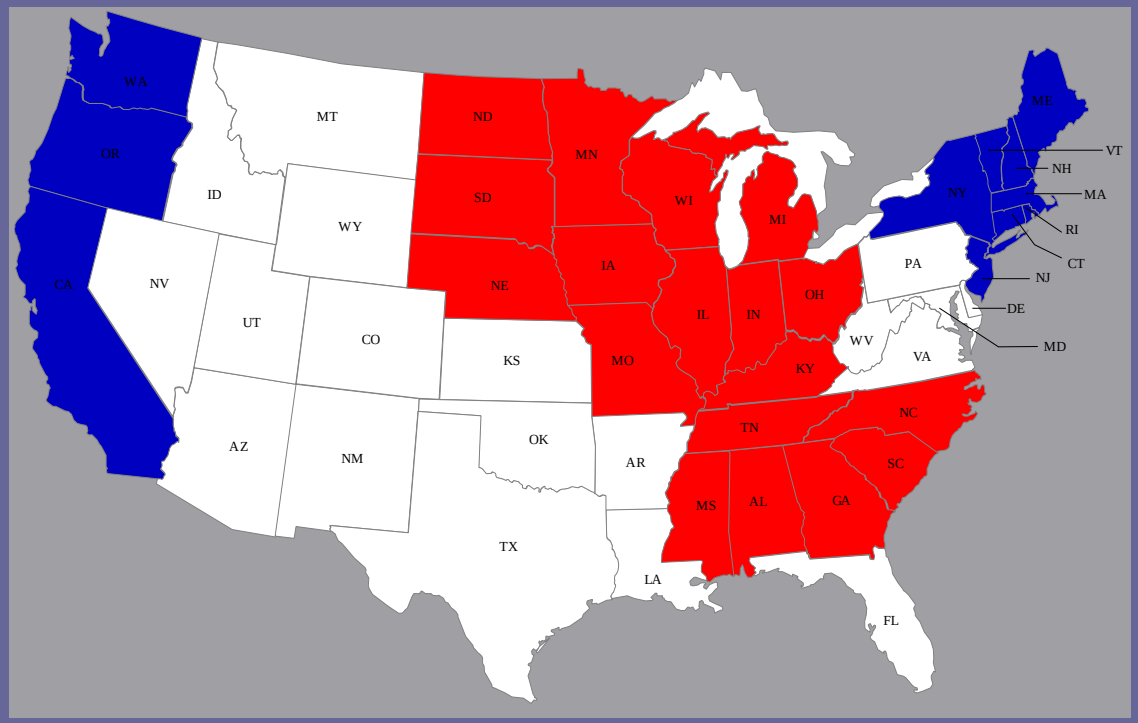
Ohio Climate Road Map

October 4th, 2005

O·H·I·O
ENVIRONMENTAL
COUNCIL
KEEP WATCH, TAKE ACTION, MAKE CHANGE

Red State-Blue State



Blue States:

Politically left of center

Economic base weighted toward service, high tech,

Energy toward natural gas, nuclear, renewables

Red States

Politically right of center

Economic base weighted toward industry, and agriculture

Energy toward coal

Ohio as key “red state”

The most intense battleground in 2004 U.S. Presidential election

Second largest state in U.S. for coal consumption

Third largest state for manufacturing jobs

In the top ten states for corn and soy production

Third largest state for carbon dioxide emissions (first for the power sector)

Challenge

- Current Ohio policymaker frame – *Climate action = Kyoto = coal (jobs) in China but not Ohio*
- No recognition of climate as legitimate issue
- Fear of unknown – how much will it cost, how will it hurt Ohio competitiveness

