

DON'T BELIEVE THE "JOB KILLER" HYPE:

Decades of Economic Research Show that Environmental Regulations are Good for the Economy



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THE ENVIRONMENTAL INTEGRITY PROJECT

The Environmental Integrity Project (<http://www.environmentalintegrity.org>) is a nonpartisan, nonprofit organization established in March of 2002 by former EPA enforcement attorneys to advocate for effective enforcement of environmental laws. EIP has three goals: 1) to provide objective analyses of how the failure to enforce or implement environmental laws increases pollution and affects public health; 2) to hold federal and state agencies, as well as individual corporations, accountable for failing to enforce or comply with environmental laws; and 3) to help local communities obtain the protection of environmental laws.

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Executive Summary

When Donald Trump announced that he had picked billionaire investor Carl Icahn as a special adviser on regulation, he said that Icahn would be a "leader in helping American entrepreneurs shed job-killing regulations that stifle economic growth."¹ And there it is again. The perennial bogeyman. The mythological notion that regulations are bad for jobs and the economy has been repeatedly debunked,² but it keeps coming back. This report reviews the evidence, and shows, once again, that there is no truth to the idea of "job-killing" regulations. In fact, decades of economic research demonstrate that the economic impact of environmental regulations has been overwhelmingly positive.

JOBS LOST AND JOBS GAINED

A large body of evidence accumulated over the past 30 years shows that regulations, and in particular environmental regulations, tend to create jobs, not kill them. Although it is true that regulations sometimes lead to layoffs in regulated sectors of the economy, and these are serious upheavals for affected families, they represent a small fraction of total layoffs.

- According to information reported by employers to the U.S. Bureau of Labor Statistics, only 0.2% of "mass" layoffs – layoffs of 50 or more workers – are caused by government intervention or regulations (of any kind, not just environmental regulations).³
- For every job lost due to regulations, 15 are lost due to "cost cutting" and 30 are lost due to "organizational changes" (e.g., change in ownership).⁴

And the jobs lost are just one side of the coin – regulations also stimulate new hiring, for example of construction workers to build sewage treatment plants and air pollution control systems at power plants. On balance, the net effect tends to be positive. When looking at the effect of pollution control spending over time, researchers have estimated that some industries show no significant change in employment, while others, for example the plastics industry, see significant job creation.



Clean water regulations require the hiring of construction workers and engineers to build and upgrade sewage treatment plants.

When looking at the effects of specific regulations – for example, fuel efficiency standards – researchers have predicted significant job losses, but also significant job creation that more than offsets the losses.

- In the case of fuel efficiency standards, net job creation was estimated to be in the hundreds of thousands, with five jobs created for every job lost.⁵

Regulations that guide the energy sector away from fossil fuels and toward clean energy will lead to job losses in the fossil fuel industry, but will also create jobs in the clean energy sector, again resulting in a net increase in jobs. This is because clean energy requires more labor for every unit of electricity generated. Clean energy also produces more jobs for every dollar invested.

- For every dollar invested, wind and solar projects create twice as many jobs as fossil fuel projects.⁶
- Wind and solar generate almost five many times more jobs, per Gigawatt-hour of electricity generation, than fossil fuels.⁷

And the jobs generated in the clean energy sector are good jobs: One of the studies reviewed in this report shows that, per dollar invested, clean energy projects create more jobs in manufacturing and construction, and more jobs at a high wage, than fossil fuel projects.⁸

PRODUCTIVITY AND COMPETITIVENESS

The evidence also shows that environmental regulations do not hamper productivity growth. A 2014 review paper from the London School of Economics concluded that the effect of environmental regulations on competitiveness is “negligible compared to other factors such as market conditions and the quality of the local workforce.”⁹ This is true at the national level, at the state level, and at the industry level.

- A 2014 report from the Organization for Economic Cooperation and Development (OECD) found that stronger environmental policies lead to short-term gains in productivity growth, resulting in permanently higher levels of productivity.¹⁰

NET ECONOMIC BENEFIT

Finally, when looking at the total effect of environmental regulations on the economy, the effect is overwhelmingly positive. According to the Office of Management and Budget, cost-benefit calculations for all major regulations between 2005 and 2014 showed economic benefits that dramatically exceeded costs, every single year.¹¹

- The benefits of environmental regulations have exceeded costs by a ratio of more than 10:1.¹²
- All told, major regulations provide net economic benefits to the U.S. of over \$500 billion per year.¹³

The idea that regulations are bad for jobs and the economy is nonsense. The facts show that our environmental protections are immensely valuable, from an ecological perspective, from a human health perspective, and also from an economic perspective.



