Why We Need a Carbon Tax

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With the exhaustion of fossil fuel resources looming on the horizon, it is crucial that the United States develop a coherent strategy to transition away from carbon-based energy sources. This Article makes the case that the government should utilize a carbon tax to mobilize new technology markets in an effort to respond to the developing energy crisis. The Article examines three major clean technologies—solar, wind, and biofuel—and argues that the government must support these emerging industries if they are to play a central role in the creation of new, wealth-generating, environmentally responsible economies. A carbon tax—more so than cap-and-trade programs—presents the best alignment of technology, capital, and policy to directly respond to the approaching energy and environmental crisis.

INTRODUCTION

One way or another, the era of cheap carbon energy is ending. The question before us is how to best navigate the transition from carbon energy to clean technology. Since the industrial revolution, carbon has been a key facilitator in the most explosive growth in human history. Fossil fuels, however, are finite, and numerous analyses suggest that we have already hit peak consumption.[1] In addition to their inevitable depletion, several factors compel a transition away from fossil fuels and toward clean-energy sources such as solar, wind, and biofuels (collectively referred to as "clean tech"). This Article argues that a carbon tax is the best policy to facilitate the unavoidable transition to new energy sources.

The move away from human reliance on fossil fuels is both pushed by the need to avoid negative environmental and geopolitical consequences and pulled by the opportunity for economic growth. Under the current system for redistributing the world's fossil fuel reserves, both importing and exporting nations face great political and economic costs. For supplying nations—especially those with weak democracies or dictatorships—the presence of oil frequently corrupts the political culture and leads to violent struggles for control.[2] For oil consuming nations, the payment of trillions of dollars annually to oil producing countries is causing one of the biggest transfers of wealth in human history.[3] The United States steadily pays billions annually to producing countries such as Venezuela, Iran, and Russia.[4] In sheer economic terms, the rising bill for imported petroleum lowers the United States savings rate, adds to inflation, worsens the trade deficit, and undermines the dollar.[5] Profound redistributions of wealth also impact relationships between nations. Nations ideologically opposed to the United States gain financial independence, confidence, and capabilities.[6] Moreover, fossil fuel resource depletion could "potentially destabilize the geo-political environment, leading to skirmishes, battles, and even war due to resource constraints."[7]

Environmental concerns present another host of reasons that compel the

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[1] KENNETH S. DEFFEYES, HUBBERT'S PEAK: THE IMPENDING WORLD OIL SHORTAGE 1 (2003).

[2] *See generally* PETER MAASS, CRUDE WORLD: THE VIOLENT TWILIGHT OF OIL (Vintage Books 2010).

[3] Steve Mufson, *High Oil Prices Spur Massive Wealth Shift*, WASHINGTON POST, Nov. 10, 2007, at A1.

[4] *Id*.

[5] *Id*.

[6] *See id.* (suggesting that Russia uses its oil revenue to spread its influence within the former Soviet Republic).

[7] PETER SCHWARTZ & DOUG RANDALL, AN ABRUPT CLIMATE CHANGE SCENARIO AND ITS IMPLICATIONS FOR UNITED STATES NATIONAL SECURITY 2 (2003).

transition away from fossil fuel consumption. Governments and a growing public majority are joining the near uniform scientific consensus that global warming is a reality and that a century of industrial development has acutely impacted the ecosystem.[8] Scientists believe that most of the warming in the last fifty years is human-induced[9] and has led to melting glaciers, rising sea levels, the unbalancing of ecosystems, and intensified droughts and wildfires.[10] Scientists also believe that rising temperatures will increase the frequency of catastrophic, Katrina-like events, such as the submergence of low-lying coastal areas and violent storms.[11]

The possible environmental and geopolitical consequences alone raise reason enough to discontinue the current "business as usual" path. But this Article does not intend to join the increasingly cacophonous chorus of doomsayers. Rather, it argues that the inevitable move away from fossil fuels presents an opportunity for an unprecedented economic and technological shift. If governments, individuals, and organizations choose to develop renewable energies, we can address pressing global issues, build new high-growth economies, improve collective security, and ensure brighter prospects for future generations.[12] In a unique moment in modern history, renewable energy offers a simultaneous promise of economic growth and environmental sustainability. Indeed, a clean tech revolution will depend on financial growth, built around current and future business opportunities, driving us toward a more sustainable world. Technology markets, supported by capital and the right governmental policies, can provide the engine that generates new high-paying jobs, competitive businesses, vast infrastructure investment, and long-term sustainability.[13]

Ultimately, this Article embraces a market-based solution. A carbon tax—to be imposed on coal, natural gas, and oil produced in or imported to the United States—would create a price signal for private markets to reduce carbon dioxide emissions and invest in the development of fossil fuel alternatives. Such a signal would utilize the undeniable force and meritocratic nature of capitalist markets to transition to a new, wealth-generating economy. In relying on our

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[8] Elizabeth Kolbert, *Up in the Air*, NEW YORKER, Apr. 12, 2010.