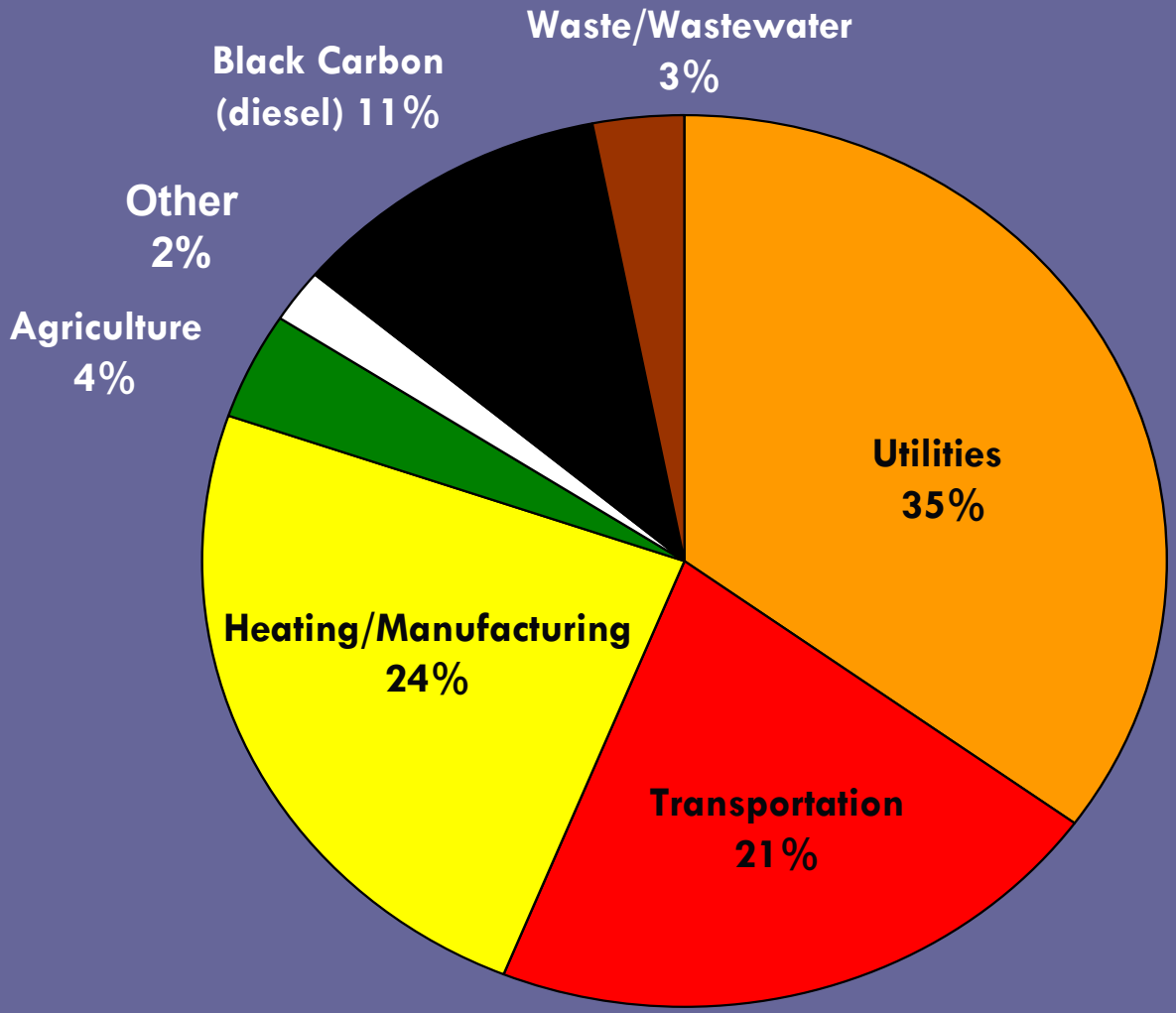
Why Ohio needs to focus on solutions

- Ohio is third in nation for CO_2 emissions (behind TX and CA)
- Political reality – whether its 1 year or 10 years, the U.S. will eventually begin to address greenhouse gases in a serious manner
  - Administration's position - “The United States is taking prudent steps to address the long-term challenge of global climate change. We are reducing projected greenhouse gas emissions in the near term, while devoting greater resources to improving climate change science and developing advanced energy technologies”. – President Bush (2002)
  - International pressure – “There is no bigger long-term question facing the global community than the threat of climate change”. British Prime Minister Tony Blair (closest U.S. international ally) (2004)
  - Congressional activity – Majority party Senators, such as John McCain (R-AZ) and Richard Lugar (R-IN) are working to enact the first mandatory limits on U.S. greenhouse gases

Why Ohio needs to focus on solutions (cont.)

- The choices Ohio makes today will affect how it can meet future national policies and treaty agreements that cut greenhouse gases.
  - Failure to prepare will likely leave Ohio at an economic disadvantage.
  - Leadership will allow Ohio to help shape future policies and provide the greatest chance for economic opportunity
  - Ohio's economic base – coal, agriculture, manufacturing – could be poised to be large suppliers of climate solutions if the state leads rather than follows

Ohio Greenhouse Gases and Particles



Source: USEPA Greenhouse Gas Inventory Tool 2004, Jacobson (2004), Bond (2002)

Ohio Climate Roadmap

- Purpose of first phase (Part 1)
  - Identify scope of challenge
  - Review technology solutions and relevance to Ohio's economic base
  - Identify general areas for policy and market opportunities
- Purpose of second phase (Part 2)
  - Provide detailed recommendation of policy and market measures

What is the Challenge?

The Objective

- Climate stabilization - ***Warming beyond 1 degree Celsius (3°F) above today's global average temperature runs the risk of triggering major climactic changes***
  - EU has chosen as this as target
  - Similar focus from U.S. climatologists
- ***The atmospheric concentration of CO2 must stabilize between 450 and 550 ppm*** - a 550 ppm target requires deep cuts in other greenhouse gases (methane, nitrous oxide, back carbon, etc.)