In response to the federal Clean Water Act, dozens of construction and engineering firms are working to fix leaks in Baltimore's sewage system.

I. Jobs Lost, Jobs Gained.

The loss of jobs can be very painful for employees, their families, and their communities, and the significance of these upheavals should not be minimized. The government should do more to help with these transitions. However, layoffs in the U.S. are almost always caused by something other than environmental regulations: According to employers, regulations are responsible for less than 1% of layoffs each year.¹⁴ Furthermore, job losses are only one side of the equation. The same industries may also hire new workers as they build pollution-control equipment or replacement facilities. In the broader economy, jobs are created as companies innovate to meet demand with new technologies and processes. A complete analysis has to consider the net employment effect, including both jobs lost and jobs gained. Researchers have looked at this issue from many angles. Sometimes they consider only losses, sometimes only gains, and sometimes both. Overall, the evidence suggests that regulations do not have a significant effect on employment; if anything, they generate a small increase in the number of jobs.

Some researchers have looked only at the jobs created by environmental policies:

- Economist Roger Bezdek and others reviewed the growth of the environmental protection industry between 1970 and 2003.¹⁵ In terms of employment, the industry grew from 704,000 jobs in 1970 to 5 million jobs in 2003.¹⁶ The authors also looked closely at the types of jobs created in six states, and found that environmental protection jobs were more likely to be in fields like manufacturing and professional, scientific, and technical services than one would see in the average statewide economy.¹⁷
- Looking at a specific example of how pollution controls create jobs, a report prepared for the Utility Air Regulatory Group estimated that the installation of a sulfur dioxide scrubber on a 500-Megawatt (MW) coal plant would create over 100 full-time jobs for three years, and that the installation of nitrogen oxide controls would create roughly 100 full-time jobs for 28 months.¹⁸

- To the extent that regulations on the energy sector shift the balance of energy generation away from fossil fuels and toward clean energy, the regulations are creating clean energy jobs. In a 2011 analysis, the World Bank calculated the jobs created by specific renewable energy projects. For example, a 75-MW solar project in Washington State was



Installations of industrial scrubbers like these and other types of pollution controls have resulted in the creation of thousands of jobs in response to environmental regulations.

estimated to create the equivalent of 167 full-time jobs for 20 years, while a 4-Gigawatt (GW) wind project, including associated transmission infrastructure, was estimated to create the equivalent of 1,500 full-time jobs.¹⁹

Others focus only on jobs lost:

- University of Chicago Economist Michael Greenstone looked at the effect of the Clean Air Act on jobs in polluting manufacturing industries.²⁰ Specifically, he analyzed manufacturing jobs in “nonattainment” counties – counties that could not meet national air quality standards – from 1972-1987. Greenstone estimated that, relative to “attainment” counties, the nonattainment counties lost approximately 40,000 jobs per year.²¹ There is at least one important caveat to these results. Greenstone was only looking at job losses within a specific sector of the regulated economy, and only in part of the country. The national manufacturing sector as a whole did not lose jobs over this period;²² Greenstone acknowledged that many of the jobs lost in nonattainment counties probably moved to attainment counties, which means that his results “probably overstate the national loss of activity.”²³
- In a book published in 2013, Economists Wayne Gray and Ronald Shadbegian looked at manufacturing employment between 1973 and 1994 and estimated that pollution control costs could result in “statistically significant but very small” job losses.²⁴ Specifically, the authors estimated that a 10% increase in pollution control costs would reduce employment by 0.08%.²⁵ The authors did not consider possible job gains. They did state, however, that they “expect that the number of jobs created

by additional abatement spending would approximately equal the number of jobs lost.”²⁶

The examples cited above have either looked at jobs created or jobs lost; a more complete analysis looks at both. When researchers take both losses and gains into account, they find that the net effect on employment is either insignificant,²⁷ or positive:

