

A landscape photograph showing a geothermal area. In the foreground, a calm, brownish lake reflects the sky. In the middle ground, a dense forest of green pine trees is partially obscured by thick, white steam rising from the ground. In the background, rolling hills are covered in dark evergreen trees under a cloudy, overcast sky.

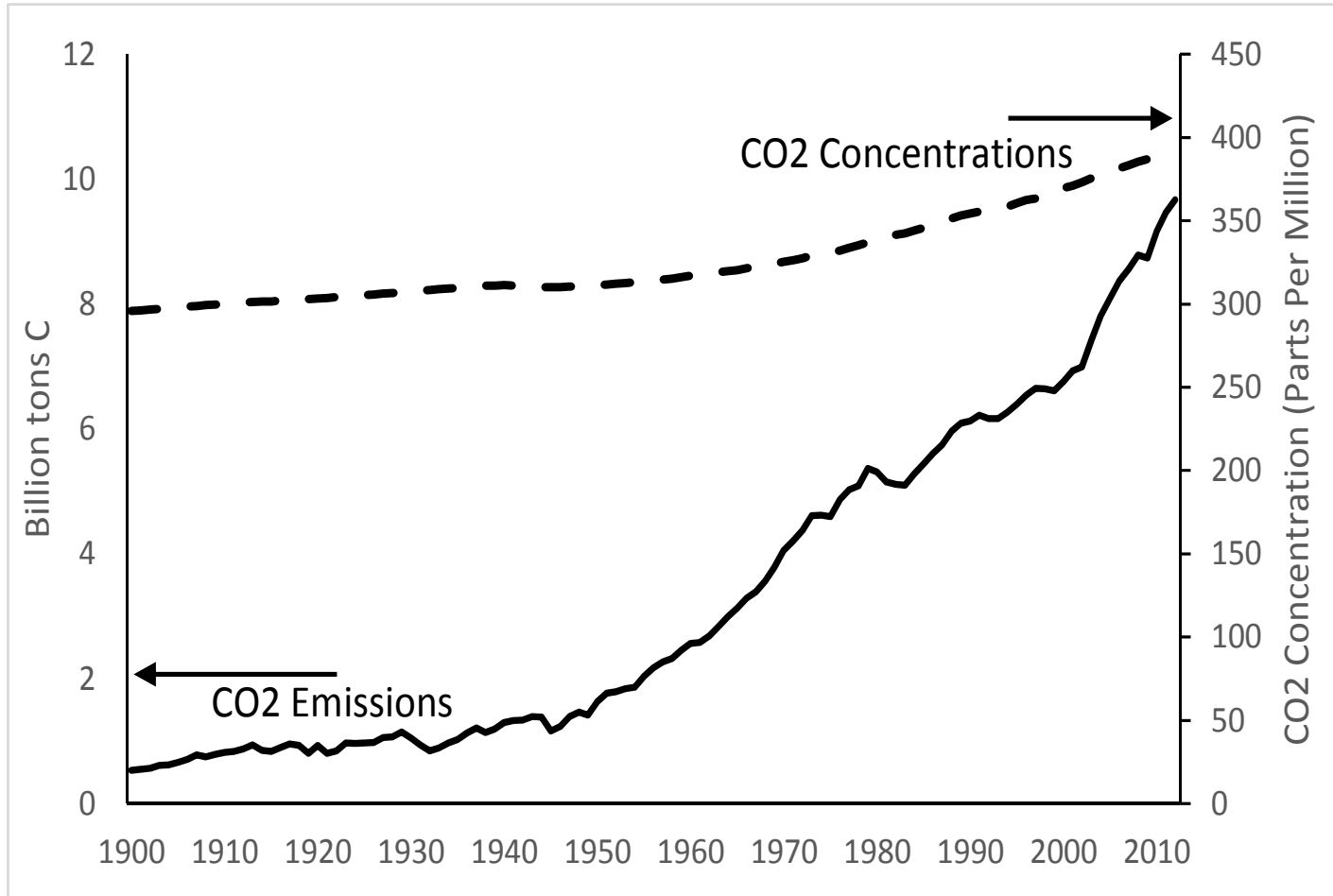
Climate Change and the Clean Power Plan

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Outline

- Climate change summary
- Ohio's contribution to climate change
- The Supreme Court and the Social Cost of Carbon
- The Clean Power Plan
- The UNFCCC Conference of Parties – Paris.

