THE GREENHOUSE GAS REDUCTION IMPACT OF A CARBON POLLUTION CHARGE IN MARYLAND

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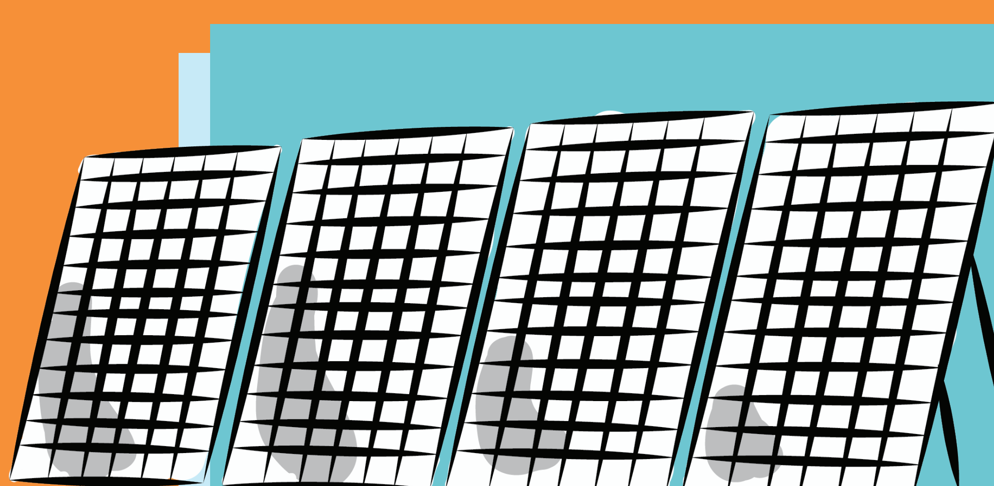
Climate × Change



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CONTENTS

FIGURES

I. SUMMARY

This study examines the outcomes of two policy scenarios on Maryland's greenhouse gas emissions profile. One scenario assumes that the state's existing climate policies remain in effect during the forecast period. The other scenario implements a carbon pollution price on top of those policies in the year 2020. The price begins at $15 per metric ton of carbon dioxide emissions (or the equivalent from other gases), rises $5 per year until it reaches $45/mton, and then remains constant.

We find that the carbon price would cut the state's overall emissions by approximately 12%, or 13 million metric tons, by 2030 compared to total emissions in the base year of 2006. In combination with the state's other policies, this forecasted reduction would put Maryland on course to reach its 2030 target of a 40% reduction. This cut exceeds the 11.4 million tons that we estimate the state's current policies will fall short of reaching for its 2030 goal.[1]

II. PURPOSE OF THE STUDY

Maryland has a strong commitment to fighting climate change. In 2009, the state passed the Greenhouse Gas Reduction Act (GGRA) that "requires the state to achieve a minimum 25% reduction in statewide greenhouse gas emissions from 2006 levels by 2020."[2] The law was reauthorized in 2016 by the state legislature and amended to include future reduction goals. The new law requires the state to reduce its GHG emissions to 40% below the 2006 level by 2030.[3]

The most recent update from the Maryland Department of the Environment (MDE) and the Maryland Commission on Climate Change (MCCC) indicates that through execution of the 2012 and 2015 GGRA plans, the state is on track to reach and exceed its 2020 target.[4] This is a significant achievement, due at least in part to state, regional, and federal policies. Previous policies that have proven effective include Maryland's participation in the Regional Greenhouse Gas Initiative (RGGI) that limits emissions from electricity generation plants; the state's Renewable Portfolio Standard (RPS) that requires 25% renewable electricity by 2020; EmPOWER Maryland, which provides funding for energy efficiency programs; and federal fuel-efficiency standards for both cars and trucks. These programs will continue to reduce the state's emissions, but Maryland does not yet have a comprehensive plan that will bring the state to its 2030 target. This study evaluates the effectiveness of an economy-wide carbon pollution price as an important tool in closing that emissions reduction gap.

