CADMUS

Carbon Pricing Methods

Effects on the Valuation of Energy Efficiency

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Table of Contents

Executive Summary 1

Potential Next Steps and Questions for Consideration 3

Carbon Dioxide Valuation: 3

Co-pollutant Valuation: 3

Background: Focus on Energy Valuation of Emissions 4

Current CO_2 Valuation Approach 6

Current Co-Pollutant Valuation Approach 7

Alternative Valuation Based on Social Impacts 8

CO_2 Valuation: Social Cost of Carbon 8

States Using the Social Cost of Carbon in Utility Policy Proceedings 11

California 12

Colorado 12

Illinois 12

Maine 12

Maryland 13

Minnesota 13

Nevada 13

New York 13

Virginia 13

Washington 14

Co-Pollutants: Health Impacts 14

Impact of Carbon Pricing on the Value of Energy Efficiency 15

Approach 15

Results 15

Monetized Health Impacts 17

Approach 17

Results 17

Sensitivity Analysis: CO_2 Impacts on MTRC Test 19

Tables

Table 1: Current Evaluation of Emissions 6
Table 2: Social Cost of Carbon 2010-2050 10
Table 3. IWG Central Scenario Social Cost of Carbon 2020-2050 10
Table 4: Emissions Benefits for Various Valuations, 2019 - 2034 16
Table 5: Summary of Benefits from Emissions Savings in One Year 18
Table 6. Benefit Cost Ratio Calculation Components 19
Table 7: Costs, Benefits, and Modified Total Resource Cost Test for CY2019 20

Figures

Figure 1. Carbon Valuation Scenarios 15
Figure 2. AVERT Regions 17

Executive Summary

In its assessment of the cost effectiveness of energy efficiency investments, Focus on Energy (Focus) currently values efficiency-driven emissions reductions of Carbon Dioxide (CO_2), Sulfur Dioxide (SO_2) and Nitrogen Oxides (NO_x) at $15, $2 and $7.5 per ton emitted, respectively. CO_2 currently accounts for approximately 20% of the benefits in the Modified Total Resource Cost Test (mTRC), while the other pollutants' contributions are negligible. The CO_2 valuation is applied to emissions from electricity generation and natural gas usage. SO_2 and NO_x valuation is applied to only emissions from electricity generation.

The 2011-2015 planning process used a value of $30 per ton "to strike a balance between the two primary sources for determining carbon values: market-based values and the long-term societal value of reduced emissions" (PSC REF# 279739). This value was re-examined as part of the Quadrennial Planning Process II (for 2015-2018) which, at the time, established a rationale to align the valuation with a market-based value though several PSC Orders and Memorandum:

- In PSC REF# 215245, the Commission directed that "Commission staff and the EWG shall evaluate and report back to the Commission on appropriate market-based carbon values not later than October 2015, at which time the Commission will select the proper valuation."
- In PSC REF# 279042 the EWG and Commission staff presents alternatives on carbon pricing for Commission consideration. The memo first reviews updates to the social cost of carbon. Second, it reviews Focus' criteria for choosing a carbon value: consistency with Focus' life cycle savings framework; consistency with general Focus program goals and policies; and transparency. Finally, it reviews different market price levels and forecasts at the time.
- PSC REF# 279739 suggests that the valuation should meet the "dual criteria of being informed by present-day market values and recognizing future market conditions for consistency with Focus' life cycle savings framework." Wisconsin and its regional grid (MISO) currently do not participate in carbon markets.
- PSC REF# 279739: Existing markets (e.g., California) and forecasts were insufficient to provide a definitive value but identified a range of $11.5 to $28 per ton. As such the commission established a value of $15 per ton, which was consistent with the then current proxy value and was regarded a reasonable mid-point of the identified range of likely market prices.

The use of a proxy market value during the Quadrennial Planning Process II was based on the anticipation that a market price on carbon would be established under a regulatory mechanism such as the Clean Power Plan proposed by the Obama Administration. The Trump administration effectively scuttled this plan. Thus, the current Focus on Energy CO_2 value reflects not a direct benefit, but instead reflects an anticipated cost avoidance that never materialized. The Commission elected to keep the $15 per ton value for the Quadrennial Planning Process III (2019-2022)

The regulatory basis for the Clean Power Plan and its targets was legally justified by the EPA's calculation of the social cost of carbon (SCC). Any resultant market price would have been in part influenced by this, as well as other factors of policy design. The social cost of carbon is a commonly used metric for valuing the society-wide impacts of greenhouse gas emissions (changes in agricultural productivity, health, property damage). It estimates the total economic harm resulting from emitting one ton of carbon dioxide into the atmosphere. The most widely used estimate for the SCC in the United States is that established in 2015 by the U.S. Government's Interagency Working Group *on Social Cost of Greenhouse Gases* (IWG).[1, 2] The Biden Administration recently adopted an interim cost of carbon value of $51 per ton, which is consistent with the values previously released by the IWG. Other changes may be coming, which will be monitored by Focus on Energy.

This valuation of the social cost of carbon is used by numerous states in similar energy efficiency programs. California, for example, both operates a cap-and-trade carbon market (with allowances currently priced at approximately $15 per metric ton) and uses the social cost of carbon to inform integrated resource planning decisions.

The IWG valuation is approximately 4 times that of the current $15 per ton Focus valuation. If the IWG's benchmark value for the social cost of carbon were to the replace the current $15 valuation avoided CO_2 emissions would account for 50% of the total benefits in the mTRC and increase the cost benefit ratio from 2.6 to 4.1.

The use of a market-based valuation versus a social impacts valuation is a policy choice. A market-based valuation is appropriate if the goal is to measure direct costs of an emission in a regulated market. A social impacts valuation is appropriate if accounting for the broader economic damages associated with carbon emissions is desired. Focus' current approach established during Quad II planning, and carried forward in Quad III planning, appears to serve the role of anticipating a market price that never materialized.

