2017

The Price of Climate Deregulation: Adding Up the Costs and Benefits of Federal Greenhouse Gas Emission Standards

Nadra Rahman
Columbia Law School, Sabin Center for Climate Change Law

Jessica A. Wentz
Columbia Law School, Sabin Center for Climate Change Law

COLUMBIA LAW SCHOOL

SABIN CENTER FOR CLIMATE CHANGE LAW

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By Nadra Rahman[*] and Jessica Wentz[**]

August 2017

Federal climate regulations are currently under attack, in part due to the perception that these regulations will impose excessive costs on regulated industries and society as a whole. But according to federal projections, the benefits of these regulations would significantly outweigh the costs. We added up the projected economic impacts of major federal rules aimed at reducing greenhouse gas emissions and found that the net benefits could reach nearly $300 billion per year by 2030. The rules will also generate a variety of non-monetized benefits, such as improved public health outcomes and the creation of jobs, as well as climate mitigation benefits that will extend well beyond 2030.

I. Introduction

On March 28, 2017, President Trump issued an Executive Order on Promoting Energy Independence and Economic Growth, which established a federal policy that executive agencies review all existing regulations "that potentially burden the development or use of domestically produced energy resources, with particular attention to oil, natural gas, coal, and nuclear energy" and to suspend, revise, or rescind those that "unduly burden" the

[*] Nadra Rahman is a student at Columbia University and an intern at the Sabin Center for Climate Change Law.
[**] Jessica Wentz is a staff attorney at the Sabin Center for Climate Change Law.

development of these energy resources.[1] Consistent with this policy, the Order directed the U.S. Environmental Protection Agency (EPA) and the Bureau of Land Management (BLM) to immediately review federal rules establishing greenhouse gas emission standards for power plants and other sectors and, if appropriate, to suspend, revise, or rescind those rules as soon as practicable.[2] With the stroke of a pen, President Trump thus initiated the process of unraveling the federal climate protections that were put into place by the Obama Administration.[3]

This is not the only action President Trump has taken to unravel federal climate protections. He has also initiated a review of the greenhouse gas emission standards for motor vehicles,[4] and has stated his intention to withdraw the U.S. from the 2015 Paris Agreement – the global framework established for implementing the United Nations Framework Convention on Climate Change (UNFCCC) – and to terminate U.S. contributions to UNFCCC funding mechanisms.[5] In addition, Executive Order 13783 takes aim at federal mitigation and adaptation planning efforts, for example by rescinding an Obama-era executive order on "Preparing the United States for the Impacts of Climate Change" and instructing federal agencies to suspend, revise, or rescind any actions taken in accordance with that executive order.[6] Of all of these actions, the rollback of federal greenhouse gas emission standards is likely the most detrimental to U.S. efforts to combat climate change.

President Trump and other opponents of these emission standards have argued that they are too onerous and that the benefits do not justify the costs.[7] It is true that environmental regulation can entail high compliance costs for regulated entities – but the agencies promulgating these standards have found that the benefits of regulation significantly outweigh the costs. These benefits include direct benefits from the reduction of greenhouse gas emissions (e.g., avoided economic losses and adverse health effects associated with rising temperatures, sea level rise, and other changes), public health benefits from the reduction of co-pollutants, and the creation of new jobs and economic opportunities in the clean energy sector.

[1] Executive Order 13783: Promoting Energy Independence and Economic Growth §1(c) (Mar. 28, 2017).
[2] *Id.* at §§4, 7.
[3] The agencies that promulgated these rules have issued notice of their intent to review and, as appropriate, amend or repeal the rules consistent with the policy set forth in Executive Order 13783. The public will have an opportunity to submit comments on rule revisions and repeals. For up-to-date information on the status of each rule and public commenting opportunities, see *Climate Deregulation Tracker*, Sabin Center for Climate Change Law, http://columbiaclimatelaw.com/resources/climate-deregulation-tracker.
[4] EPA, Notice of Intention to Reconsider the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022-2025 Light Duty Vehicles, 82 Fed. Reg. 14671 (Mar. 22, 2017).
[5] Press Release, White House, Statement by President Trump on the Paris Climate Accord (June 1, 2017), https://www.whitehouse.gov/the-press-office/2017/06/01/statement-president-trump-paris-climate-accord.
[6] *Id.* at §3.
[7] *See, e.g.*, Nicholas Loris, *The Many Problems of the EPA's Clean Power Plan and Climate Regulations: A Primer* (Heritage Foundation 2015).