- Economist Richard Morgenstern and others analyzed the effect of environmental spending on employment in four high-pollution industries – pulp and paper mills, plastics manufacturing, petroleum refining, and iron and steel mills – between 1979 and 1991.²⁸ The authors evaluated factors that would lead to job losses (e.g., increased consumer prices and reduced demand) and factors that would create jobs (e.g., changes in production that require more labor). Overall, the authors found more jobs created than lost. The net effect on employment was significantly positive for plastics and petroleum, and insignificant for the other two industries. Across all four industries, environmental spending was associated with a small net increase in employment.
- Economist Anna Belova and others updated the Morgenstern analysis in 2013, extending the time period through 2005 and adding six additional industries.²⁹ The authors found significant net increases in employment for three industries (paper, petroleum, and plastics), and insignificant, though generally positive, changes in employment for the other industries. Again, spending to comply with environmental regulations did not lead to job losses, and in some cases led to significant gains.
- In 2005, Economists Roger Bezdek and Robert Wendling calculated the long-term employment impacts of fuel efficiency standards on all industries in the U.S. economy.³¹ The authors estimated that enhanced fuel economy standards would cost jobs in some sectors (e.g. petroleum pipelines and refining), but create jobs in most sectors, with a net positive effect on employment. For example, looking at an “advanced” suite of fuel efficiency standards, the authors predicted that 86,000 jobs would be lost by 2020, but that 433,000 jobs would be created, for a net gain of 347,000 jobs.³²



Through the increase of fuel efficiency standards, it's predicted that the automotive industry will gain over 150,000 jobs by 2020.³⁰

- A 2011 report from the Political Economy Research Institute examined the effect of two proposed Clean Air Act regulations, both of which would require pollution controls on coal plants, on employment in the Eastern United States. The authors estimated that the construction phase – five years during which pollution controls and new generating capacity would be built – would employ roughly 290,000 people. Over the longer term, roughly 18,000 jobs would be lost as older coal plants retired, but over 22,000 jobs would be created to maintain new pollution controls and new sources of electricity, for a net gain of over 4,000 permanent jobs.³³
- One of the two rules analyzed in the 2011 report cited immediately above was the 2012 Mercury and Air Toxics Standards, also known as the MATS rule or the ‘air toxics’ rule.³⁴ The EPA conducted its own analysis of the rule’s employment impacts, and estimated that there would be 46,000 job-years of temporary hiring to build pollution controls,³⁵ and an additional net gain of 8,000 permanent jobs.³⁶ An alternative analysis estimated that the rule would result in a net increase of 117,000 jobs, including both pollution control construction and permanent positions.³⁷

Regulations that shift the balance of U.S. energy generation toward clean energy also create jobs, on balance, as several studies have shown:

- In 2007, Economist Stephen Grover, working under contract for the Department of Energy, estimated the employment effects of adding new generating capacity as either solar photovoltaic (PV) or natural gas. Grover estimated that the addition of 10 GW of solar capacity by 2015 would create 45,000 more jobs than the addition of natural gas capacity.³⁸ As an estimate of job creation by the solar industry, Grover’s results are almost certainly an underestimate. Grover’s “high” prediction for 2015 included 10 GW of total capacity, 16.6 TWh of generation, and 48,960 people directly employed in the solar industry. In fact, 2015 solar PV capacity was over 25 GW,³⁹ net generation was over 35 TWh,⁴⁰ and the solar industry employed over 200,000 people.⁴¹
- In 2009, Economists at the University of Massachusetts, Amherst found that per dollar of spending, solar and wind energy projects create twice as many jobs as coal or natural gas, including more jobs in manufacturing and construction, and more “high-credentialed” jobs at an average hourly wage of \$24.50.⁴²
- Clean energy also creates more jobs per unit of energy generation. In 2010, researchers at the University of California, Berkeley compiled the results of multiple studies and concluded that “all renewable energy and low carbon sources generate more jobs than the fossil fuel sector per unit of energy delivered.”⁴³

- A 2011 World Bank analysis confirmed that renewable and energy efficiency projects, per dollar spent or per unit of energy output, generate more employment than fossil fuel projects, even after taking jobs in fuel mining, processing, and transportation into account.⁴⁴
- In 2015, researchers at Duke University evaluated jobs data from 2008-2012, looking specifically at operations and maintenance jobs in electricity generation. The data show that jobs lost in the coal industry (49,000 jobs) were more than offset by jobs gained in wind and solar (79,000 jobs).⁴⁵

II. Environmental Regulations Do Not Hinder Productivity or Competitiveness

A number of studies have looked at the effect of environmental regulations on productivity at the international and interstate levels, and at the level of regulated industries.