Climate change consequences

Avoiding – Dangerous Anthropogenic Interference (**DAI**)

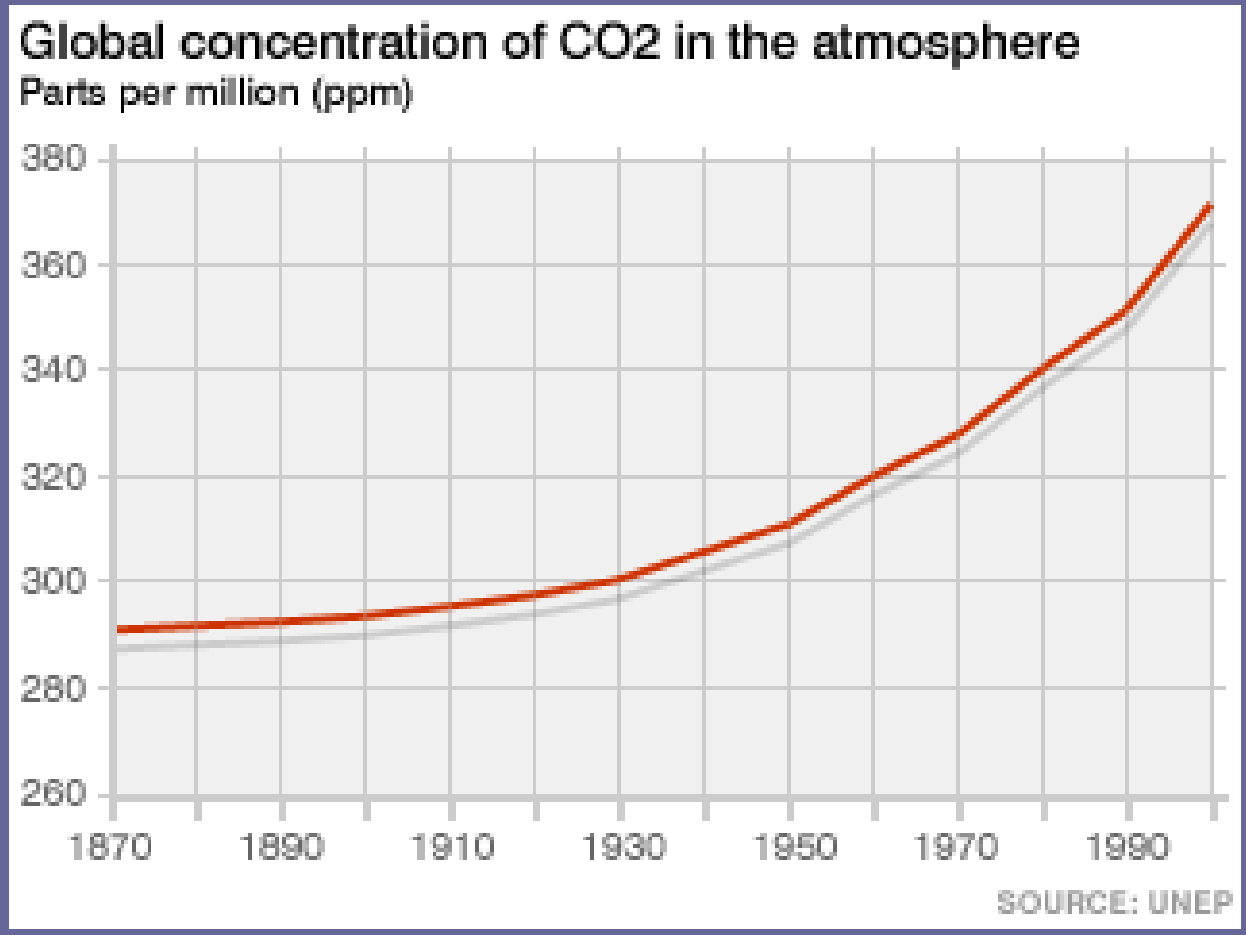
•The goal of Article 2 of the United Nations Framework Convention on Climate Change is "the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."

•Warming of more than 1° C by 2100 could produce as an irreversible trend toward sea level rise of seven meters (23 feet) resulting from the melting of glaciers and large ice sheets over the next 1,000 years

•Unless warming is limited, sea level increases of one to two meters (three to six feet) could occur in the next 100 years and hit the coastal and low lying areas the hardest. Repercussions could include impacts on the global economy and large population migrations.

