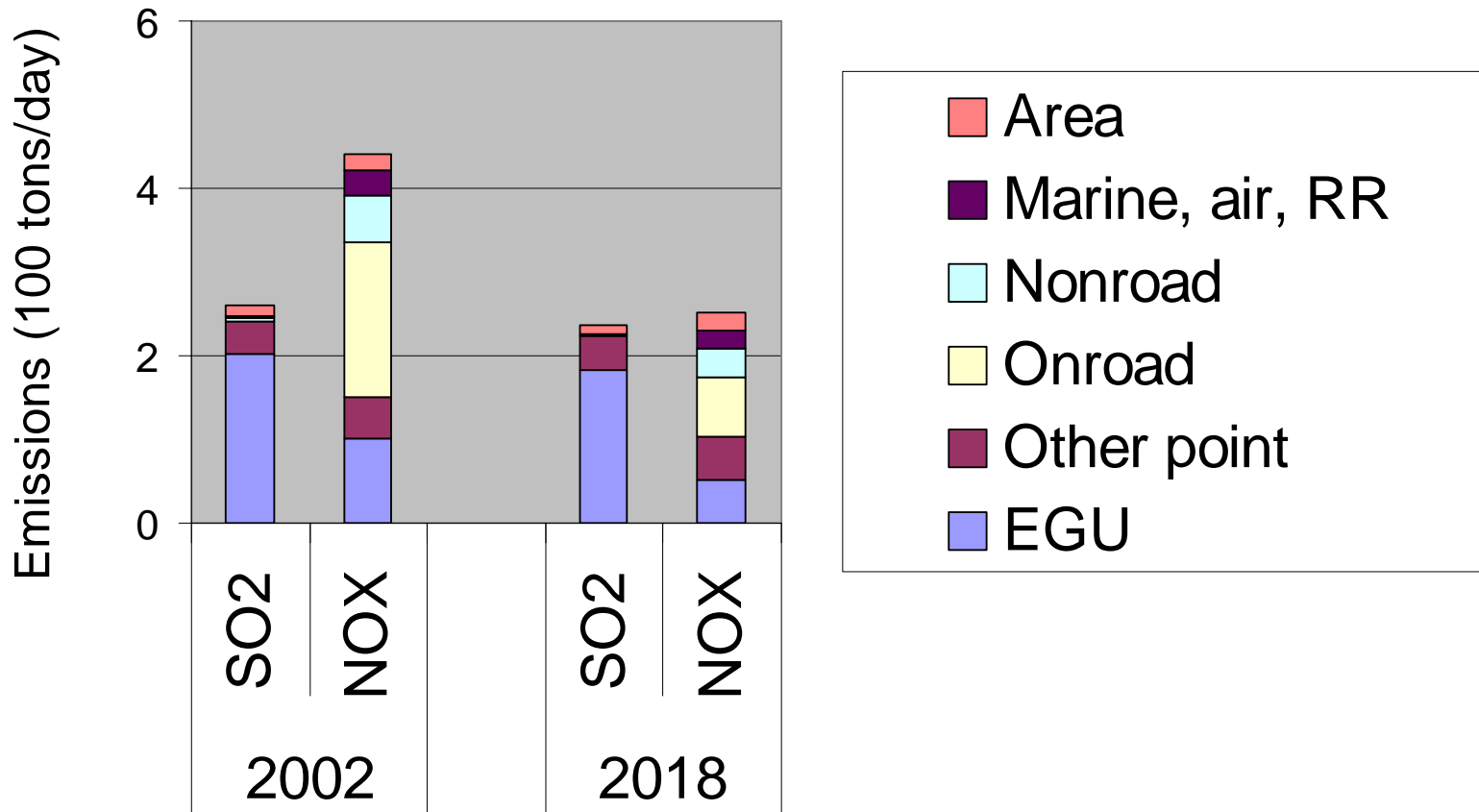
Background

- Midwest RPO and State Agencies have carried out source apportionment analysis
- Priority pollutants: SO_2 , NO_x , ammonia
- Priority sources
 - Electric Generating Units (EGUs)
 - Other stationary combustion sources
- Other sources of potential interest
 - Agricultural sources of ammonia
 - Mobile sources



