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Energy Conservation Program for
Consumer Products: Landmark Legal
Foundation; Petition for
Reconsideration
Via electronic delivery to LLFPetition2013PET0043@ee.doe.gov

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On behalf of the Competitive Enterprise Institute (CEI), a non-profit public policy group specializing in regulatory issues, I am pleased to submit this comment in support of the Landmark Legal Foundation's petition for reconsideration[1] of the Department of Energy's (DOE's) final rule establishing Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens.[2]

The comment letter develops the following points:

- Inserting the administration's revised social cost of carbon (SCC) estimates into the final microwave rule without subjecting them to public notice and comment during the rulemaking was improper.
- SCC analysis all-too-easily becomes a pretext or excuse for expanding regulatory activism and increasing regulatory stringency. Indeed, that is its primary purpose.
- The concept of carbon's social cost is highly subjective, deriving from assumptions about inherently speculative issues such as climate sensitivity, how global warming will affect weather patterns, how climate changes will affect economic activity, and how adaptive capabilities will develop as climate changes. Uncertainties multiply through each stage of the analysis, enabling modelers to get pretty much whatever results they want.
- Contrary to the popular "worse than we thought" mantra, the state of the climate is better than we've been told. Catastrophic scenarios are implausible; climate models

predict more warming than is actually observed; the science on the key variable – climate sensitivity – is increasingly unsettled; and it is dauntingly difficult to discern carbon's social cost in either the behavior of extreme weather or in properly-adjusted weather-related damages.

- Flouting OMB best practices, the Inter-Agency Working Group inflated its SCC estimates by excluding calculations based on a 7% discount rate, and by estimating only the global SCC rather than the domestic SCC.
- Even if the Inter-Agency Working Group got the science and technical economics exactly right, its SCC analysis would still be one-sided (partisan), because it ignores the *social cost of carbon mitigation*.
- For all the foregoing reasons, DOE should re-propose the rule and invite specific comment on the revised SCC estimates and, more broadly, the appropriateness of using SCC estimates in regulatory development and benefit assessment.

I. Process Concerns

DOE's benefit calculation in the final microwave rule uses the administration's "updated" May 2013 Technical Support Document (TSD) on the social cost of carbon (SCC).[3] That document came out roughly two months after DOE's Supplemental Notice of Proposed Rulemaking (SNOPR) on microwave conservation standards.[4] The SNOPR's benefit calculation used the SCC estimates from the administration's 2010 TSD.[5] The SCC estimates in the May 2013 TSD are about 60% higher than those in the 2010 TSD.[6]

DOE did not allow the public an opportunity to comment on the new and higher SCC estimates informing the final rule's benefit calculations.[7] This sets a troubling precedent. Higher SCC estimates can be used as justification, excuse, or pretext to impose more stringent regulations, not just for microwave ovens, but for all technologies that use energy derived from carbon-based (fossil) fuels, or for any economic activity that emits GHGs. As LLF cautions:

> With this unilateral change, agency cost benefit analyses will be drastically affected. Going forward, any federal rule limiting carbon dioxide emissions will appear considerably more valuable than under previous analyses. Such a change could ''have wide-ranging implications for everything from power plants to the Keystone XL pipeline.''[8]

Indeed, fossil-energy foes applaud the updated TSD for those very reasons. In a column on its blog, Climate Progress enthused:

> The first rule to use these updated numbers is a new efficiency standard for microwaves. With the new numbers, the cost-benefit analysis of the regulation more accurately takes into account how beneficial reducing carbon emissions actually is.
>
> Perhaps most critically, if the White House relies on EPA regulations to carry out its climate mitigation agenda, the updated numbers will strengthen those rules. A

> regulation that reduces the amount of carbon that coal power plants are allowed to emit will more accurately reflect how beneficial each reduced ton of CO2 actually is.
>
> When the State Department issued its draft Environmental Impact Statement on the Keystone XL pipeline this year, the Environmental Protection Agency recommended that State use a monetized Social Cost of Carbon estimate. If State does this, it will have more complete numbers to use in its analysis, which should make clear that projects like Keystone will emit too much carbon dioxide to allow it to pass a true cost-benefit analysis.
>
> Other regulations, like energy efficiency and clean energy mandates that displace the use of carbon-heavy fuels, are clearly an even better deal when the true Social Cost of Carbon is taken into account.[9]

DOE should have subjected the "updated" SCC estimates to proper notice and comment before incorporating them into a final rule. Use of the updated TSD may seem innocuous at first glance, because the conservation standards in the final rule are the same as in the SNOPR. But once incorporated into a final rule, the updated TSD estimates become precedential for future rulemakings by multiple agencies, and will appear to justify more costly interventions.

The remainder of this comment letter examines the broader issue of whether the social cost of carbon is an appropriate basis for estimating regulatory benefits and imposing regulatory burdens on the public.

II. Assumption-Driven Hocus-Pocus

The social cost of carbon is an estimate of how much damage an incremental ton of carbon dioxide-equivalent (CO2-e) greenhouse gas (GHG) emissions does to humanity and the biosphere.

