INSTITUTE FOR ENERGY RESEARCH

# COMMENT ON OIL AND NATURAL GAS SECTOR: EMISSION STANDARDS FOR NEW AND MODIFIED SOURCES

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## INTRODUCTION

This rule uses the novel Social Cost of Methane (SCM) to justify on cost-benefit grounds an amendment of the new source performance standards (NSPS) for the oil and natural gas source category. Specifically, the rule sets standards for both methane and volatile organic compounds (VOC) for certain equipment, processes, and activities across this source category. The problem, however, is that the use of the Social Cost of Carbon (SCC) and (even more so) the SCM (which is derived from the SCC) as inputs into federal regulatory actions is totally inappropriate. The Administration is treating the SCC and SCM as if they were scientifically valid, objective facts of the external world, akin to the charge on an electron or the boiling point of water at sea level. However, the SCC and SCM are no such thing, at least in our present state of understanding. Rather, the SCC and SCM are arbitrary outputs from very speculative computer models. They can be adjusted up or down as the analyst wishes, simply by changing a few key parameter choices. For example, simply by adjusting the parameter and modeling choices in plausible ways, a knowledgeable economist can generate SCC estimates that are very high, very low, or even *negative*—meaning that carbon dioxide emissions actually shower "positive externalities" on humans beyond the direct benefits to the emitters, and therefore should (according to the Administration's logic) receive federal subsidies.

The ultimate reason federal agencies use the SCC and now SCM is in order to comply with Executive Order 12866, which requires agencies to "assess both the costs and the benefits of the intended regulation."[1] Yet

[*] The Institute for Energy Research (IER) is a not-for-profit organization that conducts intensive research and analysis on the functions, operations, and government regulation of

[1] Executive Order 12866, Sept. 30, 1993, http://www.archives.gov/federal-

Executive Order 12866 *also* requires costs and benefits to be quantified "to the fullest extent that these can be usefully estimated."

This comment explains that the costs and benefits of proposed federal regulations *cannot* be "usefully estimated" by the inclusion of the SCC, let alone the SCM. Because the SCC and SCM as implemented by federal agencies are completely arbitrary and without theoretical or experimental support, not to mention a lack of data supporting the Working Group's calculations, this calculation of the SCC and SCM also violate the Information Quality Act of 2001 (IQA). According to OMB's own guidelines, the IQA requires information disseminated by agencies to be "accurate, reliable, and unbiased" and "presented in an accurate, clear, complete and unbiased manner."[2]

Our objections can be classified as both theoretical and practical. First, in terms of the pure theory, the SCC and SCM are inappropriate for use in federal rule-making because of the malleability of the underlying concept itself; to repeat, neither the SCC nor the SCM is an objective feature of the world "out there" but is instead reliant on subjective modeling decisions made by the analyst.

Second, in terms of the practical implementation, use of the SCC (and now SCM) has lacked transparency and—more serious—has violated long-standing OMB guidelines. Even if the SCC and SCM were objective scientific parameters—which they are not—these procedural abuses in the *use* of the SCC and SCM would alone render them dubious elements for continued use in the regulatory process.

This comment deals with each category of objections—both theoretical and procedural—in sections I and II, respectively. In section III we explain why the Social Cost of Methane (SCM) is even more dubious than the Social Cost of Carbon (SCC) in federal regulatory analysis. We then conclude that in light of these serious problems, the SCC and SCM should no longer be used as inputs in federal regulatory analysis and rule-making.

As a final prefatory note, the reader should be aware that "the social cost of carbon" (SCC) is a bit of a misnomer in a discussion involving methane, which itself contains an atom of carbon (as well as four hydrogen atoms). Some authors therefore refer more accurately to the SC-CO2 versus

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register/executive-orders/pdf/12866.pdf.

[2] Office of Management and Budget Information Quality Guidelines, Oct. 1, 2002, at 8.

the SC-CH4. However, because the label "SCC" is now so widespread, in this Comment we will retain it exclusively for reference to carbon *dioxide* and use "SCM" to refer to the social cost of methane.

## *I. THEORETICAL PROBLEMS WITH USING THE SOCIAL COST OF CARBON AND SOCIAL COST OF METHANE IN FEDERAL REGULATORY ANALYSIS AND RULE-MAKING*

Even on a purely theoretical level, the SCC and SCM are dubious concepts that are inappropriate for use in federal regulatory analysis and rule-making.

### A. Economic Theory Background: Market Failure, Negative Externalities, and Social Costs

In standard economic analysis, the decentralized market economy contains tendencies for equilibrium outcomes to correspond to socially "optimal" arrangements. Market prices, and the corresponding profits and losses that they imply, provide incentives for entrepreneurs to efficiently allocate resources across sectors. As Adam Smith's famous metaphor of the "Invisible Hand" illustrated, the self-interest of market participants leads them to promote (perhaps unwittingly) the general welfare.

However, the typical textbook economic analysis also categorizes examples of "market failure," where market forces do *not* guarantee socially desirable outcomes. One such example is the case of a "negative externality," in which a firm's market activities impose harms on others, even though the firm is not penalized for such harms.

Following in the framework established by A.C. Pigou,[3] economists often distinguish between the *private costs* of the firm's actions versus the *social* costs. The owners of the firm want to maximize profits, and thus will adjust its activities in accordance with the private benefits and private costs of its actions. However, in the case of a negative externality, the firm will *overproduce*, because the owners are only considering the out-of-pocket expenses (such as wages) but are ignoring all of the social costs.

[3] Pigou, A.C. (1920) *The Economics of Welfare*. London: Macmillan.

**B. Anthropogenic Global Warming and the SCC/SCM**

The 2007 Nobel Peace Prize awarded to the Intergovernmental Panel on Climate Change (IPCC) and Al Gore underscored the public's growing awareness and concern over anthropogenic (manmade) global warming. Many climatologists and other relevant scientists claim that unchecked emissions of greenhouse gases (GHGs) from human activity will lead to significantly rising temperatures, which in turn will spell potentially catastrophic hardship for future generations.[4] If this is true, then the economist will recognize what former Chief Economist of the World Bank Nicholas Stern described, in his famous report to the British government, as "the greatest example of market failure we have ever seen."[5]

Within this context, we can understand that the "social cost of carbon" (SCC) is simply the particular label given to the social costs imposed on third parties from the negative externality of carbon dioxide emissions because of anthropogenic global warming (or climate change more generally). The "social cost of methane" (SCM) has a similar definition. For much of the rest of our Comment, we will focus on the more popular SCC but all of our points apply with equal (or greater) force to the SCM.

For a formal definition, we can turn to the White House Interagency Working Group. Its May 2013 report defines the SCC as:

> an estimate of the monetized damages associated with an incremental increase in carbon emissions in a given year. It is intended to include (but is not limited to) changes in net agricultural productivity, human health, property damages from increased flood risk, and the value of ecosystem services due to climate change.[6]

The quantitative estimates of the SCC are extremely significant. The Working Group document itself states that the purpose of the SCC estimates "is to allow agencies to incorporate the social benefits of reducing carbon

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[4] IPCC. (2007) *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, UK and New York: Cambridge University Press).