Background - Emissions

Distribution of emissions in Michigan, Minnesota, and Wisconsin

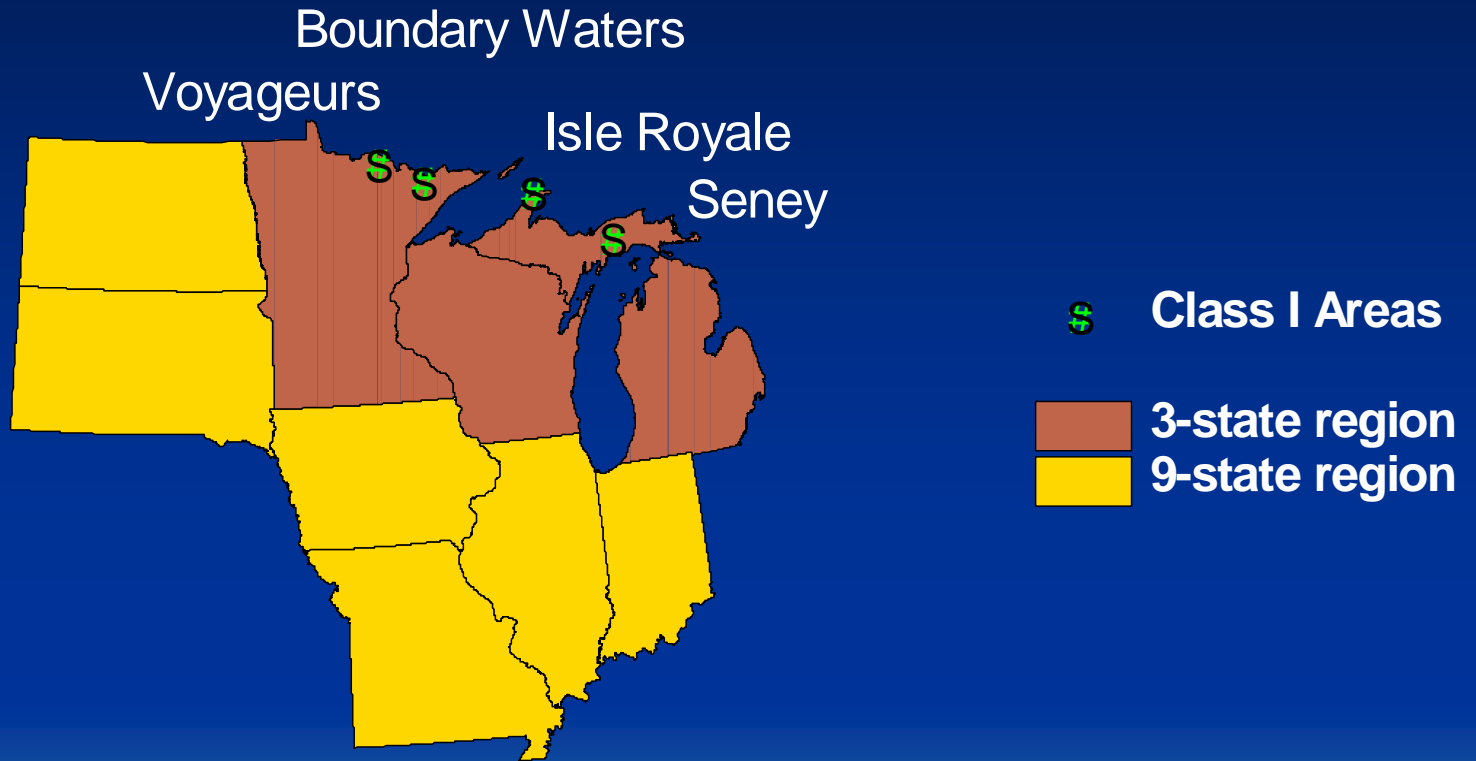


Methodology

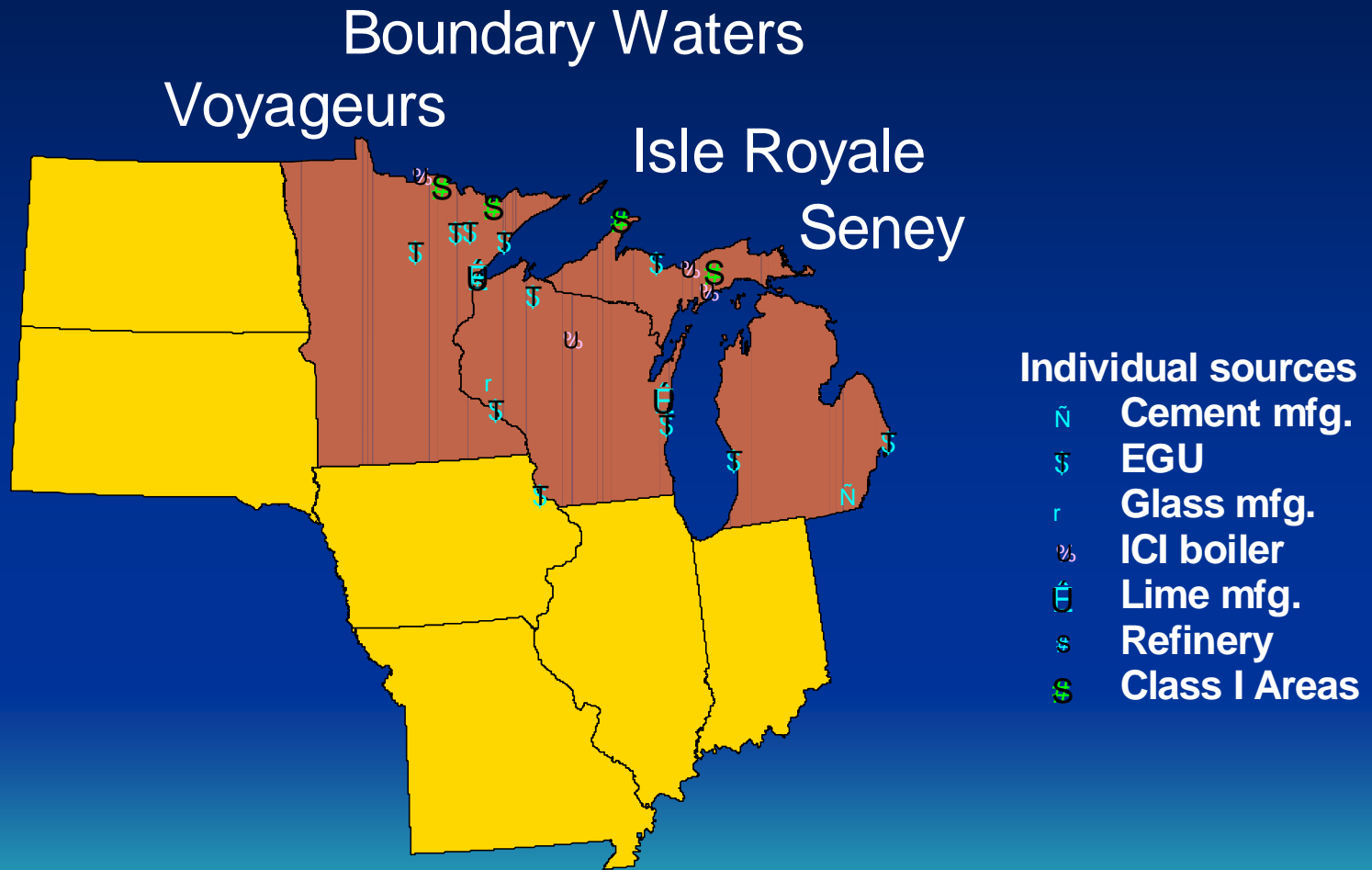
- Framed in a collaborative process involving EC/R, the Midwest RPO, States, other RPOs and the Park Service
- Two pronged approach
 - Category-level strategy analysis
 - More in-depth analysis for selected individual facilities
- Timeframe: 2018
- Baseline: LADCO Base K inventory (2002) and 2018 projections with on-the-books controls (Scenario 1)
- Geographic region of analysis
 - 3-state (MI, MN, WI)
 - 9-state (MI, MN, WI, IL, IN, IA, MO, ND, SD)



Geographic Regions



Individual sources selected



Reasonable Progress Factors

- Factors listed in the Regional Haze Rule
 - 1) Cost
 - 2) Time required for compliance
 - 3) Energy and other non-air impacts
 - 4) Remaining equipment life
- Additional criterion identified in EPA guidance
 - 5) Visibility improvement



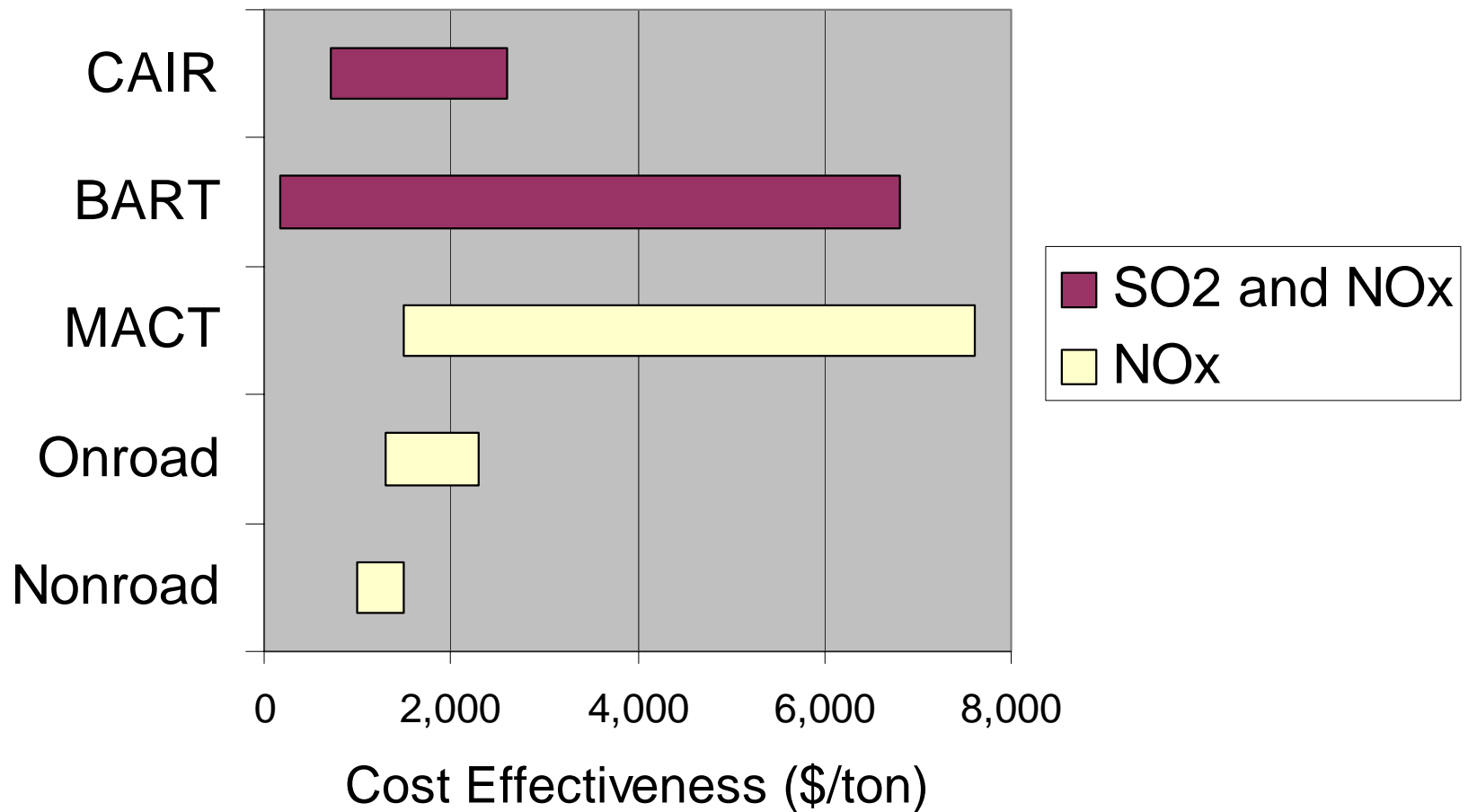
On-the-books measures

- Electric Generating Units
 - CAIR
 - NOX SIP Call
 - Acid Rain Program
- Other point sources
 - BART
 - MACT combustion standards
- Mobile source measures
 - Tier II / Low sulfur fuel
 - Heavy-duty diesel engine standard
 - Large spark ignition and RV standards
 - Inspection and maintenance programs