Policymakers, pundits, and activists increasingly invoke SCC estimates to justify the imposition of carbon taxes, fuel economy mandates, Soviet-style production quota for wind farms, and other interventions to rig the marketplace against fossil fuels. They speak as if SCC estimates disclose an objective reality like the boiling point of water or the specific gravity of iron. In fact, SCC is a highly subjective concept. SCC estimates derive from assumptions about highly speculative issues, such as:

- Climate Sensitivity (how feedback mechanisms, positive or negative, will amplify or damp down the direct warming effect of rising GHG concentrations);
- Climate Impacts (how projected warming will affect weather patterns, ice-sheet dynamics, sea-level rise, and eco-system services);
- Economic Impacts (how projected changes in global temperature, weather, sea-level rise, and eco-systems will affect agriculture, forestry, tourism, and other climate-related activities absent adaptation); and,

- Technological Change (how adaptive capacities will develop as climate changes to offset potential damages to economic output and public health).

Assumptions about those factors and more are fed into computer programs called "Integrated Assessment Models" (IAMs). The IAMs purport to "determine" the net impact of each incremental ton of CO2-e emissions on public welfare and the Earth's biota. But each layer of the analysis is fraught with uncertainty and is educated guesswork at best. By tweaking assumptions, modelers can get pretty much any result they want.

III. 'Worse than We Thought' or Better than They Told Us?

A. Catastrophic Climate Change

The administration's Interagency Working Group uses three IAMs, three discount rates (2.5,% 3,% and 5%), and a fourth value representing low-probability catastrophic impacts to estimate the social cost of carbon from 2010 through 2050. As noted, SCC estimates are roughly 60% higher in the May 2013 TSD than in the 2010 TSD. This is a bit strange, since anthropogenic climate change supposedly occurs over a period of decades to centuries. Did climate change accelerate so dramatically in just three years?

It is hard to shake the suspicion that the revised TSD is just another variant of the "worse than we thought" mantra. Climate change can't look ever-more dire if SCC estimates decline or stay the same. So each review is bound to produce higher SCC estimates. There's just one problem: Recent scientific research indicates the climate outlook is better than they told us.

Consider first the most influential rationale for rationing carbon: the risk of catastrophic climate change. The SCC estimate for the high-impact scenario in 2050 increased from $136.20 per ton in the 2010 TSD to $221 per ton in the 2013 TSD. Where's the evidence that the risk of catastrophe has increased?

There are three main climate catastrophe scenarios: ocean circulation shutdown triggering a new ice age, ice sheet disintegration raising sea levels 10-20 feet during our lifetimes or those of our children and grandchildren, and runaway warming from melting frozen methane deposits and carbon stored in peat bogs.

The once-fashionable scare of a warming-induced ice age[10] was always scientifically implausible,[11] and is seldom mentioned today as a reason to control GHG emissions. Since publication of the 2010 TSD, Zhang et al. (2011) found that the "anticipated slowdown" in the Atlantic Meridional Overturning Circulation (AMOC) "has not occurred yet, even though global temperatures have been significantly higher since the 1970s."[12] So this particular doomsday scenario does not appear to be any more likely today than it was in 2010.

What about the risk of runaway climate change? Climate alarm literature in the mid-2000s[13] featured scenarios in which melting permafrost would release vast deposits of frozen methane

from the sea floor and huge stores of CO2 from peat bogs. These "positive feedbacks" would supposedly cause more warming, which then would release even more methane and CO2, producing a climate-destabilizing feedback loop threatening the survival of civilization and the habitability of the Earth. Recent scientific research does not support such gloomy speculation.

Schultz (2011) found that even under the most extreme climatic scenario tested, permafrost thaw in the Siberian shelf will not exceed 10 meters in depth by 2100 or 50 meters by the turn of the next millennium, whereas the bulk of methane stores are trapped roughly 200 meters below the sea floor.[14]

Kessler et al. (2011) found that microbes digested the methane released during the 2010 BP Deepwater Horizon oil spill, indicating that any warming-induced "large-scale releases of methane from hydrate in the deep ocean are likely to be met by a similarly rapid methanotrophic [methane-eating] response."[15]

Charman et al. (2012), a team of 36 researchers, examined "carbon accumulation" in Northern latitude peat lands over the past millennium. "Opposite to expectations," the scientists found that in warm periods, peat lands become more bio-productive, leading to net increases in "long-term carbon accumulation." Thus, the researchers opine, "the carbon sequestration rate could increase over many areas of northern peat lands" as the world warms.[16]

So what accounts for the higher SCC estimate for catastrophic events in the 2013 TSD? The authors say the revised SCC estimates are higher because the IAMs contain an "explicit representation" of sea-level rise "dynamics."[17] But if anything, recent science points to a reduction in the risk of catastrophic sea-level rise.

King et al. (2010) found that the rate of Antarctic ice loss is not accelerating and translates to less than one inch of sea-level rise per century.[18] Faezeh et al. (2013) found that Greenland's four main outlet glaciers are projected to contribute 0.7 to 1.1 inches to sea-level rise by 2200 under a mid-range warming scenario (2.8°C by 2100) and 1.1 to 1.9 inches under a high-end warming scenario (4.5°C by 2100).[19] Twenty-first century sea-level rise is more likely to be measured in inches than in feet or meters.