II. Aggregate Costs and Benefits Greenhouse Gas Emission Standards

According to federal projections, the total benefits of the greenhouse gas emission standards issued during the Obama Administration could reach nearly $370 billion by 2030, more than four times the projected costs of approximately $84 billion. These figures reflect the aggregated costs and benefits of the following federal rules:

- The Clean Power Plan, which establishes CO_2 performance standards for existing fossil fuel-fired power plants;[8]
- The motor vehicle emission standards for light-duty vehicles, model years 2012-2025,[9] and heavy-duty vehicles, model years 2014-2028;[10]
- The new source performance standards for the oil and gas sector (which encompass methane (CH_4) emissions as well as volatile organic compounds);[11] and
- The methane waste prevention rule for the oil and gas sector.[12]

Table 1 (next page) summarizes the sum total of the projected economic impacts as well as impacts on emissions, jobs, and public health outcomes from these rules.[13] Additional information about the scope and requirements of each of these rules is available on the Sabin Center's Climate Regulation Database.[14]

Across individual years, the benefit-cost ratios for the rules range from nearly 1:1 to 10:1, with some of the biggest ratios for the Clean Power Plan and the standards for medium- and heavy-duty vehicles. The monetized benefits include positive impacts from greenhouse gas emission reductions (nearly 980 MMT CO_2e in 2030) as well as public health benefits from the reduction of co-pollutants such as nitrogen oxides (NO_x). The costs reflect compliance costs for regulated industries as well as social costs (such as those resulting from additional "accidents, noise, and congestion" associated with an increase in vehicle use spurred by more efficient vehicles).

[8] EPA, Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64662 (Oct. 23, 2015).
[9] EPA & NHTSA, Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, 75 Fed. Reg. 25324 (May 7, 2010); EPA & NHTSA, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62624 (Oct. 15, 2012).
[10] EPA & NHTSA, Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, 76 Fed. Reg. 57106 (Sept. 15, 2011); EPA & NHTSA, Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, Phase 2, 81 Fed. Reg. 73478 (Oct. 25, 2016).
[11] EPA, Oil and Natural Gas Sector: Emission Standards for New, Reconstructed and Modified Sources, 81 Fed. Reg. 35824 (June 3, 2016).
[12] BLM, Waste Prevention, Production Subject to Royalties, and Resource Conservation, 81 Fed. Reg. 83008 (Nov. 18, 2016).
[13] The table does not include impacts from the new source performance standards for CO_2 emissions from the power sector because EPA did not perform a comparable cost-benefit analysis for that rule.
[14] *Climate Law Database*, Sabin Center for Climate Change Law, http://columbiaclimatelaw.com/resources/climate-deregulation-tracker/database/.

Table 1: Aggregate Economic Impacts of Federal Greenhouse Gas Emission Standards

Economic Impacts	2020 (all except heavy-duty 2019-2027)	2025 (all expect light- and heavy- duty standards)	2030 (all except oil & gas NSPS, methane waste prevention)
Benefits (millions)			
Climate Benefits (SC-GHG, 3% DR)	$10,210	$13,939	$49,233
Other Benefits	$79,401	$18,509	$320,470
Total Benefits	**$89,275**	**$31,718**	**$369,973**
Costs (millions)			
Compliance	$32,226	$4,017	$71,197
Other Costs	$3,477	$0	$12,416
Total Costs	**$35,703**	**$4,017**	**$83,614**
Net Benefits (millions)	**$52,288**	**$28,443**	**$286,939**

Notes:

- It is not possible to aggregate costs and benefits for all rules in a specific year, as the timeframe for the cost-benefit analysis varies for each rule. Thus, we provide estimates for 2020, 2025, and 2030, as well as information on which rules are covered.
- All figures are drawn from official analyses conducted by the federal agencies promulgating these rules. Third party studies have corroborated these findings and, in some cases, have found that the net benefits are even greater than what the agencies projected. These studies are discussed below.
- All $ values have been updated to 2016$ for consistency across rules. The factor 1.145 was used for conversions from 2007$, 1.114 for 2009$, 1.101 for 2010$, 1.079 for 2011$, 1.059 for 2012$, and 1.042 for 2013$. The Gross Domestic Product: Implicit Price Deflator maintained by the Federal Reserve Bank of St. Louis was used to calculate these factors.[15]
- Net benefits are those as calculated by EPA, and may diverge from the difference of the costs and benefits due to rounding.
- Figures for Clean Power Plan are based on EPA's upper-bound estimate of net benefits under a mass-based compliance approach, applying a 3% discount rate to climate and air quality health co-benefits.
- Figures for the heavy-duty vehicle emission standards, MY 2019-2028 reflect EPA's estimate of net benefits under analysis Method B and in comparison to scenario 1a, in which fuel economy is not expected to improve without regulation.

The appendix to this document contains tables depicting a more detailed breakdown of aggregated costs and benefits, as well as costs and benefits for each of the rules discussed here.