[5] Stern, Nicholas. (2007) *The Economics of Climate Change: The Stern Review*. Cambridge, UK: Cambridge University Press, online at: http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/sternreview_index.cfm, page 1.

[6] Working Group May 2013, page 2.

dioxide ($CO_2$) emissions into cost-benefit analyses of regulatory actions that impact cumulative global emissions." Some obvious examples of the application of the SCC estimates are fuel economy standards, EPA greenhouse gas regulations of power plants, efficiency standards for household appliances, and programs to subsidize so-called "alternative" energy sources and transportation technologies. More recently rules that have a significant impact on methane emissions have begun citing the SCM.

### C. Computer-Simulated Damages

The Interagency Working Group chose three computer models from the economics of climate change literature in order to estimate the SCC. Specifically, they chose the PAGE, FUND, and DICE models. The specific label for such simulations is "Integrated Assessment Models" or IAMs, because they integrate computer models of the entire global economy and climate system, which is necessary in order to assess the marginal damages caused by the emission of an additional ton of carbon dioxide today. The Working Group ran thousands of simulations through the year 2300, and then analyzed the results in order to report its estimates of the SCC (based on various parameters) through time.

Note that these computer models are also relevant for discussion of the SCM, because the pioneering work in this field—specifically, Marten and Newbold (2011)—uses (components of) the DICE model coupled with the MAGICC model of GHGs in order to provide early estimates of the SCM.[7] Their further work with other collaborators, as produced in Marten et al. (2014), uses the other IAMs from the Working Group in order to emulate its procedures when providing the latest estimate of the social cost of methane.[8] Specifically, Marten et al. (2014) uses the PAGE, FUND, and DICE models, as well as the same socioeconomic and emissions scenarios, and climate sensitivity assumptions as the Working Group on the Social Cost of Carbon. Thus all of the problems associated with the Working Group's procedures for estimating the SCC now apply to estimates of the

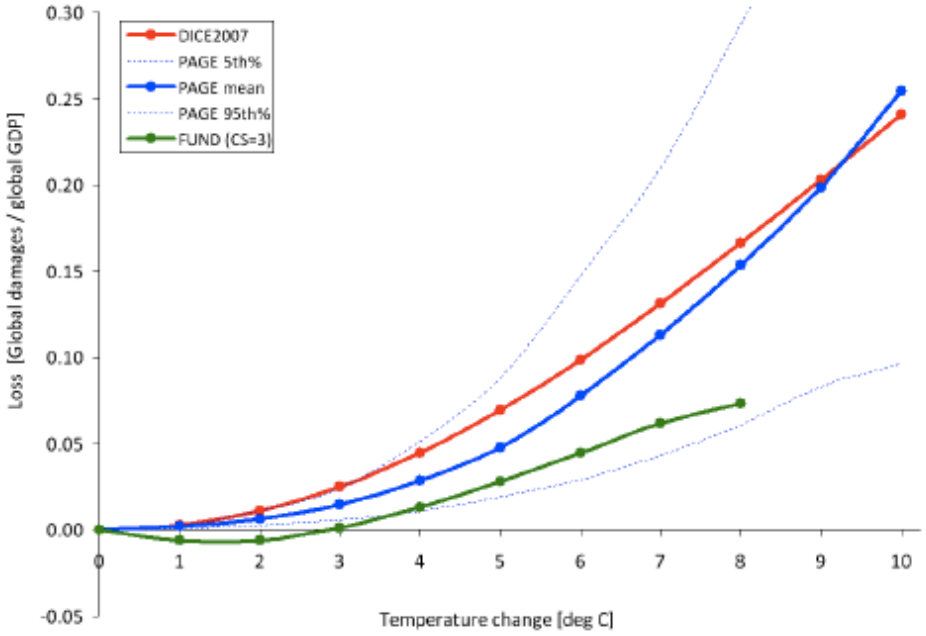
[7] Marten, Alex L. and Stephen C. Newbold. "Estimating the Social Cost of Non-CO2 Emissions: Methane and Nitrous Oxide," National Center for Environmental Economics, February 2, 2011, Paper #2011-01. Available at: http://yosemite.epa.gov/ee/epa/eed.nsf/WPNumber/2011-01?OpenDocument.

[8] Marten, A.L., E.A. Kopits, C.W. Griffiths, S.C. Newbold & A. Wolverton (2014, online publication; 2015, print publication). Incremental CH4 and N2O mitigation benefits consistent with the U.S. Government's SC-CO2 estimates, Climate Policy, DOI: 10.1080/14693062.2014.912981.

SCM.

One of the crucial steps in the computer models is to posit a "damage function" that relates a stipulated increase in global temperature with a corresponding impact on global GDP. The following diagram from the February 2010 Working Group report shows how each of the models handles global warming of varying intensity:

**Annual Consumption Loss as a Fraction of Global GDP in 2100 Due to an Increase in Annual Global Temperature in the DICE, FUND, and PAGE models**




Source: Figure 1A (page 9) of February 2010 Working Group TSD

As the diagram above indicates, the three models selected for the Working Group analysis yield different results. In particular, the FUND model shows much lower impacts from global warming, especially at higher temperatures. Indeed, the green line's initial (and slight) dip into negative territory shows that the FUND model assumes global warming will shower the world with *positive externalities* up through about 3 degrees Celsius. The fact that the FUND model yields (moderate) net *benefits* from global warming in the initial stages will be very significant when we consider the role of discount rates in the analysis.

**D. Discount Rates**

When estimating the social cost of carbon (SCC) and social cost of methane (SCM), the choice of discount rate is crucial, because the computer simulations of large climate change damages occur decades and even centuries in the future, and also because some models show net *benefits* from global warming through mid-century.

Indeed, the Working Group generates its estimates of the SCC by equally weighting the estimates provided by the three computer models discussed above (namely the PAGE, FUND, and DICE models). As the diagram in the previous section illustrated, in the early decades (while the earth has only warmed one to two degrees Celsius) the cumulative impact of global warming is either close to zero or even positive.

Therefore, the rate at which we discount future damages into present monetary terms will have an enormous impact on the estimated SCC. For example, in the May 2013 Working Group update, the SCC in the year 2010 was reported as $11/ton at a 5% discount rate, but $52/ton at a 2.5% discount rate. In other words, cutting the discount rate in half caused the reported SCC to more than quadruple. Policymakers and citizens should realize just how influential the choice of discount rate is, when it comes to the SCC.