- One early analysis looked at changes in productivity in the United States, Canada, and Germany in the 1960s and 1970s as a function of pollution abatement spending.⁴⁶ For the United States and Canada, environmental spending appeared to have depressed productivity growth in the 1960s, but stimulated productivity growth in the 1970s. For Germany, the authors only had data from 1972-1981, but throughout that time period regulation was associated with slightly higher productivity growth. As the authors explain, “[i]n the 1973-80 time period, without environmental regulation U.S. and Canadian productivity growth would have been about 0.03 percentage points worse per year, whereas Germany would have been only 0.005 percent worse on average.”⁴⁷
- Another early analysis ranked the U.S. states according to the strength of their environmental policies in the 1970s, and evaluated subsequent economic performance in the 1980s.⁴⁸ The author found that states with stronger environmental policies saw faster growth in gross state product, in total non-farm employment, in construction employment, and in overall labor productivity.⁴⁹ Among other things, the author noted that “[g]rowth in gross state product among the strong environmental states was more than twice that of environmentally weak states.”⁵⁰ When comparing the 1980s to the 1970s, economic growth accelerated in states with strong environmental policies, but slowed in states with weak environmental policies.⁵¹
- In 2014, the Organization for Economic Cooperation and Development (OECD) ranked OECD countries by their relative “environmental policy stringency” and looked for an effect on productivity.⁵² Between 1990 and 2012, at the national level,

the “bottom-line result” was that “an increase in stringency of environmental policies does not harm productivity growth or productivity levels.”⁵³

- A 2014 review paper from the London School of Economics concluded that

[T]here is little evidence to suggest that strengthening environmental regulation deteriorates international competitiveness. The effect of current environmental regulations on where trade and investment take place has been shown to be negligible compared to other factors such as market conditions and the quality of the local workforce.⁵⁴

At the level of regulated industry, the story is very similar: Environmental regulations tend to have an effect on productivity and competitiveness that ranges from negligible to slightly positive.

- A 1995 paper reviewed the evidence on the effect of environmental regulations on the competitiveness of manufacturing firms, and concluded that “[o]verall, there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness.”⁵⁵ One key reason is that “international differences in environmental costs (as a fraction of total production costs) are trivial compared with apparent differences in labor costs and productivity.”⁵⁶
- A 2009 study looking at productivity among several industrial sectors in four countries, including the United States, concluded that “pollution abatement capital expenditures are not associated with a substantial decline in productivity.”⁵⁷ In some cases, pollution abatement spending was associated with small reductions in productivity growth (e.g., manufacturing in the United States), in other cases it was associated with small increases in productivity growth (e.g., manufacturing in Germany, chemicals and plastics in the United States), but in all cases the effects were very small.⁵⁸
- The 2014 OECD report cited above also looked at productivity growth at the industry and firm levels. At the industry level, the authors found that “a tightening in environmental policy stringency is associated with a subsequent short-run increase in productivity growth, which translates into permanently higher [productivity] levels.”⁵⁹ At the firm level, the effect on productivity growth varied by baseline levels of productivity, with only the more productive firms showing an increase in productivity growth.⁶⁰
- In 2015, a group of Italian researchers evaluated the effect of environmental regulations on productivity in European manufacturing, and concluded that “more stringent environmental regulation does not harm productivity ... Rather, the overall productivity effect is neutral.”⁶¹

III. The Total Economic Impact of Regulations is Overwhelmingly Positive

The effect of regulations on jobs or productivity should not be confused with the overall economic impact of regulation. A full accounting must also consider the economic benefits of, for example, cleaner air. Regulatory “cost-benefit analyses” attempt to make this kind of calculation. Cost-benefit analyses are imperfect,⁶² and they are systematically biased in two ways. First, the historical record shows that government and industry tend to overestimate costs.⁶³ Second, cost-benefit analyses always underestimate total benefits by ignoring the benefits that cannot be quantified. For example, when the EPA revised the Maximum Contaminant Level for arsenic in 2001, it only quantified the benefits of reduced lung and bladder cancer cases, despite the fact that arsenic is also associated with other types of cancer, neurological damage, and other health problems.⁶⁴ These two biases work in the same direction, with the result that cost-benefit calculations tend to overestimate the cost:benefit ratio (or underestimate the benefit:cost ratio).

Keeping the caveats in mind, the results of cost-benefit analyses conducted over the past ten years show that benefits dramatically outweigh costs across the board. In 2015, the U.S. Office of Management and Budget (OMB) reviewed the costs and benefits of all major rules between 2005 and 2014.⁶⁵ Benefits exceeded costs every single year, by large margins.⁶⁶ Over the ten-year period, annual costs were between \$68 and \$103 billion, while annual benefits were between \$261 and \$981 billion.⁶⁷ Looking specifically at EPA regulations, benefits were roughly ten times higher than costs.⁶⁸ In other words, the major regulations reviewed by OMB had an enormous net benefit, on the order of hundreds of billions of dollars per year, to the U.S. economy. Given the caveats discussed above, the true economic benefits are even greater.

