CLEAR & The Economy

Innovation, Equity, and Job Creation

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This policy brief discusses the Carbon Limits and Energy for America's Renewal (CLEAR) Act in the context of the green economy, with a special focus on its ability to drive innovation, avoid regressive wealth transfers, contain costs, and create new jobs. The primary findings of this report are:

- By setting an economy-wide price on carbon, the CLEAR Act will create equal incentives for greenhouse gas reduction for all economic actors, **maximizing incentives to innovate and invest across all sectors**, while rewarding the lowest-cost opportunities for the abatement of emissions.
- The auction approach in the CLEAR Act **will reduce overall compliance costs** because it does not mute price signals by giving away free allowances.
- The CLEAR Act **avoids large regional disparities**.
- Because the amount of the dividend is the same across income distributions, the auction-and-dividend structure provides the **greatest support to low-income families**, and avoids regressive wealth transfers.
- A strong economy-wide price signal that drives innovation and investment in energy efficiency and clean energy can help **spur job growth in a number of important economic sectors**, and help support promising nascent industries.
- Overall costs imposed by the CLEAR Act are modest, and are overwhelmed by the social benefits achieved by greenhouse gas reductions. In addition to short-term job creation and technological innovations**, the environmental benefits of the bill are likely to greatly exceed the costs.**

Scope of Analysis

The CLEAR Act embodies a
cap-and-refund approach to
reducing greenhouse gas emissions

A Different Approach

On December 11, 2009, Senators Cantwell and Collins introduced the CLEAR Act, which embodies a "cap-and-refund" approach to addressing climate change.[1] The Act would create a nationwide limit on greenhouse gases by capping total emissions and requiring major polluters to buy "allowances" for each ton of greenhouse pollution produced. The Act would auction off all allowances and would distribute 75% of revenue generated by that auction to American households. The remaining 25% of revenue is reserved for a variety of purposes, including additional greenhouse gas reductions, transition assistance, and investments in renewable energy technology.

Several potential tools to respond to the problem of greenhouse gas emissions are currently on the table. Under the Supreme Court's decision in *Massachusetts v. Environmental Protection Agency*, the Clean Air Act grants EPA the power to regulate greenhouse gas emissions, and the duty to move forward with several mandatory regulatory steps. In *The Road Ahead: EPA's Options and Obligations for Regulating Greenhouse Gases* (IPI Report No. 3, Apr. 2009), Jason A Schwartz and Inimai M. Chettiar discuss how EPA can use its authority in the most cost-effective way, without interfering with potential congressional action, finding that EPA likely has authority to create an economy-wide cap on greenhouse gas emissions.

Climate change bills have been offered in both the House of Representatives and Senate during the 111th Congress, and the American Clean Energy and Security Act of 2009 (H.R. 2454) passed the House on June 26, 2009. That bill would establish a national economy-wide cap on greenhouse gas emissions, as well as several additional measures meant to augment reductions under the cap or reduce compliance costs. In *The Other Side of The Coin: The Economic Benefits of Climate Legislation* (IPI Policy Brief No. 4, Sept. 2009), J. Scott Holladay and Jason A Schwartz calculate a preliminary but conservative estimate of the economic value of H.R. 2454's environmental benefits, finding that the costs of the bill are well-justified by its payoffs.

This policy brief examines a third approach—the cap-and-refund model in the CLEAR Act—through the lenses of innovation, job creation, and equity-sensitive cost-benefit analysis. In *Unlocking the Green Economy: How Carbon Pricing Can Open the Floodgates of Private Investment in Clean Energy* (IPI Policy Brief No. 2, Dec. 2008), Michael A. Livermore discussed the relationship between carbon pricing and energy innovation. That analysis is extended here to cover the innovation and job creation potential of the CLEAR Act, as well as its distributional impacts, environmental benefits, and mechanisms for cost-containment. The analysis contained here draws extensively on existing literature and seeks to summarize some of the key economic and policy implications of the legislative proposal.

Innovation

A price on carbon will help drive investment in and adoption of new technologies across the economy

Prices: The Spurs that Drive Innovation

Strong empirical and theoretical evidence reveals that price signals drive innovation.[2] As far back as 1932, economists noted that "a change in the relative prices of factors of production is itself a spur to invention."[3] The argument is a straightforward application of basic economic principles: as returns on innovation grow, investment in creating innovation will increase. Businesses currently pay nothing when they emit greenhouse gases; there is therefore no financial incentive to invest in research to reduce those emissions; a price signal on carbon would change those incentives.

Price signals drive not only research and development, but also the adoption of existing technologies. As returns for adopting a technology increase, consumption of the technology by businesses and households will increase. Prices also serve a signaling function that can help overcome informational or behavioral barriers to technological adoption.[4]

Private investment has led to breakthrough technologies in areas as diverse as aeronautics, pharmaceuticals, and information technology. The development of new technologies across the economy characterized the twentieth century and drove rising living standards throughout the United States.[5] In the areas of energy production and efficiency, some early successes carry the promise of tremendous opportunities. For example, recent investments in the research and development of windmills have started to lead to significant improvement in turbine quality.[6] Technological breakthroughs in solar panel manufacturing have similarly begun to decrease the price of renewable electricity generation.[7] But many potential opportunities remain untapped at the current levels of investment.

The most comprehensive analysis of innovation and adoption opportunities related to energy efficiency and clean energy production was conducted by the consulting firm McKinsey & Company.[8] The McKinsey analysis found a very large number of technological opportunities to reduce or avoid greenhouse gas emissions across a variety of economic sectors. Five core "clusters" of opportunities were identified: buildings and appliances, transportation, industry, carbon sinks, and power. In each of these clusters, a range of technologies or practices would be profitable if a sufficient price were placed on carbon.