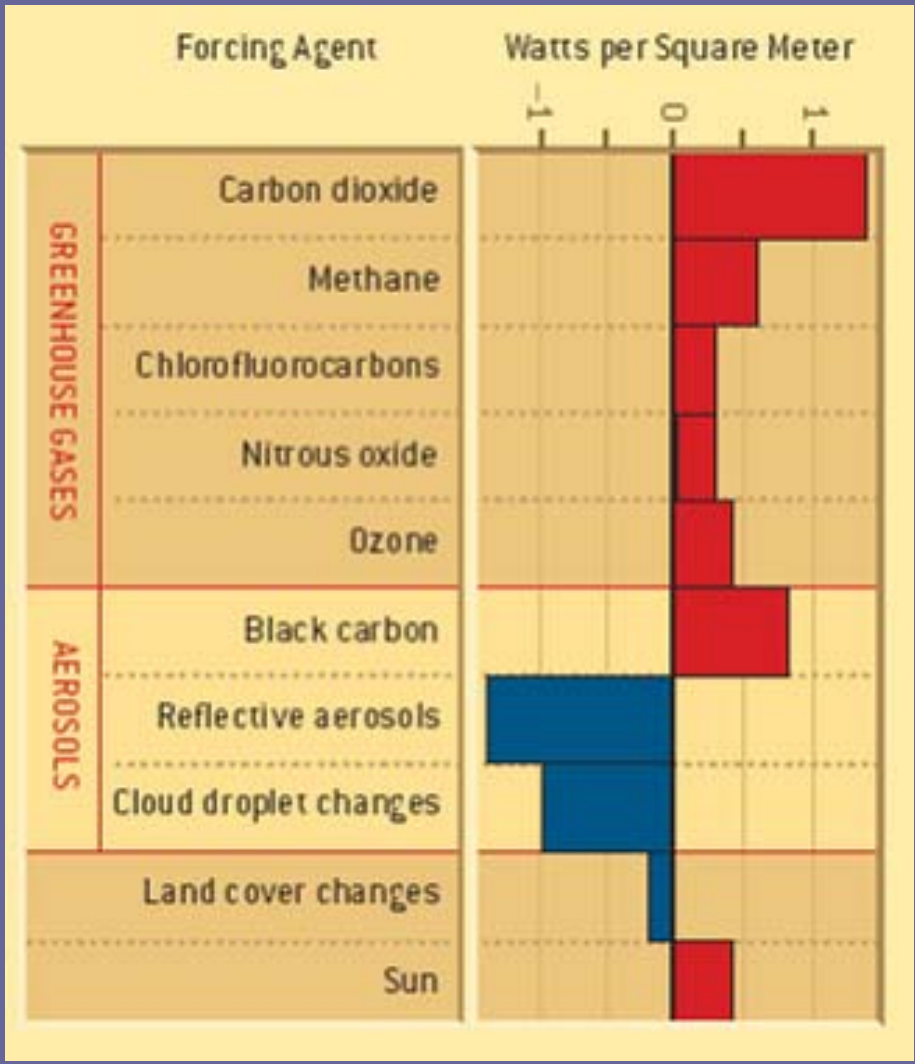
The Quori Kalis glacier, Peruvian Andes. Top, a 1978 view. Bottom, the same location as seen in 2000. Ohio State Univ. image.

CO_2 in the atmosphere



Greenhouse Gases and aerosols

- **Gases and aerosols** – Carbon dioxide is the greenhouse gas with the single largest warming impact on the climate. However, black carbon from diesels, ozone and methane are all major climate forcing pollutants and potentially larger than carbon dioxide taken together.
- **Time matters –** Some climate forcing agents persists for centuries and others for only weeks. Climate benefits from reducing CO_2, which can stay in the atmosphere for a century or longer, will accrue decades after emissions are reduced.



Ozone, methane and black carbon soot rival CO_2 in climate effects. Source: Scientific American (Hansen), March 2004.

Possible Emission Reduction Paths for Ohio

Path 1: Targets met with CO2 and non-CO2 reductions

Carbon dioxide	
2000 Emissions	71.75
Target for 2100 (65% reduction)	26
Methane	
2000 Emissions	3.69
Target level for 2030 and beyond (70% reduction)	1.1
Nitrous Oxide	
2000 Emissions	3.62
Target level for 2030 and beyond (12% reduction)	3.19
HFC, PFC, and SF6	
2000 Emissions	0.83
Target - maintenance levels	0.83
Black Carbon (fine soot)	
2000 Emissions	10
Target level for 2015 and beyond (90% reduction)	1

Units – Million Metric Tons Carbon equivalent (MMTC eqv)