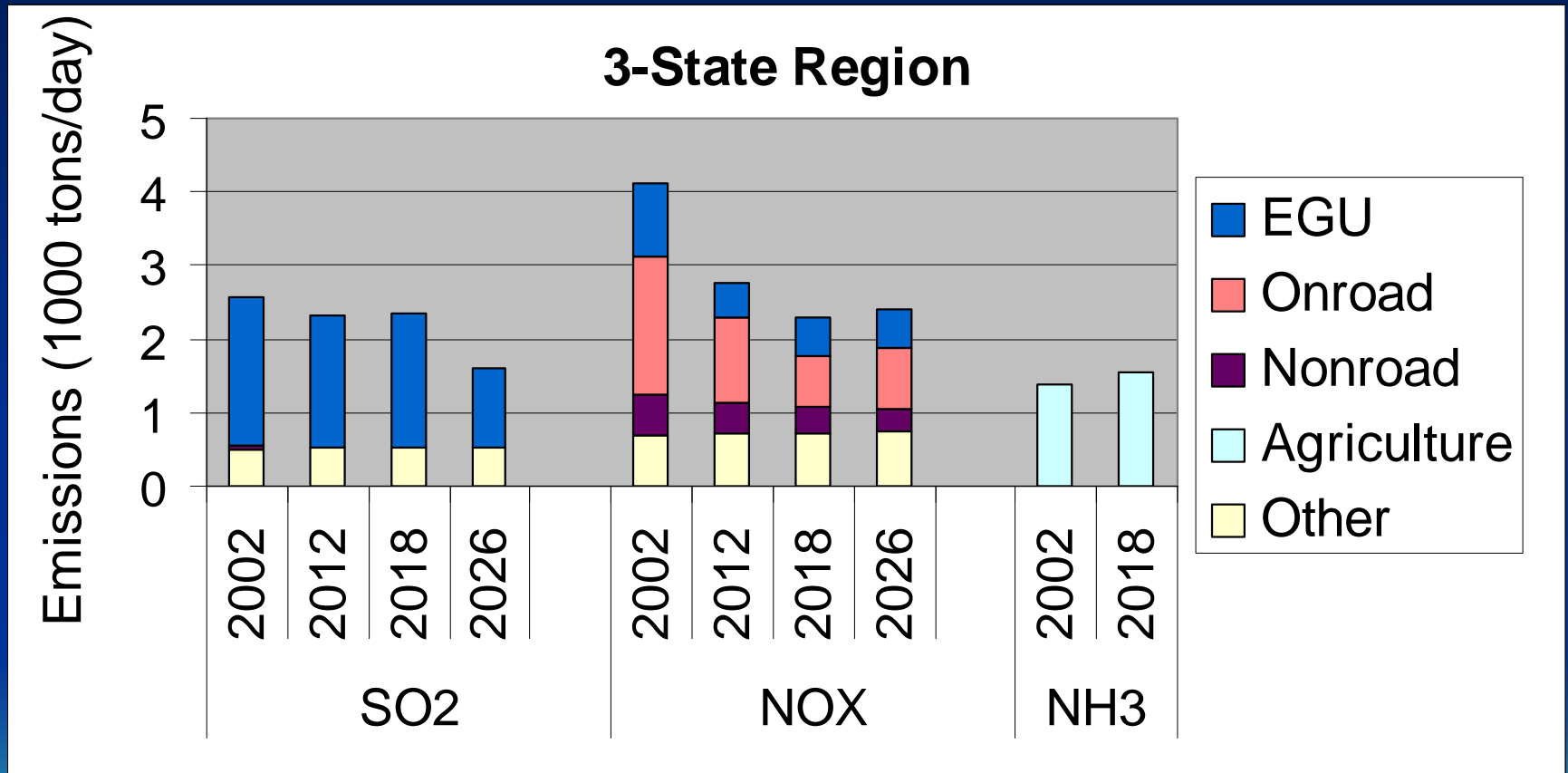
On-the-books measures – Factor 1

Cost effectiveness



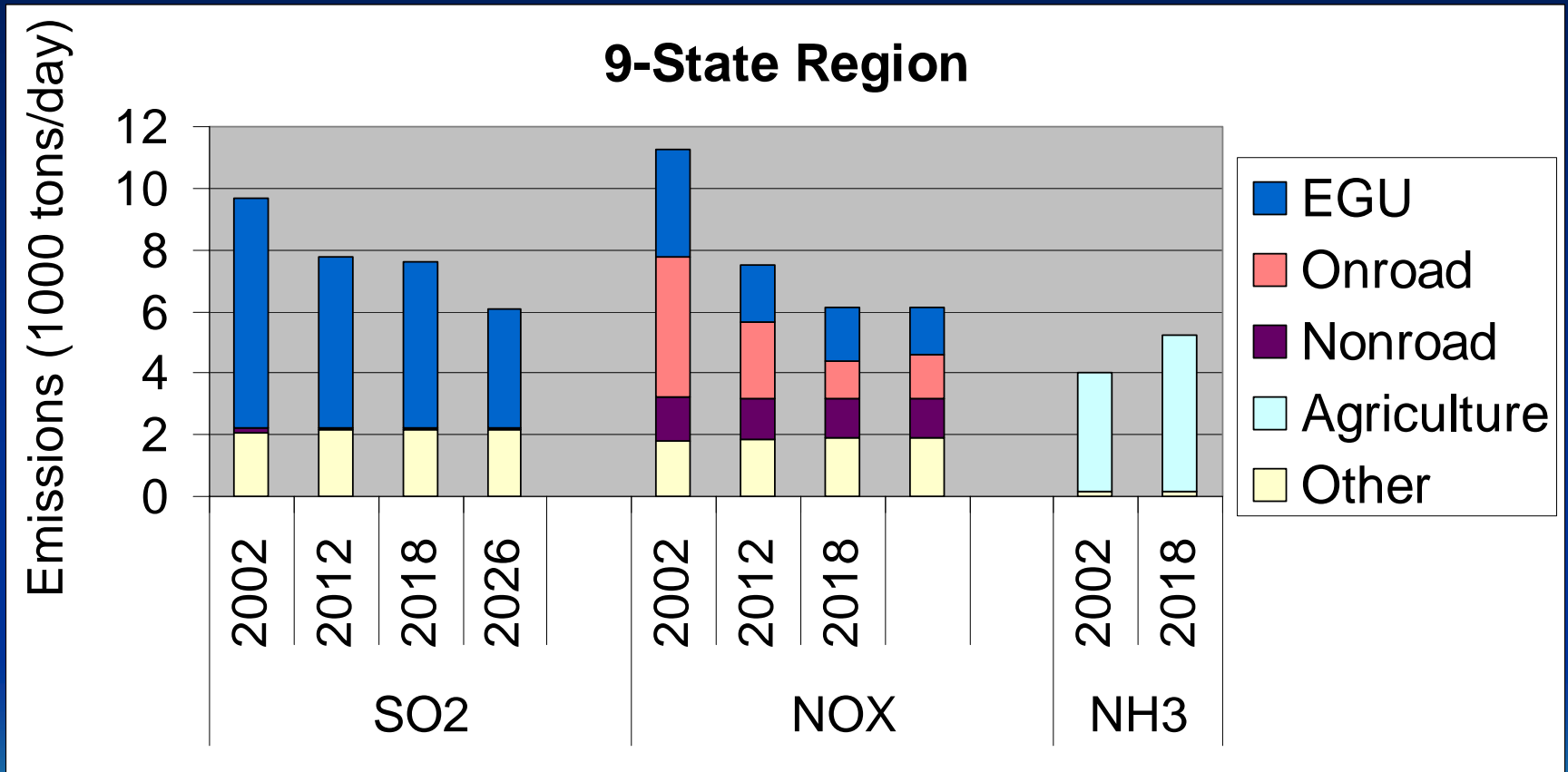
On-the-books measures – Factor 2

Time required for compliance



On-the-books measures – Factor 2

Time required for compliance



On-the-books measures – Factor 3

Energy and non-air impacts

- CAIR
 - Energy
 - Solid waste
- BART
 - Factor 3 impacts are generally described as manageable in BART analyses
- Onroad
 - Energy impacts not available
- Nonroad
 - Background documentation suggests potential fuel savings
- General note: on-the-books controls will also result in reductions in acid deposition and nitrogen deposition