Carbon dioxide levels are increasing

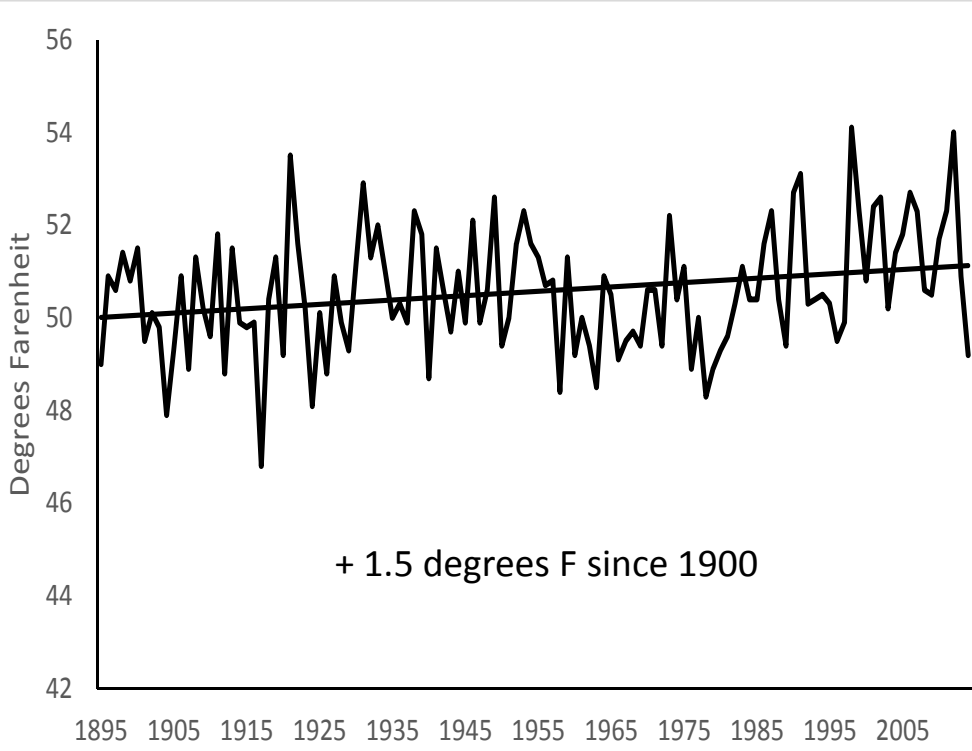


Debate about climate change

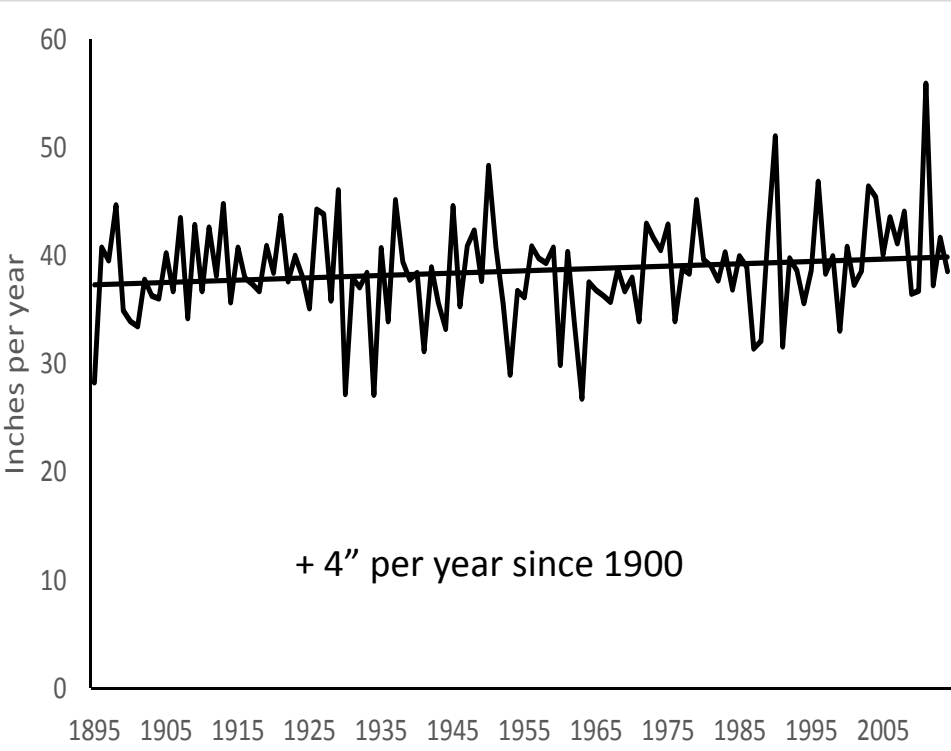
- The theory of climate change is that rising concentrations of CO₂ in the atmosphere will cause the average temperature of the earth to rise, leading to many other potentially negative consequences including sea level rise, droughts, floods, hurricanes, et.
- There is discussion about the science where supposedly 97% of scientists really believe in climate change.....
 - But who really cares, if only one or two scientists are correct then future generations have a problem on their hands...
- The most important debate is really about the economic costs and benefits of reducing carbon dioxide emissions.