Regarding the SCM, we see a similar pattern. For example, the currently-authoritative work of Marten et al. (2014) has the following estimates:

**TABLE: Social Costs Methane for Select Years (2012$/metric ton)**

| Discount Rate: | 5.0% | 3.0% | 2.5% |
|---|---|---|---|
| Year | | | |
| 2015 | $490 | $1,100 | $1,500 |
| 2020 | $580 | $1,300 | $1,700 |
| 2050 | $1,400 | $2,700 | $3,300 |

SOURCE: Marten et al. (2014)

As the above table demonstrates, the discount rate has an enormous

impact on the estimated "social costs" of three greenhouse gases. For example, depending on the year, cutting the discount rate in half from 5% to 2.5% can *triple* the estimated social cost of methane (SCM). The effect is not as pronounced as with carbon dioxide (because methane does not take as long to dissipate from the atmosphere), but nonetheless much of the impact (in the computer model) from an additional ton of methane emissions refers to simulated economic damages far out in the future, which must then be discounted back to the present for a cost assessment.

The problem is that the choice of discount rate *is not something that can be settled objectively* through technical analysis. If policymakers were going to use market rates of interest, there might be some hope of objectivity. There would still be significant "wiggle room" by selecting the time periods and particular interest rates to use in the computation, but at least market rates are externally generated and, in principle, could be measured objectively.

However, the trend in both academia and in policymaking circles is to use discount rates that are influenced by philosophical and ethical considerations, *not* based solely on observed market returns.[9] Presumably the proponents of one discount rate versus another may have strong arguments on their side, but the critical point is that *these "ethical" discount rates are subjective and in an important sense, arbitrary*.

There is no "objective" indicator of how many dollars of climate change damage in the year 2300 would need to be averted, in order to justify $100 of forfeited economic growth today because of regulations restricting carbon dioxide emissions. Therefore, using the SCC and SCM as part of regulatory cost/benefit analyses gives great leeway to the analyst, who can alter the benefits and costs (as expressed in present value terms) just by tweaking the discount rate. Because the discount rate is arbitrary, there is no "right" or "wrong" one to use.

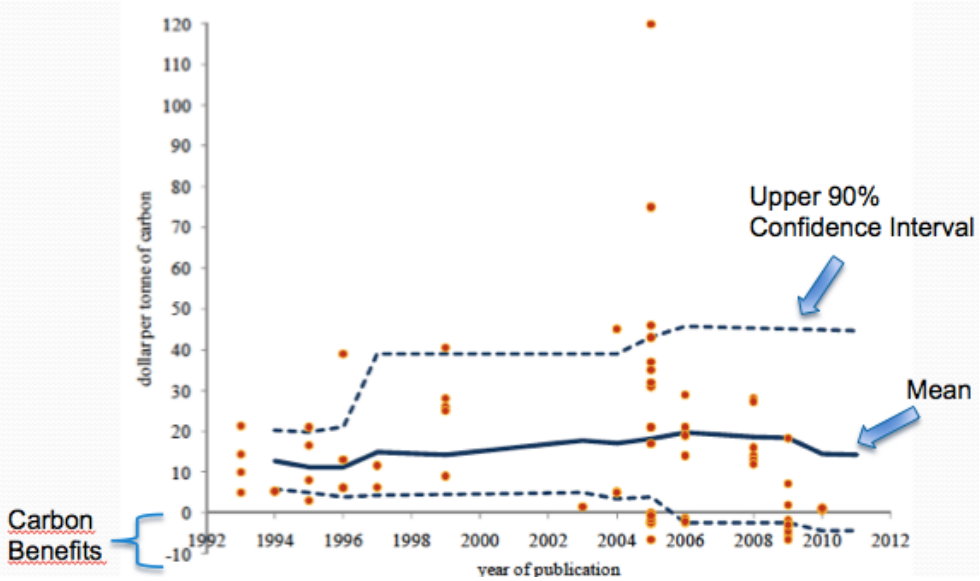
## E. The Estimates of the SCC in the Literature Are Quite Dispersed

To illustrate just how tenuous is the scholarly understanding of the

[9] A good example of the current academic thinking on discount rates over centuries is Arrow, Kenneth et al. (2012) "How Should Benefits and Costs Be Discounted in an Intergenerational Context?" *Resources for the Future* Discussion Paper 12-53, December 2012, available at: http://www.rff.org/RFF/documents/RFF-DP-12-53.pdf.

SCC—and to see why it is *not* a "fact of the world" in the same way that the boiling point of water is a objective and measurable concept—consider the following diagram taken from a survey article written by a world expert on the SCC literature (and creator of the FUND model):

**Survey of Published Estimates of SCC That Use 3% "Pure Time Preference" Rate for Discounting (dot indicates individual estimate).**




Source: Richard Tol. (2011) "The SCC," ESRI Working Paper #377.

The diagram above is quite striking. It show that the 90% confidence interval of the "true" SCC has widened over the last two decades. This is *not* what one would expect from a maturing science that is honing in on the "true" value. Even more shocking, from 2006 onward (at least until the time of Tol's survey, in 2011) the lower portion of the 90% confidence interval was in the *negative* region of the graph, meaning that one could not rule out (with 95% confidence[10]) the possibility that further carbon dioxide emissions at that point would *benefit* humanity at large (beyond the private benefits accruing to the emitters).

[10] Because the interval is 90% confidence, the bottom region (below the interval) corresponds to only 5% of the probability range, meaning that anything above that threshold contains the true SCC with 95% probability.

The final takeaway from the above diagram is the enormous dispersion in the point estimates of the SCC. In particular, the 2005 estimates show a range from about *negative* $5/ton up to an enormous $120/ton. (Note that the y-axis on the above chart refers to tons of carbon, not carbon dioxide. Thus these values would need to be multiplied by 3.67 to make them comparable to the SCC estimates that are typically used in U.S. policy discussions.) This chart *alone* should disqualify use of the SCC in federal regulatory analysis and rule-making.

## F. Computer-Generated SCC Values Are "Close to Useless"

To illustrate just how dubious are the Integrated Assessment Models (IAMs)—including the three particular IAMs chosen for the Working Group's calculations—we quote the abstract of a peer-reviewed article by MIT economist Robert Pindyck titled "Climate Change Policy: What Do the Models Tell Us?":[11]

> **Very little.** A plethora of integrated assessment models (IAMs) have been constructed and used to estimate the social cost of carbon (SCC) and evaluate alternative abatement policies. **These models have crucial flaws that make them close to useless as tools for policy analysis:** certain inputs (e.g. the discount rate) are arbitrary, but have huge effects on the SCC estimates the models produce; the models' descriptions of the impact of climate change are completely ad hoc, with no theoretical or empirical foundation; and the models can tell us nothing about the most important driver of the SCC, the possibility of a catastrophic climate outcome. **IAM-based analyses of climate policy create a perception of knowledge and precision, but that perception is illusory and misleading.** [Bold added.]

In the above quotation, Pindyck echoes and confirms our analysis given above. Later in the paper, Pindyck explains the arbitrary nature of the damage functions, which of course underlie the SCC estimates generated by the computer models:

[11] Robert Pindyck, (2013) "Climate Change Policy: What Do the Models Tell Us?" *Journal of Economic Literature*, Vol. 51, No. 3, September 2013, pp. 860-72.