On-the-books measures – Factor 4

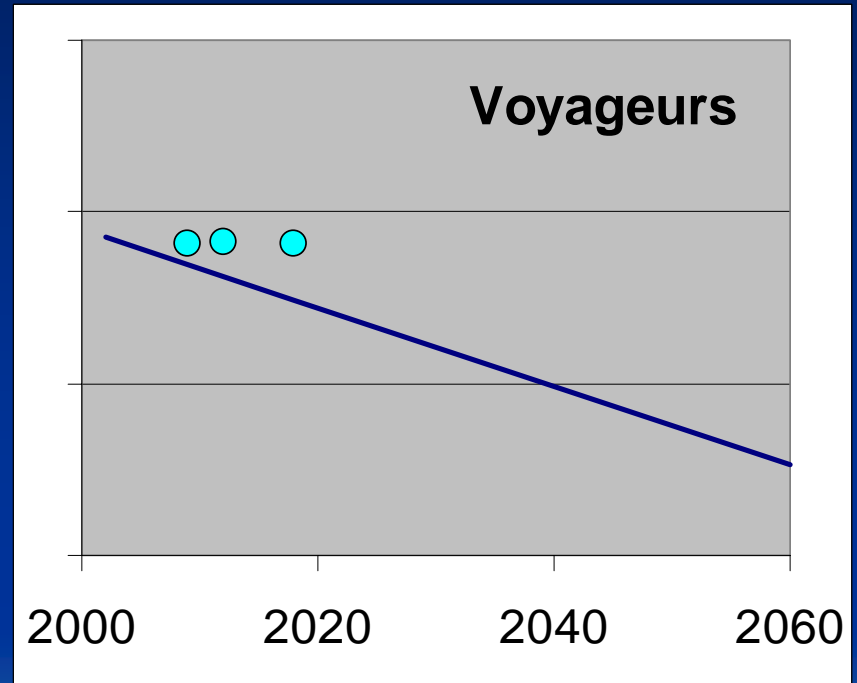
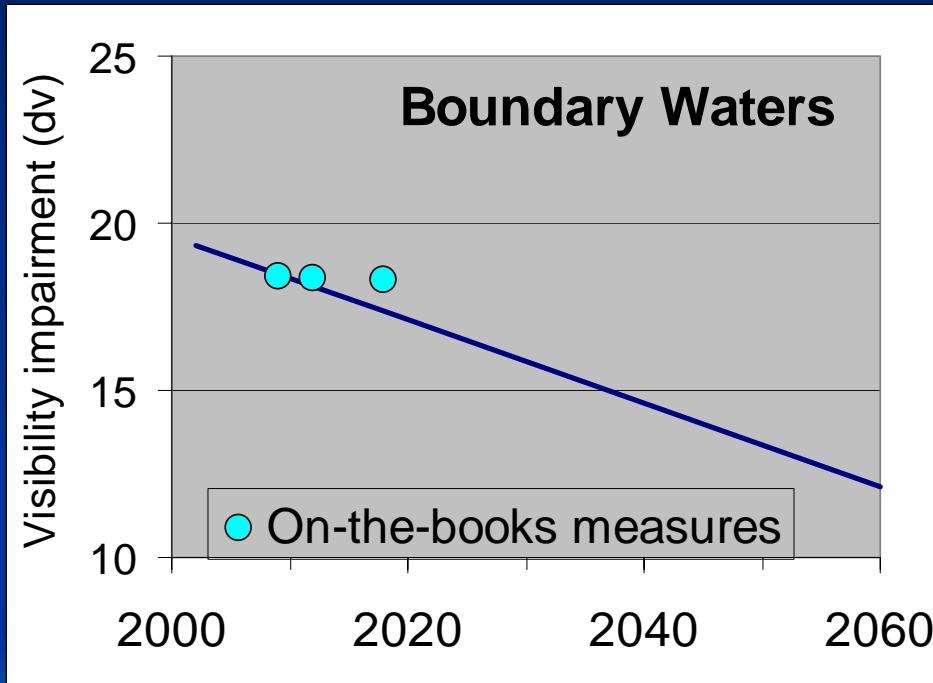
Remaining equipment life

- Some units projected to close prior to 2018 in order to comply with CAIR.
- New generating capacity is projected to replace these units.
- Existing BART analyses include remaining useful life.
- Onroad and nonroad measures take advantage of fleet turnover.



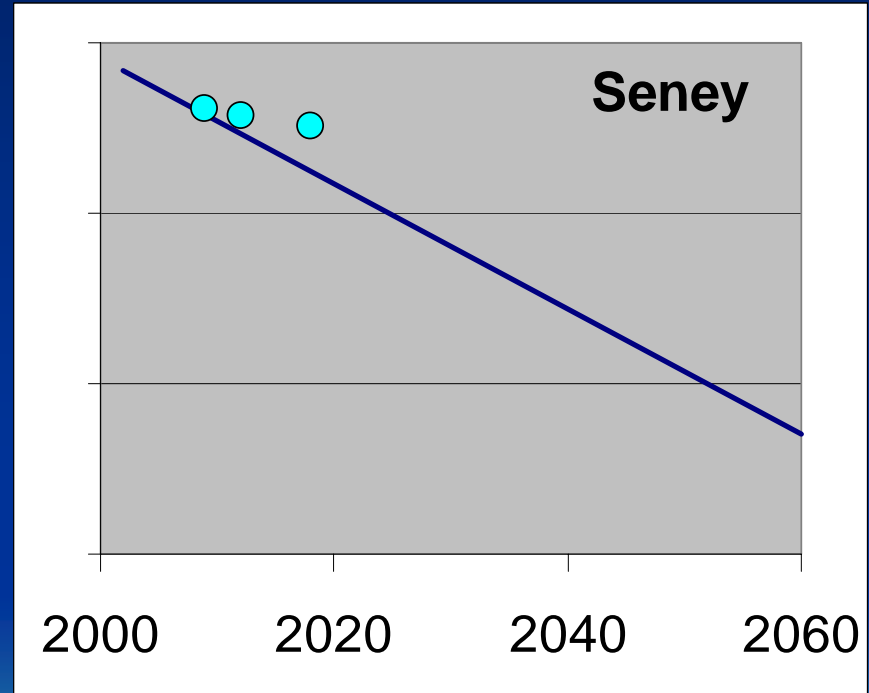
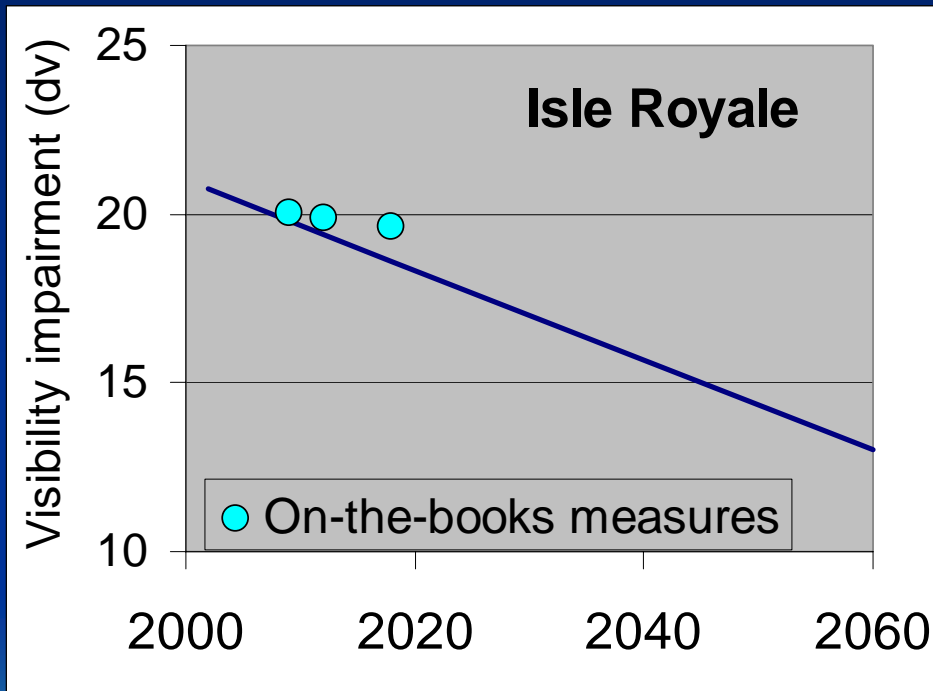
On-the-books measures – Factor 5