Ohio temperature and precipitation have increased.

Temperature



Precipitation



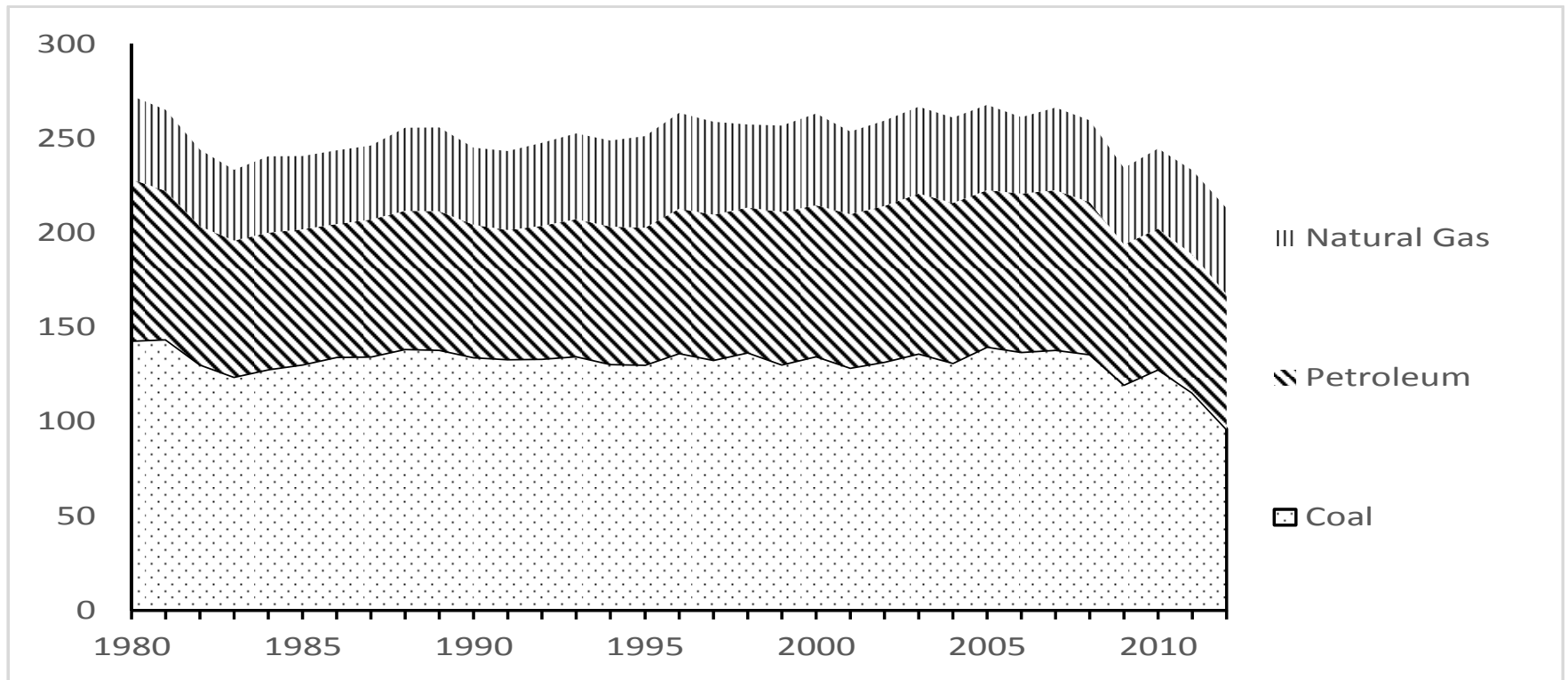
How will climate change affect Ohio's agriculture?