IV. Discussion

The evidence discussed above shows that there is no simply no truth to the idea that regulations kill jobs or stifle growth. In fact, regulations provide huge economic benefits to our society, with minimal, though generally positive, effects on jobs and productivity. On the other hand, the absence of regulation can have severe economic consequences, with perhaps the most notable example being the 2008 financial collapse.⁶⁹ The millions of jobs lost through that failure to regulate are orders of magnitude higher than any projected job losses associated with new regulations. In short, environmental regulations are not just good for health and the environment, they are good for the economy. A knee-jerk roll-back of environmental regulations would be profoundly unwise, and would not be justifiable from an honest financial perspective.

What might a less-regulated future look like? In his study of states’ economic performance in the 1980s as related to environmental policies, Stephen Meyer made the following observation:

The period 1982-1989 is an especially good choice for analysis because the largest divergences in environmental policies among the fifty states occur at

this time. Most notably this period represents the height of New Federalism policies of the Reagan administration. Federal funding to the states was cut significantly; enforcement of federal regulations was scaled back; and the states were given broad new discretionary powers for implementing and enforcing policy.⁷⁰

The incoming Trump administration is very likely to repeat the same pattern. Scott Pruitt, selected by Trump to run the EPA, is expected to pursue “an increasing effort to delegate environmental regulations away from the federal government and towards the states.”⁷¹ If this happens, we may also see a repeat of what Meyer observed in the 1980s – states with stronger environmental policies will outperform weak states and create more jobs, while states with weak environmental policies will suffer.

At the international level, given the fact that environmental regulations appear to have no significant effect on competitiveness, and may even benefit the U.S. economy, there is simply no justification for backing away from our commitments to protecting human health and the environment. It is also worth noting that an argument implied by the rhetorical hostility to regulation – that the U.S. is at a disadvantage because we have such strict environmental policies – is misinformed. In fact, relative to other OECD countries on a scale of environmental stringency, the United States is below average.⁷² If anything, our environmental policies should be strengthened, not weakened. The U.S. economy, not to mention our health and our ecosystems, would benefit.

Notes

¹ Chris Isidore, “Trump taps Carl Icahn for regulations busting post,” CNN Money, Dec. 21, 2016, <http://money.cnn.com/2016/12/21/news/economy/donald-trump-carl-icahn>

² See, e.g., Eban Goodstein, *The Trade-Off Myth: Fact and Fiction about Jobs and the Environment*, Island Press, Washington D.C. (1999); I. Shapiro and J. Irons, *Regulation, Employment, and the Economy*, Economic Policy Institute Briefing Paper #305, at 21 - 25 (Apr. 2011); Cary Coglianese et al., eds., *Does Regulation Kill Jobs?*, University of Pennsylvania Press, Philadelphia PA (2013).

³ This can be seen through 2012, after which the Bureau of Labor Statistics stopped collecting mass layoff statistics due to budget cuts. For example, for the years 2010, 2011, and 2012, employers cited “government regulations/intervention” as the cause of layoffs 0.2%, 0.1%, and 0.3% of the time. U.S. Bureau of Labor Statistics, *Extended Mass Layoffs in 2012*, Report 1043, Table 4 (Sep. 2013). The same can be seen, for example, in the late 1980s, when environmental regulations were cited as the cause of less than 0.2% of layoffs each year. E. B. Goodstein, *Jobs and the Environment: The Myth of a National Trade-Off*, Economic Policy Institute, at Table 3 (1994).

⁴ Bureau of Labor Statistics, 2013, at Table 4.

⁵ R.H. Bezdek and R.M. Wendling, Potential long-term impacts of changes in US vehicle fuel efficiency standards, *Energy Policy* 33:407-419 (2005).

⁶ R. Pollin et al., *The Economic Benefits of Investing in Clean Energy*, Political Economy Research Institute and Center for American Progress, Table 5 (June 2009).

⁷ M. Wei et al., Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US?, *Energy Policy* 38:919-931, Table 2 (2010). Wind, energy efficiency, and solar PV generate 0.17, 0.38, and 0.87 job-years per GWh, respectively, while coal and natural gas generate 0.11 job-years per GWh.

⁸ Pollin, Tables 7 and 10.

⁹ A. Dechezleprêtre and M. Sato, *The impacts of environmental regulations on competitiveness*, Grantham Research Institute on Climate Change and the Environment (Nov. 2014).