The current valuation of SO_2 and NO_x stems from their inclusion as regulated pollutants in the EPA's Clean Air Act Acid Rain Program. The program is considered at the end of its policy life, and Focus on Energy's current valuation of SO_2 and NO_x results in negligible impacts to the mRTC calculation.

Alternatively, health impacts assessment is a commonly used approach for valuing reductions in emissions (SO_2, NO_x and $PM_{2.5}$) due to efficiency actions. This approach is used widely in academic studies and similar programs. These impacts are substantially larger than the current valuation of non-GHG emissions: SO_2 and NO_x.

The following report provides a detailed review of alternative valuation approaches and their potential impacts to the valuation of emissions in the Focus on Energy portfolio.

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[1] United States Environmental Protection Agency. The Social Cost of Carbon: Estimating the Benefits of Reducing Greenhouse Gas Emissions. Retrieved from https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

[2] The EPA under the Trump administration changed the method for calculating the social cost of carbon. The resultant lower range of values ($1-$6) was a key reason for the EPA's rollback of the Clean Power Plan.

Potential Next Steps and Questions for Consideration

Focus has historically re-examined its carbon valuation approach during each Quadrennial planning process. If carbon valuation is similarly addressed as part of the Quad IV planning process, the following questions are designed to help guide its decision making:

Carbon Dioxide Valuation:

- Focus' current valuation of carbon emissions does not reflect a direct market-based cost, but an anticipated regulatory cost which has not yet materialized. Should Focus continue to prioritize market-based valuations, or adopt a social cost of carbon approach? *High impact decision.*

Co-pollutant Valuation:

- Should Focus continue to use SO_2 and NO_x market prices in its valuation given the negligible impacts and status of the Clean Air Act's Acid Rain Program? *Low impact decision.*
- Should Focus incorporate the value of health benefits associated with the reduction in co-pollutants? *Medium impact decision*.

Background: Focus on Energy Valuation of Emissions

The Focus on Energy (Focus) program's estimates of the cost-effectiveness of energy efficiency measures incorporates a valuation of associated CO_2 emissions savings and a valuation of the reduction in harmful air pollutants (currently SO_2 and NO_X). These valuations are combined with other benefits of efficiency (energy savings, avoided distribution investments) in the Modified Total Resource Cost (mTRC) test.

The rationale for setting a valuation has evolved over the lifetime of the Focus program. For the 2011-2015 Quadrennial Planning Process, a $30 per ton valuation of CO_2 emissions was established "to strike a balance between the two primary sources for determining carbon values: market-based values and the long-term societal value of reduced emissions".[3] In the subsequent 2015-2018 planning process a valuation of $15 per ton was established based on the "dual criteria of being informed by present-day market values and recognizing future market conditions for consistency with Focus' life cycle savings framework."[4]

Market-based carbon prices refer to a valuation that results from the framework created by market-based regulations.[5] Cap-and-trade programs are the most prevalent regulation resulting in market-based carbon pricing. Market-based pricing reflects the marginal cost of abating an additional ton of pollutant emissions *within the scope of the regulation*. As a result, market-based prices are largely determined by three factors:

- The emissions limits of the regulation;
- The scope of who is subject to the regulation; and
- The cost of alternative low-carbon technology or emissions control technology.

The EPA's regulation of SO_2 and NO_X under its Clean Air Act Acid Rain cap-and-trade program is broadly considered a successful archetype of market-based pollution mitigation. Mitigation of these pollutants has largely reduced the impacts of acid rain across the United States. Given its outcomes and low-cost of implementation, this program has been used as a model for the implementation of market-based programs for mitigating greenhouse gases.

The two most prominent carbon pricing programs are the Regional Greenhouse Gas Initiative (RGGI) and the California cap-and-trade program. The RGGI participants includes 10 Northeast and Mid-Atlantic

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[3] PSC REF#197255 Quadrennial Planning Process II, January 13, 2014. https://apps.psc.wi.gov/ERF/ERFview/viewdoc.aspx?docid=%20197255

[4] PSC REF#279739 Quadrennial Planning Process II, December 23, 2015. https://apps.psc.wi.gov/pages/viewdoc.htm?docid=279739

[5] Center for Climate and Energy Solutions. (n.d.). State Carbon Pricing: Market-Based Strategies. Retrieved from https://www.c2es.org/content/market-based-strategies/

states.[6] The two programs are very different in their scope, resulting in different market prices. The RGGI covers emissions only from the electric power sector (18% of the jurisdiction's emissions), whereas California's program is broader in scope, covering emissions from the electric power sector, industry, transportation, and buildings (85% of California's emissions). As of August 2020, the market price in RGGI and California was $5.13 and $15.30, respectively.[7] These prices differ by a factor of about three, because the rules regulating carbon emission are different. Generally, California's caps are more stringent, limiting the supply of emission allowances, and leading to higher market prices. Notably Massachusetts also operates a second cap-and-trade program in addition to RGGI (see Box 1: Policy Design and Market Prices below). While the prices in these programs fluctuate over time, they are generally upwards in recent years as the result of an increasing price floor and a more stringent cap on emissions.[8, 9] Current valuations for all pollutants are shown in Table 1.

Box 1: Policy Design and Market Prices

In addition to participating in RGGI, Massachusetts has implemented another cap-and-trade program – the *Limits on Emissions from Electricity Generators* program - that covers emissions from the electric power sector. This program sets stricter limits on emissions than those under RGGI. Under this program, emitters need to pay for their emissions both in the RGGI program and the Massachusetts-specific program. As of August 2020, the market price for an allowance per metric ton in the Massachusetts program was $8.20, bringing the effective market-price of carbon in Massachusetts to $13, while it remains at $6.80 in surrounding states. This difference in price is not a result of inherent differences in the overall economic harm caused by carbon emissions, but rather a result of Massachusetts' more stringent policy objectives.