Visibility improvement



On-the-books measures – Factor 5

Visibility improvement



Potential future control strategies

- Emission source categories
 - Electric Generating Units (EGUs)
 - Industrial, commercial, and institutional (ICI) boilers
 - Agricultural sources of ammonia
 - Onroad and nonroad mobile sources
 - Reciprocating engines and turbines



Control strategy analysis for EGUs

- Potential regional emission caps
 - EGU-1
 - SO₂: 0.15 lb/MM-Btu ~76% from 2002
 - NO_X: 0.10 lb/MM-Btu ~72% from 2002
 - EGU-2
 - SO₂: 0.10 lb/MM-Btu ~84% from 2002
 - NO_X: 0.07 lb/MM-Btu ~80% from 2002
- Control regions
 - 3-states
 - 9-states



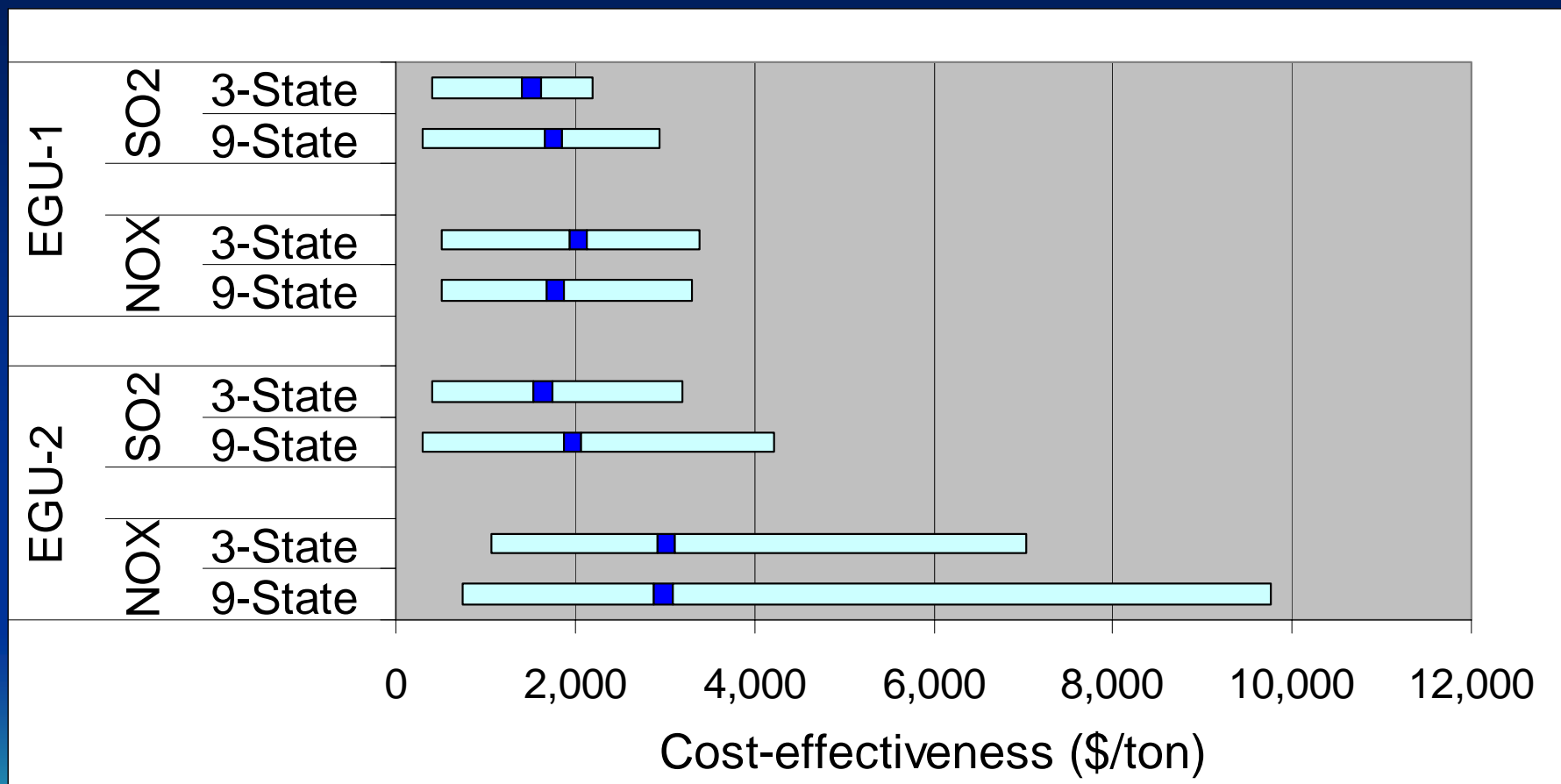
Factor 1 – Methodology for EGU Cost

- **Baseline – IPM projections**
 - Emissions in 2018
 - Total fuel usage in 2018
 - Controls installed for CAIR
- **Least cost analysis for controls beyond CAIR**
 - Control measures
 - Limestone forced oxidation (LSFO) scrubber for SO₂
 - Lime spray dryer (LSD) scrubber for SO₂
 - Dry sorbent injection for SO₂
 - Selective catalytic reduction (SCR) for NO_x
 - Selective noncatalytic reduction (SNCR) for NO_x
 - Low-NO_x burner technology



EGU strategies – Factor 1

Cost effectiveness



EGU strategies – Factor 2

Time required for compliance

- Estimated time required
 - 6 years for EGU-1 or for EGU-2 applied to the 3-state region
 - 7 years for EGU-2 applied to the 9-state region
- Assumptions
 - 1 year for regulatory development
 - 1 year for arranging capital investment
 - 30 months to install a single control device
 - 12 months for staging of multiple control devices at a single facility
 - Boilermaker capacity estimated based on CAIR analyses




Factor 3 – Methodology for energy and non-air impacts

- Based on data from CueCost on:
 - Fan electricity requirements
 - Steam requirements
 - Sludge generation rates
 - Catalyst replacement rates



EGU strategies – Factor 3

Energy and non-air impacts

- Energy
 - 630 to 2,900 GW-hrs/year (for EGU-1 in the 3-state region and EGU-2 in the 9-state region)
 - Less than 0.33% of total electricity generation in the region
 - Solid waste impacts
 - 1.3 to 4.1 million tons of sludge and spent catalyst per year
 - Disposal cost less than 5% of total annual cost
- 

EGU strategies – Factor 4

Remaining equipment life

- EGU strategies are market-based caps.
- Controls not expected to be used when remaining equipment life is short.