[15] *Gross Domestic Product: Implicit Price Deflator*, Federal Reserve Bank of St. Louis, https://fred.stlouisfed.org/series/GDPDEF.

Tables 2 through 4 summarize the aggregate effects of these rules on emissions (greenhouse gases and conventional air pollutants), employment, and public health outcomes. All figures are drawn from the regulatory impact analyses accompanying the rules. The public health impacts are particularly notable: in 2030, the rules for which we have data will result in over 3,345 cases of avoided premature mortality, 4,500 fewer asthma attacks, 1,630 fewer non-fatal heart attacks, and over one million fewer minor restricted activity days—outcomes that are linked to reductions in particulate matter and ozone.

Table 2: Emissions Impacts

Emission Impacts	**2020 (all except heavy-duty 2014-2027)**	**2025 (all except light-duty 2012-2015, heavy duty 2014-2018)**	**2030 (all except oil & gas NSPS, heavy-duty 2019-2027, methane waste prevention)**
GHG (metric tons CO_2e)	**-260,703,464**	**-279,756,493**	**-979,667,405**
CO_2 (short tons)	-259,649,184	-302,924,132	-409,409,137
CH_4 (short tons)	-690,786	-728,904	-642,040
N_2O (short tons)	-333	-141	-634
SO_2 (short tons)	-54,000	-185,000	-280,000
NO_x (short tons)	-54,513	-225,110	-263,650
VOC (short tons)	-118,591	-60,305	-37,009

Notes:

- For heavy-duty vehicle standards 2014-2018, EPA specified economic benefits for the year 2020 (including benefits from CO_2 reductions) but did not specify the actual amount of CO_2 that would be reduced in 2020. Thus, the CO_2 reductions in 2020 from that rule are reflected in Table 1 (economic impacts) but not this table.

Table 3: Employment Impacts

Jobs	**2020**		**2025**		**2030**
	Oil & Gas NSPS, Light-Duty 2017-2015, Heavy Duty 2018-2025	**Clean Power Plan**	**Oil & Gas NSPS, Heavy-Duty 2018-2025**	**Clean Power Plan**	**Clean Power Plan**
Jobs ↑	+12,170 job-years	+2,500 job-years; +37,570 to 59,700 jobs	+6,170 job-years	+15,000 job-years; + 52,590 to 83,590 jobs	22,800 job-years; 83,360 jobs
Jobs ↓	-	-15,700 job-years	-	-41,000 job-years	56,600 job-years
Net Jobs	+12,170 job-years	-13,100 job- years; +37,570 to 59,700 jobs	+6,170 job-years	-26,000 job-years; +52,590 to 83,590 jobs	-33,800 job-years; 83,360 jobs

Table 4: Public Health Impacts

Public Health Impacts (PM2.5- & ozone-related)	**2030 (all except Oil & Gas NSPS, Heavy-Duty 2019-2028, Methane Waste Prevention Rule)**
Avoided Premature Mortality (adult)	3,345
Avoided lower respiratory symptoms (age 7-14)	24,200
Avoided upper respiratory symptoms (age 9-11)	32,450
↓ Asthma exacerbation (age 6 - 18)	4,500
↓ Emergency room visits for asthma	537
↓ Lost work days (age 18 - 65)	151,600
↓ Non-fatal heart attacks (age > 18)	1,630
↓ Minor restricted-activity days (age 18-65)	1,277,070
↓ School absence days	121,450

III. Breakdown of Costs and Benefits by Rule

A. Clean Power Plan

The Clean Power Plan, intended to reduce carbon pollution from existing power plants, is a prime example of a regulation where the benefits greatly exceed overall costs.

EPA projected that the net monetized benefits of the rule could reach approximately $7 billion in 2020, $28 billion in 2025, and $46 billion in 2030.[16] EPA's calculations accounted for:

- Reductions in CO_2 emissions of approximately 74 million metric tons (MMT) in 2020, 239 MMT in 2025, and 375 MMT in 2030; [17]
- Health co-benefits arising as a result of reductions in co-pollutants such as sulfur dioxide (SO_2) and nitrogen oxides (NO_x); and
- Compliance costs for regulated power plants.