[6] Current participants include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. Virginia is slated to join January 1, 2021 and Pennsylvania is conserving joining. See: https://www.spglobal.com/platts/en/market-insights/latest-news/coal/090420-rggi-carbon-dioxide-allowance-prices-jump-to-five-year-high

[7] The World Bank. (n.d.). Carbon Pricing Dashboard. Retrieved from https://carbonpricingdashboard.worldbank.org/map_data

[8] Congressional Research Service. (July 2019). The Regional Greenhouse Gas Initiative: Background, Impacts, and Selected Issues. Retrieved from https://fas.org/sgp/crs/misc/R41836.pdf

[9] Environmental Defense Fund. (February 2020). California-Quebec Carbon Auction Kicks off 2020 with Record Allowance Price. Retrieved from: http://blogs.edf.org/climate411/2020/02/26/california-quebec-carbon-auction-kicks-off-2020-with-record-allowance-price/

Table 1: Current Evaluation of Emissions

	Carbon	SO_2	NOx
Current Focus Valuation	**$15/ton**	**$2/ton**	**$7.50/ton**
Current Valuation Basis	2015 QPP II Finding PSC# 279739 Aggregation of 2015 Market Prices	U.S. EPA Cross State Air Pollution Rule Allowance Price	U.S. EPA Cross State Air Pollution Rule Allowance Price
Recent Prices	RGGI: **$6.8/ton** (9/2/2020) CARB: **$16.68/ton** (8/25/20)	**$2/ton** (2019 June 11 spot)	**$3/ton** (2019 June 11 spot)

Avoided emissions of these pollutants are estimated from the energy savings associated with a Focus-supported energy efficiency measure. Emissions are currently calculated using local hourly marginal emissions rates in the EPA's Avoided Emissions and geneRation Tool (AVERT)[10] model by assuming the energy savings of an emissions action is distributed evenly across a whole year. AVERT reports hourly and annual emissions impacts of energy savings for CO_2, SO_2 and NO_x, as well as generates output for the further evaluation of the health impacts of SO_2, NO_x, and $PM_{2.5}$. A separate companion report evaluates the impact of a greening grid on this calculation. Future work should aim to more clearly incorporate the hourly impacts of an efficiency measure as opposed to the current assumption of equal impact for each hour of the year.

Current CO_2 Valuation Approach

The inclusion of a value for CO_2 emissions in the mTRC test is designed to account for the avoided cost of the CO_2 emissions that would be released in the absence of energy savings. Wisconsin and its regional grid operator currently do not participate in CO_2 emissions markets. As such, Focus' inclusion of a market CO_2 valuation does not currently reflect any actual cost savings incurred by emitters.

As noted above, the Focus program currently assumes a value of $15 per metric ton of CO_2 avoided which was set by the PSC in 2015[11]. Previously the valuation was set at $30 to reflect a balance of market and social cost of carbon valuations. The PSC noted in 2015 that due to the absence of an active market that no single source of data met the "dual criteria of current market values and future market conditions". To meet this dual criteria, the valuation was ultimately informed by the then current

[10] U.S. EPA AVoided Emissions and geneRation Tool (AVERT) https://www.epa.gov/statelocalenergy/avoided-emissions-and-generation-tool-avert

[11] Ibid.

market price of CO_2 in California and a forecast published by Synapse Energy Economics (Synapse)[12] that aimed to estimate a likely carbon price that would be established under the EPA's Clean Power Plan. The forecast's intended use was to provide interested parties with guidance on what the likely level of the carbon price would be. The forecast is based on state (e.g., California) and regional programs (e.g., Regional Greenhouse Gas Initiative), as well as then pending federal action. Synapse ceased publishing this forecast in 2017 in line with decreased federal CO_2 regulatory activity when the Trump administration effectively scuttled the Clean Power Plan

The 2015 valuation was adopted in an environment where CO_2 emissions were anticipated to be regulated in the near future. That regulatory environment has yet to emerge and it is uncertain how, or if, it will emerge in the coming years. However, with the climate goals of the Biden administration, as well as Wisconsin (and neighboring) states' commitments to carbon mitigation, it is conceivable that such regulation may emerge over the next several years. Until then, the valuation of CO_2 in Focus' program does not reflect an actual cost, but rather an anticipated market cost.

Current Co-Pollutant Valuation Approach

The inclusion of a valuation of a reduction in SO_2 and NO_X stems from historic acid rain regulations under the 1990 amendments to the Clean Air Act. Efficiency actions that reduce the demand of electricity subsequently reduce the combustion of fossil fuels that lead to the release of SO_2 and NO_X. Since these pollutants are covered under Clean Air Act's Acid Rain cap-and-trade program, the mitigation by Focus efficiency programs thus represents an actual compliance cost savings. The Clean Air Act's SO_2 and NO_X programs have been widely regarded as successful in abating these pollutants. As a result, the total emissions of SO_2 and NO_X are low, and the subsequent market prices of these pollutants are negligible contributors to the mRTC. Focus currently values these at $2 per ton of SO_2 and $7.50 per ton of NO_x.

The Focus program has begun to estimate health benefits of the Program in Quad III and reports them as part of a secondary cost-effectiveness test for information purposes. Such benefits would be realized though the reduction in emissions of pollutants such as SO_2 and NO_X, as well as fine particulate matter (e.g., $PM_{2.5}$). This new approach uses the EPA's benefits per kilowatt-hour (BPK) tool.

[12] Synapse Energy Economics. 2015 Carbon Dioxide Price Forecast (March 3, 2015). https://www.synapse-energy.com/sites/default/files/2015%20Carbon%20Dioxide%20Price%20Report.pdf

Alternative Valuation Based on Social Impacts

As part of this study, an alternative valuation approach was reviewed and analyzed for CO_2 and the other pollutants. The valuation approaches are reviewed in this section, while their relative impacts on total valuation and the mTRC test are evaluated in subsequent sections.