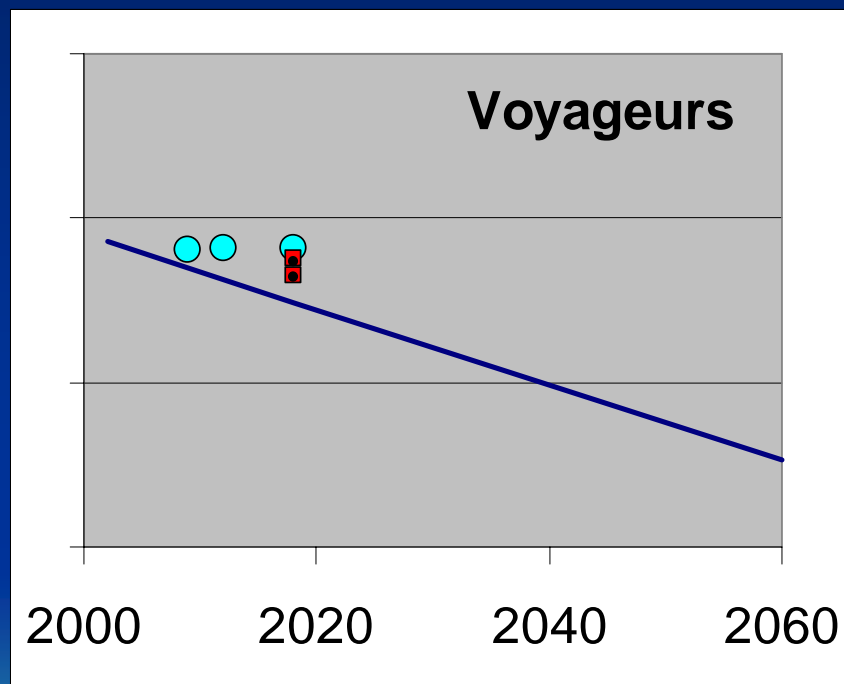
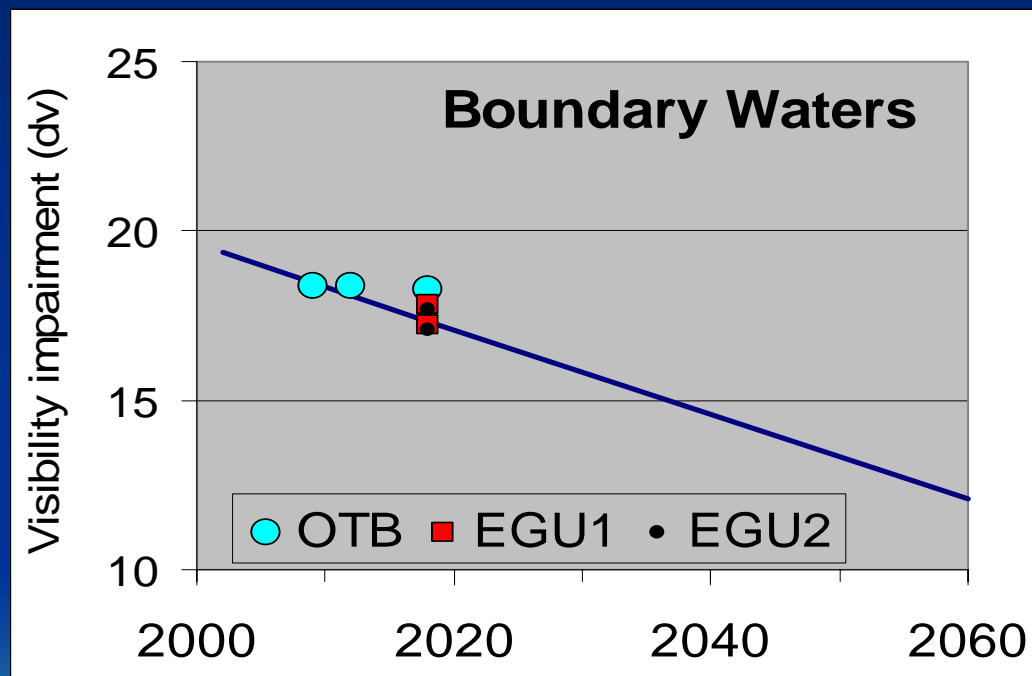
Factor 5 – Methodology for evaluating visibility Improvement

- Based on PSAT modeling for 2018 on-the-books controls
- New strategies evaluated using a linear rollback methodology
 - Specific to
 - States level emissions
 - PSAT source categories
 - EGU
 - Other point sources
 - Ammonia
 - Onroad mobile
 - Nonroad mobile
 - Other area
 - PSAT PM fractions



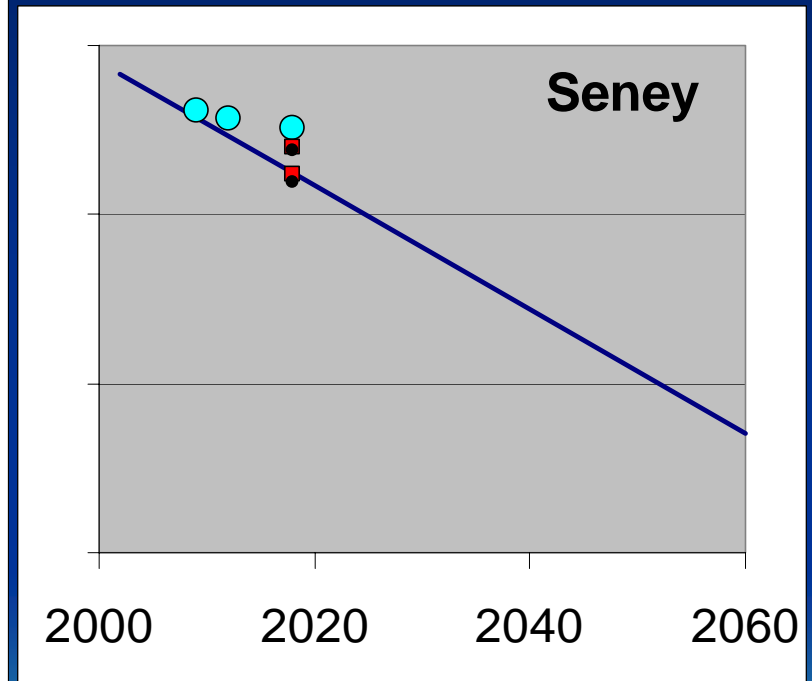
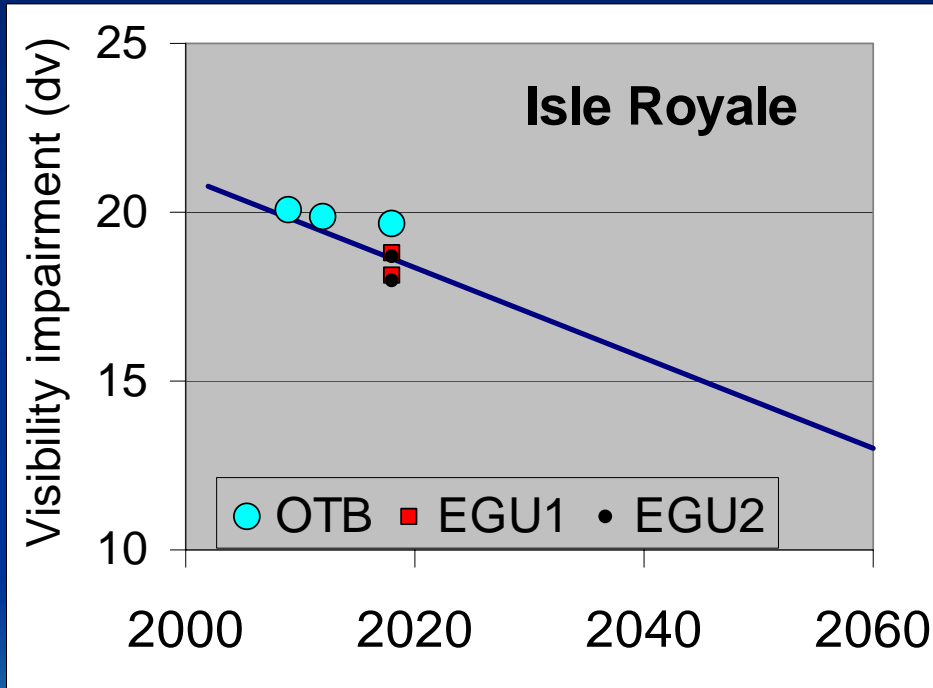
EGU strategies – Factor 5