Climate benefits are calculated using the social cost of carbon (SC-CO_2), a framework which incorporates such diverse inputs as changes in agricultural productivity, human health, insurance rates, and energy system costs to assess the monetary value of changes in CO_2 emissions; it is important to note that this is a global measure, as the effects of greenhouse gas emissions are not localized.[18] The use of the SC-CO_2 standard is now at risk, as with Executive Order 13783, President Trump disbanded the Interagency Working Group on Social Cost of Greenhouse Gases, withdrew technical documents it published related to the SC-CO_2, and called for agencies to look to the Office of Management and Budget (OMB)'s 2003 Circular A-4 (guidance on regulatory impact analysis) when valuing changes in greenhouse gas emissions.[19] Nonetheless, the SC-CO_2 remains a useful metric for assigning value to greenhouse gas emission reductions. The underpinning methodology for calculating the SC-CO_2 and the estimates of the SC-CO_2 underwent multiple stages of interagency consultation, public comment, and peer review, and the OMB has previously concluded that the use of the SC-CO_2 is consistent with the requirements of OMB's Information Quality Guidelines Bulletin for Peer Review and OMB Circular A-4.[20]

Domestic public health impacts of the rule, meanwhile, include thousands of avoided premature deaths and asthma attacks, among other morbidity events, brought about by reduced exposure to $PM_{2.5}$ and ozone associated with reduced emissions of SO_2 and NO_x. Other domestic benefits, such as reduced exposure to hazardous air pollutants (HAP),

[16] EPA. *Regulatory Impact Analysis for the Clean Power Plan Final Rule*, EPA-452/R-15-003 (2005) at ES-23 (these figures reflect EPA's upper-bound estimate for net benefits under a mass-based compliance approach, applying a 3% discount rate to climate and air quality health co-benefits). (2011$ values have been converted to 2016$ using a factor of 1.079) (hereinafter "Clean Power Plan RIA").
[17] *Id.* at ES-15, 23.
[18] *Id.* at 4-3.
[19] Executive Order 13783: Promoting Energy Independence and Economic Growth §5 (Mar. 28, 2017).
[20] *Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide* (Aug. 2015) at 3.

ecosystem effects, and visibility improvements were not monetized in EPA's cost-benefit analysis for the rule.[21]

Moreover, EPA expects the Clean Power Plan to create +37,570 to +59,700 jobs in demand-side energy efficiency in 2020, offset by a net decrease of -13,100 job-years in the electricity, coal, and natural gas sectors.[22] Though the two units cannot be added, it is evident that more jobs are created than lost, with creation concentrated in cleaner, more sustainable sectors.

Outside studies—both those conducted by independent researchers and environmental groups—largely affirm EPA's findings, or suggest even greater benefits from the rule. Buonocore et al. (2016) undertook an analysis of the costs and co-benefits of a U.S. power plant carbon standard that resembles the Clean Power Plan, finding that the net benefits of such a rule would be $12 billion (2010$) in 2020; it diverges from EPA in not discounting these benefits in its final analysis.[23] The high estimated co-benefits are likely realistic—the Integrated Planning Model study conducted by M.J. Bradley & Associates (2016) revealed that the targets of the rule are achievable under many of the fourteen scenarios analyzed. The study, which includes insights from diverse stakeholders, also forecasts household electric bills to drop 3 to 11 percent below the reference case in 2030, depending on the level of energy efficiency and policy option.[24] Synapse Energy Economics (2016), backed by a grant from the Energy Foundation, supported this conclusion, projecting that the Clean Power Plan would save consumers $3 to $17 on their monthly electric bills, with the variation arising from different energy efficiency savings scenarios.[25]

A study by Linn, Burtraw, and McCormack (2016) for Resources for the Future (RFF) found potential compliance costs to be higher than EPA's estimates, providing a counterpoint to other analyses. Their simulation of nearly fifty implementation scenarios for the Clean Power Plan yielded total compliance costs of $6.3 billion per year in 2025 and $8.4 billion in 2030 (2011$), compared to EPA's $1 to $3 billion in 2025 and $5.1 to $8.4 billion in 2030. Net benefits would still be positive under these projected costs. The study also asserts that the costs imposed upon the coal industry by the rule are miniscule compared to the recent effect of natural gas prices on the profitability of coal—so that the rule results in near-zero costs beyond current trends until 2025, particularly if states reduce emissions by expanding their utilization of natural gas-fired generation facilities instead of immediately dismantling coal-fired power plants.[26]

Analyses commissioned by conservative-leaning or industry groups reported fewer benefits and even higher costs. Lesser's (2016) study for the Manhattan Institute critiques EPA's comparison of global climate and economic benefits to U.S.-only costs, as well as the agency's methodology for estimating climate and health co-benefits and compliance costs.