CO_2 Valuation: Social Cost of Carbon

The social cost of carbon (SCC) is a monetary estimate of the economic harm caused by emitting a ton of greenhouse gases (GHG) into the atmosphere. It was developed to evaluate the cost-effectiveness of a given GHG-reduction policy action.[13] It is notable that the first Quadrennial Planning Process (2011-2015) adopted a value of $30 per ton to strike a balance between the two primary sources for determining carbon values: market-based values and the long-term societal value of reduced emissions".[14]

CO_2 emissions are the primary driver of global climate change. The SCC is calculated by modeling the economic impacts caused by a changing climate.[15] These economic impacts include changes in agricultural productivity, health, property damage, and changes in energy use. However, it is important to note that the Intergovernmental Panel on Climate Change has indicated that many estimates of the SCC are actually underestimates, having excluded a number of physical, ecological, and economic impacts that have large uncertainties (e.g., migration, climate conflicts). These additional costs are not included due to a lack of reliable data, but their absence suggests that the SCC underestimates the true cost of incremental GHG emissions.[16]

In the United States, the SCC values that are most frequently adopted are those created by the United States Government's *Interagency Working Group on Social Cost of Greenhouse Gases* (IWG).[17] This group was formed under the Obama administration and released SCC estimates in 2013, which were most recently revised in 2016.[18] In 2017, the Trump administration disbanded the IWG and subsequently recalculated the SCC to range between $1 and $6. Despite this, the values generated by

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[13] Rennert, K. & Kingdon, Cora. (2019). Social Cost of Carbon 101. Resources for the Future. Retrieved from https://media.rff.org/documents/SCC_Explainer.pdf

[14] PSC REF#197255 Quadrennial Planning Process II, January 13, 2014. psc.wi.gov/apps35/ERF_view/viewdoc.aspx?docid=%20197255

[15] Ibid.

[16] United States Environmental Protection Agency. (n.d.). The Social Cost of Carbon: Estimating the Benefits of Reducing Greenhouse Gas Emissions. Retrieved from https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

[17] Institute for Policy Integrity, New York University School of Law. (n.d.). The Cost of Carbon Pollution: States Using the SCC. Retrieved from https://costofcarbon.org/states

[18] United States Environmental Protection Agency. (n.d.). The Social Cost of Carbon: Estimating the Benefits of Reducing Greenhouse Gas Emissions. Retrieved from https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

the IWG have been upheld by federal courts for use in federal decision making and have been endorsed by the National Academy of Sciences and the Government Accountability Office.[19]

The IWG developed its SCC values using models that predict future emissions and their resulting climate responses, which are then translated into monetary impacts to the economy.[20] Because these monetary values extend to future years, they are converted to the present value using a discount rate.[21] Because there is a large amount of uncertainty in the model runs, the IWG released four different social cost of carbon scenarios in their most recent technical documents. The three primary scenarios show the average of the model runs using discount rates of 5%, 3%, and 2.5%. An additional high impact scenario represents damages in the 95th percentile of model runs using a 3% discount rate.

While the IWG encourages all four scenarios to be considered, they consider the 3% discount rate scenario to be the central value. The values for these scenarios are shown in Table 2[22] with annual values for the central scenario shown in Table 3. The SCC of carbon increases over time due to social and economic systems becoming increasingly stressed as a result of climate change.[23]

Since the disbanding of the IWG, there has been significant follow up research from several academic sources. Most subsequent peer-reviewed literature indicate that the SCC values that were set by the IWG underestimate the true societal cost of carbon emissions.[24] However, given the inherent uncertainty in modeling[25] and the lack of consensus among SCC research,[26] the IWG's SCC values, most

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[19] Institute for Policy Integrity. (n.d.). The Cost of Carbon Pollution: Are the Federal IWG Numbers Still the Best? Retrieved from https://costofcarbon.org/stateshttps://costofcarbon.org/faq/are-the-federal-iwg-numbers-still-the-best

[20] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. (2016). Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

[21] Rennert, K. & Kingdon, Cora. (2019). Social Cost of Carbon 101. Resources for the Future. Retrieved from https://media.rff.org/documents/SCC_Explainer.pdf

[22] Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. (2016). Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

[23] United States Interagency Working Group on Social Cost of Greenhouse Gases. (2016). Technical Support Document: - Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. Retrieved from https://19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf

[24] Harvey, C. (2017). Should the Social Cost of Carbon Be Higher? Scientific American. Retrieved from https://www.scientificamerican.com/article/should-the-social-cost-of-carbon-be-higher/

[25] van den Bergen, J.C.J.M., Botzen, W.J.W. (2015). Monetary Valuation of the Social Cost of CO2 Emissions: A Critical Survey. Ecological Economics, Volume 114, Pages 33-46. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0921800915001007

[26] Wang., P. et al. (2019). Estimates of the Social Cost of Carbon: A Review Based on Met-analysis. Journal of Cleaner Production, Volume 209, Pages 1494-1507. Retrieved from https://www.sciencedirect.com/science/article/abs/pii/S0959652618334589?via%3Dihub

recently updated in 2016, are the values most frequently adopted by governments and jurisdictions in the United States.[27] Examples are provided below.