There is extensive precedent for such a policy, as there are currently more than 40 countries that put a charge on carbon dioxide emissions from fossil fuels and more than 20 cities, states, and provinces that do the same.[5] The most familiar to policymakers in Maryland is RGGI, which includes Maryland and puts a small price on carbon across nine[6] (soon ten[7] and potentially eleven[8]) states in the Northeast United States. This policy has been responsible for a substantial fraction of the reduction in CO_2 emissions from electricity in the region since it was instituted in 2009.[9] It has also brought in $2.7 billion of revenue that the states have used for energy efficiency programs, renewable energy adoption, assistance for low-income households, and other purposes, which from 2015–2017 yielded "1.4 billion [dollars]…of net positive economic activity in the nine-state region."[10] Another re-

Potential wind turbines in a Maryland sunflower field.

gional policy is the Western Climate Initiative, which is an international carbon pricing effort that includes California, British Columbia, Québec, Ontario and Manitoba.[11]

Maryland's membership in RGGI means that the electricity sector in the state, which is responsible for close to 40% of total emissions[12] (its share has been dropping in recent years), faces a small carbon price. Although this is an important policy, it leaves out most of the state's emissions, which derive from transportation, heating, industrial and other uses of fossil fuels, and other greenhouse gases such as refrigerants. In addition, the price for emitting a ton of CO_2 under RGGI is far below widely-accepted estimates of the "social cost of carbon" and the price level that would provide a substantial incentive to reduce emissions.[13] The potential for an economy-wide carbon price that can enhance emissions reductions in all sectors of the economy is key to reaching the 2030 targets. Additionally, this policy provides an opportunity to create new revenue to support investments in clean energy programs, improve resilience to sea-level rise, and fund other important climate-related objectives.

THERE IS EXTENSIVE PRECEDENT FOR CARBON PRICING POLICY, AS THERE ARE CURRENTLY MORE THAN 40 COUNTRIES THAT PUT A CHARGE ON CARBON DIOXIDE EMISSIONS FROM FOSSIL FUELS AND MORE THAN 20 CITIES, STATES, AND PROVINCES THAT DO THE SAME.

III. ASSUMPTIONS OF THE ANALYSIS

For the purposes of the analysis we use a set of policy parameters for our hypothetical carbon price. First, the fee is charged based on the CO_2 emissions caused by burning fossil fuels, which are different per amount of useful energy derived from each fuel type, including coal, natural gas, gasoline, diesel fuel, and heating oil. Per the widely-used standard, emissions are measured in metric tons of CO_2, or the equivalent warming impact of other greenhouse gases, abbreviated as $MTCO_2e$.

POLLUTION PRICE LEVEL: In this study the price starts at \$15/$MTCO_2e$ and increases yearly by \$5 increments until it reaches \$45/$MTCO_2e$ in year seven. \$45 is within the range of estimates for the social cost of carbon used by the federal Environmental Protection Agency (EPA) in 2016,[14] although a number of experts on climate change believe that the cost is much higher.[15]

SOURCES OF POLLUTION COVERED: The price is applied to the use of fossil fuels throughout the economy, including electricity generation, transportation, residential and commercial buildings, and industrial consumption. Although the term "carbon price" refers to CO_2 emissions, ideally such a policy would apply to all major greenhouse gases. However, due to their relatively small role in the state's total emissions, and to limitations in the techniques available for estimating impacts on the other gases, this study is restricted to CO_2. We do include in our calculations an estimate for the greenhouse impacts of greater "fugitive" emissions of methane, prior to burning, when use of natural gas increases.[16]

POINT OF APPLICATION OF THE CARBON FEE: In order to reduce administrative costs and related difficulties, the charge is imposed at the first point of sale or transfer in the state, rather than at the retail level or on end-use consumers. It includes all imported electricity and fuels.