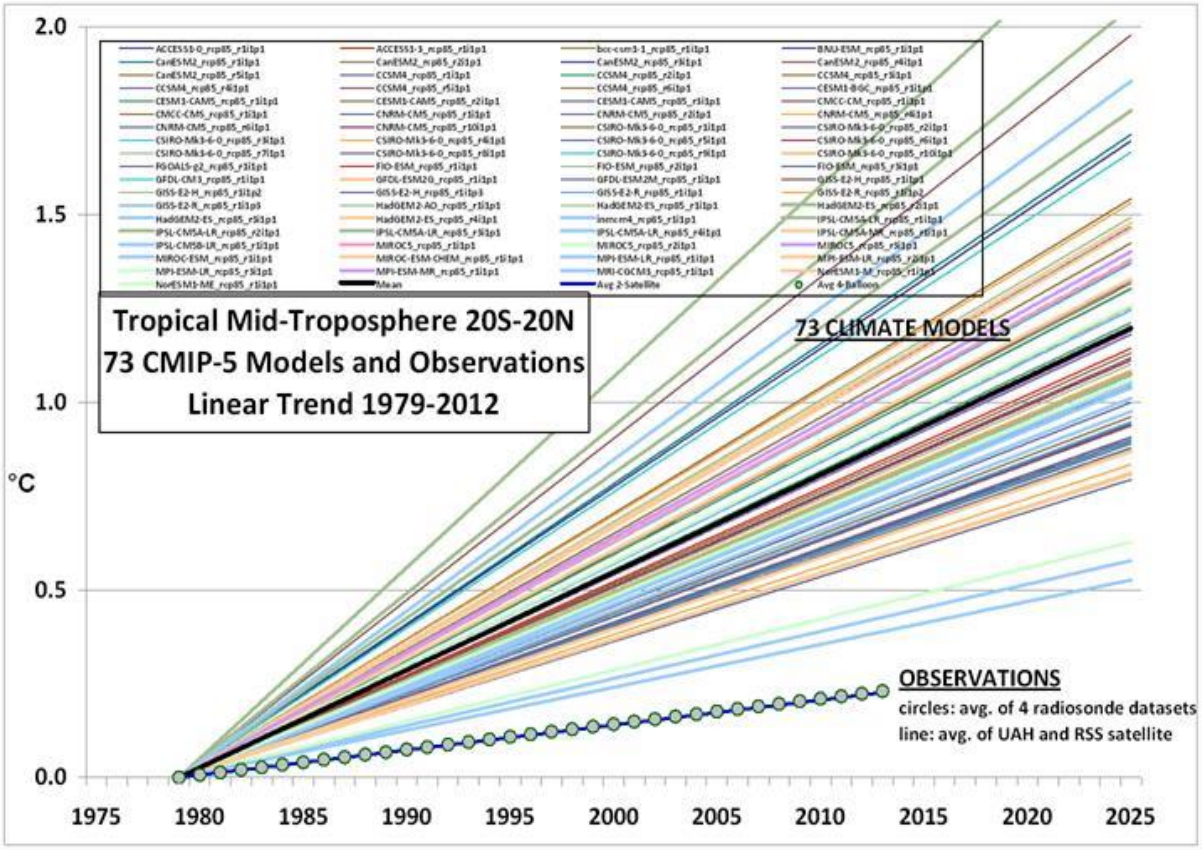
The higher SCC estimates for catastrophic climate change in the 2013 TSD appear to have been pulled out of a hat.

B. Failing Models

Official SCC estimates imply a degree of precision that is particularly untenable at a time when the alleged scientific "consensus" is crumbling in full view of the public.

The growing gap between model projections and observations is a topic of daily discussion in newspapers, blogs, and scientific papers. John Christy of the University of Alabama in Huntsville (UAH) found that all 73 models used by the IPCC for its Fifth Assessment Report (AR5)

overshoot the warming of the tropical atmosphere during past 33 years as measured by two independent satellite datasets and four independent balloon datasets. Christy's colleague Roy Spencer shows the contrasting linear trends between models and observations in the figure below:



Spencer comments: "Note that the observations (which coincidentally give virtually identical trends) come from two very different observational systems: 4 radiosonde datasets, and 2 satellite datasets (UAH and RSS). . . . Now, in what universe do the above results not represent an epic failure for the models?"[20]

Spencer and Christy are prominent skeptics, so critics may be tempted to assume there must be something wrong with their data. But, in a curious turn of events, the satellite dataset developed by Frank Wentz and his team at Remote Sensing Systems (RSS) shows less warming than the UAH dataset.

There has been no net warming in the RSS dataset from Dec. 1996 through July 2013 – a 200 month period.[21]