A major finding of the McKinsey analysis is that many abatement opportunities already have positive potential payoffs, but have not yet been adopted. Such opportunities exist throughout the energy efficiency sector. Market failures that account for this sub-optimal technological adoption can be institutional, informational, or behavioral. Institutional arrangements can dull market signals: for example, the landlord-tenant relationship can complicate the adoption of energy-efficient improvements in apartment buildings.[9] A number of informational problems can plague the energy efficiency market, including lack of awareness about returns on energy efficiency investment.[10] Finally, a lack of salience, cognitive dissonance, or normative bias may all interfere with consumer decisions—and even many business decisions—in the energy sector.[11]

Analysis

The CLEAR Act has several features that will affect technological development. Most important, the legislation creates a consistent and predictable pricing signal across the entire economy. In addition, specific features of the Act will help overcome market inefficiencies that impede optimal technological adoption.

New Technologies: **A large number of potential technologies will come online in response to the CLEAR Act's pricing mechanism.**

Putting a price on carbon[12] emissions will expand the range of abatement, clean energy, and energy efficiency technologies that are financially attractive. Even with a relatively modest price on carbon, retrofitting residential buildings with better insulation and adopting new hydrofluorocarbons management protocols become cost-effective. Over time, as the CLEAR Act raises the minimum price for the emissions allowances sold at auction, other abatement strategies start to become more profitable: first, carbon sinks like active forest management, reforestation, and winter cover crops; later, carbon sequestration and retrofits of heating, and air conditioning equipment.[13]

Figure 1

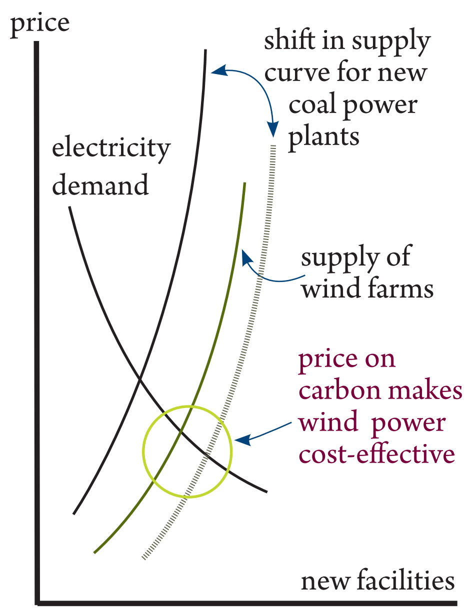


Figure 1 illustrates how, even at the bottom of the price collar, the CLEAR Act makes wind power competitive with coal-fired electricity generation,[14] driving new investments in, and more widespread adoption of, clean energy technologies.[15] As the price collar increases, the CLEAR Act will make producing power from renewable resources more attractive, spurring investment and innovation.

Overcoming Market Failures: **The CLEAR Act can help overcome institutional, informational, and behavioral barriers to technological adoption.**

Many investments could already be made (but, to date, have not been made) in a range of existing energy-efficiency technologies with positive economic returns,[16] indicating that market failures or barriers are preventing the optimal economic choices.

The CLEAR Act can help overcome these failures in several important respects. Landmark legislation can direct attention to energy prices and abatement opportunities, helping to overcome salience issues associated with the small, incremental nature of energy efficiency payouts.[17] Environmental measures can force companies to rethink their production processes and overcome the institutional inertia that stops smart investments.[18]

Additionally, the CLEAR Act's dividend checks to Americans can be coupled with information on energy-saving opportunities,[19] helping to counteract consumers' lack of knowledge about their options and the potential payoffs of investment. The dividend will serve as a periodic reminder of energy efficiency opportunities and will help overcome barriers to capital[20] by providing individuals and families with bursts of funds that can be directed to the kind of small-scale investments where many of the highest returns on energy efficiency are found.

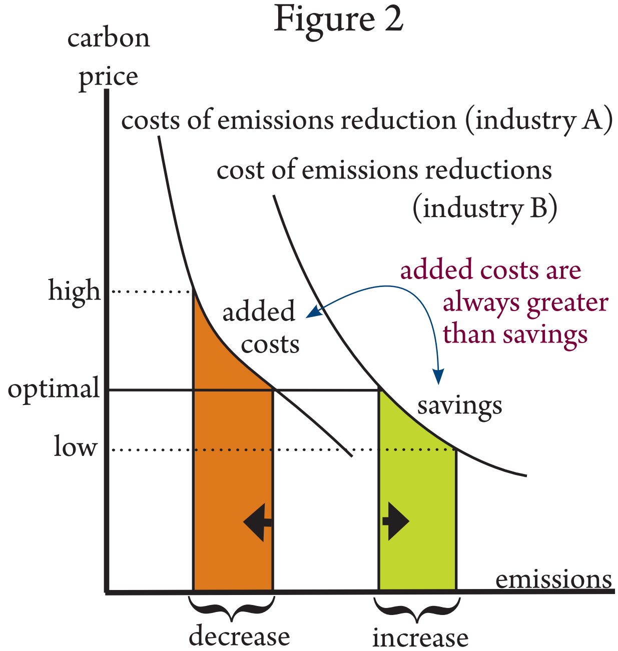
Overcoming these market failures can have big paybacks. Improvements in lighting alone could produce $20 billion in direct return on investment.[21] Technologies with positive paybacks include fuel economy packages for light trucks, improved efficiency of residential water heaters, increasing efficiency at existing power plants, and conservation tillage.[22] Taking advantage of these technologies can generate billions of dollars for the U.S. economy in energy efficiency savings.[23]

Equalizing Incentives: **The CLEAR Act sets an economy-wide price for carbon, sending equal signals for innovation across economic sectors.**

The CLEAR Act takes an economy-wide approach to correcting market failures. Charging polluters in different industries the same price for carbon emissions expands the potential for cross-industry trade-offs and lowers the overall costs of compliance. Some polluters will find it less expensive to reduce emissions, and will pursue direct emission abatement options rather than purchase carbon allowances at auction; other emitters will face greater costs for pollution controls and will instead choose to purchase carbon shares. Regulating the entire economy at the same level allows market forces to identify the lowest-cost options and so determine which polluters should invest in abatement.