Table 2: Social Cost of Carbon 2010-2050

Year	5% Average*	3% Average [Central]	2.5% Average	High Impact [95th Pct at 3%]
2010	$10	**$31**	$50	$86
2015	$11	**$36**	$56	$105
2020	$12	**$42**	$62	$123
2025	$14	**$46**	$68	$138
2030	$16	**$50**	$73	$152
2035	$18	**$55**	$78	$168
2040	$21	**$60**	$84	$183
2045	$23	**$64**	$89	$197
2050	$26	**$69**	$95	$212

* All values shown in 2007 US Dollars per metric ton of CO_2

Table 3. IWG Central Scenario Social Cost of Carbon 2020-2050

Year	Carbon Value* [2020 USD / ton CO_2]	Year	Carbon Value* [2020 USD / ton CO_2]
2020	$52	**2036**	$70
2021	$52	**2037**	$71
2022	$54	**2038**	$72
2023	$55	**2039**	$74
2024	$56	**2040**	$75
2025	$57	**2041**	$76
2026	$59	**2042**	$76
2027	$60	**2043**	$77
2028	$61	**2044**	$79
2029	$61	**2045**	$80
2030	$62	**2046**	$81
2031	$64	**2047**	$82
2032	$65	**2048**	$84
2033	$66	**2049**	$85
2034	$67	**2050**	$86
2035	$69		

* Calculated and interpolated from 2007 values listed in Table 2.

[27] Institute for Policy Integrity. (n.d.). The Cost of Carbon Pollution: Are the Federal IWG Numbers Still the Best? Retrieved from https://costofcarbon.org/stateshttps://costofcarbon.org/faq/are-the-federal-iwg-numbers-still-the-best

The Biden administration has released an interim social cost of carbon value of $51 per ton, which is based on the IWG's 2016 numbers. This value differs slightly from the one calculated in this study, likely the result of slightly different inflation numbers used to convert the 2007 values to 2020 values.[28]

The SCC is designed to capture the inherent cost to society of emitting greenhouse gases. Conversely, market-based carbon prices represent the marginal cost of abating greenhouse gas emissions based on the scope of the regulatory program that creates the carbon market. Because the SCC is a more comprehensive and holistic value, it is more appropriate than market-based prices for use in determining the costs and benefits of programs and policies. Evidence of its efficacy is seen in the number of states who currently use the SCC in policy proceedings and resource planning to capture the cost of greenhouse gas emissions, including Wisconsin's neighbors, Illinois and Minnesota. While there is some contention as to the best approach for measuring the social cost of carbon, the IWG's estimates are the most widely used values and have been upheld by courts across the country as the best available science and economics. Additional resources describing approaches to setting and using a social cost of carbon are listed in Box 2 below.

Box 2: Recent Research on the Social Cost of Carbon

The following papers and report are sampling of the current best available science and application on the social cost of carbon:

- Kauffman et al. *A near-term to net zero alternative to the social cost of carbon for setting carbon prices*. Nature Climate Change (2020). doi.org/10.1038/s41558-020-0880-3
- Rennert & Kingdon. Resources for the Future. *Social Cost of Carbon 101* (2019) www.rff.org/publications/explainers/social-cost-carbon-101/
- Nordhaus. *Revisiting the Social Cost of Carbon.* Proceedings of the National Academy of Sciences of the United States of America (2017). doi.org/10.1073
- National Academy of Sciences. Updating Estimation of the Social Cost of Carbon Dioxide (2017). https://doi.org/10.17226/24651

States Using the Social Cost of Carbon in Utility Policy Proceedings

In deciding the appropriate cost of carbon to adopt, it is important to consider what other states use as a cost of carbon in their policy proceedings. There are several states that currently utilize a social cost of carbon in various policies. The following section provides a brief description for each of these states.

[28] This report utilized three websites to confirm inflation numbers from 2007 to 2020, so it is unclear why the social cost of carbon differs slights from the Biden Administration. The websites used include: https://data.bls.gov/cgi-bin/cpicalc.pl?cost1=10&year1=200001&year2=202007; https://www.in2013dollars.com/us/inflation/2007?endYear=2020&amount=1; https://www.officialdata.org/us/inflation/2007?endYear=2020&amount=100

California

The California Air Resources Board used IWG's SCC in 2017 as part of the state's updated scoping plan for climate change policy.[29] In 2019 the California Public Utilities Commission issued an order requiring utilities to use both IWG's central scenario along with the high impact scenario in resource planning with regards to distributed energy resources.[30] What is notable about the California approach is that while they have a CO_2 emissions market that currently prices allowances at about $15 per metric ton, they have adopted more aggressive values[31] for their long-term integrated resource planning that are derived from the IWG's social cost of carbon.

Colorado

As of 2017, the Colorado Public Utilities Commission requires Xcel Energy to account for the social cost of carbon in its Electric Resource Plan using the IWG central (3%) scenario.[32]

Illinois

In 2016, the Illinois legislature passed an energy bill, which among other things, created a zero emission credits (ZEC) program. The ZEC program rewards nuclear generators one ZEC for each MWh of electricity generated. The prices of the zero emissions credits are based on the IWG central (3%) scenario. [33]

Maine

In determining the value of distributed solar projects in a study conducted in 2015, the Maine Public Utility Commission used the IWG central (3%) scenario values as one component of determining the societal benefits, particularly the environmental benefits, of avoided GHG emissions.[34]

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[29] Institute for Policy Integrity. (n.d.). California Air Resources Board Uses the SCC in Updated Climate Change Plan. Retrieved from https://costofcarbon.org/states/entry/california-air-resources-board-uses-the-scc-in-updated-climate-change-plan

[30] California Public Utilities Commission. (2019). Decision Adopting Cost-effectiveness Analysis Framework Policies for All Distributed Energy Resources. Retrieved from https://costofcarbon.org/states/entry/california-puc-uses-scc-to-help-determine-value-of-ders

[31] California Public Utilities Commission. (2019). Decision 18-02-018: Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements. (Feb. 8, 2018) https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M209/K771/209771632.PDF

[32] Institute for Policy Integrity. (n.d.). Colorado PUC Requires Utility to Use SCC in Electric Resource Plan. Retrieved from https://costofcarbon.org/states/entry/colorado-puc-requires-utility-to-use-scc-in-electric-resource-plan

[33] State Power Project. (n.d.). Illinois: Commerce Clause and Supremacy Clause Challenge to Nuclear Zero Emission Credit Program. Retrieved from https://statepowerproject.org/illinois/