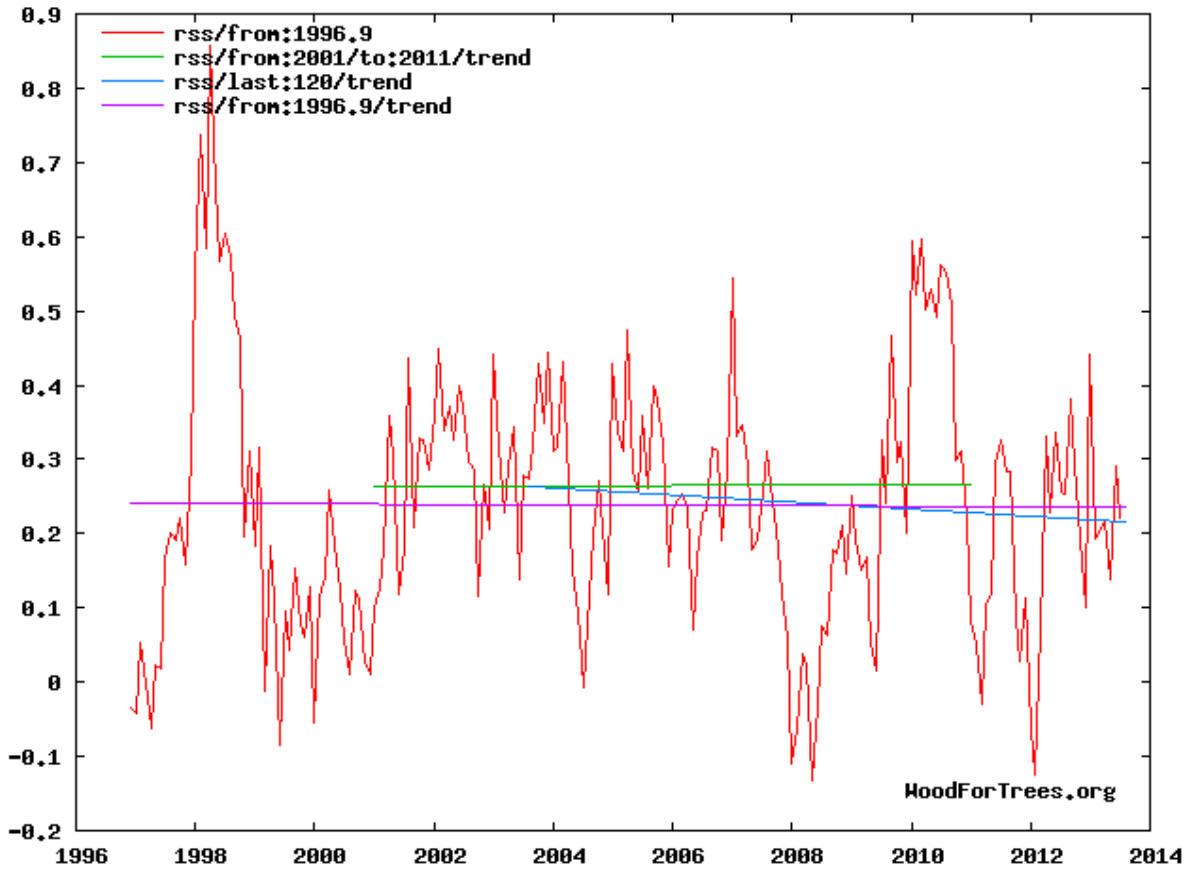


Figure explanation*: The magenta line shows no net warming over the past 16.6 years; the green line shows no warming during the decade of 2000-2010; the blue line shows a slight (non-statistically significant) cooling during the past 10 years.*

In a *Der Spiegel* interview, Hamburg University Prof. Hans von Storch discusses the "puzzle" facing climate scientists today:

> Recent CO2 emissions have actually risen even more steeply than we feared. As a result, according to most climate models, we should have seen temperatures rise by around 0.25 degrees Celsius (0.45 degrees Fahrenheit) over the past 10 years. That hasn't happened. In fact, the increase over the last 15 years was just 0.06 degrees Celsius (0.11 degrees Fahrenheit) — a value very close to zero. This is a serious scientific problem that the Intergovernmental Panel on Climate Change (IPCC) will have to confront when it presents its next Assessment Report late next year.

In a recent discussion paper, Storch and three colleagues examine the accuracy of the CIMP3 and CMIP5 model ensembles used, respectively, to inform the IPCC's 2007 (AR4) and forthcoming (AR5) assessment reports.[22] They find that "for the 15-year trend interval corresponding to the latest observation period 1998-2012, only 2% of the 62 CMIP5 and less than 1% of the 189 CMIP3 trend computations are as low as or lower than the observed trend."

In other words, model projections matched observations only 2% of the time. The models are on the verge of failure. As the researchers put it, "Applying the standard 5% statistical critical value, we conclude that the model projections are inconsistent with the recent observed global warming over the period 1998-2012."

Perhaps most significant as an indication of the unsettled state of climate science is a recent commentary in *Nature Climate Change* by John C. Fyfe, Nathan P. Gillett and Francis W. Zwiers.[23] All three are IPCC bigwigs. Zwiers is Vice Chair of Working Group 1 (physical science) of the forthcoming Fifth Assessment Report (AR5); Fyfe was a lead author for AR4; and Gillett is a lead author for AR5's Chapter 10 on climate change detection and attribution.

The authors find that over the past 20 years (1993-2012), the warming trend computed from 117 climate model simulations (0.3°C/decade) is more than twice the observed trend (0.14°C/decade); and over the past 15 years (1998-2012), the simulated trend (0.21°C/decade) is more than four times the observed trend (0.05°C/decade). They note that "such an inconsistency is only expected to occur by chance once in 500 years."

What factors might explain the inconsistency? According to Storch and his colleagues, "the underestimation of internal natural climate variability on decadal time scales is a plausible candidate, but the influence of unaccounted external forcing factors or an overestimation of the model sensitivity to elevated greenhouse gas concentrations cannot be ruled out."

C. Unsettled Sensitivity

Cato Institute climatologists Patrick Michaels and Chip Knappenberger maintain an ever-growing list of scientific studies since 2011 indicating that the IPCC's best estimate of climate sensitivity is too hot.[24] As of April 2013, the list included 14 studies estimating lower sensitivity than the best estimates of both IPCC AR4 and the 'leaked' IPCC AR5.

In the figure below, the light grey vertical bar is the mean of the best estimates of the 14 new studies. The AR4 best estimate of 3°C is 50% higher than the mean of the recent estimates (2°C); the AR5 best estimate of 3.4°C is 70% higher.