Figure 2 illustrates the counter-productive outcomes from placing different carbon prices on different economic sectors. An optimal economy-wide price generates the efficient level of emissions reductions, and achieves that result through the lowest-cost abatement strategies.[24] If the price varies by sectors, industry B may come out ahead because it faces a lower price, but industry A will be worse off. Most importantly, the savings in industry B will always be less than the added costs for industry A, meaning that society pays more to achieve the same level of emissions.

Figure 2



The CLEAR Act is able to send a constant, un-distorted price signal to all sectors of the U.S. economy in large part because it auctions off all its emissions allowances, rather than giving some carbon shares away by free allocations.[25] Other legislative proposals on climate change have included significant free allocations of emissions allowances to certain industries, and economists can predict the consequences. If free allowances are allocated to local electric distribution companies, the overall cost of the program rises by 25.9%, electricity prices are depressed, and the electric sector emits 24% more emissions than it would without the free allocations.[26] To offset that emissions increase, corresponding emissions reductions must be made in other sectors, which will come at a higher price.

Job Creation

Development of new technologies and economic opportunities will help generate jobs in key sectors

Unemployment and Underutilization

Economists have devoted considerable attention to the causes of unemployment and have proposed a range of competing explanations for persistent unemployment, include wage inflation, search costs, suppressed demand, and the effect of government programs on labor supply.[27] In recent years, regional unemployment and unemployment within specific demographic populations have become growing concerns.[28]

Underemployment and shrinking real wages also pose threats to well-being, especially for lower-income families. Changes to the U.S. economy in recent decades have triggered large shifts in employment opportunities from manufacturing jobs (which in the past had been characterized by stability and rising wages) to service sector employment (typically offering less opportunity for wage growth and long-term stability).[29] During this transition period, skills that had been acquired through years of on-the-job training also have become less valuable, reducing worker productivity and wage potential.

Competition from overseas workers, who have much lower real wages, has increased as trade barriers have been eliminated, communications technologies have improved, and many developing countries have gained greater political and economic stability. While, in the aggregate, this global competition can be expected to increase productivity, certain domestic populations have seen their livelihoods threatened. In the past thirty years, the fraction of U.S. workers employed in manufacturing has fallen from 25% to less than 9%.[30]

In addition to this longer-term trend, the recent housing bubble and financial crisis have caused shocks that have led to higher levels of unemployment.[31] The run up in home prices encouraged investors to seek out opportunities in the real estate markets and encouraged low-income workers to focus on developing construction skills. The bursting of the house price bubble left many workers once drawn to the construction industry un- or under-employed.

The financial crisis also served as a more general shock to the economy as credit tightened, businesses had difficulty borrowing for expansion, and uncertainty about the health of the economy spread to investors and consumers. As a consequence, labor participation has fallen, creating significant unused or underutilized labor resources. While real productivity and hours worked per employee have grown,[32] job growth has lagged other indicators as the United States economy has emerged from the recent recessions.[33] Steps by the U.S. government to stimulate demand and avoid public sector layoffs have only partially mitigated these effects.

Analysis

The CLEAR Act will likely have several beneficial effects on the labor market—helping to employ workers hit hardest by the bursting of the housing bubble and generating jobs through increased consumer spending and green technology investment.

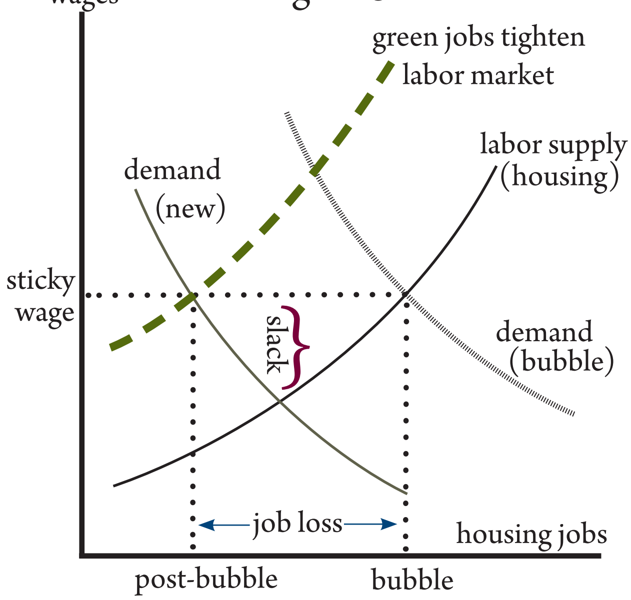
Realignment: **By creating a vast new field of business opportunities, the CLEAR Act can help increase the utilization of labor resources.**

Long-term, negative trends in the manufacturing labor market have been compounded by the recent financial crisis and resultant recession, causing significant underutilization of resources, particularly for workers without a college education but with strong work histories or on-the-job training.

The CLEAR Act will generate jobs in several sectors. In the construction sector, jobs installing solar panels, re-insulating homes, and buildings and installing new infrastructure are likely to be created. These jobs are of particular interest because they offer low-credentialed workers the opportunity to earn relatively high wages. The CLEAR Act will also increase the demand for manufactured products, such as solar cells, wind turbines, and heating, ventilation and air conditioning systems (HVAC). The price signals sent by the CLEAR Act will lead to investment and production of these green technologies and, if manufacturing takes place in the United States, lead to a reduction of the overcapacity in the manufacturing sector.

Adoption of a price signal for carbon during a recession also reduces the likelihood that the jobs created in this sector will come at the expense of jobs in other industries, or lead to inflation. As illustrated in Figure 3,[34] when the housing bubble burst, it caused job loss as demand for construction workers decreased. Because wages are slow to fall to match demand (i.e., wages are "sticky"), those workers unwilling to take pay cuts soon find themselves unemployed. But green investment can take up this wage slack by tightening the labor market in housing—as jobs are created by green investment, presently unemployed workers from the housing sector can find work in the green sector. At the same time, these new jobs do not put pressure on wages for housing workers, reducing inflationary pressure and maintaining employment levels in the housing sector.