> When assessing climate sensitivity, we at least have scientific results to rely on, and can argue coherently about the probability distribution that is most consistent with those results. When it comes to the damage function, however, we know almost nothing, so **developers of IAMs [Integrated Assessment Models] can do little more than make up functional forms and corresponding parameter values. And that is pretty much what they have done.** [Pindyck p. 11, bold added.]

Pindyck then goes on to say:

> Most IAMs (including the three that were used by the Interagency Working Group to estimate the SCC) relate the temperature increase T to GDP through a "loss function" L(T), with L(0) = 1 and L'(T ) < 0. For example, the Nordhaus (2008) DICE model uses [an] inverse-quadratic loss function…
>
> Weitzman (2009) suggested the exponential-quadratic loss function…which allows for greater losses when T is large. But remember that **neither of these loss functions is based on any economic (or other) theory. Nor are the loss functions that appear in other IAMs. They are just arbitrary functions, made up** to describe how GDP goes down when T goes up.
>
> **The loss functions in PAGE and FUND, the other two models used by the Interagency Working Group, are more complex but equally arbitrary...[T]here is no pretense that the equations are based on any theory.** [Pindyck p. 11, bold added.]

Furthermore, the previous administrator of the Office of Information Regulatory Affairs, Cass Sunstein, explains that "[m]any people believe that the TSD relies on unreliable integrated assessment models."[12]

[12] Cass R. Sunstein, *On Not Revisiting Official Discount Rates: Institutional Inertia and the Social Cost of Carbon*, Regulatory Policy Program Working Paper RPP-2013-21, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School, Harvard University, http://www.hks.harvard.edu/var/ezp_site/storage/fckeditor/file/RPP_2013_21_Sunstein.pdf

Note that although Pindyck reserved his harsh remarks for the SCC, his points apply with equal validity (indeed even more so) to the SCM. The estimates of the SCM are also derived from the same IAMs. Yet there has been even less work on the SCM than the SCC, so the results here are even more dubious.

### G. Theoretical Flaws With SCC and SCM: Summary

As the above analysis demonstrates, the "social cost of carbon" and "social cost of methane" are *not* objective, empirical facts of the world that could be measured by scientists. Instead, even at a conceptual level the SCC and SCM are driven by subjective and ultimately arbitrary choices made by the analyst, including the damage function to be used and the discount rate to apply to those future damages (or benefits).

Because of these tremendous ambiguities in the concept, it is not surprising that even scholarly estimates of the SCC are widely dispersed. As an expert in the field—who is *in favor* of a carbon tax, proving he is not motivated by ideological reasons—describes the situation, the SCC estimates generated through current computer models are "close to useless." His analysis applies with equal or greater force to the SCM, which enjoys even less scholarly work at the moment.

## *II. PROCEDURAL PROBLEMS WITH USING THE SOCIAL COST OF CARBON AND SOCIAL COST OF METHANE IN FEDERAL REGULATORY ANALYSIS AND RULE-MAKING*

In the first section of this comment, we showed the theoretical problems with using the SCC/SCM for regulatory purposes. In other words, we showed that the SCC/SCM is dependent on arbitrary assumptions and does not provide a coherent guide to cost/benefit analysis and rule-making.

Another problem with the Working Group's calculation of the SCC is a number of *process* problems where the Working Group consistently, and without theoretical justification, made arbitrary choices that increased the SCC. The same problems with the Working Group's estimate of the SCC plague the procedure by which the SCM is currently being estimated, so most of our analysis in this section applies to the SCM with equal validity.

## A. Ignoring Clear OMB Guidelines

The most obvious example of the dubious implementation of the SCC in federal cost/benefit analyses is the ignoring of clear OMB guidelines on how such analyses are to be quantified. Specifically, OMB requires that the costs and benefits of proposed policies be quantified at discount rates of 3% and 7% (with additional rates being optional), and OMB also requires that the costs and benefits be quantified at the domestic (not global) level. In practice, the Working Group and agencies that have relied on its estimates of the SCC have simply ignored these two clear OMB guidelines. We explain each issue in the below subsections.

### (1) Exclusion of 7% Discount Rate from Cost/Benefit Analysis

The Office of Management and Budget writes instructions for federal agencies in regulatory analysis. These are called "OMB Circulars." OMB Circular A-4[13] (relying in turn on Circular A-94) states that "a real discount rate of 7 percent should be used as a base-case for regulatory analysis," as this is the average before-tax rate of return to private capital investment. However, Circular A-4 acknowledges that in some cases, the displacement of consumption is more relevant to assess the impact of the policy under consideration, in which case a real discount rate of 3 percent should be used. Thus it states: "For regulatory analysis, you should provide estimates of net benefits using both 3 percent and 7 percent." Note that Circular A-4 does *not* say that a discount rate should be chosen based on the impacts, and which of the two rates is deemed more appropriate to the situation; instead it says quite clearly that estimates should be made *using both rates*. In addition, the agency is also free to use other discount rates, as long as both 3 and 7 percent are used.

In the economics of climate change academic literature, there are disputes over the proper discount rate, with some economists arguing that very low rates should be used in order to place future generations on a nearly equal footing with the present generation in policy analysis. Circular A-4 and the White House's primer on Circular A-4,[14] explicitly cited the work of Martin Weitzman, one of the leading scholars in the field on this

[13] OMB Circular A-4 available at: http://www.whitehouse.gov/omb/circulars_a004_a-4.

[14] "Regulatory Impact Analysis: A Primer," available at: http://www.whitehouse.gov/sites/default/files/omb/inforeg/regpol/circular-a-4_regulatory-impact-analysis-a-primer.pdf.

issue, who argues for a low discount rate in climate change analysis.[15] Nonetheless, after this discussion the 2011 primer still concluded:

> If the regulatory action will have important intergenerational benefits or costs, the agency might consider a sensitivity analysis using a lower but positive discount rate, ranging from 1 to 3 percent, **in addition to calculating net benefits using discount rates of 3 percent and 7 percent.** ["Regulatory Impact Analysis: A Primer," p. 12, bold added.]

Note the significance of the above quotation: The 2011 primer is fully aware that some policies have intergenerational effects spilling into the distant future, and that a discount rate lower than even 3 percent might be appropriate for such analyses. Yet it *still* said that the cost/benefit analysis should be reported at the 7 percent rate.

Yet even though the guidance from OMB was quite explicit on this point, both the initial White House Working Group report from 2010, as well as the recent update in May, did *not* report the SCC using a 7 percent discount rate; they only used discount rates of 2.5, 3, and 5 percent. Furthermore, the various responses on this point, offered by Administration officials, dodge and dissemble on this crucial issue.[16] For example, last July Howard Shelanski, the Administrator of the Office of Information and Regulatory Affairs of the Office of Management and Budget, testified on the omission of the SCC at 7 percent:

> We don't use 7 percent when what we are interested in understanding are effects on future consumption by individuals, by consumers, by citizens.
>
> …
>
> Now, that said, just two things. To be sure, 7 percent was not used in the range of numbers given for social cost of carbon ***because of the belief that it was inappropriate to discount to zero intergenerational effects***, effects that would occur one or two

[15] See: http://www.whitehouse.gov/sites/default/files/omb/inforeg/regpol/circular-a-4_regulatory-impact-analysis-a-primer.pdf.