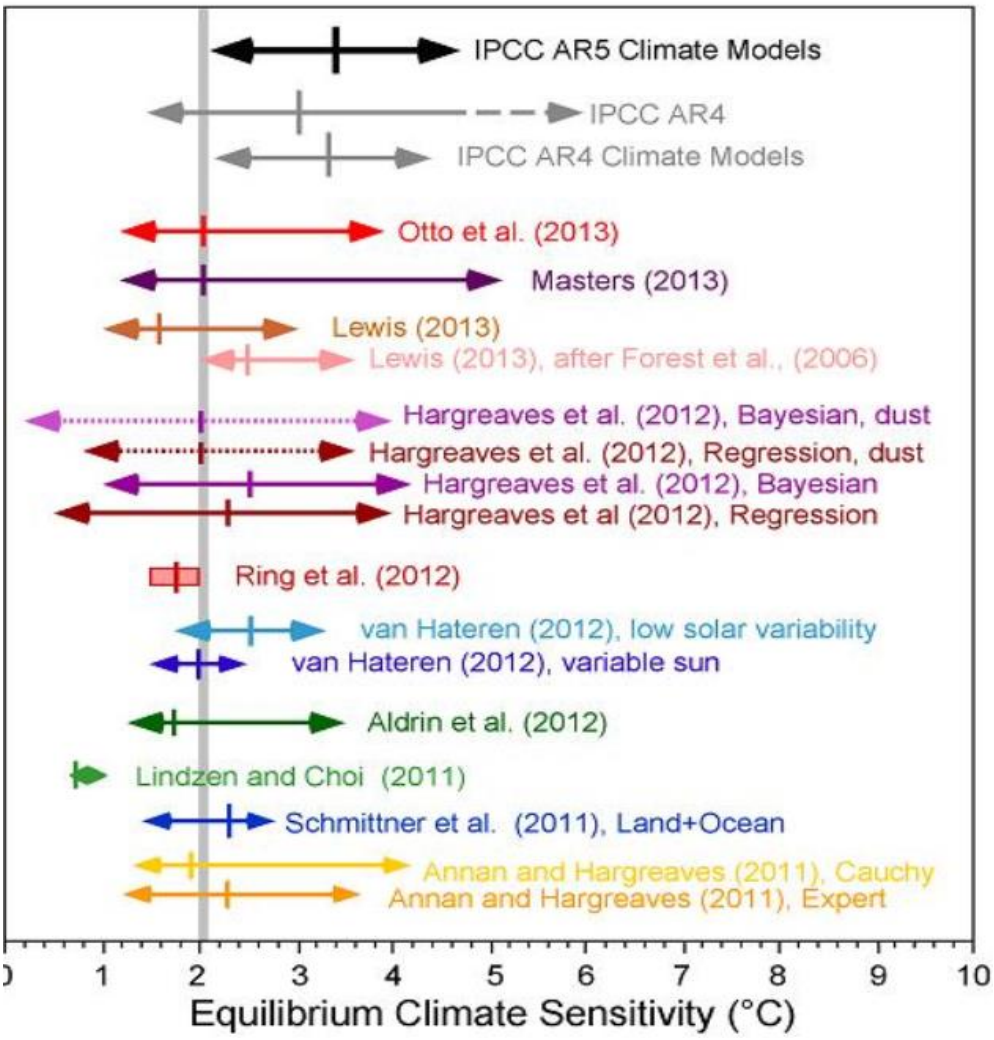


Figure explanation: *Climate sensitivity estimates from new research beginning in 2011 (colored, compared with the range given in the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4) (gray) and the IPCC Fifth Assessment Report (AR5; black), which has yet to be published. The arrows indicate the 5 to 95 percent confidence bounds for each estimate along with the best estimate (median of each probability density function; or the mean of multiple estimates; colored vertical line).*

An obvious question is whether the IAMs used to estimate the carbon's social cost have been adjusted in light of either real-world observations or recent climate sensitivity studies? The answer is no. As the TSD states, the climate sensitivity assumptions come straight out of the IPCC AR4.[25]

The science is clearly too uncertain and unsettled for anyone to estimate the SCC with any degree of accuracy. About all we can confidently say is that if the 2010 TSD was accurate in its day, the revised SCC estimates should be lower. Instead, the revised estimates are higher. The

revised SCC estimates have no place in rulemakings that impose legal obligations on the private sector.

D. Extreme Weather Hype

Even if the IPCC got climate sensitivity exactly right, and even if model projections closely matched observed warming, much additional information would still be needed to forecast the impacts of warming on weather patterns.

It is widely assumed, for example, that global warming will make extreme weather more frequent and/or more severe. But so far the empirical evidence for this hypothesis is lacking. Here's the big picture on extreme weather:

- There has been no long term trend in the strength or frequency of hurricanes, tornadoes, U.S. floods or drought.[26]
- The one exception is heat waves, but, paradoxically, the more common hot weather becomes, the more heat-related mortality declines: People adapt![27]
- There is no long-term trend in "normalized" extreme weather damages (losses adjusted for increases in wealth, population, and consumer price index).[28]
- Globally, mortality rates and aggregate mortality related to extreme weather have declined by 98% and 93%, respectively, since the 1920s.[29]

It is not possible to discern a "social cost" for carbon in the foregoing information.