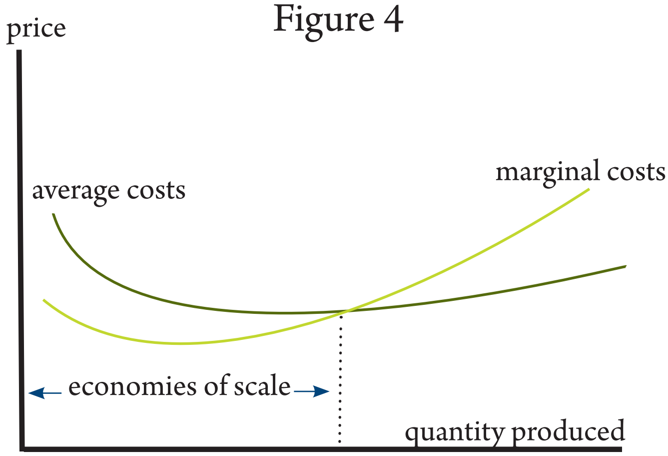
Figure 3



Promising New Industries: **The CLEAR Act can help the United States develop capacity and economies of scale to compete internationally in the field of clean energy.**

The green energy field is poised for tremendous growth in the coming decades, and several countries have already made significant investments to gain a head start in developing and deploying those technologies. The United States lags behind countries such as Germany, Japan, and China in creating incentives for investors to support green investment.[35] Globally, the United States ranks nineteenth in terms of a nation's green technology production relative to the overall size of its economy. By that same measure China ranks sixth; Denmark, Brazil, and Germany lead the rankings due to their respective investments in wind technology, bioethanol production, and the manufacture of turbines and solar cells.[36]

Figure 4



The economic argument in favor of developing green technology capacity early is that the average price of manufacturing new technology tends to decrease sharply with the quantity produced. These reduced costs, known as economies of scale, are enjoyed by large or growing companies and industries.[37] Figure 4 shows how economies of scale can be realized as the average price of production falls (which occurs until the incremental costs of production exceed the average costs).[38] By encouraging investment in the green energy sector, the CLEAR Act can help reduce the costs of production in that sector, potentially allowing these producers to capture an important segment of this growing market and ultimately helping to facilitate the creation of a robust domestic industry.

Green Jobs: **Many of the jobs created by energy efficiency and clean energy investment are necessarily domestic, and will help increase wages for low-income earners.**

The CLEAR Act will generate an increase in jobs through two channels: the dividend will be used to purchase goods and services, and prices will spur green spending by businesses and households. The jobs created from dividend expenditures will likely mirror the types of jobs in the economy overall, but investment in green technology will have important new effects on the labor market.

As the carbon prices rise, industries reliant on fossil fuels may potentially shed some jobs; those losses will be offset by job gains in other sectors such as construction, wind and solar power installation, and mass transit. Investment in green technology has been found to generate more jobs than comparable spending on fossil fuels.[39] This is due to the higher domestic content of green energy compared to fossil fuels—a large fraction of the fossil fuel base in the United States is imported from foreign countries; more of the inputs for renewable energy capacity (including installation and maintenance) occur in the United States. Energy efficiency jobs similarly are more likely to be domestically based.

Investment in clean energy also generates jobs at all ranges of the income spectrum. Studies have reported that spending on green technology produces substantially more low-credentialed (high school degree or less) but relatively higher-earning jobs as a comparable amount of spending on fossil fuel powered energy. Because of the high level of job creation from green energy spending, more jobs of every type are created and those jobs are proportionally of higher quality.[40]

Equity, Costs & Benefits

The benefits of inaction are severe
and can be mitigated at low cost
with few distributional effects

Cost-Benefit Analysis and Distribution

Cost-benefit analysis seeks to maximize the net benefits that society will enjoy from its regulations and policy choices. Net benefits are calculated by subtracting the costs of the policy from the benefits. The benefits of environmental policies may include prices lowered, lives saved, wetlands restored, or diseases avoided. The costs of environmental policies include direct costs, compliance costs, enforcement costs, and price increases. The goal of the cost-benefit process is to identify the policy alternatives for which the cumulative benefits exceed the cumulative costs by the largest margin. These are the projects that generate the largest net benefits for society.

Estimating the costs and benefits forces analysts to carefully consider the proposed policy and think through its impact on both the economy and non-market sectors such as human health and the environment. By monetizing these impacts cost-benefit analysis simplifies comparisons between projects and generates results that are salient to policymakers, advocacy groups, and the public. While cost-benefit analysis has been controversial in some circles,[41] it remains a useful tool for allocating resources across policy options.

Well-conducted cost-benefit analyses also consider the distributional impacts of a proposed policy. The current executive order governing cost-benefit analysis by federal agencies (signed by President Clinton and kept in place by both President George W. Bush and President Obama) requires distributional analysis of proposed regulations.[42] The goal of distributional analysis is to augment cost-benefit analysis by identifying who bears regulatory costs, and who are the regulatory beneficiaries.

In the climate change context, it is extremely difficult to fully characterize the costs, benefits, and distributional effects of a particular policy. Climate change itself is a complex process, and scientists are continually updating their knowledge about the effects of greenhouse gas emissions on global temperatures, and the effects of temperature increases on a variety of complex systems ranging from weather patterns (including extreme weather), ecosystems, and climate feedback loops. The lack of full scientific understanding hampers ability to predict the outcomes of policy choices.

In addition, many of the effects of climate change are difficult to monetize, and implicate important value questions concerning inter-generational equity and the global responsibility for greenhouse gas emissions. Finally, the costs of climate policy are difficult to know in advance, because many economic sectors are likely to be affected and to respond in a number of different ways, including through unanticipated innovation.