¹⁰ S. Albrizio et al., *Do Environmental Policies Matter for Productivity Growth? Insights from New Cross-Country Measures of Environmental Policies*, OECD Economic Department Working Paper No. 1176 (Dec. 2014).

¹¹ U.S. Office of Management and Budget, *2015 Report to Congress on the Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act (2015)*, available at https://www.whitehouse.gov/sites/default/files/omb/foreg/2015_cb/2015-cost-benefit-report.pdf.

¹² Id. at 9. The costs of EPA regulations ranged from \$37 to \$45 billion, while the benefits were between \$160 and \$788 billion (2010 dollars). Assuming the midpoint of each range, the ratio of benefits to costs is 11.4.

¹³ Id. at 1 – 2. Again assuming the midpoints of annual costs (\$68-\$103 billion) and benefits (\$261-\$981 billion), total net benefits were \$536 billion per year.

¹⁴ This can be seen through 2012, after which the Bureau of Labor Statistics stopped collecting mass layoff statistics. For example, for the years 2010, 2011, and 2012, employers cited “government regulations/intervention” as the cause of layoffs 0.2%, 0.1%, and 0.3% of the time. U.S. Bureau of Labor

Statistics, Extended Mass Layoffs in 2012, Report 1043, Table 4 (Sep. 2013). The same can be seen, for example, in the late 1980s, when environmental regulations were cited as the cause of less than 0.2% of layoffs each year. E. B. Goodstein, *Jobs and the Environment: The Myth of a National Trade-Off*, Economic Policy Institute, at Table 3 (1994).

¹⁵ R.H. Bezdek et al., *Environmental Protection, the economy, and jobs: National and regional analyses*, *J Environ Mgmt* 86:63-79 (2008).

¹⁶ *Id.* at 72. This includes both direct and indirect employment. The industry added over 2 million jobs between 1970 and 1985, roughly the same period over which Greenstone (*supra*) estimates that the Clean Air Act may have cost 590,000 manufacturing jobs.

¹⁷ *Id.* at 73.

¹⁸ J. E. Cichanowicz, *Current capital cost and cost-effectiveness of power plant emissions control technologies*, prepared for the Utility Air Regulatory Group (Jan. 2010). Specifically, the author estimated that a Flue Gas Desulfurization (FGD) project would create 750,000 man hours over 36 months, and that a Selective Catalytic Reduction (SCR) project would require 500,000 man-hours over 28 months. *Id.* at 3-5. We assumed a standard 2,087 hours/per year for a full-time position.

¹⁹ R. Bacon and M. Kojima, *Issues in estimating the employment generated by energy sector activities*, World Bank, pages 29-31 (June 2011). This analysis included direct, indirect, and induced employment. The authors specifically calculated 3,347 job-years over the 20-year life of the 75-MW solar project, and 30,235 job-years over the 20-year life of the wind project.

²⁰ Michael Greenstone, *The Impacts of Environmental Regulations on Industrial Activity: Evidence from the 1970 and 1977 Clean Air Act Amendments and the Census of Manufactures*, National Bureau of Economic Research Working Paper 8484 (Sep. 2001). Specifically, Greenstone looked at employment in manufacturing industries that emit 7% or more of total industrial emissions of one of the “criteria pollutants,” which were, at the time, ozone, sulfur dioxide, total suspended particulates, and carbon monoxide. *Id.* at 6.

²¹ *Id.* at 26.

²² As Greenstone acknowledges, employment in the U.S. manufacturing sector fluctuated, but with no clear trend, and could therefore be described as “flat” during this period (*Id.* at 26). The manufacturing sector had 17.7 million workers in 1972 and 17.6 million workers in 1987. U.S. Department of Labor, Bureau of Labor Statistics (manufacturing employment data 1972-1987), https://data.bls.gov/timeseries/CES3000000001?amp%253bdata_tool=XGtable&output_view=data&include_graphs=true.

²³ Greenstone, at 27.

²⁴ W. B. Gray and R. J. Shadbegian, *Do the Jobs Effects of Regulation Differ with the Competitive Environment?*, in Coglianesi et al., eds., *Does Regulation Kill Jobs?*, pp. 51 – 69 (University of Pennsylvania Press, Philadelphia PA (2013)).

²⁵ *Id.* at 54.

²⁶ *Id.* at 66.

²⁷ C. Coglianesi and C. Carrigan, *The Jobs and Regulation Debate*, in Coglianesi et al., eds., *Does Regulation Kill Jobs?*, pp. 1 – 30, 7 (University of Pennsylvania Press, Philadelphia PA (2013) (“[T]o date the empirical work suggests that regulation plays relatively little role in affecting the aggregate number of jobs I the United States.”).