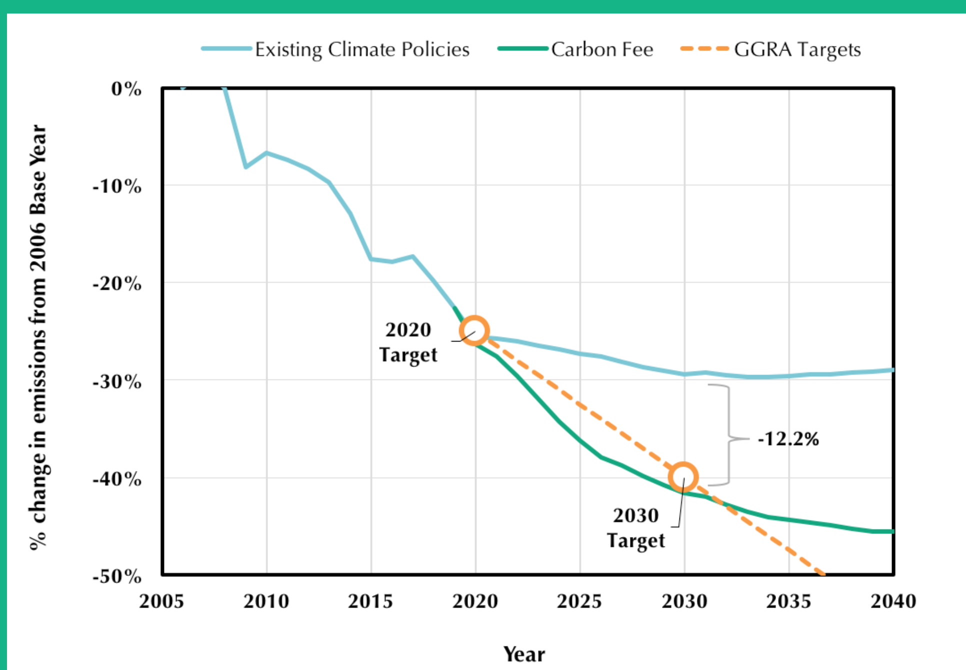
USE OF REVENUES FROM THE FEES: One aspect of the policy that is beyond the scope of this study is the revenue allocation side of the carbon price. Revenues can be returned to the public, including both households and employers, in the form of tax cuts or rebates. They can also be used for programs that reduce GHG emissions, such as incentives for energy efficiency and renewable energy, and assistance for mass transit agencies. Tax cuts and rebates are important for protection of low and moderate-income households and of "vulnerable" employers. As consumers see higher prices for fossil fuels, they can use any funds returned to them to improve the efficiency of their energy use and to convert to renewables. For a detailed analysis of how funds could be distributed, see *An Analysis of Impacts on Households at Different Income Levels from Carbon Pollution Pricing in Maryland*, Climate XChange, February 2018.

EMISSIONS CUTS FROM GOVERNMENT INVESTMENTS NOT ANALYZED: In this study we examine only the effect of higher prices on reducing fossil fuel use by consumers of all types. We have not conducted an analysis of the reductions that could result from expansion of government programs that invest in GHG-reduction. Such an analysis would be valuable to do, and would increase the projected value of carbon pricing. In Climate XChange's earlier study, the scenarios devote 10% to 20% of the revenues to investment in programs, many of which directly reduce GHG emissions; and policies proposed in some other states have proposed devoting larger shares of the revenues to such purposes.[17]

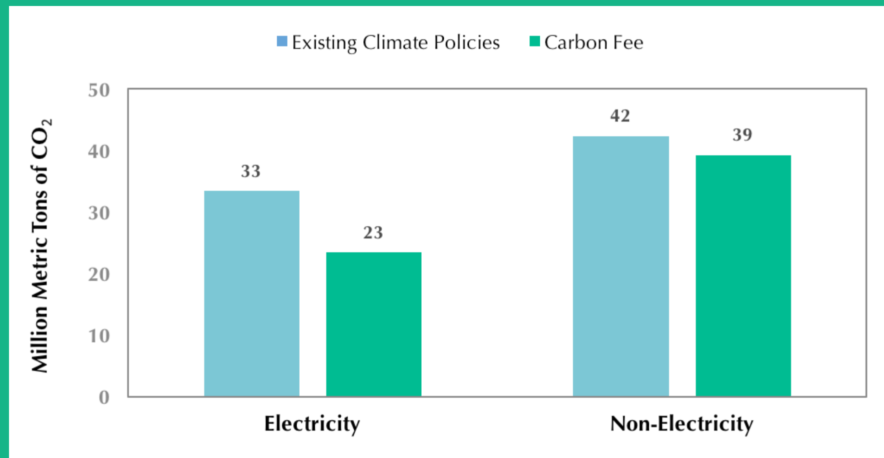
OTHER STATE AND FEDERAL POLICIES: The baseline forecast against which we measure gains from the carbon fees assumes that existing and expected environmental policies at the federal and state level will continue into the future, per forecasts from the federal Energy Information Administration.[18] These include the federal Clean Power Plan for electricity generating plants and federal fuel efficiency standards for vehicles. Because these policies already are forecast to substantially cut emissions from these sectors, their existence reduces our estimate of what a carbon price in Maryland would achieve.