Notwithstanding these difficulties, governments typically do their best to understand the effects of their choices on climate change, while recognizing the incompleteness of any particular model.

Analysis

Simple analysis of the costs and benefits of the CLEAR Act, as well as the distribution of these costs and benefits, shows that there are several mechanisms to control costs, that the benefits of action far outweigh the relatively modest costs, and that the distribution of the program's costs are fair from both an income and a regional perspective.

Cost Containment: **By spurring technological innovation and leveraging international greenhouse gas projects, the CLEAR Act contains the cost of the program.**

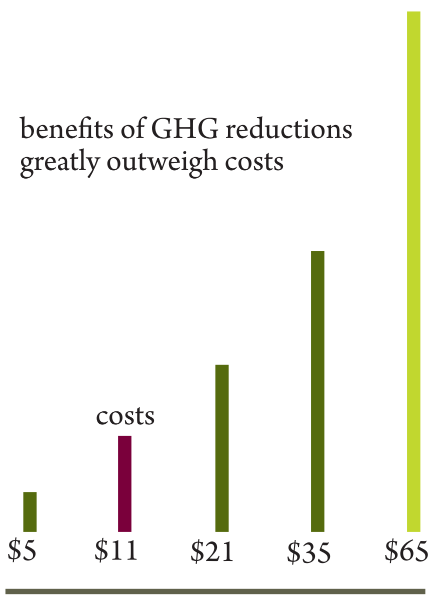
While there are many immediate and long-term economic benefits for greenhouse gas reductions, there are also costs. The CLEAR Act has several features that can help reduce these costs.

The most important cost-saving measure is the use of a carbon price, which will give all economic actors the incentive to identify the cheapest possible way to reduce emissions, and will even incentivize firms to find ways to reduce costs before the program officially begins.[43] The CLEAR Act also sets aside a fraction of the revenue acquired from its auctions to dedicate to a number of purposes, including paying for international greenhouse gas reductions. Many of the cheapest opportunities to reduce emissions exist in developing countries—the CLEAR Act achieves its emissions reduction goals in part by relying on these cheaper reductions. Under the CLEAR Act, EPA would be the sole representative of American demand for international greenhouse gas reductions, creating a "monopsony"[44] and giving the agency significant bargaining power to achieve more carbon reductions per dollar spent. Finally, the Act controls price volatility by placing both a minimum and maximum price on the auctioned allowances—a "price collar," which rises over time. The initial collar is set between $7 and $21. The high range of the collar is just below the federal government's central estimate of the damages generated by a ton of carbon emissions.[45] Over time the cap will rise faster than the rate of inflation.

Benefits: **The cost of inaction on climate change is enormous; when the modest costs of the CLEAR Act are compared against the costs of inaction, the benefits of the bill outweigh the costs considerably.**

The CLEAR Act will produce benefits significantly in excess of costs. The benefits of the bill come in the form of reduced damages from climate change and include higher agricultural yields, less sea-level rise, and reduced adaptation costs.[46] The most common tool for setting a monetary estimate on the value of greenhouse gas reductions is the "social cost of carbon," which attempts to estimate the harm imposed by the release of one ton of greenhouse gas emissions into the atmosphere—avoiding those emissions creates benefits. The costs of the bill will be imposed on carbon emitters and intensive energy users. These economic actors will be forced to take compliance steps: either reducing their emissions or paying for allowances under the cap. The cost of compliance rises as the cap falls, but so do the benefits.

Figure 5



On the basis of a relatively conservative estimate of the cost of the bill in the early years,[47] for the CLEAR Act to generate net benefits, the social cost of carbon would have to be above $10.50.[48] A recent interagency taskforce put together by the Obama Administration undertook an exhaustive effort to set a social cost of carbon for use in federal regulation, and developed a range of values of $5, $21, $25, and $64.[49] So long as the social cost of carbon does not fall at the lowest side of that range, then the costs of the bill are justified, and benefits are likely to greatly exceed costs.[50]

Equity: **The CLEAR Act avoids regressive wealth transfers and is relatively neutral with respect to regional differences.**

The impact of carbon pricing on vulnerable subpopulations is of particular concern to policymakers. On its own, a carbon cap can have regressive effects on wealth, because lower-income families spend a greater proportion of their income on energy. Because of geographic heterogeneity in the fuel used for energy production, certain regions of the country can also bear disproportionate costs under a cap.

A per capita dividend helps smooth out disparities. First, an equal dividend on a per capita basis provides greater aid to lower-income individuals because it will make up a larger share of their total income.[51] The impact of a carbon cap on prices is also greatest for higher-income earners in absolute terms, because they consume both more energy and more energy-intensive goods.[52] As a consequence, the dividend smoothes out distributional imbalances and even benefits households with below-average incomes.[53]

The regional distribution of costs and benefits from the CLEAR Act is also fairly equitable—despite regional differences in the fuel mix—because carbon intensity per capita is fairly constant across the country when indirect consumption of energy is taken into account. The average costs of the program across the country are estimated to be $232 per person per year. The costs in the highest-cost state (Indiana) are $55 per person per year above the average, and the costs in the lowest-cost state (Oregon) are $36 below the average.[54] While some regions may be better off under a scheme that allocates carbon allowances to local distribution companies,[55] because of the impact on the total costs of the program of free allocations, it is more cost-effective to auction allowances and adjust how the revenue is distributed to correct for any residual geographical imbalances.[56]

Conclusion

Overall, the CLEAR Act will help boost innovation in energy efficiency and clean energy research fields; will help create new jobs in important sectors of the economy; can help the United States build the capacity to meet growing world demand for new green technologies; and will generate massive environmental benefits that swamp the modest costs associated with the bill. By placing a single, economy-wide price on carbon, compliance costs are kept to a minimum. And crucially, the auction mechanism ensures a consistent price signal, but also allows for the distribution of a dividend to American households that smooths out distributional impact, helps low-income individuals cope with rising energy costs, and helps avoid regional disparities.