- Ohio farmers have already benefited from higher temperatures and greater precipitation, mixed with more CO₂ in the atmosphere.
- In the future, Ohio farmers likely will continue benefiting from climate change – at least over the next 30 years. Why?
- Ohio yields increase
 - Ohio is slightly cooler than the optimal temperature for agriculture, so rising temperatures help, at least for some period of time.
 - Precipitation has historically increased in summer, and likely will continue.
- Yields globally fall → prices rise.

Ohio Corn Yields

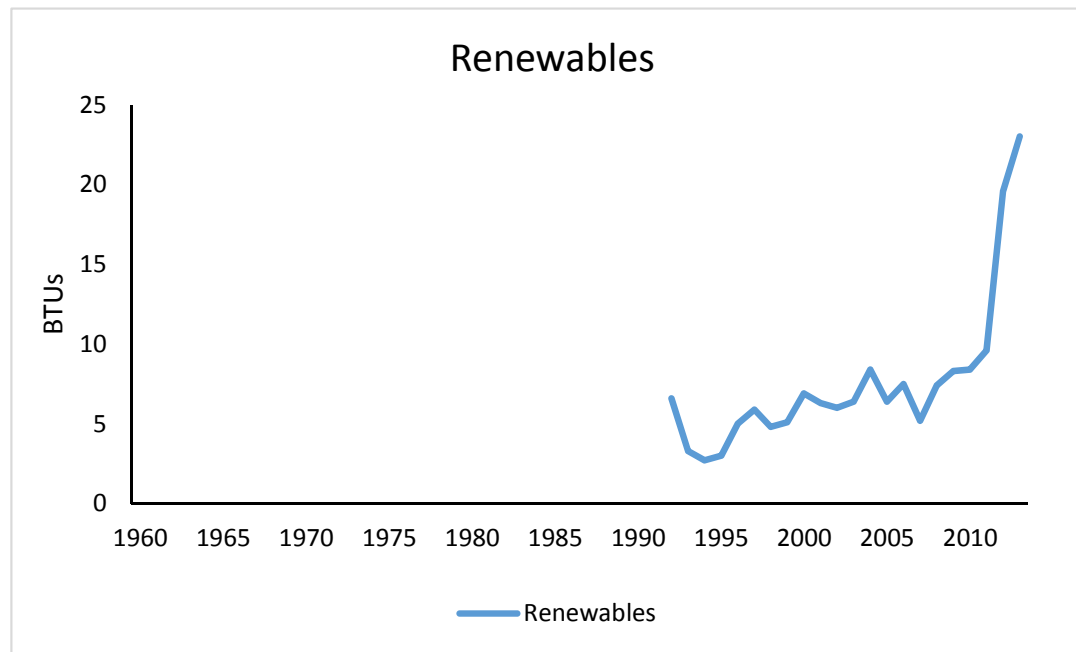
	Parameter (p-value)		Average 2010	2050 no CC	2050 with CC
Intercept	-29.237 (0)		1	1	1
Winter Temp	-0.004 (0.33)		31.9	31.9	32.8
Spring Temp	0.009 (0.3)		61.6	61.6	60.7
Summer Temp	-0.027 (0.01)		69.7	69.7	69.3
Fall Temp	0.01 (0.09)		42.6	42.6	43.1
Winter Prec	-0.017 (0.41)		2.5	2.5	2.4
Spring Prec	-0.03 (0.09)		4.3	4.3	4.3
Summer Prec	0.066 (0)		3.6	3.6	3.8
Fall Prec	-0.003 (0.84)		3.2	3.2	3.1
Year	0.018 (0)		2010	2050	2050
Real Corn P	0.002 (0.85)		1.4	1.4	1.4
Predicted Yield			172	349	355
% Change					2%

Ohio's contribution to climate change has been falling



Why have Ohio's CO2 emissions fallen?