[16] *See e.g.* testimony of Honorable Howard Shelanski, Administrator, Office of Information and Regulatory Affairs, Office of Management and Budget, before the Subcommittee on Energy policy, Health Care and Entitlements of the Committee on Oversight and Government Reform of the House of Representatives, July 18, 2013, http://oversight.house.gov/wp-content/uploads/2013/07/Shelanski-OIRA-Testimony-SCC-7-18.pdf. Mr. Shelanksi's full quote in in Appendix I below.

> generations in the future.
>
> …
>
> So while it is clearly the case that a separate 7 percent number was not listed, and we generally do, where appropriate, ask regulatory agencies to include that in rulemakings, for the purpose of this estimate, which was not a rulemaking, it was an input to rulemakings, the judgment was reached that 7 percent was not appropriate.

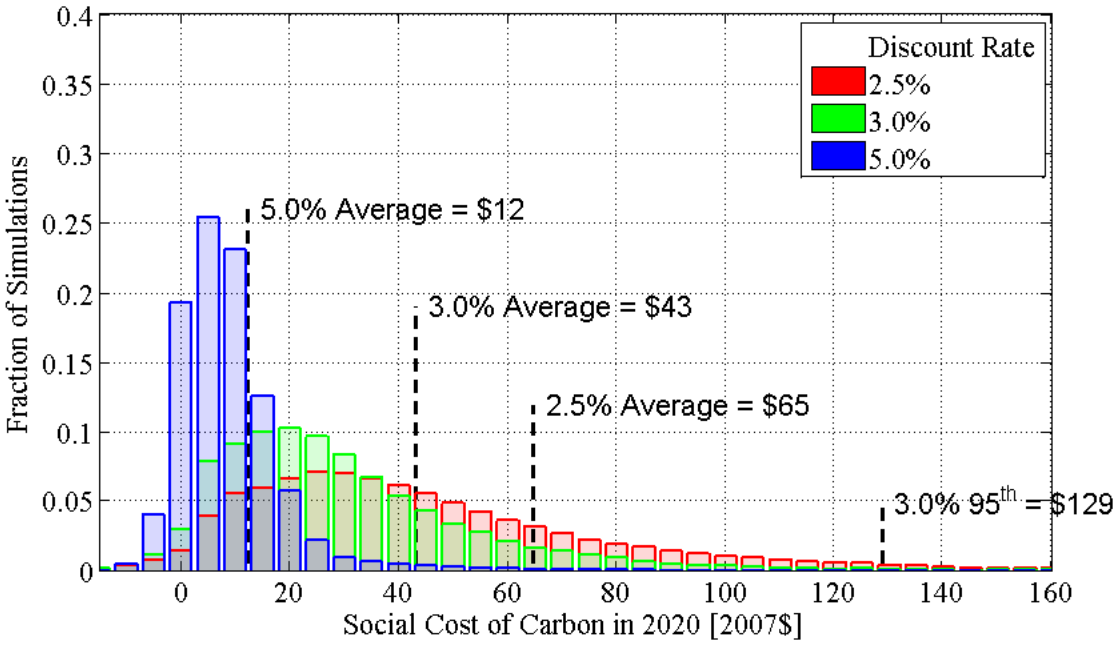
Mr. Shelanski's statement is contrary to the plain language of Circular A-4. As noted above, Circular A-4 explicitly contemplates intergenerational discounting and still requires reporting the SCC (or other benefits and costs) at 3 percent ***and*** 7 percent rates. Despite Mr. Shelanksi's statement, the failure of the Working Group to report the SCC at 7 percent is arbitrary and capricious.

No one is arguing that the Working Group or federal agencies should be prohibited from reporting results using a low discount rate. Rather, the public deserves to know what the results would be, were the cost/benefit calculations performed at a 7 percent discount rate, as OMB guidelines clearly require.

This omission of a 7 percent figure masks just how dependent the SCC is on discount rates. The figure below is taken from the May 2013 Working Group update. It shows the distribution of simulation outcomes in which the SCC fell into a certain range, with the color coding representing the discount rate used. (The reason there are ranges of SCC estimates, as opposed to a single number, is that each simulation is unique, because it draws a random value of the "equilibrium climate sensitivity" from the distribution put into the computer models by the programmers.)

In the diagram, we can see that moving from the 2.5 percent discount rate (red bars) to the 3.0 percent (green) and then to the 5.0 percent rate (blue), causes the range of possible values for the SCC to fall drastically. Indeed, when the Working Group used a discount rate of 5 percent, more than a fifth of the computer simulations reported a SCC that was near-zero or even *negative*, and that was for the year 2020. (See the three left-most blue bars in the figure.) Once the pattern exhibited in the figure below is understood, we can see the tremendous relevance of the Working Group's decision to omit the 7 percent discount rate from its list of SCC estimates. At the 7 percent rate, the estimated SCC for early years would be close to $0/ton, if not negative.

**SOCIAL COST OF CARBON AT VARIOUS DISCOUNT RATES.**




SOURCE: Figure 1 in May 2013 White House Working Group on Social Cost of Carbon.

Although the Working Group did not analyze its thousands of computer runs using a 7 percent discount rate, analysts at the Heritage Foundation have been able to conduct such an experiment using two of the models that the Working Group selected.[17] (Specifically, Heritage used William Nordhaus' DICE model and Richard Tol's FUND model.) The following table shows their findings for the DICE model:

[17] Dayaratna, Kevin and David Kreutzer. (2013) "Loaded DICE: An EPA Model Not Ready for the Big Game." Heritage Foundation Backgrounder #2860, November 21, 2013, available at: http://www.heritage.org/research/reports/2013/11/loaded-dice-an-epa-model-not-ready-for-the-big-game.

TABLE 1

**Average SCC Baseline, End Year 2300**

| Year | Discount Rate: 2.5% | Discount Rate: 3% | Discount Rate: 5% | Discount Rate: 7% |
|---|---|---|---|---|
| 2010 | $46.57 | $30.04 | $8.81 | $4.02 |
| 2015 | $52.35 | $34.32 | $10.61 | $5.03 |
| 2020 | $56.92 | $37.79 | $12.10 | $5.87 |
| 2025 | $61.48 | $41.26 | $13.60 | $6.70 |
| 2030 | $66.52 | $45.14 | $15.33 | $7.70 |
| 2035 | $71.57 | $49.03 | $17.06 | $8.70 |
| 2040 | $76.95 | $53.25 | $19.02 | $9.85 |
| 2045 | $82.34 | $57.48 | $20.97 | $11.00 |
| 2050 | $87.69 | $61.72 | $23.06 | $12.25 |

**Source:** Calculations based on Heritage Foundation Monte Carlo simulation results using the DICE model. B 2860 heritage.org

SOURCE: Table 1 from "Loaded DICE: An EPA Model Not Ready for the Big Game." Heritage Foundation.