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[21] Clean Power Plan RIA at ES-11.
[22] Clean Power Plan RIA at 6-35.
[23] Jonathan J. Buonocore et al., *An Analysis of Costs and Health Co-Benefits for a U.S. Power Plant Carbon Standard*, 11(6) PLOS ONE e0158792 (2016).
[24] M.J. Bradley & Associates, *EPA's Clean Power Plan: Summary of IPM Modeling Results with ITC/PTC Extension* (2016) at 3,26.
[25] Pat Knight et al., Synapse Energy Economics, Inc., *Cutting Electric Bills with the Clean Power Plan - EPA's Greenhouse Gas Reduction Policy Lowers Household Bills: March 2016 Update* (2016) at ii.
[26] Joshua Linn et al., Resources for the Future (RFF), *An Economic Assessment of the Supreme Court's Stay of the*
Clean Power Plan and Implications for the Future, RFF DP16-21 (2016) at 5, 18, 20.

Notably, Lesser claims that the Clean Power Plan will have no measurable impact on world climate, eliminating the possibility of any climate benefits.[27] And in an analysis commissioned by the American Coalition for Clean Coal Energy, NERA Economic Consulting (2015) modeled two compliance scenarios for the Clean Power Plan, finding that the regulation would lead to large reductions in CO_2 emissions, but also increases in energy expenditure and average annual retail electricity rate period.[28] The modeling did not monetize climate or health benefits related to reductions in emissions, which may offset even these high projected costs.

B. Motor Vehicle Emission Standards

a) Light-Duty Vehicles

The greenhouse gas emission standards / fuel economy standards for light-duty vehicles are, like the Clean Power Plan, projected to bring about more societal gains than losses.

According to EPA, standards set for light-duty motor vehicles from model years 2012 to 2016 are expected to result in monetized net benefits of $34.7 billion in 2020 and $100.4 billion in 2030.[29] Similar standards for light-duty vehicles from model years 2017 to 2025 are expected to result in monetized net benefits of $168 million in 2020 and $81.4 billion in 2030, in addition to net benefits from the first phase of the standards.[30]

The same set of factors were considered in both cost-benefit analyses, including:

- For model years 2012-2016: reductions in CO_2 emissions of approximately 153 million short tons in 2020 and 301 million in 2030;[31]
- For model years 2017-2025: additional reductions in CO_2 emissions of approximately 25 million short tons in 2020 and 272 short tons in 2030;[32]
- Health co-benefits arising as a result of reductions in co-pollutants such as NO_x, volatile organic compounds (VOCs), and air toxics;
- Massive fuel savings arising from better fuel economy;
- Improved energy security in the case of a price shock;
- The value of reduced refueling and increased traveling (the latter just for 2017-2025);
- The costs of accidents, noise, and congestion due to increased driving; and

[27] Jonathan Lesser, *Missing Benefits, Hidden Costs: The Cloudy Numbers in the EPA's Clean Power Plan* (June 2016) at 5-6.
[28] NERA Economic Consulting, *Energy and Consumer Impacts of EPA's Clean Power Plan* (Nov. 5, 2016) at 3-5.
[29] EPA, *Regulatory Impact Analysis: Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards*, EPA-420-R-10-009 (2010) at 8-24. (2007$ values have been converted to 2016$ using a factor of 1.145) (hereinafter "Light-Duty RIA (2010)").
[30] EPA, *Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards*, EPA-420-R-12-016 (2012) at 7-27. (2010$ values have been converted to 2016$ using a factor of 1.101) (hereinafter "Light-Duty RIA (2012)").
[31] Light-Duty RIA (2010) at 5-4.
[32] Light-Duty RIA (2012) at 4-133.

- Compliance costs for regulated vehicle manufacturers.

Again, the SC-CO_2 was used by EPA to calculate the value of reduced emissions and energy consumption—which, over the lifetime of model year 2012-2016 vehicles, will total 960 million metric tons of greenhouse gases and 1.8 billion barrels of oil.[33] Excluded from the monetized greenhouse gas benefits are the emissions reductions of non-CO_2 greenhouse gases, such as hydrofluorocarbons, CH_4, and nitrous oxide (N_2O), though these reductions are also expected to reap climate benefits.[34] Public health benefits *are* monetized, and include over 430 avoided premature deaths and 230 non-fatal heart attacks in 2030, across both rules.[35] The sum of social and economic benefits is more than double the estimated compliance cost in almost every year analyzed for both rules—even with the internalization of effects such as the accidents, noise, and congestion that are produced by more convenient, less expensive driving. The ratio of benefits to costs becomes even more impressive when the values are summed across rules, as they are additive for the two phases.

Strikingly, fuel savings alone outweigh the costs of compliance, without factoring in the climate or health impacts of the rule. For an individual consumer, the 2012-2016 rule adds $950 to the cost of a vehicle, an amount that can be recouped within three years if the vehicle was bought in cash, and immediately if it was bought on credit—due entirely to fuel savings.[36] The payback period is slightly longer for the 2017-2025 rule at 3.5 years,[37] but still much shorter than the lifetime of the vehicle.