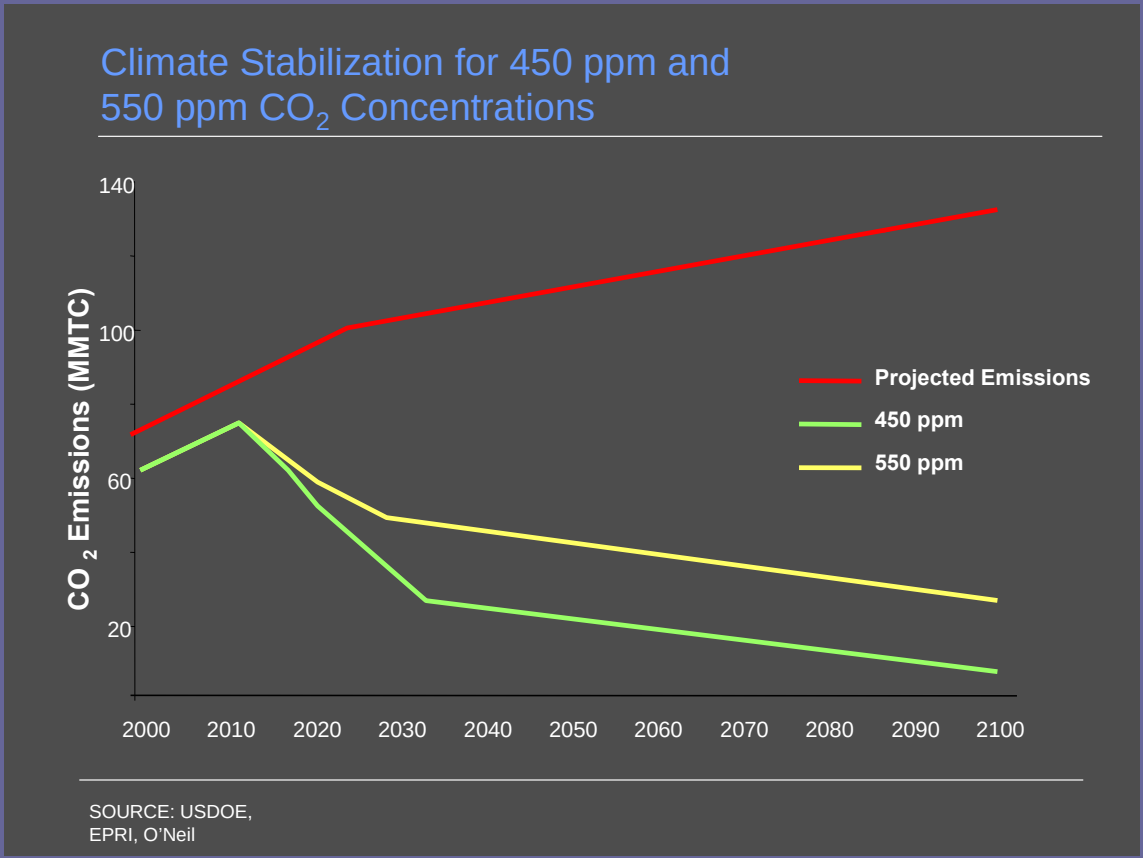
Path 2: Targets met just with CO2 reductions

Carbon dioxide	
2000 Emissions	71.75
Target for 2100 (95% reduction)	8
Methane	
2000 Emissions	3.69
Target - maintenance levels	3.69
Nitrous Oxide	
2000 Emissions	3.62
Target - maintenance levels	3.62
HFC, PFC, and SF6	
2000 Emissions	0.83
Target - maintenance levels	0.83
Black Carbon (fine soot)	
2000 Emissions	10
Target - maintenance levels	10

Units – Million Metric Tons Carbon equivalent (MMTC eqv)

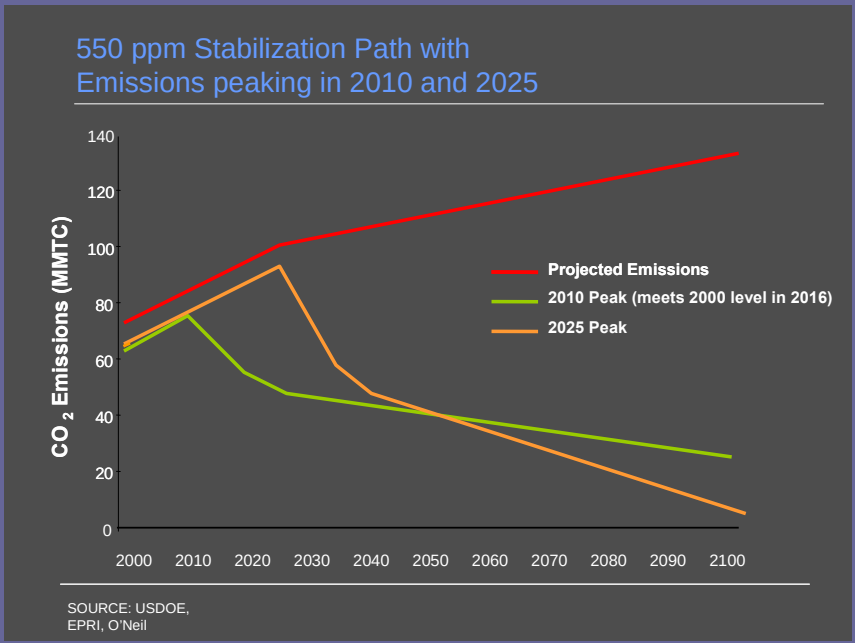
450 ppm CO_2 v. 550 ppm CO_2

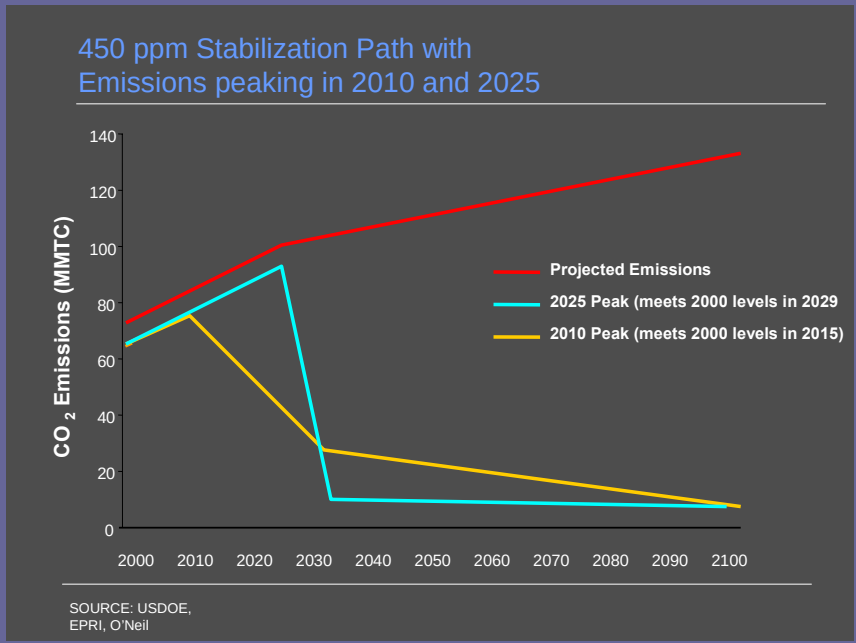
Cutting non-CO2 greenhouse gases and particles means less challenging emission reduction targets for CO2