ESTIMATED GHG EMISSIONS REDUCTIONS IN MARYLAND (2006-2040)

Figure 1 – Forecasted Emissions for Maryland with and without a carbon fee. See detailed description in the Results Section (p.6)



The administration of President Donald Trump is seeking to end the Clean Power Plan and to roll back future requirements for increased vehicle efficiency. If these policies are terminated or made less strict, the impacts of a carbon price in Maryland, and of other state-level action, will be heightened.



FORECASTED EMISSIONS FROM ELECTRICITY AND ALL OTHER ENERGY SOURCES IN MARYLAND IN 2030

Figure 2 – Forecasted emissions coming from the electricity and non-electricity sectors for Maryland, with and without a carbon fee. See detailed description in the Results Section (p.6)

IV. PROCEDURE FOR ESTIMATING CHANGES IN FUEL USE

As the price of GHG-emitting fuels rises, clean energy sources and energy efficiency become economically more appealing to consumers, utilities, fuel suppliers, and business owners. This shift in price will result in a decrease in demand for the polluting energy sources. If we can estimate the magnitude of this shift in consumption, then we can forecast the subsequent reduction in emissions.

Economists forecast the change in demand for any product when its price changes through statistical analysis of past changes. Many studies have been conducted for electricity and specific fossil fuels, and we have relied on these for our estimates of the response to carbon fees.[19]

It is well known that the demand for essential products and services, which include energy, is resistant to price changes, because people and businesses cannot easily reduce their consumption. Thus, when the price of such a product goes up by 10%, the reduction in use will be less than 10%. In general, various studies find that demand for different fuels and electricity fall by around 2% to 6% when the price rises by 10%, with the ratio being similar for other magnitudes of change. The best estimate for responsiveness is different for each fuel and end-use sector (residential, commercial, industrial, transportation, electricity).[20]

Potential solar panels on a block of Baltimore row houses.

In addition, the reductions do not take place entirely in a short span of time, such as weeks or months. While consumers and suppliers can make some changes in the short-term, such as buying more electricity from existing renewable sources or implementing simple efficiency measures, many changes take longer to accomplish. Substantially increasing production of renewable energy, such as building new wind turbines, takes years. For consumers, reducing fossil fuel use often requires large capital investments that are made at infrequent intervals, such as replacing the heating system in a home or purchasing a new vehicle.

Another way to cut emissions is for electricity generation to switch from the most carbon-intensive to less carbon-intensive fossil fuels, such as conversion from coal to natural gas. Much of the reduction in emissions in the RGGI states in recent years has come from such conversion. But, as with other changes, building a new natural gas plant or converting a plant from one fuel to another usually takes years to implement.

For all these reasons, we expect that it will take from five to 20 years for the effects of carbon pollution fees to be fully realized. In our analysis, different periods of adjustment are used for each fuel type and end-use sector, based on the studies that have been done by a number of economists.

We should note that the economic studies may well underestimate the impacts of price increases, because they rely entirely on responses to past changes. They do not explicitly take account of larger technological changes that future price changes are likely to help bring about, such as large-scale conversion from petroleum-based fuel to electric vehicles.