Furthermore, some studies claim that EPA may have overestimated costs for compliance, widening net benefit estimates. Lutsey et al. (2017) of the International Council on Clean Transportation write that emerging technologies make it possible to lower emissions and improve fuel economy using cost-effective approaches. They believe the costs to achieve emissions targets are 34 to 40 percent lower than projected in EPA's U.S. Midterm Evaluation Regulatory Analysis—the development of advanced engines, light-weighting technology, and electric vehicles is occurring faster and cheaper than EPA predicted.[38] This means that payback periods will grow briefer and more advantageous to the consumer as technologies evolve and penetrate the fleet, allowing manufacturing companies to exceed the standards.

Other studies point to the peculiarity of the so-called "efficiency gap." If energy-saving technologies are economically beneficial in the long run, why are consumers hesitant to pay the higher initial costs, such that government intervention is required to implement higher fuel economy standards? There are several possibilities, the most likely of which is that consumers discount future energy savings too heavily, focusing more on the immediate consequences of an expensive purchase. Gayer and Viscusi critique EPA's easy acceptance of this explanation and point to the agency's 2011 Motor Vehicle Fuel Economy Label Final Rule, which should have addressed consumer choice failures by securing consumers

[33] EPA Office of Transportation and Air Quality, *Regulatory Announcement: EPA and NHTSA Set Standards to Reduce Greenhouse Gases and Improve Fuel Economy for Cars and Trucks*, EPA-420-F-12-014 (2010) at 2 (hereinafter "Light-Duty Regulatory Announcement (2010)").
[34] Light-Duty RIA (2010) at ES-2.
[35] *Id.* at 7-93, 7-94; Light-Duty RIA (2012) at 6-80, 6-81.
[36] Light-Duty Regulatory Announcement (2010) at 3.
[37] *Id.* at 2.
[38] Nic Lutsey, et al., *Efficiency Technology and Cost Assessment for U.S. 2025-2030 Light-Duty Vehicles* (2017), at iv.

unfettered access to fuel economy information—if the label rule, which was not mentioned in the Regulatory Impact Analysis for the light-duty fuel economy standards, had any benefits, then perhaps the benefits for the fuel economy standards are overstated. The authors also critique EPA's comparison of global climate benefits to more localized costs, though it must be noted that these climate benefits are a small fraction of the total benefits calculated by the agency.[39]

Another explanation for the efficiency gap is the existence of hidden costs, such as a decline in vehicle quality after the incorporation of energy-efficient technologies. If hidden costs are high enough, equaling or surpassing the benefits of fuel savings, consumers would not be incentivized to purchase energy-efficient vehicles on their own. Helfand et al. (2016) delved into this subject by analyzing the content of auto reviews, searching for signs that consumers' utility was lessened by new technology, but found that energy-efficient technologies and negative characteristics were not strongly correlated; indeed, hidden benefits appear more likely than hidden costs.[40]

It is more difficult to quantify the effect of light-duty vehicle standards on job creation. As EPA notes, regulation should have minimal impact on net job growth or loss if the economy is at full employment. In other cases, there are no sure methods to predict the hiring and firing methods of firms. EPA may find that jobs grow in one sector or part of the process, but these jobs may be reallocated from a different sector, and ultimately indicative of net loss rather than net growth.[41] While the Regulatory Impact Analysis for the 2012-2016 standards for light-duty vehicles does not address the effect of the rule on employment, the 2017-2025 standards suggest that the total employment impact ranges from +30,300 to +148,800 job-years in the motor vehicle manufacturing sector, with unquantified gains in other sectors. Overall, the employment effect is expected to be positive.[42]

b) Medium- and Heavy-Duty Vehicles

Emissions standards for medium- and heavy-duty motor vehicles model years 2014-2018 (Phase 1) and 2019-2028 (Phase 2) display similar patterns for costs and benefits. EPA projects monetized net benefits of $10 billion in 2020 and $27.3 billion in 2030 for Phase 1[43] and monetized net benefits of $31.5 billion in 2020 and $74.4 billion in 2030 for Phase 2.[44] As with the light-duty vehicle rules, costs, benefits, and net benefits are additive across the two rules. EPA calculations accounted for:

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[39] Ted Gayer & W. Viscusi, *Overriding consumer preferences with energy regulations*, 43 Journal of Regulatory Economics (2013) at 250-7.
[40] Gloria Helfand et al., *Searching for hidden costs: A technology-based approach to the energy efficiency gap in light-duty vehicles*, 98 Energy Policy (2016).
[41] Light-Duty RIA (2012) at 8-19.
[42] Light-Duty RIA (2012) at 8-28, 8-32.
[43] EPA, *Regulatory Impact Analysis, Final Rulemaking to Establish Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles*, EPA-420-R-11-901 (2011), at 9-46 (hereinafter "RIA Heavy-Duty Phase I"). 2009$ values have been converted to 2016$ using a factor of 1.114.
[44] EPA, *Regulatory Impact Analysis, Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2*, EPA-420-R-16-900 (2016), at 8-74 (these figures assume EPA's estimate for net benefits under analysis Method B and in comparison to scenario 1a, in which fuel economy is not expected to improve without regulation) (hereinafter "Heavy-Duty RIA Phase II "). 2013$ values have been converted to 2016$ using a factor of 1.042.