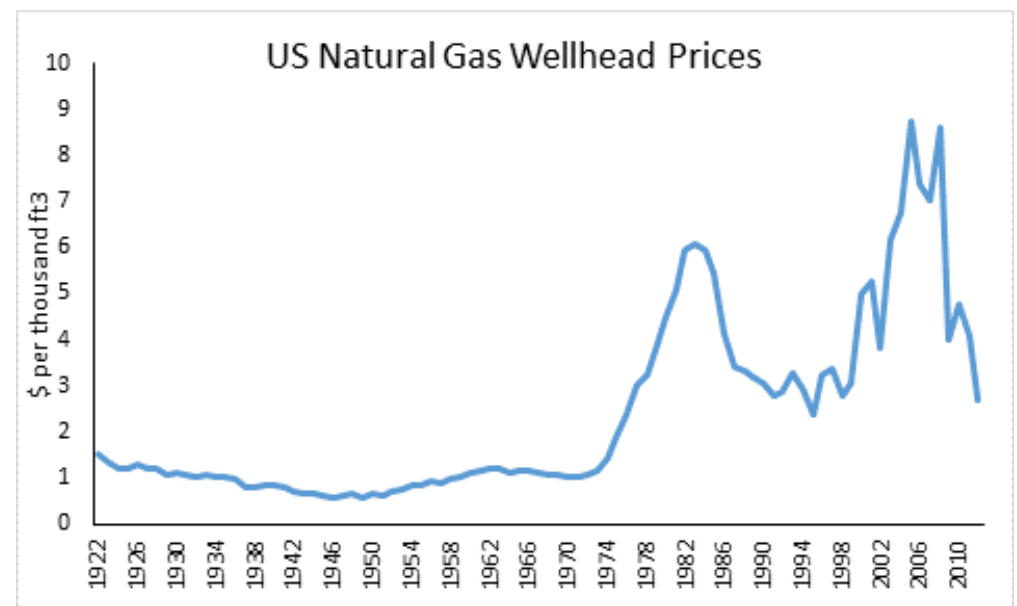
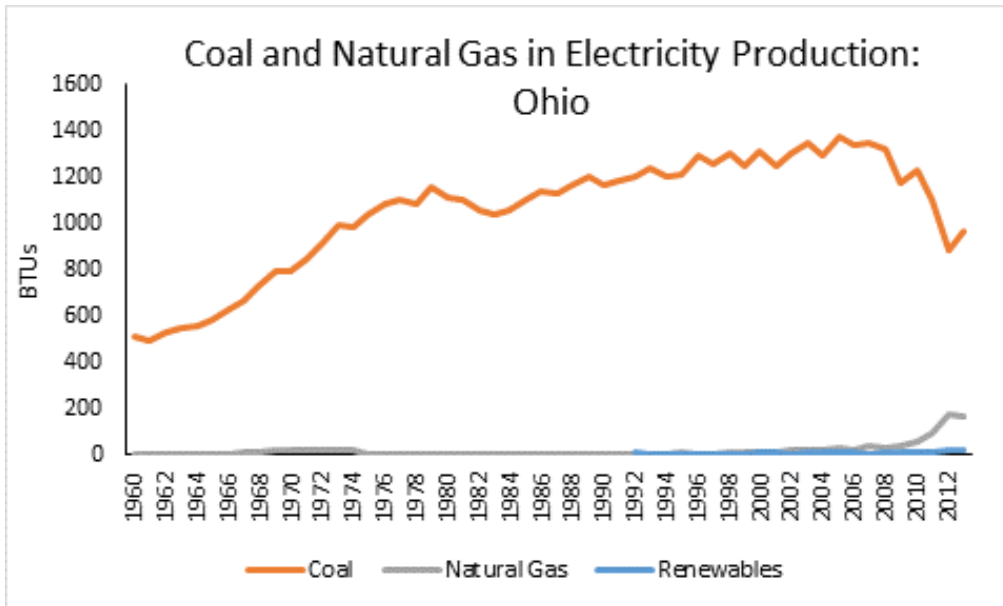
- Renewable energy standards have caused renewable energy to increase to about 1.7% of total electric power production



US DOE Energy Information Administration

Why have Ohio's CO2 emissions fallen?