The table above shows that moving from the Working Group's highest discount rate of 5 percent to the OMB guideline of 7 percent would essentially cut the SCC *in half* for the years through 2050. This outcome yet again underscores the tremendous sensitivity of SCC estimates to the discount rate used in the analysis.

The results were even more striking when the Heritage programmers re-ran the FUND model, plugging in a 7 percent discount rate.[18] They found that the SCC was *negative* at least through the year 2030:

Table 1

| | Average SCC: Baseline | | | |
|---|---|---|---|---|
| **Year** | **Discount Rate: 2.50%** | **Discount Rate: 3%** | **Discount Rate: 5%** | **Discount Rate: 7%** |
| **2010** | $29.69 | $16.98 | $1.87 | -$0.53 |
| **2020** | $32.90 | $19.33 | $2.54 | -$0.37 |
| **2030** | $36.16 | $21.78 | $3.31 | -$0.13 |
| **2040** | $39.53 | $24.36 | $4.21 | $0.19 |
| **2050** | $42.98 | $27.06 | $5.25 | $0.63 |

SOURCE: "Building on Quicksand: The Social Cost of Carbon." Heritage Foundation.

[18] Dayaratna, Kevin and David Kreutzer. (2014) "Building on Quicksand: The Social Cost of Carbon." Heritage Foundation, February 12, 2014, available at: http://blog.heritage.org/2014/02/12/building-quicksand-social-cost-carbon/.

The results in the table above are simply astounding. To reiterate, the FUND model was one of the three *chosen by the Obama Administration's Working Group* to represent the academic community's understanding of climate change economics. This was not a product of the Heritage Foundation; they simply took the model and plugged in the parameter (a 7 percent discount rate) that OMB said was a necessary component of any federal cost/benefit analysis.

Heritage researchers have performed a similar analysis with the DICE model regarding the social cost of methane, after obtaining code from the EPA on how the DICE model was updated. The following table shows their results:

TABLE: Social Cost of Methane Using DICE Model, at Various Discount Rates

| Year | 3% Discount Rate | 7% Discount Rate |
|---|---|---|
| 2015 | $792 | $212 |
| 2020 | $922 | $259 |
| 2030 | $1,218 | $369 |
| 2040 | $1,593 | $514 |
| 2050 | $2,051 | $700 |

SOURCE: Heritage Foundation[19]

As the table indicates, there is an enormous drop in the estimated social cost of methane when using (the OMB required) 7 percent discount rate. The omission of the 7 percent rate thus skews the perception among policymakers and the public about the severity of the alleged problem.

The purpose of this discussion is not to argue for or against a particular discount rate. Rather, it demonstrates how crucial this apparently innocuous modeling choice is. Further, in neglecting the clear guidance from OMB on reporting costs and benefits using a 7 percent discount rate, the Working Group on Social Cost of Carbon has misled policymakers, most of whom probably had no idea of the significance of this parameter. If the choice of discount rate means the difference between a SCC of $50/ton versus $1/ton,

[19] David Kreutzer and Kevin Dayaratna, "Another Useless EPA Regulation That'll Cost Americans More Money," Daily Signal, December 3, 2015, available at: http://dailysignal.com/2015/12/03/another-useless-epa-regulation-thatll-cost-americans-more-money/.

this is clearly a matter that should not be left to a handful of regulators to decide. It underscores our position that the "social cost of carbon" is not an objective empirical feature of the world, but is rather an arbitrary, malleable figure dependent on subjective modeling assumptions, and can be made large, small, or even negative depending on parameter choices.

**(2) Domestic versus Global Social Cost of Carbon**

Related to its decision regarding discount rates, the Working Group has also neglected clear OMB guidance to report costs and benefits from a *domestic* perspective. As the original 2010 Working Group report admits: "Under current OMB guidance contained in Circular A-4, analysis of economically significant proposed and final regulations from the domestic perspective is required, while analysis from the international perspective is optional" (p. 10). Nonetheless, the Working Group goes on to explain why it will instead use a global perspective in reporting its estimates of the SCC.

Were the Working Group to present its main findings from the domestic perspective, the impact would be striking. Using two different approaches, the Working Group in 2010 "determined that a range of values from 7 to 23 percent should be used to adjust the global SCC to calculate domestic effects. Reported domestic values should use this range" (p. 11).

When the May 2013 update came out, the headline media reports typically focused on the SCC figure for the year 2010 at a 3 percent discount rate, which was $33/ton; this value was often reported as "the" social cost of carbon. Yet this was a *global* estimate of the SCC. If instead the default reports were expressed from the *domestic* perspective, then the same 2010 figure at a 3 percent discount rate would only have been in the range of $2 to $8 per ton.

To see the significance of this decision by the Working Group, consider the following scenario: Suppose the EPA issues a new regulation that causes private industry to restrict carbon emissions, and that the economic costs (in terms of forfeited economic output in the U.S. because of the new regulation) work out to $25/ton. Using the Working Group's May 2013 headline SCC estimate of $33/ton, this regulation would apparently pass a cost/benefit test, because the $25 cost to American industry and consumers for every ton of restricted emissions would be counterbalanced by $33 in avoided future climate change damage. However, *Americans* would still on

net be hurt by the regulation, as they would only receive $2 to $8 of the stipulated benefits (i.e. avoiding the *domestic* social cost of carbon on each ton no longer emitted), while suffering the full $25 in compliance costs.

A related problem is that reporting the global cost and omitting the domestic cost ignores the well-known issues of "leakage." As the Resources for the Future explains, "If emissions regulation raises prices for domestic producers, the loss of competitive advantage would lead to the displacement of production and thereby emissions abroad."[20] The result of "leakage" could be so great that leakage rates could be "as high as 130%, in which case GHG [greenhouse gas] control policies in the industrialized countries actually lead to higher global emissions," according to a paper by Mustafa H. Babiker published in the Journal of International Economics in 2005.[21]

To understand why leakage rates could be very high, note that many of the regulations that use the SCC increase the cost of energy or the cost of using energy in the United States. This means a loss of competitive advantage for the United States and a displacement of production abroad. By naively relying on a global SCC, the Working Group is implicitly assuming that if a ton of carbon dioxide is not emitted in the United States, then there would be no displacement and trade effects. This assumption is clearly wrong and contrary to standard economics. Because leakage could be as high as 130 percent, U.S. federal regulations could be given credit (in the form of the reduced social cost of carbon) even though they spur an *increase* in carbon dioxide emissions.