²⁸ R.D. Morgenstern et al., Jobs versus the Environment: An Industry-Level Perspective, Resources for the Future Discussion Paper 99-01-REV (June 2000); R.D. Morgenstern et al., Jobs Versus the Environment: An Industry-Level Perspective, J Environ Mgmt 43(3):412-436 (May 2002).

²⁹ A. Belova et al., Environmental Regulation and Industry Employment: A Reassessment, Center for Economic Studies Paper CES 13-36 (July, 2013).

³⁰ R.H. Bezdek and R.M. Wendling, Potential long-term impacts of changes in US vehicle fuel efficiency standards, Energy Policy 33:407-419, 415 and Table 5 (2005). The total net gain in jobs by 2020 under an “advanced” scenario was expected to be 346,948 jobs, of which roughly 155,000 were in the automotive industry.

³¹ Id. at 407-419

³² Id. at 415.

³³ J. Heintz et al., New Jobs – Cleaner Air: Employment Effects Under Planned Changes to the EPA’s Air Pollution Rules, Ceres and the Political Economy Research Institute (Feb. 2011).

³⁴ U.S. EPA, National Emission Standards for Hazardous Air Pollutants From Coal- and Oil-Fired Electric Utility Steam Generating Units and Standards of Performance for Fossil-Fuel-Fired Electric Utility, Industrial-Commercial-

Institutional, and Small Industrial-Commercial-Institutional Steam Generating Units; Final Rule, 77 Fed. Reg. 9304 (Feb. 16, 2012).

³⁵ A “job-year” is equivalent to one full-time job for one year. If the construction phase were to last 3 years (from the promulgation of the MATS rule through 2015), then 46,000 job-years would be equal to roughly 15,000 full-time jobs over that period of time.

³⁶ U.S. EPA, Regulatory Impact Analysis for the Final Mercury and Air Toxics Standards, EPA-452/R-11-011, at 6-12 (Dec. 2011).

³⁷ J. Bivens, The ‘Toxics Rule’ and Jobs, Economic Policy Institute Issue Brief #325 (Feb. 2012). Bivens’ analysis differed from EPA’s in that he calculated both direct and indirect (e.g., jobs with firms that supply materials for pollution controls) employment for the construction phase, and also estimated the number of jobs lost as a result of higher electricity costs (roughly 10,000 jobs). See also J. Bivens, Macroeconomic Effects of Regulatory Changes in Economies with Large Output Gaps, Economic Policy Institute Working Paper (Mar. 2012); J. Bivens, A Lifesaver, Not a Job Killer, Economic Policy Institute Briefing Paper #312 (June 2011) (revising EPA’s proposed jobs analysis).

³⁸ S. Grover, Energy, Economic, and Environmental Benefits of the Solar America Initiative, National Renewable Energy Laboratory NREL/SR-640-41998 (Aug. 2007).

³⁹ Solar Energy Industries Association, Solar Market Insights 2015 Q4, <http://www.seia.org/research-resources/solar-market-insight-2015-q4>.

⁴⁰ U.S. Energy Information Administration, Net Generation from Renewable Sources, 2005-2015, https://www.eia.gov/electricity/annual/html/epa_03_01_b.html.

⁴¹ The Solar Foundation, National Solar Jobs Census 2015, <http://www.thesolarfoundation.org/national/>.

⁴² R. Pollin et al., The Economic Benefits of Investing in Clean Energy, Political Economy Research Institute and Center for American Progress (June 2009); see Tables 5, 7 and 10.

⁴³ M. Wei et al., Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US?, *Energy Policy* 38:919-931 (2010). For example, wind, energy efficiency, and solar PV generate 0.17, 0.38, and 0.87 job-years per GWh, respectively, while coal and natural gas generate 0.11 job-years per GWh.

⁴⁴ R. Bacon and M. Kojima, Issues in estimating the employment generated by energy sector activity, World Bank (June 2011); see page 9.

⁴⁵ D. Haerer and L. Pratson, Employment trends in the U.S. electricity sector, 2008-2012, *Energy policy* 82:85-98 (2015).

⁴⁶ K. Conrad and C.J. Morrison, The Impact of Pollution Abatement Investment on Productivity Change: An Empirical Comparison of the U.S., Germany, and Canada, *Southern Economic J* 55(3):684-698 (Jan. 1989).

⁴⁷ *Id.* at 695.