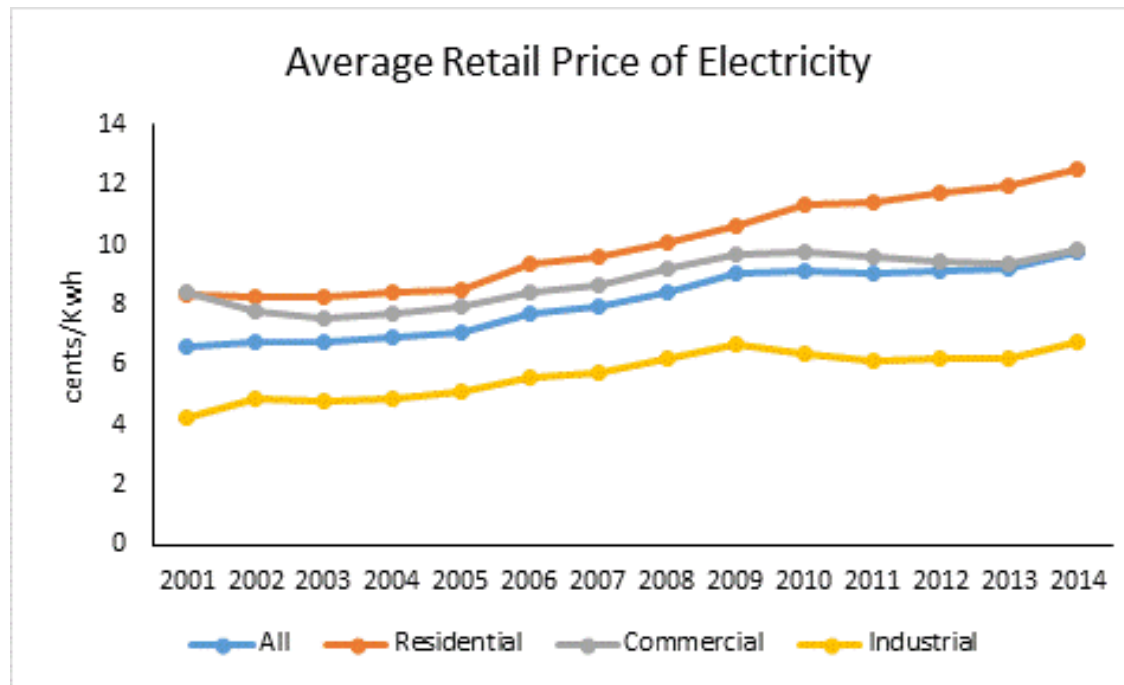
- Coal has been replaced with natural gas.
 - This has not cost us much because natural gas prices have remained low.



US DOE Energy Information Administration

Why have Ohio's CO2 emissions fallen?

- Consumption has fallen, due to higher electricity prices, recession and demand side regulation.
 - Average retail prices increase in the US by around 2cents per Kwh for each 1% increase in renewable energy.



US DOE Energy Information Administration

Why is the federal government regulating carbon dioxide?

- The Supreme Court in 2007 required the US Environmental Protection Agency to regulate CO₂ as a pollutant using the Clean Air Act (Massachusetts versus USEPA).
- The Obama administration believes the science that carbon dioxide emissions lead to climate change and the damages from climate change are large enough to justify action.
- US EPA issue an Endangerment Finding in 2009, with climate change damages estimated to range from \$12-\$39 per ton CO₂.
 - \$10-\$22 per year per Ohio driver (1-4 cents per gallon of gasoline)
 - \$1-\$4 per year per Ohio household for electricity consumption.
 - But note that each ton of CO₂ provides \$2300 in economic output in Ohio.

What is the Clean Power Plan?

- Federal regulation of electricity production through the Clean Air Act.
- Intended to reduce carbon dioxide emissions by around 15% by 2020 and 28% by 2030 in the electricity sector.
- Each state has a different federally mandated CO2 reduction goal.
- Ohio's current emissions from the electricity sector are around 102 million tons CO2. They are required to fall to around 74 million tons CO2 by 2030.
- A mass-based option paves the way for carbon trading/Cap-and-Trade.

Nationwide Effects of Clean Power Plan

- Study by Jeff Hopkins (2015) that evaluated 6 different model results.
- Continued shift to natural gas, although coal remains a large part of the energy mix through 2030.
- Higher electricity prices: +3 to +13%.
- Higher natural gas prices: 40% to 70%.
- Annual costs of compliance: \$5 to \$30 billion per year.
- Rely importantly on energy efficiency and reduced consumption, which cost less than renewables.
- Renewables play a small part because they are fairly expensive.