## B. Lack of Transparency

According to Cass Sunstein, the man who convened the SCC Working Group, "Neither the 2010 TSD nor the 2013 update was subject to peer review in advance, though an interim version was subject to public comment in 2009."[22] This is a direct violation of the administration's stance on

[20] Carolyn Fischer & Alan K. Fox, *Comparing Policies to Combat Emissions Leakage: Border Tax Adjustments versus Rebates*, Resources for the Future, Feb. 2009, http://www.rff.org/documents/RFF-DP-09-02.pdf.

[21] Mustafa H. Babiker, *Climate change policy, market structure, and carbon leakage*, 65 Journal of International Economics 421 (Mar. 2005), http://www.sciencedirect.com/science/article/pii/S0022199604000467.

[22] Cass R. Sunstein, *On Not Revisiting Official Discount Rates: Institutional Inertia and the Social Cost of Carbon*, Regulatory Policy Program Working Paper RPP-2013-21, Mossavar-Rahmani Center for Business and Government, Harvard Kennedy School, Harvard University,

"Transparency and Open Government."[23]

President Obama's transparency and open government initiative rests on three pillars: (1) the government should be transparent, (2) the government should be participatory, and (3) the government should be collaborative. The estimation of the SCC, especially the 2013 update, is anything but transparent. Earlier we have explained the troubling omission of key data that would allow agencies to comply with OMB guidelines. Making matters worse, outside groups can't simply generate the 7 percent rates themselves, or even reproduce the Working Group's numbers. This is because one of the three computer models—specifically, the PAGE model—is not publicly available, as are the other two. (This is why the Heritage programming team was able to re-run the DICE and FUND results at a 7 percent discount rate.) Chris Hope, the developer of the PAGE model, has insisted on either co-authorship of papers relying on his model, or asked for a fee in the thousands of dollars to train outsiders on how to use it. This is certainly Hope's right in his capacity as the developer of a computer model, but it places an excessive burden on outside groups who want to check the robustness of the Working Group's results, or who simply want to make sure it committed no error in its calculations. By picking a computer model that is not publicly available, the Working Group effectively established a "paywall" around its work. This situation is antithetical to the administration's stance on "Transparency and Open Government."[24]

The announcement of the 2013 update to the SCC was especially non-transparent. Instead of announcing the update in a proposed rule, the administration made the announcement in a final rule, in the "Energy Conservation Program: Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens; Final Rule."[25]

The Office of Management and Budget has taken the appropriate action by establishing a comment period on the 2013 update, but because OMB has failed to provide key criteria, such as the SCC at 7 percent and domestic benefits, OMB has not been transparent and open with the public.

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http://www.hks.harvard.edu/var/ezp_site/storage/fckeditor/file/RPP_2013_21_Sunstein.pdf

[23] President Barack Obama, *Memorandum for the Heads of Executive Departments and Agencies on Transparency and Open Government*,

[24] President Barack Obama, *Memorandum for the Heads of Executive Departments and Agencies on Transparency and Open Government*,

[25] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Energy Conservation Program: Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens; Final Rule*, 78 Fed. Reg. 36316, June 17, 2013, http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-STD-0048-0027.

**C. Cherry-Picking of "Updates"**

Finally, it is troubling to note that the Working Group updated its estimates from 2010 to 2013 by heavily favoring those developments in the scientific literature that would *increase* the estimated SCC, while downplaying or ignoring those that would decrease it. This procedure results, of course, in an estimate of the SCC that is biased upward.

For example, as professional climate scientists Patrick Michaels and Paul Knappenberger explain in their own January 27, 2014 Comment submitted on behalf of the Cato Institute,[26] the May 2013 TSD ignored the growing evidence in the peer-reviewed research that the "equilibrium climate sensitivity" parameter is lower than what had been used in the 2010 estimate. The equilibrium climate sensitivity (ECS) relates a doubling of atmospheric $CO_2$ concentrations (relative to the preindustrial benchmark) to the long-term (including feedback effects) increase in average global temperature. The ECS is thus a critical input into the three computer models chosen by the Working Group to estimate the social cost of carbon. The higher the ECS, the more damaging a ton of carbon dioxide emissions will appear in these simulations, because it will cause a greater increase in global temperature and the assumed negative impacts following from this warming.

As Michaels and Knappenberger explain in their Comment, in the Working Group's original 2010 report, there was a lengthy discussion about the probability density function (pdf) plugged into the computer models, which would reflect the discussion in the IPCC's Fourth Assessment Report (published in 2007) on the distribution of possible values for the ECS.

Yet by the time the 2013 IPCC Report came out, there had been several papers calling into question the Fourth Assessment Report's discussion. Indeed, the IPCC itself in 2013 admitted that it was lowering the bottom limit of the "likely" range of the equilibrium climate sensitivity from 2°C

[26] Patrick Michaels and Paul Knappenberger, Comment for Cato Institute on "OMB's Office of Management and Budget's Request for Comments on the Technical Support Document entitled Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866," January 27, 2014, available at: http://object.cato.org/sites/cato.org/files/pubs/pdf/omb_scc_comments_michaels_knappenberger.pdf.

down to 1.5°C.

Even though the IPCC from 2007 to 2013 has reduced its (probabilistic) ranges of where the true ECS lies, the Working Group failed to revise the specific probability distribution function that it plugged into the three computer models. Had the Working Group revised the distribution downward, it naturally would have reduced estimates of the social cost of carbon across the board.

At the same time, the Working Group relied on several changes to their three chosen computer models that *increased* the SCC. To give one specific comparison, illustrating the rapid escalation of the estimate: The February 2010 Working Group report estimated the 2030 SCC, using a 3 percent discount rate, at $32.80. Yet just three years later, the May 2013 TSD estimated the 2030 SCC (again at 3 percent) at $52, a 59 percent increase.

In addition to all of the other theoretical and procedural problems, the Working Group's apparent cherry-picking of developments casts serious doubts upon use of the SCC for federal regulatory purposes.

## *III. PROBLEMS WITH EXTENDING THE "SOCIAL COST OF CARBON" APPROACH TO NON-$CO_2$ GREENHOUSE GASES*

In the first two sections of this comment, we documented theoretical and procedural problems with the use of "social cost" concepts when it comes to regulations affecting greenhouse gas emissions. In these sections, we made little distinction among the particular gases, because the problems applied to all of them.

However, as dubious as use of the social cost of carbon (SCC) has been, it is even less warranted for analysts to begin using the "social cost of methane" and/or the "social cost of nitrous oxide" in cost/benefit evaluations. In this section we will give three reasons.

### A. Paucity of Scholarly Research

The most obvious problem with using the "social cost" concept for other greenhouse gases is that almost all of the scholarly literature refers to carbon dioxide. In contrast, the pioneering work of Marten and Newbold

(now with collaborators) is providing the federal government's numerical estimates for the SCM. As Marten and Newbold themselves wrote in 2012, *"Many estimates of the social cost of CO2 emissions (SCCO2) can be found in the climate economics literature. However, to date far fewer estimates of the social costs of other greenhouse gases have been published, and many of those that are available are not directly comparable to current estimates of the SCCO2."*[27]

Furthermore, as Marten and Newbold point out, many of the existing estimates of other greenhouse gases use a shortcut approach, by taking the gas' "Global Warming Potential" (GWP) and multiplying it by the social cost of *carbon dioxide* to estimate the "social cost" of the gas in question. However, this approximation technique can lead to "large" (their term) errors in some applications, which is why in their earlier work Marten and Newbold used the MAGICC and DICE models to directly estimate the social cost of methane and nitrous oxide.