- For Phase 1: reductions in CO_2 emissions of approximately 80 MMT in 2030, along with reductions in CH_4 and N_2O;
- For Phase 2: additional reductions in CO_2 emissions of approximately 40 MMT in 2025 and 179 MMT in 2040, along with reductions in CH_4 and N_2O;
- Health co-benefits arising as a result of reductions in co-pollutants such as sulfur oxides (SO2) and NOx);
- Massive fuel savings arising from better fuel economy;
- Improved energy security in the case of a price shock;
- The value of reduced refueling and increased traveling;
- The disbenefit of accidents, noise, and congestion due to increased driving; and
- Compliance costs for regulated vehicle manufacturers.

As with light-duty vehicles, the regulations address greenhouse gas emissions, with Phase 2 standards lowering greenhouse gas emissions by nearly 200 MMT CO_2 equivalent (CO_2e) in 2050—while simultaneously reducing exposure to harmful co-pollutants such as NO_x and SO_x. The climate benefits of reduced CO_2, CH_4, and N_2O (but not hydrofluruocarbons) were monetized through the SC-CO_2 and other frameworks; monetized health co-benefits resulting from reduced emissions of harmful co-pollutants include approximately 440 premature deaths averted by Phase 1 standards in 2030 and approximately 640 averted by Phase 2 standards in 2040. When combined with economic benefits, the net benefits increase dramatically from year to year. According to an RFF study by Leard et al. (2016), however, these may be overestimates. The authors suggest that the rebound effect, in which lower per-mile fuel costs induce an increase in energy use, is greater for tractor trailers than assumed by EPA. This implies that projected fuel savings and emissions reductions from the standards may be overestimated in the government's analysis. The authors also find that the *short-run* rebound effect may be smaller than expected due to the transition from unregulated older trucks to regulated new trucks, resulting in greater short-run emission reductions.[45] Regardless, the margin between costs and benefits is so large across all years analyzed that monetized net benefits are likely to remain not just positive, but high.

The matter of the efficiency gap is again pertinent, especially as firms that operate trucks have narrow profit margins: why is this industry not moving to fuel-efficient vehicles on its own? The agencies offer up several reasons, such as a lack of adequate or reliable information, the state of the resale market, split incentives between owners and operators of the trucks (the operators purchase fuel), and the transaction costs of the transition. Gayer and Viscusi level the same criticisms they had for the light-duty standards at these explanations, pointing to labeling standards and other solutions that might resolve these market failures.[46]

There were uncertainties surrounding the employment impact of the standards, but the overall effect is likely to be positive. Of Phase 1, EPA concluded the rulemaking would have a "relatively small effect on net employment" through the truck and engine manufacturer industry and related industries.[47] Fuel savings brought about by both phases, however, may

[45] Benjamin Leard et al., Resources for the Future (RFF), *Fuel Costs, Economic Activity, and the Rebound Effect for Heavy-Duty Trucks*, RFF DP 15-43-REV, 3-5 (2016).
[46] Ted Gayer & W. Viscusi, *Overriding consumer preferences with energy regulations*, 43 Journal of Regulatory Economics (2013) at 257-9.
[47] Heavy-Duty RIA Phase I (2011) at 9-56.

stimulate spending, and thus employment, in other sectors. Additionally, EPA expects Phase 2 to increase employment in the motor vehicle manufacturing sector by +500 to +4,500 job-years in 2027, and for employment gains in truck shipping. Due to fuel savings, there may be less employment in the fuel provision sectors.[48]

C. New Source Performance Standards for Oil and Gas Sector

The 2016 New Source Performance Standards for the Oil and Gas Sector acts to curb emissions of CH_4, VOCs, and toxic air pollutants from new, reconstructed, and modified oil and gas sources, potentially limiting CH_4 emissions to 40 to 45 percent below 2012 levels by 2025. Benefits surpass costs across the years analyzed, though with narrower margins than some other rules.