Levelized Costs of Electricity

Method and rate	Pounds CO2/Kwh	cents per Kwh
Conventional Coal	2100-2400	9.5
Conventional Natural Gas	1000-1200	7.3
Low/No Emission		
Wind	0	7.3
Energy Efficiency	0	8.0
Nuclear	0	9.5
Geothermal	0	10.0
Natural Gas – CCS	<1000	10.2
Solar	0	12.5
Coal – CCS	<2000	14.4

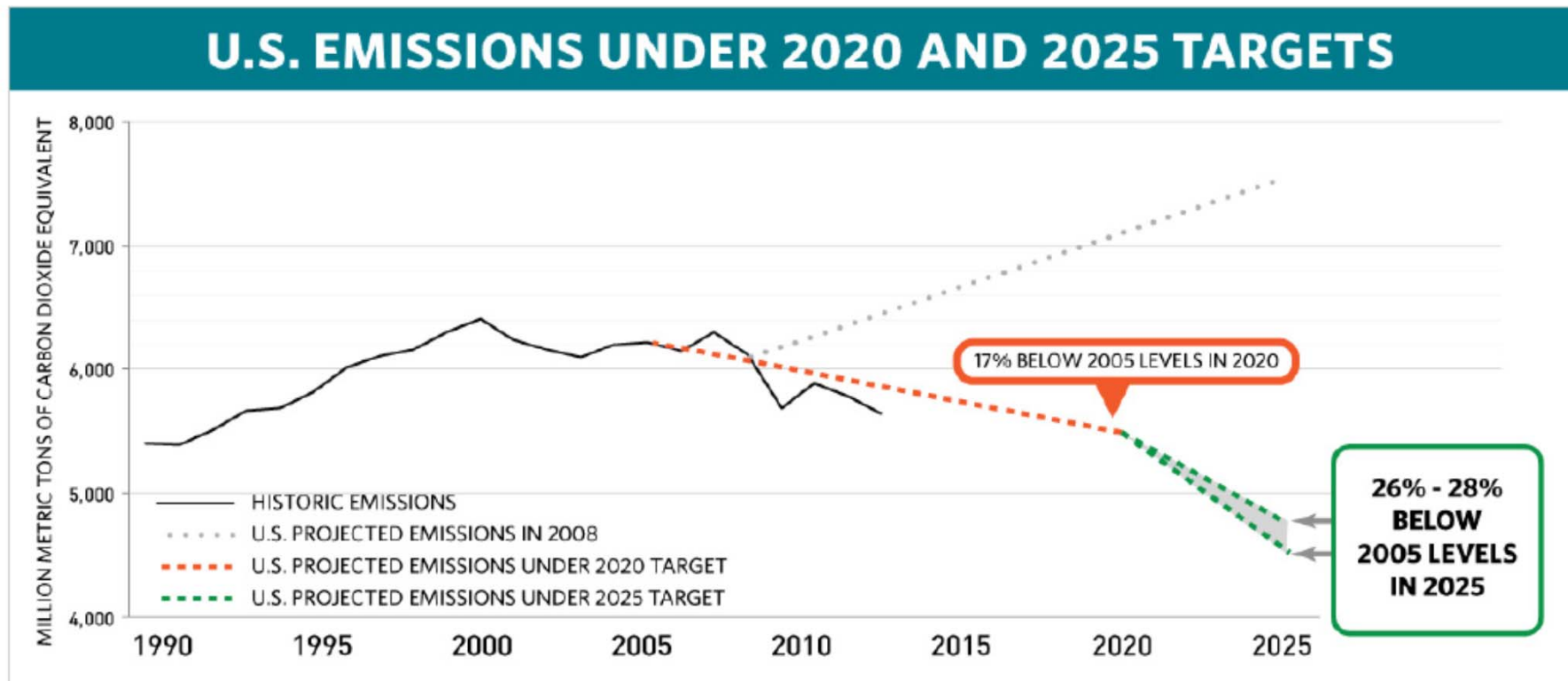
Ohio's Renewable Energy Standards

- Requires 12.5% of electricity production in Ohio be produced with renewable energy
- Requires significant energy efficiency investment
- Frozen in 2014 and under consideration by committee.
- Committee has recommended to continue the freeze.
- Having more wind power in the system with the Clean Power Plan will stabilize electricity prices and provide cost-certainty, which is not available if the Clean Power Plan is implemented entirely with natural gas and reduced consumption.