[34] Maine Public Utility Commission. (2015). Maine Distributed Solar Valuation Study. Retrieved from https://www.maine.gov/mpuc/electricity/elect_generation/documents/MainePUCVOS-ExecutiveSummary.pdf

Maryland

The Maryland Public Service Commission released a report in 2018 analyzing the costs and benefits of behind the meter and utility scale solar in Maryland. This report utilized the IWG central (3%) scenario as a component of the total value of solar.[35]

Minnesota

The Minnesota Public Utilities Commission requires that utilities use the SCC when planning for new projects. The Commission requires that utilities use a range of values, which is based on the IWG 2.5%, 3%, and 5% scenarios. The SCC is also used by the Commission to evaluate and select resource options in all proceedings.[36]

Nevada

In 2018, the Nevada Public Utilities Commission finalized rulemaking that requires utilities to consider the SCC in their integrated resource plans. The rulemaking references the IWG SCC as the best available science and economics and recommends its use by utilities. However, utilities can use other values for the SCC if they can justify why it is the best available science and economics.[37]

New York

In 2016, the New York State Public Service Commission adopted the Clean Energy Standard, which created Zero Emissions Credits (ZECs). The price of these credits is based on the IWG central (3%) scenario.[38] The SCC's use in determining the value of ZECs was later upheld by New York's Supreme Court.[39]

Virginia

As the result of a law that was passed in 2020, the Virginia State Corporation Commission must use the SCC when assessing the impact of new fossil fuel power plants. The value for the SCC is yet to be determined but is directed to be based on the best available science and economics including the IWG value.[40]

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[35] Maryland Public Service Commission. (2018). Benefits and Costs of Utility Scale and Behind the Meter Solar Resources in Maryland. Retrieved from https://cleantechnica.com/files/2018/11/MDVoSReportFinal11-2-2018.pdf

[36] Institute for Policy Integrity. (n.d.). Minnesota PUC Requires SCC Use for Utilities. Retrieved from https://costofcarbon.org/states/entry/minnesota-puc-requires-scc-use-for-utilities

[37] Public Utilities Commission of Nevada. (2018). Investigation and rulemaking to implement Senate Bill 65. Docket No. 17-07020. Retrieved from http://pucweb1.state.nv.us/PDF/AxImages/DOCKETS_2015_THRU_PRESENT/2017-7/32153.pdf

[38] Patricio Silva. (2016). New York Clean Energy Standard Update. ISO New England. Retrieved from https://www.iso-ne.com/static-assets/documents/2016/08/a3_update_on_new_york_environmental_issues.pdf

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[40] Institute for Policy Integrity. (n.d.). Virginia Passes Bill to Require Use of Social Cost of Carbon. Retrieved from https://costofcarbon.org/states/entry/virginia-passes-bill-to-require-use-of-social-cost-of-carbon

Washington

In 2018, the Washington State Utilities and Transportation Commission recommended that utilities use a more robust version of the social cost of carbon in their integrated resource plans. In April 2019, the Commission required the use of the IWG 2.5% scenario.[41]

Co-Pollutants: Health Impacts

The current valuation of SO_2 and NO_x in Focus' programs is based solely on their regulation by the Clean Air Act and this program's focus on abating acid rain from electric power plants. As mentioned above, this program has been largely successful in this goal. However, these pollutants, along with $PM_{2.5}$, are still emitted by electricity generators and have the potential to cause deleterious health outcomes such as cardiovascular and respiratory disease which can lead to hospitalizations, lost workdays and death.

The Environmental Protection Agency develops several tools for the valuation (or monetization) of changes in the emission of these pollutants. The Co-Benefits Risk Assessment Tool (COBRA)[42] is the most common and easiest to use of these tools. It calculates the monetized benefits associated with changes in these pollutants by using changes in emissions to quantify changes in air quality and subsequent health outcomes. The tool uses up-to-date studies on pollution-caused illness and its monetary impacts. COBRA has been used in several state-level studies associated with changes to energy use and demand across the United States, including energy efficiency programs.[43] COBRA is also capable of incorporating outputs from AVERT, allowing for easy integration with the current procedure for calculating benefits from emissions mitigation.

COBRA values the societal costs of hospitalizations, lost workdays, asthma events and death (mortality) among other metrics. Mortality is generally the largest driver of COBRA's valuation of emissions reductions. This is a result of the high value of a statistical life (VSL). The VSL does not reflect a direct cost to society (although premature death does certainly incur a variety of social costs). Instead, because of inherent challenges in valuing such social costs, the VSL is based on society's average willingness to pay to avoid death. This makes VSL a suitable tool in policy decision-making as it provides a socially determined metric for evaluating the effectiveness of a policy.

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[41] Institute for Policy Integrity. (n.d.). Washington State UTC Directs Utilities to Use "Robust" SCC Estimate. Retrieved from https://costofcarbon.org/states/entry/washington-state-utc-directs-utilities-to-use-robust-scc-estimate

[42] EPA COBRA (2020) https://www.epa.gov/stat elocalenergy/co-benefits-risk-assessment-cobra-health-impacts-screening-and-mapping-tool#2

[43] Cobra Example Studies: https://www.epa.gov/sites/production/files/2019-05/documents/cobra_publications_05-21-19_sxf.pdf