IV. Questionable Technology Assumptions

Even if IAMs incorporated accurate climatology and meteorology, they would still exaggerate carbon's social cost if they underestimate future technology and improvements in adaptive capabilities. Some influential climate change damage assessments do just that.

Consider, for example, the UK Government's "Fast Track Assessments" (FTAs) of climate change impacts, conducted by leading IPCC-affiliated researchers. Economist Indur Goklany found that:

> The [FTA] study of agricultural productivity and hunger allows for increases in crop yield with economic growth due to greater usage of fertilizer and irrigation in richer countries, and decreases in hunger due to economic growth, some secular (time-dependent) increase in agricultural productivity, as well as some farm-level adaptations to deal with climate change. But these adaptations are based on 1990s technologies, rather than technologies that would be available at the time for which impacts are estimated (i.e., 2025, 2055 and 2085 in the FTA). Nor does the study account for any technologies developed to specifically cope with the negative impacts of global warming or take advantage of any positive outcomes.[30]

Similarly, the FTA study on coastal flooding "allows societies to implement measures to reduce the risk of coastal flooding in response to 1990 surge conditions, but not to subsequent sea level rise," even if the measures are adopted in 2050 in response to then-prevailing sea levels and surge conditions. What's more, the study assumes "a constant lag time between initiating protection and sea-level rise," so that even if sea-level rise accelerates, adaptations remain "reactive" rather than "anticipatory."

The word "technology" nowhere appears in the text of the 2013 TSD. The document's technology assumptions seem rather conservative. It assumes that for a warming between 1°C and 2°C, adaptation "will reduce damages by 15-30% depending on the region," and that beyond 2°C, "no adaptation is assumed to be available to mitigate the impacts of climate change."[31]

What is indisputable is that technological change has done far more to transform the human condition than climate change has during the past century and more of global warming, and that the past 150 years of largely fossil-fueled development have been a period of unprecedented improvement in human well-being. There is no good reason to suppose the hare of technology change will not continue to outpace the tortoise of climate change in the coming century.

V. Cherry-Picked Discount Rates

In recent testimony, economist Robert Murphy[32] finds serious flaws in what should be the simplest part of the 2013 TSD's analysis: Which discount rates federal agencies should use to estimate the present value of future projected climate change damages.

Discounting is a necessary feature of cost-benefit analysis, especially for regulations designed to address climate change, in which most of the damages are assumed to occur decades or even centuries into the future.

SCC estimates critically depend on the choice of discount rates. Set the discount rate very high — in other words, assume that people today attach little value to costs or benefits incurred 50-100 years hence — and the SCC can become vanishingly small. Conversely, set the discount rate very low — in other words, assume that people today care a great deal about costs or benefits incurred long after their lifetimes — and the SCC can become very large.

Murphy found that the 2013 TSD flouts Office of Management and Budget (OMB) best practices in regulatory accounting. OMB Circular A-4 instructs agencies to use a 7% discount rate as the base case in regulatory analysis, because that is the "average before-tax rate of return to private capital" in the U.S. economy.[33] "Yet even though the guidance from OMB was quite explicit on this point," Murphy writes," neither the 2013 TSD nor the 2010 TSD "report the SCC using a 7 percent discount rate; they only used discount rates of 2.5, 3, and 5 percent."

There's no way the Inter-Agency Group could not know about this omission, incidentally, because the OMB is itself a member.

How significant is this flaw? In the May 2013 TSD, the SCC for 2010 is $11 per ton at a 5% discount rate but $52 per ton at a 2.5% discount rate. "In other words," Murphy comments, "cutting the discount rate in half caused the reported SCC to more than quadruple." Clearly, the choice of discount rate heavily influences SCC estimation. Murphy opines that with a 7% discount rate, the SCC might be near zero:

> If the Working Group ran the computer models again, this time using a 7 percent discount rate and an earlier reference year such as 2015, presumably a larger fraction of simulations would register zero or negative values for the SCC, so that the mean result would itself be closer to zero—or conceivably even negative, meaning that carbon dioxide emissions conferred extra benefits on humanity.

Also contrary to OMB guidance, the Interagency Working Group calculated the global SCC but not the domestic SCC. The 2010 TSD acknowledges that, "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."[34] Yet, notes Murphy, the May 2013 update reports only global SCC estimates. The effect is to make climate change appear to be a worse problem *for the U.S.* than the underlying analysis actually indicates.

The global SCC, after all, incorporates SCC estimates for developing countries, which have fewer resources for adapting to climate change, and where each incremental ton of CO2 presumably does more damage. The difference between domestic and global SCC turns out to be substantial. According to the 2010 TSD, "a range of values from 7 to 23 percent should be used to adjust the global SCC to calculate domestic effects."[35] In other words, if, using a 3% discount rate, the global SCC in 2030 is $33 per ton, the corresponding domestic impact is only $2-8 per ton.

As with omitting SCC estimates using a 7% discount rate, omitting domestic estimates creates a pro-regulation bias. Murphy explains:

> Suppose the EPA issues a new regulation that causes private industry to restrict carbon emissions, and that the compliance 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 recent headline SCC estimate of $33/ton, this regulation would apparently pass a cost/benefit test, because the $25 cost to American industry 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.

VII. Social Costs of Carbon Mitigation

Even if the climatological, meteorological, and technological assumptions underpinning SCC estimates were accurate; even if agencies used appropriate discount rates; and even if they used only domestic SCC estimates in cost-benefit calculations – SSC analyses would still be biased and misleading. Even at their theoretical best, SCC analyses ignore the other side of the regulatory ledger: the social costs of *carbon mitigation*.