According to EPA projections, the net monetized benefits of the rule could reach approximately $37 million in 2020 and $180 million in 2025.[49] EPA's calculations accounted for:

- Reductions in CH_4 emissions of approximately 300,000 short tons in 2020 and 510,000 short tons in 2025;[50] and
- Compliance costs for regulated sources.

EPA used the social cost of CH_4 (SC-CH_4), analogous to SC-CO_2, to value the effect of reduced CH_4 emissions. Though VOCs give rise to ozone (exposure to which can lead to reduced lung function and asthma) and toxic air pollutants are linked to cancer, EPA did not quantify or monetize public health impacts for this rule due to difficulties in modeling the impacts of reductions. Improvements in visibility, ecosystem effects, and additional natural gas recovery were also not modeled. EPA did, however, discuss employment impacts—projecting 1,100 annual full-time equivalents (FTEs) needed to comply with the requirements in 2020 and 1,800 annual FTEs in 2030, in addition to one-time labor requirements of 270 FTEs in both years.[51]

In studying the policy, however, Ravikumar and Brandt (2017) found that costs of the policy will be significantly lower than expected—27 percent lower than EPA estimates. Their work also indicates that the technology used to detect leaks is not as effective as assumed, suggesting that CH_4 reductions will fall short of 2025 targets by 20 to 50 percent.[52] Thus, both costs and benefits might be lower than EPA states—though net benefits are likely to remain positive across the years analyzed if the worst case for benefits reductions is avoided.

[48] Heavy-Duty RIA Phase II (2016) at 8-87, 8-89.
[49] EPA, *Regulatory Impact Analysis of the Final Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources*, EPA-452/R-16-002 (2016), at 5-2. (2012$ values have been converted to 2016$ using a factor of 1.059).
[50] *Id.* at 5-4.
[51] *Id.* 1-5, 1-6.
[52] Arvind P. Ravikumar & Adam R. Brandt, *Designing better methane mitigation policies: the challenge of distributed small sources in the natural gas sector*, 12(4) Environmental Research Letters (2017).

D. Methane Waste Prevention Rule

Relatedly, the Bureau of Land Management's Methane and Waste Prevention Rule focuses on limiting the waste of natural gas that occurs during oil and gas production by reducing venting, flaring, and leaking on public and Indian lands. The amount is significant: between 2009 and 2015, about 462 billion cubic feet of natural gas were wasted by oil and gas producers on such lands.[53]

BLM estimates this rule will result in monetized net benefits of approximately $126 million in 2020, and $197 million in 2025.[54] BLM's calculations involved:

- Reductions in CH_4 emissions of approximately 177,000 short tons in 2020 and 179,000 short tons in 2025;
- Revenues from the sale of recovered natural gas;
- The social cost of minor additions of CO_2 to the atmosphere; and
- Costs of compliance for regulated sources.

While CH_4 reductions were valued by the SC-CH_4 (and small CO_2 increases by the SC-CO_2), BLM's analysis did not monetize benefits to public health, the climate impacts of VOC reductions, and lowered HAP emissions.[55] Even without their inclusion, conservatively-estimated benefits outweigh costs by roughly 2:1 in both 2020 and 2025—which makes sense, as the costs of compliance are greatly subsidized by the recovery and sale of enough natural gas to supply hundreds of thousands of houses a year.[56] The rule is not expected to adversely impact employment, and may require labor for the installation or replacement of machinery.[57]

IV. Conclusion

The overall benefits of the federal greenhouse gas emission standards issued for power plants, oil and gas sources, and motor vehicles vastly outweigh the costs of implementing those standards. As the Trump Administration proceeds with the unraveling of federal climate policies and regulations, there will be opportunities to comment on proposals for the modification or repeal of these standards.

Finally: for those seeking a more detailed breakdown of costs and benefits, we recommend looking at the appendix to this paper, which is available online.[58] The appendix also contains a more detailed overview of how costs and benefits were aggregated across rules.

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[53] Bureau of Land Management, *Fact Sheet on Methane and Waste Prevention Rule*, 1-2 (2015).
[54] Bureau of Land Management, *Regulatory Impact Analysis for: Revisions to 43 CFR 3100 (Onshore Oil and Gas Leasing) and 43 CFR 3600 (Onshore Oil and Gas Operations)* (2016), at 112. (2012$ values have been converted to 2016$ using a factor of 1.059).
[55] *Id.* at 4-6.
[56] *Fact Sheet on Methane and Waste Prevention Rule, supra* note 53.
[57] *Regulatory Impact Analysis, supra* note 54, at 8.
[58] A PDF of the appendix is available at: http://columbiaclimatelaw.com/files/2016/06/costs_benefits_appendix.pdf. An excel file of the appendix is available at: http://columbiaclimatelaw.com/files/2016/06/costs-benefits-appendix.xls.