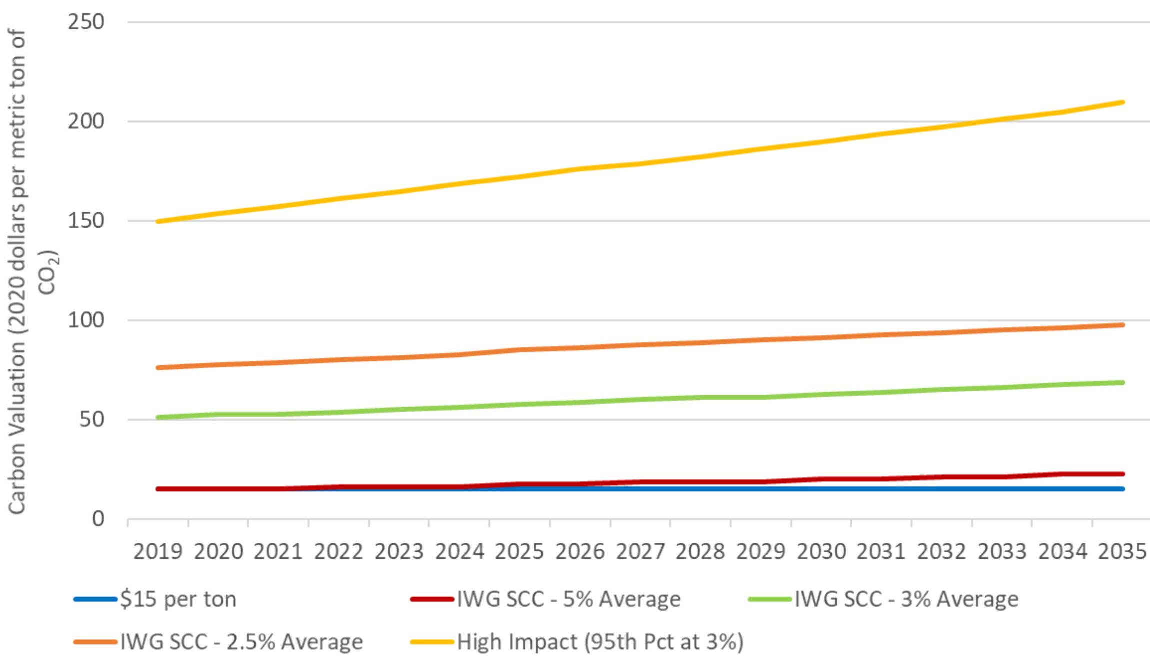
Impact of Carbon Pricing on the Value of Energy Efficiency

Approach

The 781 GWh of efficiency savings attributable to 2019 actions by the Focus program were simulated in AVERT. This resulted a reduction of 704,730 tons of CO_2. It was assumed that these emissions savings are maintained over 15 years.

The IWG's Central (3% discount rate) and 95th Percentile (3% discount rate) for the Social Cost of Carbon (Figure 1) were used as points of comparison relative to the $15 per ton market-based valuation. The Central scenario can be considered the most widely accepted valuation for the Social Cost of Carbon (see *States Using the Social Cost of Carbon* above). The 95th Percentile Scenario aims to capture the costs associated with the worst possible outcomes of climate change.

Figure 1. Carbon Valuation Scenarios



Results

In the social cost of carbon scenarios, the price of carbon is dynamic and increases over time. Implementing the social cost of carbon – as opposed to the market price approach which is currently fixed at $15 per ton CO_2 – more accurately reflects the benefits gained from mitigating carbon and may be more appropriate in a state with no carbon market. Usage of the values of the SCC established by the IWG greatly increase the valuation of emissions benefits, but the magnitude of the increase is highly sensitive to the value SCC scenario chosen (e.g., the discount rate or high impact scenario) Table 4.

Table 4: Emissions Benefits for Various Valuations, 2019 - 2034

Emissions Benefits at Market Price ($15/ton)	$182 M
Emissions Benefits SCC 5% Average	$225 M
Emissions Benefits SCC 3% Average	$733 M
Emissions Benefits SCC 2.5% Average	$1,072 M
Emissions Benefits SCC 95 Pct at 3%, High Impact	$2,302 M

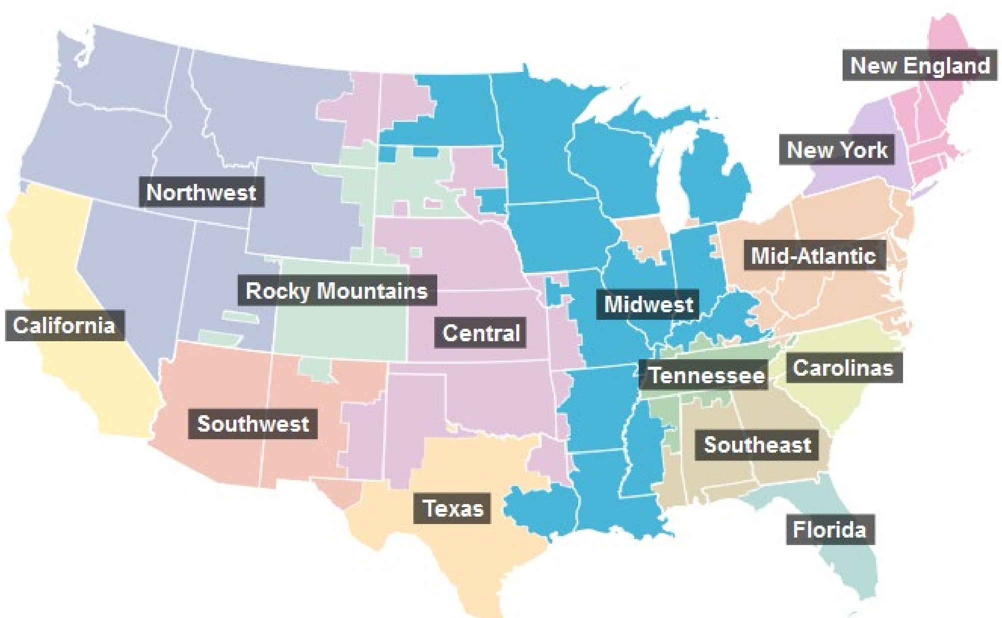
Monetized Health Impacts

Approach

A health benefits analysis was conducted using EPA's Co-Benefits Risk Assessment (COBRA) Tool to determine the health benefits associated with the avoided emissions analysis conducted in AVERT's main module. COBRA calculates the benefits of mitigated emissions in terms of mortality, work loss days, hospital costs, and many more metrics on a national level. COBRA uses an atmospheric mixing model that simulates the flows of pollutants from one region to another. For the analysis, Cadmus looked at Wisconsin's health benefits as well as those across the country.