The Institute for Policy Integrity at New York University School of Law is a non-partisan advocacy organization and think-tank dedicated to improving the quality of government decision making through advocacy and scholarship in the fields of administrative law, regulation, cost-benefit analysis, and public policy.

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Notes

[1] S. 2877, 111th Cong., 156 Cong. Rec. S13036 (daily ed. Dec. 11, 2009).

[2] *See, e.g.*, David Popp, *Innovation in Climate Policy Models: Implementing Lessons from the Economics of R&D*, 28 Energy Econ. 596, 600-603 (2006) (summarizing research); Richard G. Newell, Adam B. Jaffe, & Robert N. Stavins, *The Induced Innovation Hypothesis and Energy-Saving Technological Change*, 114 Q. J. Econ. 941 (1999); Adam B. Jaffe & Karen Palmer, *Environmental Regulation and Innovation: A Panel Data Study*, 4 Rev. Econ. & Stat. 610 (1997).

[3] John Richard Hicks, The Theory of Wages 124 (1932).

[4] See Cass R. Sunstein, *Deliberating Groups Versus Prediction Markets (or Hayek's Challenge to Habermas)*, 3 Episteme 192 (2006), for an example of how price information can prevent bad informational or reputational cascades in group settings.

[5] The basis for rising living standards is increased productivity, which is closely linked to technological development. For a very long-term perspective, see Angus Maddison, The World Economy: A Millennial Perspective (2001).

[6] See Paul Gipe, Wind Energy, ch. 3 (1995), for a full analysis of investment, research, and development in wind energy; see also U.S. Dep't of Energy, 20% Wind Energy by 2030, ch. 2 (2008) for an updated summary of current U.S. technology as well as R&D needs for the future.

[7] *See* Alex Hutchinson, *Solar Panel Drops to $1 Per Watt: Is This a Milestone or the Bottom for Silicon-Based Panels?*, Popular Mechanics, Feb. 26 2009.

[8] As part of its Climate Change Special Initiative, McKinsey & Company examined a range of existing and potential technologies that can be deployed to reduce greenhouse gas emissions, both domestically and around the globe. For a collection of their reports on the subject, see McKinsey & Company, *Greenhouse Gas Abatement Cost Curves*, http://www.mckinsey.com/clientservice/ccsi/costcurves.asp (last visited Apr. 5, 2010).

[9] *See* Marilyn A. Brown, *Market Failures and Barriers as a Basis for Clean Energy Policies*, 29 Energy Pol'y 1197, 1199 (2001). *See also* Anthony Fisher & Michael Rothkopf, *Market Failure and Energy Policy: A Rationale for Selective Conservation*, 17 Energy Pol'y 397 (1989) (describing the institutional barriers households face in accessing credit markets for small energy efficiency investments).

[10] *See* A.B. Jaffe, A. B. & Robert N. Stavins, *The Energy Paradox and the Diffusion of Conservation Technology*, 16 Resource & Energy Econ. 91 (1994); R.P. Larrick & J.B. Soll, *The MPG Illusion*, 320 Science 1593 (2008) (discussing how consumers do not understand how to translate fuel economy information into potential financial savings).

[11] *See* Jaffe & Stavins, *supra* note 10; A. Sanstad & R. Howarth, *"Normal" Markets, Market Imperfections, and Energy Efficiency*, 22 Energy Pol'y 811 (1994) (discussing how decisional shortcuts and imprecise rules of thumb can lead consumers to irrational conclusions on energy efficiency); Hunt Allcott & Nathan Wozny, *Gasoline Prices, Fuel Economy, and the Energy Paradox*, Mar. 29, 2010, *available at* http://web.mit.edu/allcott/www/papers.html (reviewing the relevant literature); C. Dennis Anderson & John D. Claxton, *Barriers to Consumer Choice of Energy Efficient Appliances*, 9 J. Consumer Res. 163 (1982).

[12] The phrase "putting a price on carbon" simply means charging greenhouse gas emitters for the long-term damages their emissions will cause to the environment and the economy. Currently, polluters are not charged for emitting carbon dioxide and other greenhouse gas pollutants, and therefore they have no incentive to reduce emissions of these heat-trapping, climate-altering gases.

[13] *See* McKinsey & Company, Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost, xiii and generally (2007).

[14] The carbon price associated with the CLEAR Act will also make renewable energy more attractive. The National Academy of Sciences report *America's Energy Future: Technology and Transformation* (2009) found that each

kilowatt of energy produced by coal-fired power plants contains 0.1 tons of carbon on average. Assuming that the CLEAR Act auctions carbon at $7 ton (i.e., the low end of the price collar in 2012; that collar is set to rise by 6.5% plus inflation each year), the price of generating power from coal will rise 0.7 cents per megawatt. Currently, the average cost of producing electricity from coal is 5.3 cents per megawatt, and the price of wind power is 5.5 cents per megawatt. U.S. Energy Info. Admin., International Energy Outlook (2006), *available at* http://www.eia.doe.gov/oiaf/archive/ieo06/special_topics.html (specifying the price of new generating capacity for coal and wind power).

15 Figure 1 represents a shift in demand for coal-fired electricity generation due to an increase in input costs. In this case, the input is environmental services: formerly free but now provided by the positive cost of carbon allowances. The shift in demand increases the equilibrium price and decreases the equilibrium quantity demanded of coal-fired power. Wind power becomes viable because the new equilibrium price of coal-fired generation is above the equilibrium price of wind power. Of course, this is a stylized example. The current energy mix includes both low-cost wind and coal. Forcing generators to pay for carbon emissions will increase the fraction of energy generated by renewables, but it will not eliminate coal-fired generation completely.

16 *See* McKinsey & Company, Reducing U.S. Greenhouse Gas Emissions, *supra* note 13 (detailing a range of such negative-cost abatement opportunities).

17 *See* Anderson & Claxton, *supra* note 11, at 164.