Timing matters - no matter what

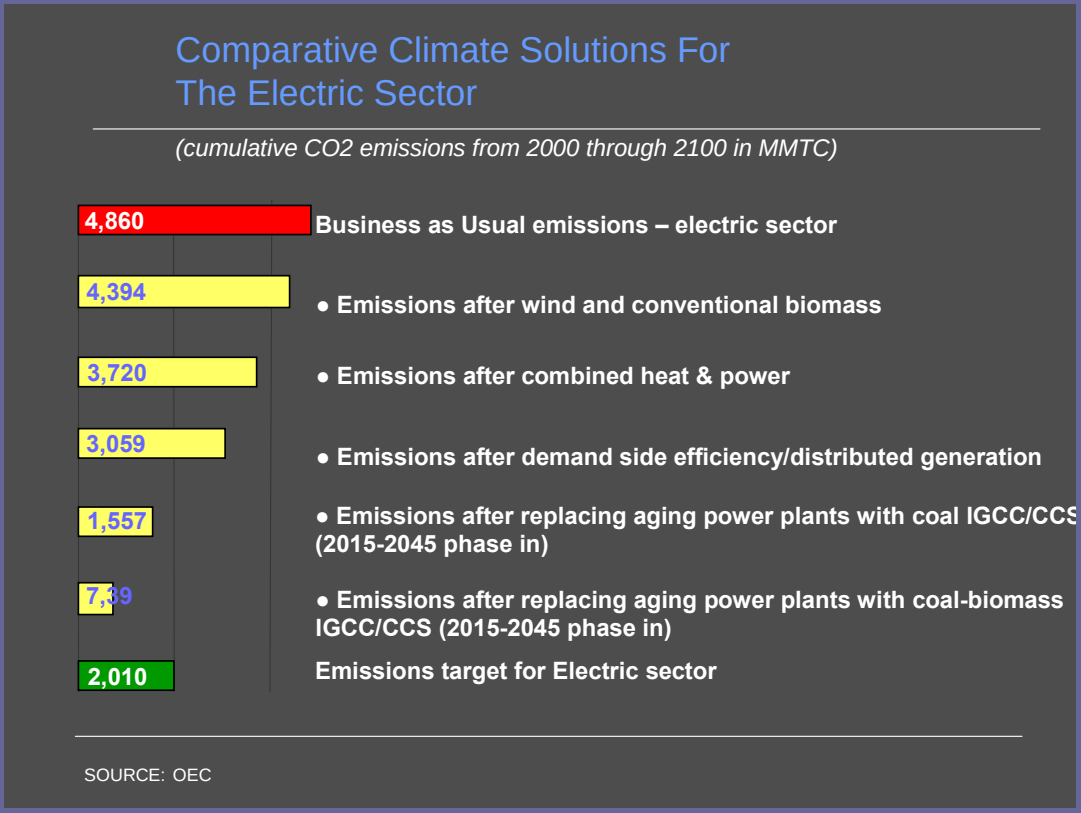
Delaying cuts in CO_2 can make meeting climate stabilization goals extremely challenging, if not impossible