UN Framework Convention on Climate Change

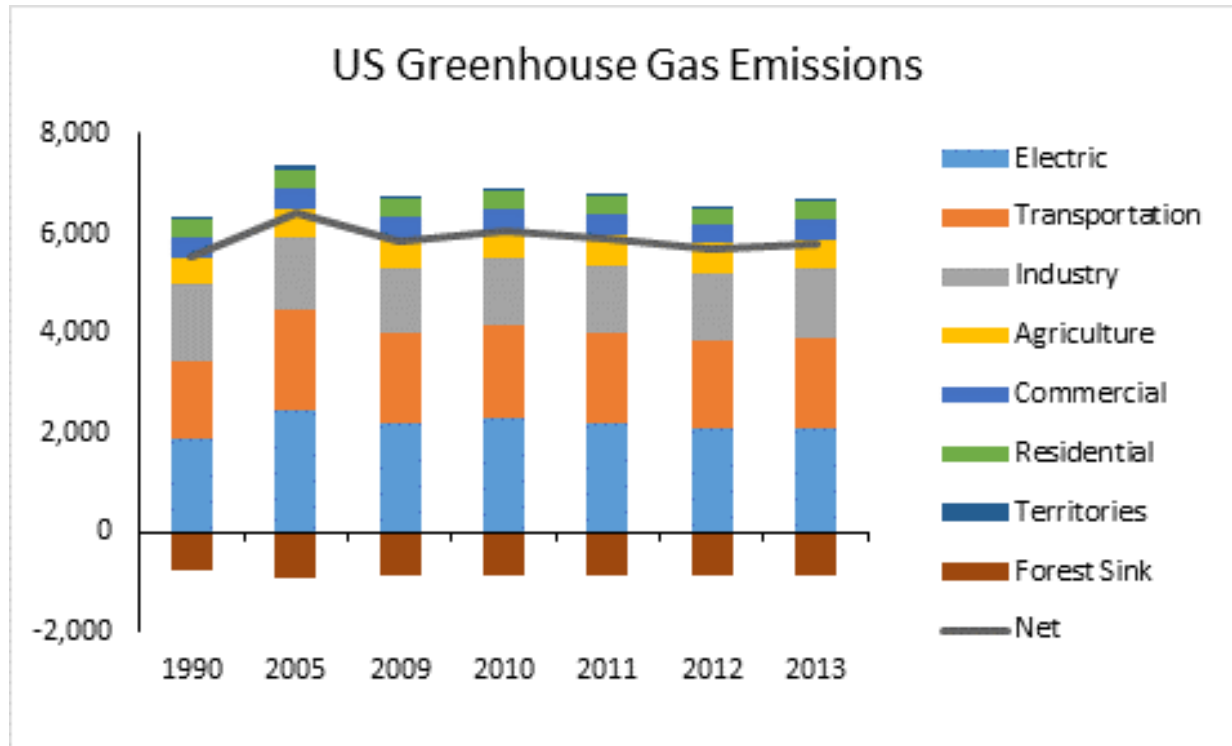
- US signed and ratified in 1992 under President George HW Bush
- The meeting in Paris going on now (the “Conference of the Parties”) is convened under this treaty.
- No new treaty is anticipated in Paris; countries will agree to implement what they are already planning to implement or what they are legally bound to implement.

US Indicated Nationally Determined Contribution



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- US goal includes all sectors, not just electricity



US Indicated Nationally Determined Contribution

- US goal includes all sectors, not just electricity
- Large ramp up in fuel efficiency standards: Cars achieve 54.5 mpg in average fuel efficiency by 2025.
 - Means many more hybrids, CNG, and diesel cars
- Reduce other gasses
- Maintain or enhance the forest sink.

Nationally Determined Contributions.

- What is everybody else doing?
 - U.S.- 2025: 26-28% Reduction below 2005 levels
 - China-2030: 60-65% Carbon Intensity Red. below 2005
 - EU (28 Nations)- 2030: 40% Reduction Below 1990
 - India-2030: 33-35% Carbon Intensity Red. Below 2005
 - Japan- 2030: 26% below 2013 levels
 - Indonesia- 2030-29%(Unconditional)-41%(Conditional) Below Business As Usual (BAU) Levels
 - Brazil-2030: Emissions 43% below 2005, with large share from reduced deforestation