Visibility improvement



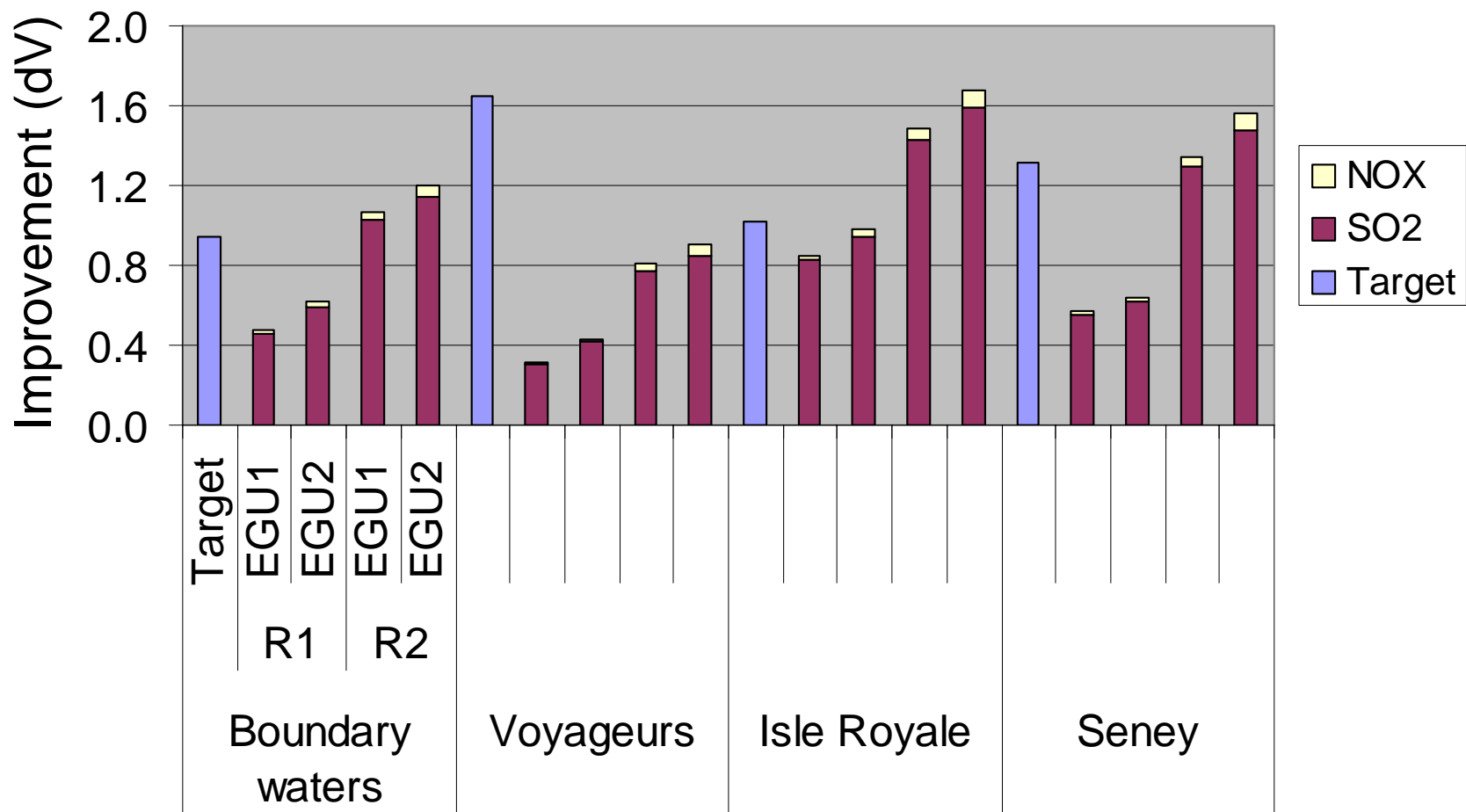
EGU strategies – Factor 5

Visibility improvement



EGU strategies – Factor 5

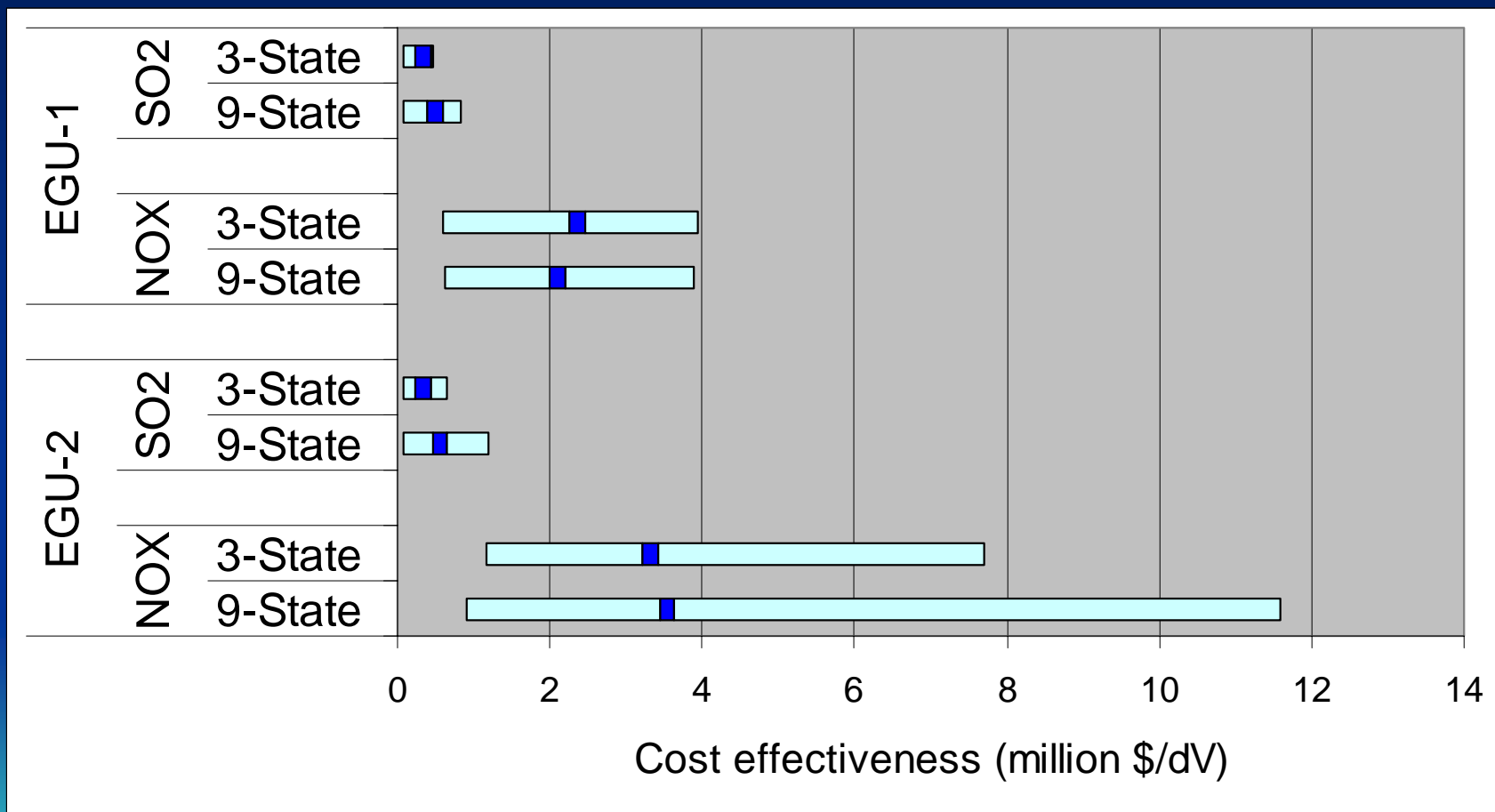
Details on visibility improvement



R1 = 3-state region; R2 = 9-state region

EGU strategies – Factor 5

Cost per visibility improvement



Control strategy analysis for ICI boilers

- Potential regional emission caps
 - ICI-1
 - SO₂: 40% reduction from 2002
 - NO_x: 60% reduction from 2002
 - ICI-2
 - SO₂: Fuel-specific limits ~77% from 2002
 - NO_x: Fuel-specific limits ~70% from 2002
- Control regions
 - 3-states
 - 9-states