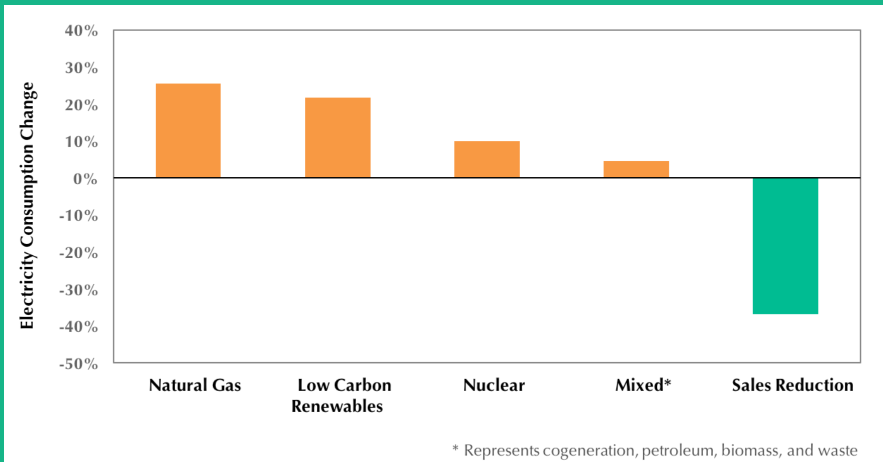
The degree of reduction in GHG emissions over time due to the implementation of carbon pricing is based primarily on five factors:

Emissions covered– in this study all major types of fossil fuels and end-uses have the carbon fees applied to them. The fee is also applied to increases in fugitive methane emissions from natural gas, which are then included in the forecast of emissions reductions. Other greenhouse gases are not included in the study.

Fee levels– as noted earlier, the fees begin at $15/mton and rise $5 a year until they reach $45/mton.

Time period– we assume that implementation begins in 2020 and carry out the forecast to 2040, with a principal focus on 2030, Maryland's interim target year.

THIS LEVEL OF FORECASTED REDUCTION WOULD PUT MARYLAND ON TARGET FOR ITS 2030 GOALS. WITHOUT A CARBON FEE, MARYLAND WOULD REQUIRE AN ADDITIONAL 11.4 MILLION TONS OF GHG EMISSIONS REDUCTIONS BEFORE REACHING ITS 2030 GOAL.



WHERE DOES THE COAL-FIRED POWER GO?

Figure 3 – Forecasted redistribution of coal-fired electricity consumption as a result of a carbon price in Maryland. Each bar in the chart represents its share of the overall reduction in coal. The percent increases in consumption of other fuels and the percent that sales fall add up to 100%. See detailed description in the Results Section (p.7)

Response to price changes – the percentage response of energy demand to price increases, which varies by fuel source and type of consumer, based on econometric studies.

Time to respond to prices – how many years it takes for consumption to fully respond to price changes, which is different for each energy source and end-use sector.

V. RESULTS

We find that a well-designed carbon fee effectively reduces GHG emissions in Maryland. Specifically, a carbon fee implemented at $15/mton in 2020 and rising to $45/mton in 2026 would yield emissions reductions of 12% in 2030, compared to the base year of 2006. In tonnage terms, it is a reduction of 13.1 million metric tons of CO_2. This level of forecasted reduction would put Maryland on target for its 2030 goals. Without a carbon fee, Maryland would require an additional 11.4 million tons of GHG emissions reductions before reaching its 2030 goal.[21]

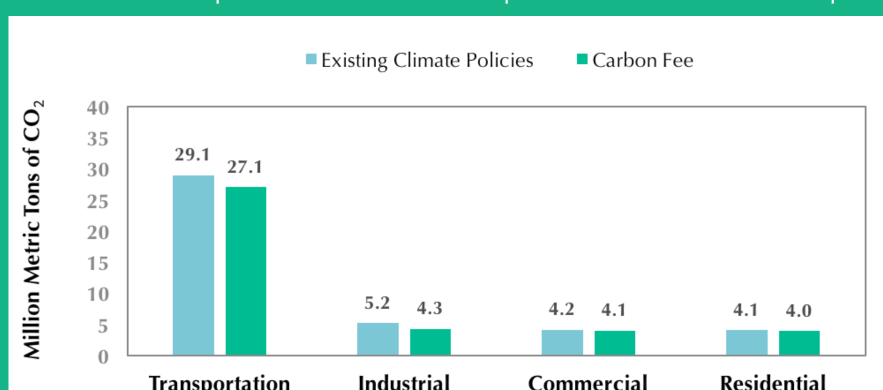
In **Figure 1 (p.3)**, the blue line shows the forecast of future emissions given the state's existing climate mitigation policies and external conditions. The orange circles show the 2020 and 2030 legislative goals while the dotted line traces a linear trend between the two goals. The green line shows our forecast of implementing the carbon fee. The impact is larger in the first seven years as the price level rises during this time before remaining constant at $45/ton. Even with this diminishing effect, a carbon price in combination with Maryland's existing policies achieve the 2030 target.