18 *See* M.E. Porter & C. van der Linde, *Toward a New Conception of the Environment Competitiveness Relationship*, 9 J. Econ. Persp. 97 (1995).

19 *See* Hunt Allcott, *Social Norms and Energy Conservation*, Feb. 25, 2010, *available at* http://web.mit.edu/allcott/www/papers/html (discussing price, non-price, and informational "nudges" on energy consumption decisions).

20 William H. Golove & Joseph H. Eto, *Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency*, 10 (Lawrence Berkeley National Laboratory Study LBL-38059, UC-1322, Mar. 1996).

21 McKinsey & Company, Reducing U.S. Greenhouse Gas Emissions, *supra* note 13, at 36 (detailing how lighting improvements will reduce carbon emissions by 240 megatons a year and simultaneously produce financial savings of around $87 per ton of greenhouse gases abated).

22 *Id.* at xiii.

23 Authors' calculation based on the approximate area under the marginal abatement cost curve represented at *id*. (1.2 billion * 90 * 0.5 = $54 billion).

24 Figure 2 illustrates the consequences of setting two different industry tax levels rather than taxing all sectors at the same level. The favored industry pays the lower tax rate, and the level of emissions generated by that sector increases by the width of the green area. To generate an equal drop in emissions elsewhere in the economy, the increase in tax rate for the second industry must be significantly larger than the decrease for the low-tax sector. A tax set at the high rate generates a reduction in emissions equal to the width of the orange area. Setting two tax rates trades relatively low-cost abatement in the favored sector for high-cost abatement in the other sector. This will increase the cost of reaching the same level of abatement.

25 There is some debate about the merits of free allocation in the economic literature. See Christopher Bohringer & Andreas Lange, *On the Design of Optimal Grandfathering Schemes for Emissions Allowances*, 49 Euro. Econ. Rev. 2041 (2005) for a summary.

26 Rich Sweeny, and Dallas Burtraw, *The Effects on Households of Allocation to Electricity Local Distribution Companies*, (Resources for the Future Memo, May 19, 2009), *available at* http://www.rff.org/wv/Documents/Regions_Household%20Incidence_LBA%20090519.pdf.

27 *See, e.g.*, Stephen Nickell, *Unemployment and Labor Market Rigidities: Europe Verus North America*, 11 J. Econ. Persp. 55, 63 (1997); Joseph. Stiglitz, *The Theory of Screening, Education, and the Distribution of Income*, 92 Amer. Econ. Rev. (2002); Bruce Meyer, *Unemployment Insurance and Unemployment Spells*, 58 Econometrica 757 (1990); Pieter A. Gautier, *Unemployment and Search Externalities in a Model with Heterogeneous Jobs and Workers*, 69 Economica 21, 30-31 (2002); John Maynard Keynes. The General Theory of Employment, Interest and Money (1936).

28 *See* Richard Florida, *Regional Unemployment Continues to Rise*, The Atlantic, Feb. 3, 2010.

[29] *See* Linda Levine & Marc Labonte, Cong. Res. Serv., RL32576, *The Quality of New Jobs from the 1990s through June 2004* (2004) (noting that while, "[f]rom [one] perspective, then, most of the net job growth during this period occurred in 'bad' [service] jobs," other evidence suggests that "new job growth occurred at opposite ends of the pay spectrum during the 1990s, but the rate of job creation was greater in the highest compared to the lowest wage group); Linda Levine, Cong. Res. Serv., R40080, *Job Losses and Infrastructure Job Creation Spending During the Recession* (2009) (noting that manufacturing jobs were hardest hit during the recent recession).

[30] Authors' calculations from BLS data, http://www.bls.gov/data/

[31] *See* Levine, *supra* note 29.

[32] Michael Chernousov, Susan E. Fleck, & John Glaser, *Productivity Trends in Business Cycles: A Visual Essay*, Monthly Labor Rev., June 2009, at p.63.

[33] Edward S. Knotek II & Stephen Terry, *How Will Unemployment Fare Following the Recession?*, Fed. Reserve Bank of Kansas City Econ. Rev., 3d Quarter 2009, pp.5-24.

[34] Figure 3 illustrates the impact of the CLEAR Act on the labor demand curve for construction jobs. The top-most demand curve depicts the demand for construction workers during the housing bubble. Where that demand crosses the supply curve marks the level of employment and construction wages during the bubble. After the bubble burst, the demand curve shifted downward, and the new equilibrium wage and employment levels are found where the "burst demand" curve crosses the supply curve. These new employment and wage levels are below the inflated bubble equilibrium, and because some workers will not suddenly accept a lower wage (i.e. wages are "sticky" and do not easily move down), there is unemployment and slack in the economy.

The CLEAR Act (or any policy that puts a price on carbon) will lead to employment opportunities for construction workers in other fields such as retrofitting old buildings or installing solar panels. These new employment outlets reduce the number of people trained to work in the construction industry available for the housing sector, shifting the supply curve for labor to the left. That supply shift increases equillibrium wages without reducing employment in the construction sector. Of course, the relative slopes of the supply and demand curves dictate the magnitude of changes in wages and employment levels. In this example, the increase in wages due to migration to green technology sectors exactly equals the decrease from the deflation of the bubble. Such exact callibration is unlikely.

[35] *See* DB Climate Change Advisors, The Green Economy: the Race Is On (2010), *available at* http://www.dbcca.com/dbcca/EN/_media/DBCCA_Policy_Tracker.pdf.

[36] *See* World Wildlife Fund, Clean Economy, Living Planet 13-14 (2009), *available at* http://www.wwf.dk/dk/Service/Bibliotek/Klima/Rapporter+mv./Clean+Economy.

[37] *See* N. Gregory Mankiw, Principles of Economics 281 (5th ed., 2008).

[38] Figure 4 graphically depicts economies of scale. In the gray region on the left, the average price of production is falling as the quantity of production increases. This is the region of economies of scale. The dotted line represents the minimum average cost of production, and to the right of that line increasing output increases prices. In a competitive market, producers will operate at the point where their marginal costs of production equals the price they charge and the marginal cost curve is sloping up.