Technology Effectiveness

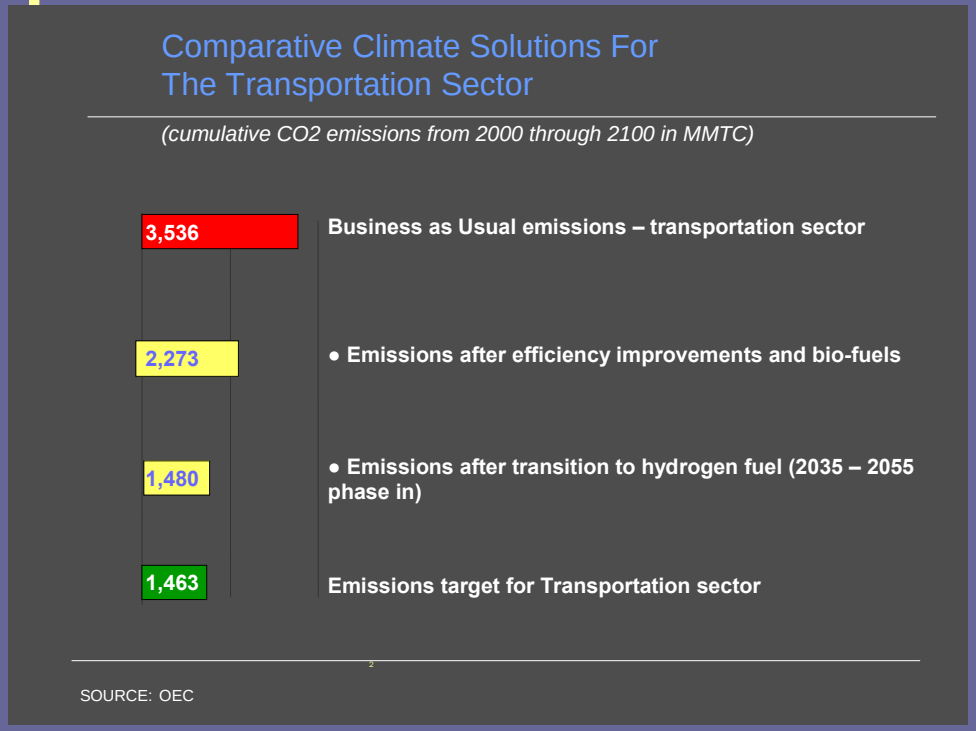
Power Generation Sector in Ohio



•Combined heat and power, demand efficiency and distributed generation can provide immediate benefits in the short-term and have large cumulative impacts in the long-term.

•IGCC coal can provide significant deep emissions cuts over the century and coal/biomass with IGCC can exceed the sector's target goal.

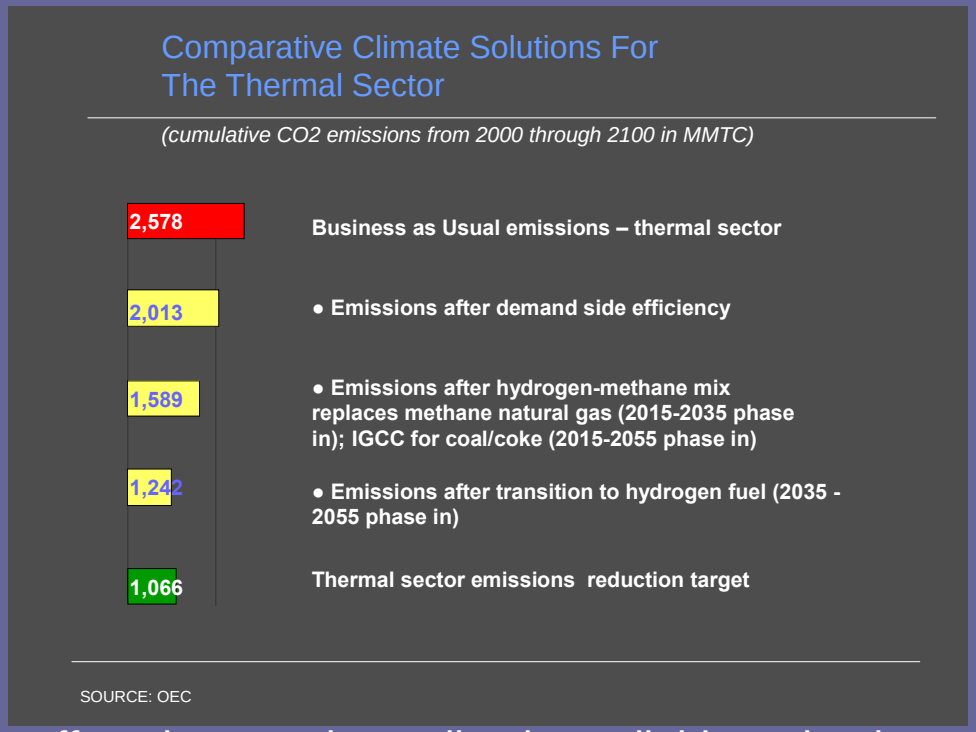
Transportation Sector in Ohio



•Driving more fuel efficient cars and trucks and use of bio-fuels could reduce total projected emissions for the century by 35%.

•In order for this sector to meet its portion of a stabilization goal, the current fleet of conventional vehicles (cars, trucks, trains, plains, and ships) would have to be transitioned to no-carbon hydrogen-based or electric vehicles (using carbonless electricity) starting in 2035 and ending in 2055 – an extraordinarily difficult challenge.