⁴⁸ Stephen M. Meyer, Environmentalism and Economic Prosperity: Testing the Environmental Impact Hypothesis, Massachusetts Institute of Technology (Oct. 1992). Data for the ranking of environmental policies came from the 1970s and early 1980s, while economic data came from 1982-1989. *Id.* at 8 – 10.

⁴⁹ *Id.* at 11 -22. Differences between “strong” and “weak” states were statistically significant for all of the named relationships.

⁵⁰ *Id.* at 11.

⁵¹ *Id.* at 24 – 27.

⁵² S. Albrizio et al., Do Environmental Policies Matter for Productivity Growth? Insights from New Cross-Country Measures of Environmental Policies, OECD Economic Department Working Paper No. 1176 (Dec. 2014, hereinafter Albrizio et al. 2014a); Albrizio et al., Empirical Evidence on the Effects of Environmental Policy Stringency on Productivity Growth, OECD Economics Department Working Papers No. 1179 (Dec. 2014, hereinafter Albrizio et al. 2014b).

⁵³ *Id.* at 28.

⁵⁴ A. Dechezleprêtre and M. Sato, The impacts of environmental regulations on competitiveness, Grantham Research Institute on Climate Change and the Environment (Nov. 2014).

⁵⁵ A.B. Jaffe et al., Environmental Regulation and the Competiveness of U.S. Manufacturing: What Does the Evidence Tell Us?, *J Econ Literature* 33(1):132-63, 157 (1995).

⁵⁶ *Id.* at 144, n 24.

⁵⁷ D. V. Aiken et al., Pollution Abatement and Productivity Growth: Evidence from Germany, Japan, the Netherlands, and the United States, *Environ Resource Econ* 44:11-28, 12, 25 (2009).

⁵⁸ *Id.* at 22. Note that the sector with the “largest decline in productivity change,” the paper industry in Japan (*id.* at 21), would have seen a change in productivity 1.0085 times higher without the effects of pollution abatement spending, a difference of less than 1%.

⁵⁹ Albrizio et al. 2014a at 28; see also Albrizio et al., Empirical Evidence on the Effects of Environmental Policy Stringency on Productivity Growth, OECD Economics Department Working Papers No. 1179, at 21 (Dec. 2014, hereinafter Albrizio et al. 2014b).

⁶⁰ Albrizio et al. 2014a at 29.

⁶¹ Y. Rubashkina et al., Environmental regulation and competitiveness: Empirical evidence on the Porter Hypothesis from European manufacturing sectors, *Energy policy* 83:288-300 (2015).

⁶² See, e.g., L. Heinzerling and F. Ackerman, *Pricing the Priceless: Cost Benefit Analysis of Environmental Protection*, Georgetown Environmental Law and Policy Institute (2002).

⁶³ See, e.g., I. Shapiro and J. Irons, *Regulation, Employment, and the Economy*, Economic Policy Institute Briefing Paper #305, at 21 - 25 (Apr. 2011).

⁶⁴ See, e.g., Heinzerling and Ackerman at 17 – 18.

⁶⁵ U.S. Office of Management and Budget, *2015 Report to Congress on the Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act (2015)*, available at https://www.whitehouse.gov/sites/default/files/omb/inforeg/2015_cb/2015-cost-benefit-report.pdf. OMB issues these reports each year; the 2015 report is the most recent final report. A draft 2016 report, covering the 2006-2015 period, was issued in December 2016, and continues to show a very high benefit:cost ratio. U.S. Office of Management and Budget, *2016 Draft Report to Congress on the Benefits and Costs of Federal Regulations and Agency Compliance with the Unfunded Mandates Reform Act (2016)*, available at https://www.whitehouse.gov/sites/default/files/omb/assets/legislative_reports/draft_2016_cost_benefit_report_12_14_2016_2.pdf.

⁶⁶ *Id.* at 21.

⁶⁷ *Id.* at 2.

⁶⁸ *Id.* at 9. The costs of EPA regulations ranged from \$37 to \$45 billion, while the benefits were between \$160 and \$788 billion (2010 dollars). Assuming the midpoint of each range, the ratio of benefits to costs is 11.4.

⁶⁹ See, e.g., Shapiro and Irons at 4 – 6.

⁷⁰ Meyer, at 9.

⁷¹ C. Davenport and E. Lipton, *Trump Picks Scott Pruitt, Climate Change Denialist, to Lead E.P.A.*, *New York Times* (Dec. 7, 2016).

⁷² Albrizio et al. 2014a, at 17.



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