[39] *See* James K. Boyce & Matthew E. Riddle, *Clear Economics: State-Level Impacts of the Carbon Limits and Energy for America's Renewal Act on Family Incomes and Jobs* 12 (Pol. Econ. Res. Inst. Working Paper, Mar. 2010), *available at* http://www.peri.umass.edu/236/hash/863fdbde6e/publication/403/.

[40] *See* Robert Pollin, James Heintz, & Heidi Garrett-Peltier, The Economic Benefits of Investing in Clean Energy 37-38 (2009).

[41] *See, e.g.*, Frank Ackerman & Lisa Heinzerling, Priceless: On Knowing the Price of Everything and the Value of Nothing 277 (2004).

[42] Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (1993).

[43] This cycle has played out before for other pollutants. See, for example, Elizabeth DeSombre, *The Experience of the Montreal Protocol: Particularly Remarkable, and Remarkably Particular*, 19 UCLA J. Envtl. L. & Pol'y 49 (2000), which describes efforts to reduce emissions of chlorofluorocarbons in the 1980s and 1990s.

[44] *See* Mankiw, *supra* note 37 at 406. Monopolies are an analogue to monopsonies; in a monopoly there is a single seller, and in a monopsony there is a single buyer.

[45] *See* Interagency Working Group on the Social Cost of Carbon, Social Cost of Carbon for

Regulatory Impact Analysis Under Executive Order 12866 (2010).

46 See Richard Tol. *The Marginal Damage Costs of Carbon Dioxide Emissions: An Assessment of the Uncertainties*, 33 Energy Pol'y 2064 (2005), for exposition on the benefits of reduced emissions and a monetization of those benefits.

47 Costs are calculated following the analysis of the costs of the American Clean Energy and Security Act (the Waxman-Markey bill) conducted by the Environmental Protection Agency. *See* EPA, Analysis of the American Clean Energy and Security Act of 2009: Appendix (2009), *available at* http://www.epa.gov/climatechange/economics/pdfs/HR2454_Analysis_Appendix.pdf

48 These costs are almost certainly an overestimate. They are found by estimating the marginal abatement costs of polluters, based on the prices of carbon allowances. The total costs are the area under the marginal abatement curve between the initial level of emissions and the emissions under the bill. This area is found by assuming the marginal abatement cost curve is linear and multiplying emissions reductions by the midpoint of the price collar for carbon shares. Because the marginal abatement curve is almost certainly convex this estimate overstates the costs of compliance, possibly by a large margin. See the EPA's cost estimate model, *id*., for more details.

49 Figure 5 illustrates the different social costs of carbon recommended by the interagency working group. *See* Interagency Working Group on the Social Cost of Carbon, *supra* note 45. The dark green bars represent the average social cost of carbon at a discount rate of 2.5%, 3%, and 5%. The light green bar represents the fourth figure that should be included in regulatory impact analysis, the 95th percentile estimate for the social cost of carbon with a 3% discount rate. This value captures the risk of catastrophic climate outcomes sometimes known as "fat right tails." The red bar represents the estimated costs of abatement per ton under the CLEAR Act at the outset of the program.

50 A cost-benefit ratio of 6.5-to-1 in 2012 is calculated from a per-ton cost of $10.50 and a per-ton benefit of $68.10. The benefit number comes from the 95th percentile social cost of carbon across three different models using a 3% discount rate as described in Interagency Working Group on the Social Cost of Carbon, *supra* note 45. The cost estimate is based on the maximum average cost of abatement under the price collar described in the CLEAR Act. If the actual costs are below the upper bound of the collar, then the benefit-cost ratio will rise.

The per-ton costs and benefits will each rise over the life of the bill. The costs will rise as the collar increases over time, and the benefits will increase with the social cost of carbon. The bill mandates a 5.5% growth rate on the upper band of the collar, and the growth rate of the social cost of carbon varies between 1.1% and 3.7%. Despite the divergent growth rates, the benefits of the emissions reductions will exceed the costs for three of the four social cost of carbon estimates until at least 2035. If investment in green technology reduces abatement cost or the price of carbon shares does not reach the upper bound of the price collar, this breakeven point will be pushed even further into the future.

The benefit-cost ratio calculated here does not include offsets. The precise annual level of offsets is difficult to determine from the text of the bill or the accompanying analysis. Each ton of offsets should generate an additional $58.91 in net benefits created by the program. The benefits are valued using the same social cost of carbon estimates as the benefits of emissions reductions. The costs are expenditures from the CERT fund and therefore budgetary rather than abatement based. The likely costs of estimate are taken from the EPA's analysis of the costs of the Waxman-Markey Bill.

51 *See* Dallas Burtraw, Richard Sweeney, and Margaret Walls, *The Incidence of U.S. Climate Policy: Alternative Uses of Revenues from a Cap-and-Trade Auction* (Resources for the Future Disc. Paper 09-17-Rev, June 2009); Boyce & Riddle, *supra* note 39.

52 *See* Boyce & Riddle, *supra* note 39, at 5-6

53 The distributional benefits of the cap-and-dividend approach are especially great when compared with a free allocation, which Burtraw, Sweeney, and Walls find benefits Americans nationwide in the top ten percent of the income distribution. *See* Dallas Burtraw, Richard Sweeney, and Margaret Walls, *The Incidence of U.S. Climate Policy: Where You Stand Depends on Where You Sit* (Resources for the Future Disc. Paper 08-28, Sept. 2008).

54 *See* Boyce & Riddle, *supra* note 39, at 5.

55 For example, Burtraw, Sweeney, and Walls find that residents of the Ohio Valley region are better off under a free allocation program, likely due to the relative abundance of coal-fired power plants in the region. *See supra* note 53.

56 *See* Boyce & Riddle, *supra* note 39.

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