The connection between livelihoods, living standards, and life expectancy is more than etymological. People use a portion of their income to enhance their health and safety. Unsurprisingly, numerous studies find that poverty and unemployment increase the risk of sickness and death.[36] This means that even if climate change is assumed to be a serious problem, anti-growth policies like cap-and-trade, carbon taxes, and costly subsidies for renewable energy have the potential to do more harm than good to public health.

Fossil fuels remain the chief energy source of what Goklany calls a "cycle of progress" in which economic growth, technological change, human capital formation, and freer trade co-evolve and mutually reinforce each other.[37] The potential for carbon mitigation schemes to stifle the cycle of progress should be obvious from the behavior of China, India, and other developing countries, which repeatedly reject European-style carbon-suppression policies.

Given the implausibility of catastrophic climate change scenarios, the continuing importance of fossil fuels to human flourishing, and the mortality risks of poverty and unemployment, the "social cost" of carbon mitigation may substantially exceed that of climate change.

As in global warming advocacy generally, the risks of climate change policy are nowhere acknowledged in the 2013 TSD. So even if the TSD got the science, technology forecasts, and technical economics exactly right, it would still be one-sided – that is, partisan – unless paired with a rigorous and thorough analysis of climate *policy* risk.

"Prediction is very hard, especially about the future," Yogi Berra said. Nonetheless, I'd be happy to bet a month's wages at 10 to 1 odds that the Obama administration will never convene an inter-agency working group on the social costs of carbon mitigation.

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[1] Department of Energy, *Energy Conservation Program for Consumer Products: Landmark Legal Foundation; Petition for Reconsideration*, 78 FR 49975-49978, August 16, 2013

[2] Department of Energy, *Energy Conservation Program: Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens; Final Rule*, 78 FR 36316-36368, June 17, 2013

[3] Interagency Working Group on the Social Cost of Carbon, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866*, May 2013, http://www.whitehouse.gov/sites/default/files/omb/inforeg/social_cost_of_carbon_for_ria_2013_update.pdf (hereafter TSD 2013)

[4] Department of Energy, *Energy Conservation Program: Energy Conservation Standards for Standby Mode and Off Mode for Microwave Ovens*, Supplemental Notice of Proposed Rulemaking, 77 FR 8526-8574, February 12, 2012, http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/mwo_snopr_fr_version_final_2_15_12.pdf

[5] Interagency Working Group on the Social Cost of Carbon, *Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, 2010,* http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/sem_finalrule_appendix15a.pdf (hereafter TSD 2010)

[6] "By way of comparison," states the May 2013 TSD (p. 2), "the four 2020 SCC estimates reported in the 2010 TSD were $7, $26, $42 and $81 (2007$). The corresponding four updated SCC estimates for 2020 are $12, $43, $65, and $129 (2007$)."

[7] 78 FR 49974

[8] 78 FR 49974

[9] Ryan Koronowsky, "The 'Social Cost of Carbon' Is Almost Double What the Government Previously Thought," June 5, 2013, Climate Progress, http://thinkprogress.org/climate/2013/06/05/2103261/the-social-cost-of-carbon-is-almost-double-what-the-government-previously-thought/?mobile=nc

[10] Peter Schwartz and Doug Randall, *An Abrupt Climate Change Scenario and Its Implications for United States National Security: Imagining the Unthinkable*, October 2003, http://www.gbn.com/articles/pdfs/Abrupt%20Climate%20Change%20February%202004.pdf; Al Gore, *An Inconvenient Truth* (Emmaus, Pennsylvania: Rodale Press, 2006), p. 149.

[11] Richard Seager, *The Gulf Stream, European Climate and Abrupt Climate Change, Past and Future*, http://www.ldeo.columbia.edu/res/div/ocp/gs/pubs/Seager_NYAS_GulfStream.pdf ;

[12] Zhang, D., Msadek, R., McPhaden, M.J. and Delworth, T. 2011. Multidecadal variability of the North Brazil Current and its connection to the Atlantic meridional overturning circulation. *Journal of Geophysical Research* 116**:** 10.1029/2010JC006812, http://onlinelibrary.wiley.com/doi/10.1029/2010JC006812/abstract .

[13] For example, Fred Pearce, *With Speed and Violence: Why Scientists Fear Tipping Points in Climate Change* (Boston: Beacon Press, 2007); Joseph Romm, H*ell and High Water: Global Warming – the Solution and the Politics – and What We Should Do* (New York: William Morrow, 2007).

[14] Colin Schultz, Siberian shelf methane emissions not tied to modern warming. 2011. *EOS* 92:48, 469, http://onlinelibrary.wiley.com/doi/10.1029/2011EO490014/abstract

[15] John D. Kessler, David L. Valentine, Molly C. Redmond, Mengran Du, Eric W. Chan, Stephanie D. Mendes, Erik W. Quiroz, Christie J. Villanueva, Stephani S. Shusta, Lindsay M. Werra, Shari A. Yvon-Lewis, Thomas C. Weber. 2011. *Science* 331: 312-315, http://www.sciencemag.org/content/331/6015/312.abstract

[16] Charman et al. 2012. Carbon-related changes in peatland carbon accumulation during the last millennium. *Biogeosciences Discussions* 9, 14327–14364, 2012 http://www.biogeosciences-discuss.net/9/14327/2012/bgd-9-14327-2012-print.pdf

[17] TSD 2013, p. 4.