Input data for COBRA is automatically generated from AVERT at the county level based on changes to emissions simulated across the across the MISO regional grid (represented as the Midwest in Figure 2). Although this approach relies on similar tools and data as the BPK approach – used for in the 2019 Focus on Energy Annual Report – it provides a more granular estimation of the benefits across different health outcomes, and if desired a more geographic resolution of the benefits.

Figure 2. AVERT Regions



Results

The results from a single year COBRA analysis are summarized in Table 5. These results include impacts accrued by Wisconsin, as well as those realized by the rest of the country.

The health benefits created by energy efficiency actions in Wisconsin are also experienced outside of Wisconsin because of avoided generation in other states within the MISO region that creates benefits in those states and downwind. The majority of the total health benefits come from avoided deaths due to the relatively high value of a statistical life (currently valued at $9.5 million in COBRA).

Table 5: Summary of Benefits from Emissions Savings in One Year

Current Valuation of $ Benefits from Avoided SO_2 and NOx Emissions		
$4,705		
COBRA Valuation of $ Benefits from Avoided SO_2 and NOx Emissions		
	Wisconsin	**United States**
Total Health Benefits (low est.)	$0.7 M	$22.2 M
Total Health Benefits (high est.)	$1.6 M	$50.1 M
Mortality (low est.)	0.07	2.04
Mortality (high est.)	0.15	4.64
Work Loss Days	7.7	231.7

Health benefits ($0.7 Million/ $22.2 million) greatly exceed the current valuation approach using the 2015 market prices of SO_2 and NO_x ($4,705). If extrapolated over 15 years, the contribution of the health benefits to the MTRC would range from $330 to $750 million.

Again, it is important to note the difference in these two approaches and their role in valuing the impact of emissions. The SO_2 and NO_X markets were intended to mitigate the generation of acid rain caused by these pollutants. In the past, allowance prices for these pollutants have been much higher than they are today: SO_2 exceeded $1,200 per ton in 2008 (600 times its valuation today). The Clean Air Act's Acid Rain cap and trade program has been influential in reducing SO_2 and NO_x to the point where market prices are effectively insignificant. Given the prevalence of SO_2 and NO_x mitigation technologies in existing power plants and the growing use of renewables in power generation, it is likely that these market-based prices will remain negligible indefinitely. Some researchers have noted that these markets have reached the end of their effective life.[44]

[44] Schamalensee & Stavins. MIT Center for Energy and Environmental Policy Research. *The SO2 Allowance Trading System: The Ironic History of a Grand Policy Experiment* (2013) http://ceepr.mit.edu/files/papers/Reprint_248_WC.pdf

Sensitivity Analysis: CO_2 Impacts on MTRC Test

In reassessing the valuation of emissions savings and their health benefits, associated effects on the cost-effectiveness of energy efficiency measures must also be considered. Within its programs and potential assessments, Focus utilizes the Modified Total Resource Cost Test (mTRC) to determine the cost-effectiveness of different energy efficiency measures. This entails developing a benefit-cost (B/C) ratio for the program and determining if the ratio meets the threshold for cost-effectiveness, which is typically set at 1.0 or greater. The inputs to this calculation are outlined in Table 6. The mTRC is relevant to emissions forecasting and carbon pricing, as avoided emissions benefits are part of the mTRC calculation. Based on the formulation, a higher cost of carbon increases the B/C for any given efficiency measure.

Table 6. Benefit Cost Ratio Calculation Components

Type	Component	Description
Cost	*Incremental Measure Costs*	Equipment and labor costs to purchase a measure and sustain savings over its estimated useful life
	Program Administration and Delivery Costs	Estimated as 20% of incremental costs, based on historic data
Benefit	*Avoided Energy Costs*	Include indirect energy savings, secondary benefits for measures that save energy on secondary fuels
	Avoided Emissions Benefits	Reflect the economic value of avoided emissions (CO_2, NO_x, SO_2)

In a previous evaluation, Cadmus conducted a cost/benefit analysis for Focus on Energy's CY2019 programs.[45] The analysis relied on the mTRC as the primary test to evaluate and compare cost-effectiveness across Focus programs. The results of this analysis are summarized in Table 7 below.

For illustrative purposes, we adjusted the mTRC to account for the average social cost of carbon over the 15-year timespan of \$60.63/ton CO_2, ranging from 2019 to 2034. The results of this exercise are summarized in the lower half of Table 7. Not included in this example are changes to valuation of other pollutants, or changes that stem from the inclusion of measures that would now be deemed to be cost effective. Still, with the application of the SCC alone, the mTRC increased by approximately 60%. This exercise shows the importance of leveraging the SCC to understand the direct benefits of reducing emissions.

[45] Cadmus, Apex Analytics, Nexant. *Focus on Energy Calendar Year 2019 Evaluation Report, Volume 1* (2020) https://www.focusonenergy.com/sites/default/files/Annual_Report-CY_2019_Volume_I.pdf

Table 7: Costs, Benefits, and Modified Total Resource Cost Test for CY2019

	Total	
Administrative Costs	$ 4.9 M	
Delivery Costs	$33.1 M	
Incremental Measure Costs	$197.5 M	
Total mTRC Costs	**$235.5 M**	
Electric Benefits	$340.6 M	
Natural Gas Benefits	$147.3 M	
	Current Valuation	**Valuation Using SCC**
Emissions Benefits	$118.8 M	$480.2 M
Total mTRC Benefits	$606.7 M	$968.1 M
mTRC Benefits Minus Costs	$371.2 M	$732.5 M
mTRC Benefits/Costs Ratio	2.58	4.11