In short, our understanding of the social costs of methane and nitrous oxide is far less sophisticated than our understanding of the social costs of carbon dioxide. If the latter is inappropriate for federal rulemaking—which we believe to be the case—than the former is definitely not ready for such an application.

**B. Magnitude of the Numbers Can Drive Draconian Outcome**

Another problem with estimates of the social cost of other greenhouse gases is that their values are so large, relative to the estimates for carbon dioxide. Here let us reproduce a table from the 2011 version of Marten and Newbold's paper:

**TABLE: Social Costs of Carbon Dioxide, Methane, and Nitrous Oxide for the Year 2010 (2007$/ton)**

| Discount Rate: | 5.0% | 3.0% | 2.5% |
|---|---|---|---|
| Greenhouse Gas | | | |
| $CO_2$ | $9.40 | $33 | $52 |
| $CH_4$ | $370 | $810 | $1,100 |

[27] Marten and Newbold, "Estimating the Social Cost of Non-$CO_2$ GHG Emissions: Methane and Nitrous Oxide," February 2012 update.

| | | | |
|---|---|---|---|
| $N_2O$ | $3,500 | $13,000 | $20,000 |

SOURCE: Marten and Newbold (2011)

As the table indicates, using Integrated Assessment Models to generate estimates of various social costs of greenhouse gases leads to enormous numbers for methane and nitrous oxide. Therefore, to the extent that several steps in this procedure are dubious at best, these enormous social cost estimates are far more dangerous if used to justify a federal regulation. For example, even if a particular regulation carries enormous *economic* damages, it would still seem to pass muster so long as the analyst could plausibly argue that it would modestly reduce emissions of methane and nitrous oxide.

To be sure, if we had good reason to trust the accuracy (within a fairly narrow confidence interval) of these "social cost" estimates, then their relatively large dollar values would simply be an unfortunate fact of life that policymakers needed to incorporate into their decisions. Yet as we've shown throughout this Comment, these numbers are the result of a very particular (and arbitrary) set of assumptions fed into a computer simulation.

### C. Methane Has Shorter Atmospheric Life than Carbon Dioxide

Finally, another important difference between carbon dioxide and methane is that the latter has a shorter atmospheric life. Indeed as Marten and Newbold explain: *"the relatively short lifespan of $CH_4$ causes the temperature impact of a perturbation in 2010 to drop from its peak level by nearly an order of magnitude by 2100, while an analogous effect for a $CO_2$ perturbation does not occur before the end of the 300 year time horizon"* (p. 14).

Given the large uncertainties of our current understanding of methane, the fact that it is relatively short-lived is an additional reason to defer the use of "the social cost of methane" in federal regulatory analysis. To put the argument differently: If proponents of a carbon tax and other regulations want to stress the *longevity* of carbon dioxide in the atmosphere as reasons for immediate action—and they do—then by consistency they should admit that humans have more flexibility when it comes to methane. Although it is a more powerful greenhouse gas (as measured by its Global Warming Potential), changes in *future* policy regarding methane emissions will be more effective than analogous policies regarding carbon dioxide**.**

## CONCLUSION

In the above Comment we have documented numerous flaws, both theoretical and procedural, with the use of the SCC and SCM for regulatory purposes. On the theoretical side, the SCC and SCM are arbitrary, malleable concepts, which can be made quite large, small, or (at least for the SCC) even negative simply by adjusting parameters in plausible ways. The estimates of the SCC and SCM are generated by computer simulations that stretch centuries into the future, and which rely on "damage functions" that are ad hoc, based neither on economic theory nor empirical observation.

As if the theoretical problems with use of the SCC/SCM weren't serious enough, the *process* by which the administration's Working Group has issued its updated estimates has also been deeply flawed. Most obvious, the Working Group's results failed to heed two clear OMB guidelines—namely, inclusion of a 7 percent discount rate and domestic (not global) calculations. Moreover, the process has been far from transparent, with the important 2013 update being buried in a microwave rule. Even worse, one of the three computer models used to generate the official SCC estimates is not publicly available. Finally, when incorporating the developments in the scientific literature to update the SCC, the Working Group seemed to heavily favor those changes that would increase the number, while downplaying those that would decrease it.

In conclusion, on both theoretical and procedural grounds, there are several fatal flaws in the use of the SCC and SCM for regulatory purposes. The SCC and SCM are arbitrary metrics that *cannot* be "usefully estimated" as required by Executive Order 12866. The administration should withdraw this proposed amendment for oil and gas new source performance standards because the estimated benefits are wholly arbitrary.

## APPENDIX I

Testimony of OIRA Administrator Shelanski before the Subcommittee on Energy policy, Health Care and Entitlements of the Committee on Oversight and Government Reform of the House of Representatives:

Mr. SHELANSKI. Well, I will come back to that in a moment.

The social cost of carbon, we are trying to get a measure of what the cost to society will be over time of a ton of carbon emissions, and we could ask ourselves, well, what would the effect be on the rate of return to private investment, and typically 7 percent is used as a discount rate because it roughly approximates the rate of return to business investment; real estate, small business, corporate investment. We don't use 7 percent when what we are interested in understanding are effects on future consumption by individuals, by consumers, by citizens.

What we are trying to get at with the social cost of carbon is what carbon emissions will mean for the expenditures and the quality of life and the standard of living of every American going forward. So consistent with OMB guidance, we would want to use the 3 percent number, which OMB says what is appropriate for consumption effects rather than investment effects.

Now, that said, just two things. To be sure, 7 percent was not used in the range of numbers given for social cost of carbon because of the belief that it was inappropriate to discount to zero intergenerational effects, effects that would occur one or two generations in the future. And, indeed, that is consistent with the OMB guidance document A–4, which states very clearly that when intergenerational effects are at issue, lower discount rates, perhaps even lower than 3 percent, should be used.

And, in fact, there is an emerging body of thought amongst leading economists that for climate change the 3 percent number is too high and should be declining over time. There is a forthcoming article in Science magazine by a number of the leading economists of the past half century that make this argument.

What the working group did in 2010 and again in 2013 was to provide a range, 2.5, 3 percent, and 5 percent. Now, that 5 percent number is quite a

high number if you look at what it implies for future generations, and it also happens to be a blend of considering the consumption effects at 3 percent, or can be thought of, and the investment effects at 7 percent.

So while it is clearly the case that a separate 7 percent number was not listed, and we generally do, where appropriate, ask regulatory agencies to include that in rulemakings, for the purpose of this estimate, which was not a rulemaking, it was an input to rulemakings, the judgment was reached that 7 percent was not appropriate.