ICI boiler strategies – Factor 1

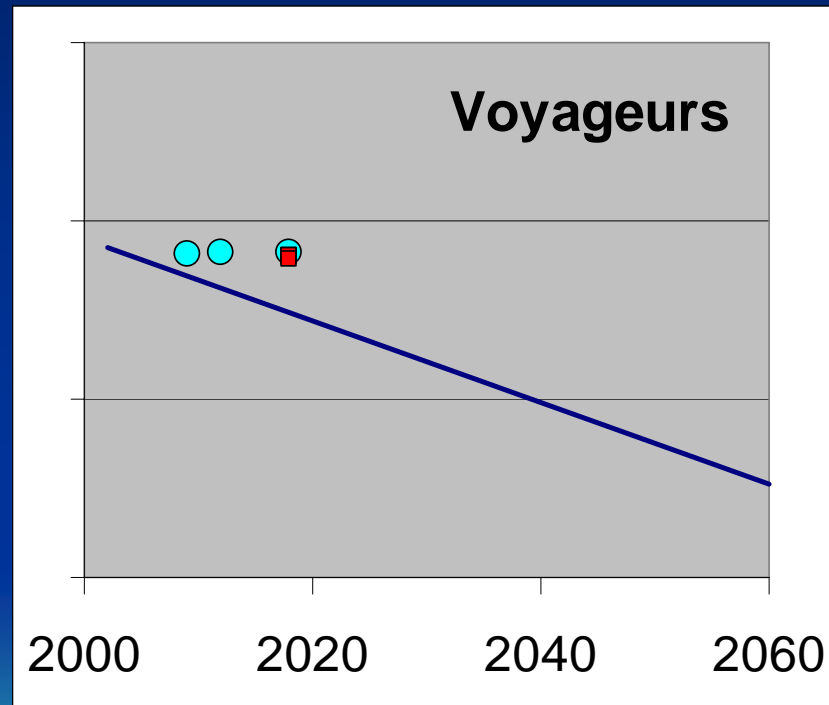
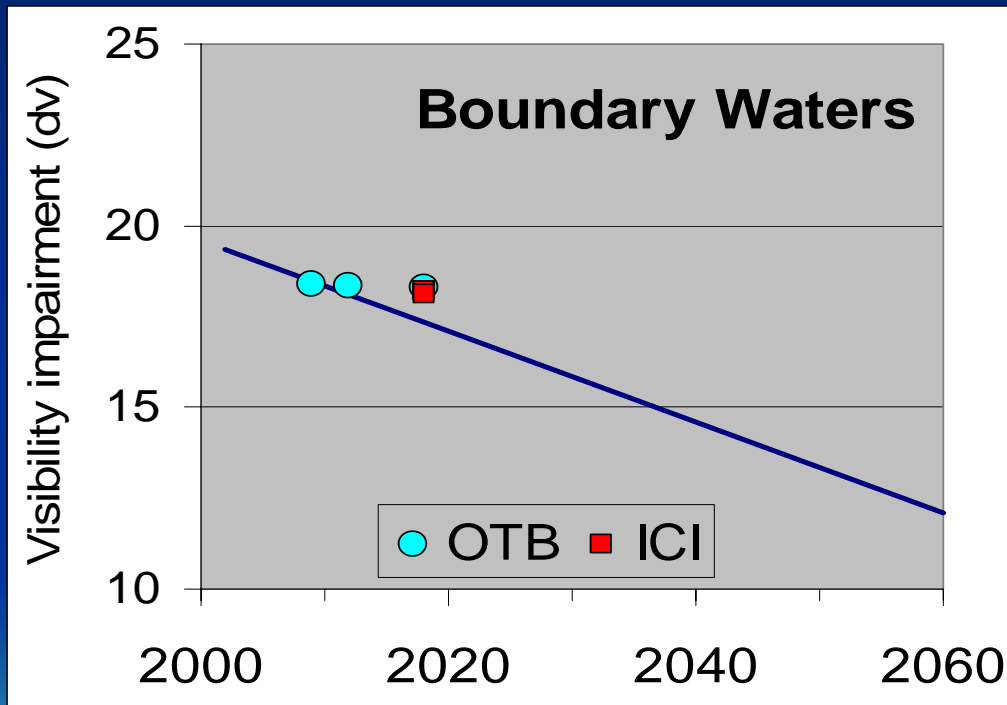
Cost effectiveness

- ICI-1
 - 3-state region: \$2,500 / ton SO₂ average



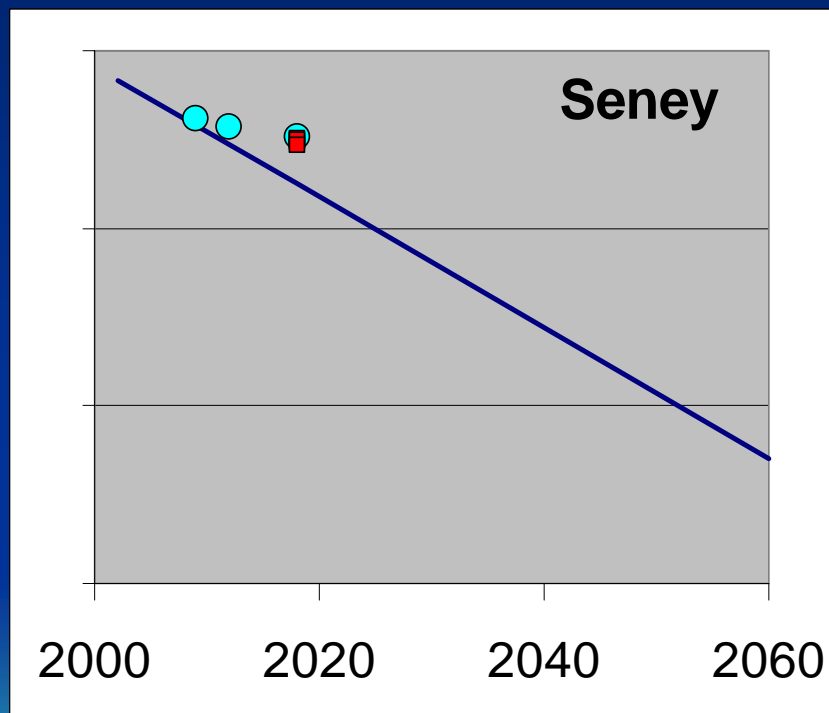
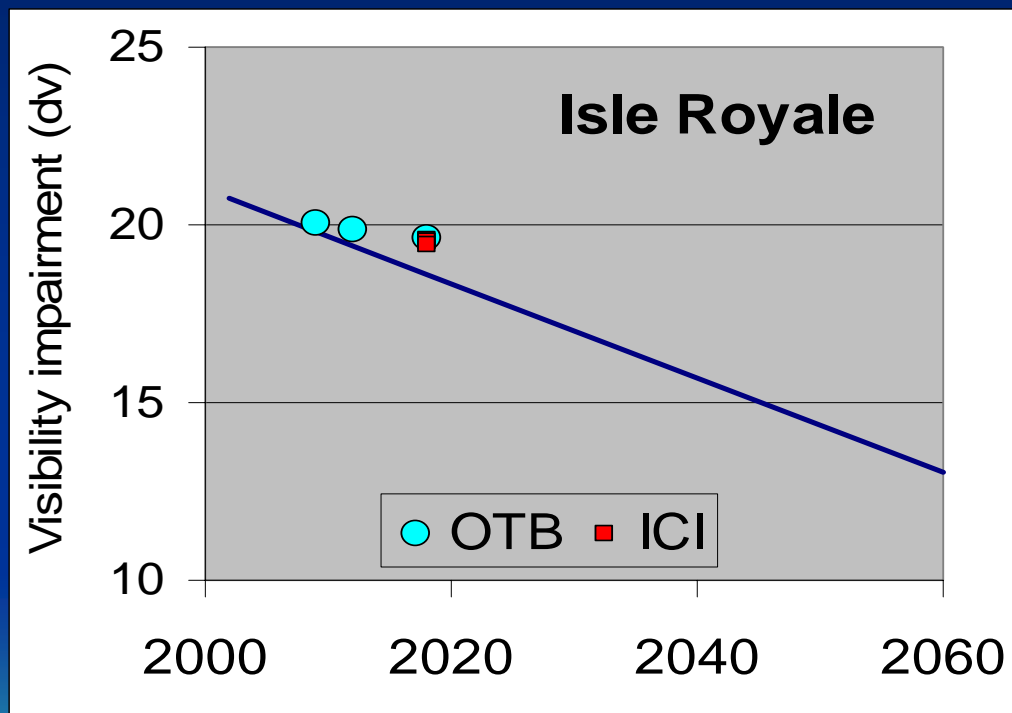
ICI boiler strategies – Factor 5

Visibility improvement



ICI boiler strategies – Factor 5

Visibility improvement



Summary of preliminary findings

- Strategies for EGU achieve the largest visibility improvement of categories analyzed to date.
- SO₂ controls are more effective than NO_x controls.
- Cost effectiveness for SO₂ controls is estimated at \$1,500 to \$2,000 / ton.
- About 5.5 years is estimated to be needed for compliance.
- Energy and other impacts are manageable.
- EGU controls achieve the RFP line for Boundary Waters, Isle Royale, and Seney.