CO-BENEFITS: HEALTH AND RESILIENCY

The primary outcomes of a carbon price in Maryland are clear. The state will move toward a cleaner energy grid.

EMISSIONS REDUCTION EFFECT OF CARBON FEE IN MARYLAND BY SECTOR (EXCLUDING ELECTRICITY)

Figure 4 – Forecasted emissions reductions by sector for Maryland with and without a carbon fee, excluding the effect of the policy on electricity generation and consumption. See detailed description in the Results Section (p.7)



Important co-benefits will also result from this shift. First, pollution reductions have a clear health benefit. A study done by the Harvard School of Public Health found that a carbon price in Massachusetts would yield "$2.9 billion...of cumulative health benefits" by saving upward of 300 lives and avoiding numerous cardiovascular and respiratory hospitalizations between 2017 and 2040. This effect would be augmented in the context of Maryland. The state has much more room for improvement when compared with the relatively clean grid in Massachusetts. Specifically, the state's emissions from coal-fired energy are approximately seven times higher than equivalent emissions in Massachusetts.[22]

Additionally, the carbon price will reduce overall electricity consumption and move the grid away from centralized coal power and toward distributed renewable systems. These two shifts would yield a grid that is less susceptible to high peak demand and the subsequent threat of blackouts, along with requiring lower peak capacity.

Where do these reductions come from?

Figure 2 (p.4) illustrates that most of the emissions reduction effect of the carbon fee is due to the electricity sector, both from shifts in underlying fuel sources and, to a smaller degree, a reduction in consumption. The left-hand bar in each pair (which compare electricity and non-electricity emissions) depicts the emissions forecasted for 2030 with the state's current policies, while the right-hand bar in each pair adds carbon pricing to those policies. When a carbon price is applied, electricity-sector emissions in 2030 drop from 33 million mtons to 23 million mtons, while non-electricity emissions drop from 42 to 39 million mtons.

This result was to be expected, as Maryland currently relies relatively heavily on coal for electricity generation, both from in-state and out-of-state facilities.[23] In many of the RGGI states, conversion from coal to natural gas, and secondarily to renewable sources, has been the largest source of emissions reductions during the past decade. Because coal is the most carbon-intensive fossil fuel, its price would rise by a much greater degree (156% increase from the baseline price) than would the price of natural gas (39% increase from baseline), while the price of low or zero-carbon renewable fuels would not be affected significantly.

In the electricity sector, two major changes take place due to the carbon price. First, sales of electricity fall compared to the baseline forecast. Second, generation shifts from coal to a variety of other fuels and renewable energy sources. All of this can be viewed as a reduction in the use of coal, with consumption from that fuel dropping by about one-third. **Figure 3 (p.6)** shows that the use of coal shifts to the following places: 37% of the reduction comes from lower sales of electricity, 25% from conversion to natural gas, 22% from increases in the use of renewable power, and 10% from increased use of nuclear power.[24]

What is driving emissions reductions outside of shifts in the electricity fuel mix?

Figure 4 (p.6) represents emissions reductions that take place outside of the electricity sector. As demonstrated in **Figure 2 (p.4)**, these reductions are small in comparison to the effects of changes in electricity. However, they do represent approximately a quarter of the emissions reduction effect of the policy. The largest driver of these non-electricity reductions is the transportation sector. Reductions in motor fuel use (gasoline and diesel fuel) yield 62% of the emissions reduction effect. The industrial sector follows, with 28% of the emissions reductions coming from decreased consumption of natural gas and coal used in industrial buildings and manufacturing processes. The commercial and residential sectors each account for an equal share of the final 10% of reductions, which both come from decreasing use of natural gas and other heating fuels.

VI. CONCLUSION

A moderate carbon pollution price, within ten years after it is first implemented, will yield a major reduction in the state's greenhouse gas pollution. This reduction should be enough to close the gap between the impact of the state's current policies and the legislated goal of a 40% emissions reduction in 2030 from the 2006 level. The largest source of reductions would come from the electricity sector. These reductions would be the result of decreased electricity consumption and conversion from coal to other energy sources including renewables. Substantial reductions in emissions would also take place in transportation and in the direct use of fuels in buildings and in industrial processes.