[18] Matt A. King, Rory J. Bingham, Phil Moore, Pippa L. Whitehouse, Michael J. Bentley & Glenn A. Milne. 2012. Lower satellite-gravimetry estimates of Antarctic sea-level contribution. *Nature* 491: 586-589, http://www.nature.com/nature/journal/v491/n7425/full/nature11621.html

[19] Faezeh M. Nick, Andreas Vieli, Morten Langer Andersen, Ian Joughin, Antony Payne, Tamsin L. Edwards, Frank Pattyn. 2013. Future sea-level rise from Greenland's main outlet glaciers in a warming climate. *Nature* 497: 235-238, http://www.nature.com/nature/journal/v497/n7448/full/nature12068.html; Tim Boyer, Syd Levitus, John Antonov, Ricardo Locarnini, Alexey Mishonov, Hernan Garcia, Simon A. Josey. 2007. Changes in the freshwater content of the Atlantic Ocean, 1955-2006. *Geophysical Research Letters*, **34**, L16603, doi:10.1029/2007GL030126, http://onlinelibrary.wiley.com/doi/10.1029/2007GL030126/abstract; "Ocean Circulation Slowdown: False Alarm," *World Climate Report*, August 22, 2007, http://www.worldclimatereport.com/index.php/2007/08/22/ocean-circulation-slowdown-false-alarm/

[20] Roy W. Spencer, "EPIC FAIL: 73 Climate Models vs. Observations for Tropical Troposphere Temperature," June 4, 2013, http://www.drroyspencer.com/2013/06/epic-fail-73-climate-models-vs-observations-for-tropical-tropospheric-temperature/

[21] Walter Brozek, RSS Flat for 200 Months (Now Includes July Data), Watts Up With That, August 25, 2013, http://wattsupwiththat.com/2013/08/25/rss-flat-for-200-months-now-includes-july-data/

[22] Hans von Storch Armineh Barkhordarian, Klaus Hasselmann, Eduardo Zorita. 2013. Can climate models explain the recent stagnation in global warming? http://www.academia.edu/4210419/Can_climate_models_explain_the_recent_stagnation_in_global_warming

[23] John C. Fyfe, Nathan P. Gillett and Francis W. Zwiers. 2013. Overestimated global warming over the past 20 years. *Nature Climate Change* 3: 767-768, http://www.see.ed.ac.uk/~shs/Climate%20change/Climate%20model%20results/over%20estimate.pdf

[24] Patrick Michaels and Paul C. Knappenberger, "Still Another Low Climate Sensitivity Estimate," April 25, 2013, http://www.cato.org/blog/still-another-low-climate-sensitivity-estimate-0

[25] TSD 2013, p. 12.

[26] Statement of Dr. Roger Pielke, Jr., Committee on Environment and Public Works, Hearing on "Climate Change: It's Happening Now," July 18, 2013, http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=a6df9665-e8c8-4b0f-a550-07669df48b15

[27] Davis RE, Knappenberger PC, Michaels PJ, Novicoff WM. 2003. Changing heat-related mortality in the United States. Environmental Health Perspectives 111(14):1712-8, http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241712/

[28] Laurens M. Bouwer, Have Disaster Losses Increased Due to Anthropogenic Climate Change? *Bulletin of the American Meteorological Society*, January 2011, http://www.ivm.vu.nl/en/Images/bouwer2011_BAMS_tcm53-210701.pdf

[29] Indur Goklany, *A Primer on the Global Death from Extreme Weather Events – Context and Long Term (1900-2008) Trends*, The Observatory, Global Warming Policy Foundation, August 15, 2010, http://www.thegwpf.org/indur-m-goklany-global-death-toll-from-extreme-weather-events-declining/

[30] Indur M. Goklany, Misled on Climate Change: How the IPCC (and others) Exaggerate the Impacts of Global Warming, Reason Foundation, Policy Study 399, September 2011, p. 18, http://goklany.org/library/Reason%20CC%20and%20Development%202011.pdf

[31] TSD 2013, p. 11.

[32] Written Testimony of Robert R. Murphy, Senior Economist, Institute for Energy Research, Senate Committee on Environment and Public Works, "The 'Social Cost' of Carbon: Some Surprising Facts," July 18, 2013, http://www.epw.senate.gov/public/index.cfm?FuseAction=Files.View&FileStore_id=d74255e9-6a8a-473f-82a3-ff19921798ef

[33] Office of Management and Budget, Circular A-4, http://www.whitehouse.gov/omb/circulars_a004_a-4

[34] TSD 2010, p. 10

[35] TSD 2010, p. 12

[36] David J. Roelfs, Eran Shor, Karina W. Davidson, Joseph E. Schwartz. 2011. Losing life and livelihood: A systematic review and meta-analysis of unemployment and all-cause mortality. *Social Science & Medicine* 72: 840-854, http://www.mcgill.ca/sociology/sites/mcgill.ca.sociology/files/2011_--_social_science__medicine_0.pdf

[37] Indur Goklany, *Humanity Unbound: How Fossil Fuels Saved Humanity from Nature and Nature from Huma*nity, Policy Analysis No. 715, Cato Institute, December 20, 2012, http://www.cato.org/sites/cato.org/files/pubs/pdf/pa715.pdf