Heating/Industrial Sector in Ohio

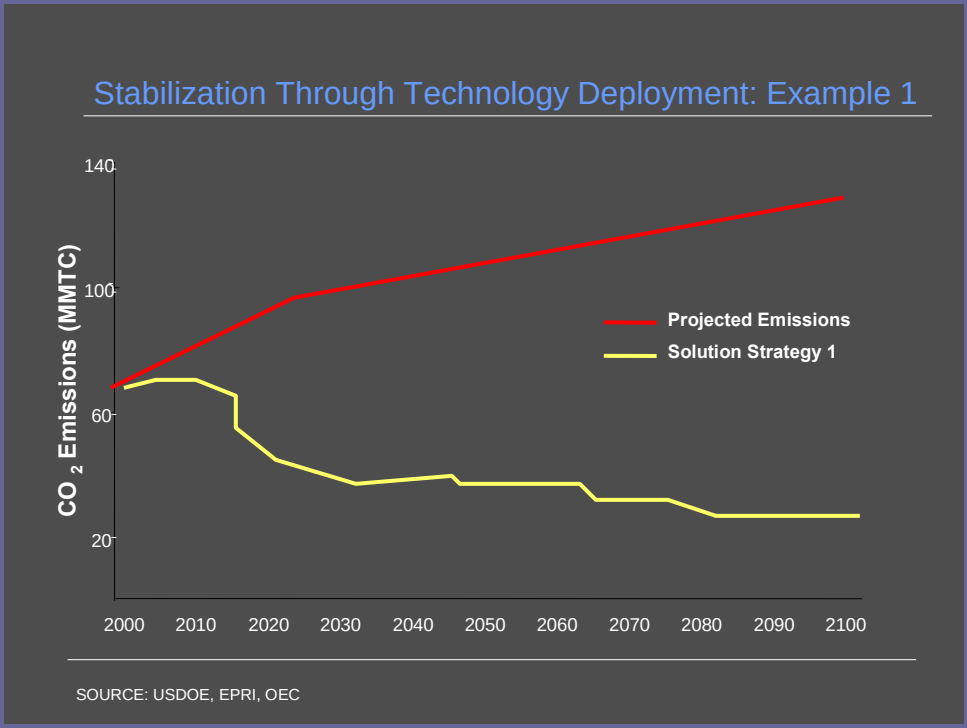


•Increased efficiency offers the most immediately available technology option, but long-term gains may be more modest – with a total reduction of around 23%.

•A combination of gradually increasing the use of hy-thene (up to 50% hydrogen) and transitioning coal and coke to gasification could cut total emissions by 40%

•In order for this sector to meet its portion of a stabilization goal, the heating and industrial process technologies would have to transition to technologies such as gasification, no-carbon hydrogen fuel, or electrification.

One possible path



•Soil sequestration through agriculture and forestry: 260 MMTC carbon sink activity through 2100.

•Greater use of energy efficiency and renewable energy combined with re-powering Ohio's old coal plants with IGCC coal plants and carbon capture and sequestration. The re-powering would occur from 2015 through 2045: 659 MMTC emissions through 2100.

•Increased efficiency and bio-fuels use for cars and trucks: 2461 MMTC emissions through 2100.

•Increased efficiency for residential, commercial, and industrial natural gas usage, beginning a phase-in of hythene, starting in 2031; and transitioning to hydrogen fuel starting in 2060: 1,340 MMTC emissions through 2100.

Climate technology solutions can come from Ohio's economic base

Key sectors of Ohio's economy, such as manufacturing, agriculture and coal can be major suppliers of the technologies and processes that will be critical to help limit temperature growth.

- Manufacturing – Polymers, Automotive, Efficiency, Distributed Generation
- Coal – Coal gasification with carbon sequestration
- Agriculture – Bio fuels and products, conservation tillage, sustainable forestry practices

Cutting other greenhouse gases can provide public health benefits

- **Diesel Black Carbon** - Cost effective technology exists today to reduce diesel particulate emissions (including diesel black carbon emissions) by 90%. In addition to contributing to premature death, heart attacks, and asthma attacks, diesel black carbon darkens clouds, snow, and polar ice sheets, resulting in increased retention of heat from solar radiation.
- **Methane** - Emissions from landfills, coal mines, animal feedlots and coal mines can be reduced between 70% to 90% by capturing the methane emissions. The methane can then be combusted for power generation in a turbine or even converted to a liquefied gas for industrial and transportation purposes.

Policy and Market Action

Recommended areas of focus

- **Process Initiatives and Industry Incubation**
  - Innovative technology funds
  - Hydrogen infrastructure R&D
  - Initiating/participating in GHG trading programs
- Clean Diesel Initiative
  - Focus on diesel clean up to protect public health; meet air quality standards – ensure clean up technologies address black carbon

Recommended areas of focus

- **Modernizing Electric System**
  - Greater use of efficiency/distributed generation and combined heat and power
  - Phasing out old coal plants and replacing with IGCC technology
  - Additional near-term deployment of base-load renewable energy
- **Transition to New Travel and Freight Systems**
  - Greater use of bio fuels
  - Utilizing more efficient vehicles
  - Investment in potential long-term solutions such as hydrogen fueled vehicles

Recommended areas of focus

- **Updating Heating and Industrial Systems**
  - Greater effort on promoting efficiency
  - Exploring “hythene” option – possible bridge to hydrogen infrastructure
  - Eventual replacement of natural gas use and coal boilers with combination of hydrogen and IGCC

Recommended areas of focus

- **Reducing Methane Emissions**
  - Incentive and technology development programs to reduce emissions from landfills, coal mines, feedlots, and wastewater treatment facilities
- **Using Agricultural and Forestry Practices**
  - Incentives for no-till farming
  - Development of accounting methods