VII. ENDNOTES

1. Our forecast is based on data from the federal Energy Information Administration (Annual Energy Outlook 2017). The latest forecast from MDE (Status Report: Draft 40 by 30 Plan. April 24, 2018) shows a smaller gap, of about 8 million tons, to reach the 2030 target.

2. MDE's 2015 Greenhouse Gas Emissions Reduction Act of 2009 (GGRA) Plan Update.

3. Greenhouse Gas Emissions Reduction Act of 2016.

4. MDE's 2015 Greenhouse Gas Emissions Reduction Act of 2009 (GGRA) Plan Update and MDE's Status Report: Draft 40 by 30 Plan, April 24, 2018, Slide 32.

5. According to the World Bank's Carbon Pricing Dashboard.

6. Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont according to RGGI's website.

7. "On January 29, 2018, Governor Phil Murphy signed Executive Order 7 (EO 7) directing the Department of Environmental Protection (DEP) and the Board of Public Utilities (BPU) to take all necessary regulatory and administrative measures to ensure New Jersey's timely return to full participation in the Regional Greenhouse Gas Initiative (RGGI)." (NJDEP website as of May 14, 2018).

8. Virginia has indicated that is interested in joining RGGI as reported by Jason Kusnetz of Inside Climate News in 2017.

9. "…about half of the region's reductions can be attributable directly to the RGGI program." Pg 588 of Murray, B. and Maniloff, P. (2015) Why Have Greenhouse Emissions in RGGI States Declined? An Econometric Attribution to Economic, Energy Market, and Policy Factors. Energy Economics, 51, 581-589.

10. The Economic Impacts Of The Regional Greenhouse Gas Initiative On Nine Northeast And Mid-Atlantic States. The Analysis Group, 2018.

11. The Western Climate Initiative was created to widen the market for carbon credits across multiple regions that have enacted their own cap and trade systems. More information can be found on the organizations website at wci.org.

12. US EIA State Energy Data System: 1960-2015 (complete), Maryland, All consumption estimates. Analysis by Climate XChange.

13. Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis. Interagency Working Group on Social Cost of Greenhouse Gases, 2016.

14. Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis. Interagency Working Group on Social Cost of Greenhouse Gases, 2016.

15. Climate Risks and Carbon Prices: Revising the Social Cost of Carbon. Ackerman and Stanton, 2012. & New science of climate change impacts on agriculture implies higher social cost of carbon. Moore, 2017.

16. Although these additional emissions are relatively small, approximately.05 MMTCO2which only diminishes emissions reductions by 0.4%.

17. The Global Warming Solutions Act of 2006 (AB 32) in California, Climate and Community Investment Act (S7645) in New York, and Governor Inslee's recent attempt to pass carbon pricing (SB 6203) in the Washington state legislature.

18. Assumptions to the Annual Energy Outlook 2017. US EIA, 2017.

19. CTAM Price Elasticity 2015. Washington Department of Commerce, 2015. Fuel Competition in Power Generation and Elasticities of Substitution. US EIA, 2012.

20. A meta-analysis on the price elasticity of energy demand. Labandeira et al, 2017.

21. The forecast of emissions with Maryland's existing climate policies is based on data from the federal Energy Information Administration. The most recent update issued by the Maryland Department of the Environment shows a smaller gap between the "reference" forecast and the 40% target under state law, of about 8 million metric tons, or 9.4% (estimated from graph on slide 32 of "Status Report: Draft 40 by 30 Plan," Maryland Department of the Environment, April 24, 2018).

22 EIA SEDS Historical Data for Maryland and Massachusetts. Climate XChange Analysis.

23. Maryland 2006 Base Year Inventory. Maryland Department of the Environment, 2006. & US EIA State Energy Data System: 1960-2015 (complete), Maryland, All consumption estimates. Analysis by Climate XChange.

24. Since no new nuclear plants are expected to be built in Maryland, and the existing plants already operate at their maximum safe capacity factor, any increases in nuclear-generated power would be due to greater imports from plants in other states. Maryland's existing nuclear plants, Calvert Cliffs, are currently licensed through 2034 and 2036.

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