[9] RISKMETRICS GROUP, CORPORATE GOVERNANCE AND CLIMATE CHANGE: THE BANKING SECTOR, at i, SN062 ALI-ABA 947, 951 (2008). Specifically, the burning of fossil fuels emits greenhouse gasses (GHG) such as carbon dioxide, sulfur dioxide, and nitrogen oxide. These gases contribute to the greenhouse effect, where an upper layer of atmospheric gases lets in high-intensity solar rays and which are then trapped as heat in the atmosphere as they lose intensity.

[10] *Id.*

[11] *See* AN INCONVENIENT TRUTH: THE PLANETARY EMERGENCY OF GLOBAL WARMING AND WHAT WE CAN DO ABOUT IT (Participant Productions May 24, 2006).

[12] RON PERNICK & CLINT WILDER, THE CLEAN TECH REVOLUTION 283 (Harper Collins 2008).

[13] *See generally* Michael Waggoner, *Why and How to Tax Carbon*, 20 Colo. J. INT'L ENVTL. L. & POL'Y 1 (Fall, 2008). Professor Waggoner prudently explores potential ill effects in the adoption of new clean technologies. *Id.* at 25-27. This Article assumes that the conjectural problems with new clean technology cannot be worse than the known problems of fossil fuels and as such should not discourage their development.

capitalistic nature, we can meet the world's rising energy needs while transitioning away from the exploitive dependence on carbon energy.

This Article first makes the case that carefully crafted governmental policy must steer the technological shift. Part II then explains why a carbon tax is the best policy. Part III provides an overview of the three major clean technologies: solar, wind, and biofuel. It then describes how a carbon tax would affect those industries. Part IV discusses a carbon tax implementation that best achieves the stated goals. Finally, Part V explains why a carbon tax offers more promise than a cap-and-trade program.

I. THE CASE FOR POLICY: THE REVOLUTION WILL NOT GO UNREGULATED

The private market is already heading toward a clean tech revolution. Indeed, many mainstream companies, like G.E., are seeing the "'green' in green."[14] As prices are generally going up for fossil fuels and down for renewables, anticipating the shift to clean tech is a smart business move. Companies are increasingly investing in clean tech, not to make ideological statements, but to maximize profits. Venture capital in clean tech increased from $1 billion in 2005, to $2.7 billion in 2007.[15] Since 2000, investment in clean tech increased from less than 1% of total venture capital to nearly 10%.[16] Worldwide, the numbers are more impressive. In 2007, global renewable-energy investment totaled $148.4 billion.[17] What was once a niche market is now poised to be a mainstream, trillion-dollar economy.

In the past decades, when oil was cheap, most clean tech was prohibitively expensive. With oil prices rocketing to recent highs, however, the dynamic is changing. In addition, "advances in core technology and manufacturing processes have significantly improved performance, reliability, scalability, and cost" of clean technologies.[18] The convergence of these cost trends make clean tech economically attractive. For instance, in November 2005, 33,000 Xcel customers in Colorado paid less for wind generated electricity than other customers buying conventional carbon-based grid power for the first time.[19] Over time, the cost advantages promise to increase. Oil and carbon prices have risen steadily for decades. But, as clean tech markets expand, efficiencies improve, and production volumes increase, the renewable energy sector is

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[14] PERNICK & WILDER, *supra* note 12, at 285 (GE CEO Jeffrey Immelt states profit maximization as the rationale for GE's Research and Development investments in the renewable sector).

[15] Brad A. Kopetsky, Comment, *Deutschland Uber Alles: Why German Regulations need to Conquer the Divided U.S. Renewable-Energy Framework to Save Clean Tech (and the World)*, 2008 WIS. L. REV. 941, 949 (2007).

[16] *Id*.

[17] *Id.* at 950.

[18] PERNICK & WILDER, *supra* note 12, at 6.

[19] *Id*. at 59.

achieving economies of scale that continually lower costs.[20]

With the possible exception of biofuels, clean tech is also attractive to investors because it can provide zero input costs. Unlike fossil fuel prices—which can vacillate wildly on world commodity markets—the sun, wind, waves, and tide arrive daily at no production cost. "The price of wind will always be zero. And that is a fundamental of [the clean tech] industry."[21] Moreover, once upfront capital expenditures are met—such as installing a solar rooftop—the pricing is stable and fixed. Because wind and solar resources can be mapped with tremendous precision, customers can enter into multi-year energy contracts with a fixed monthly charge for energy.[22] The ability to lock in consistent fuel costs is a valuable business advantage. It converts a variable budget line item into a fixed cost.[23]

Some of the advances in clean tech are attributable to government support. For example, the federal government has sporadically supported various clean technologies, such as funding research and development for solar power and incentivizing hybrids with tax credits.[24] Numerous states have also passed legislation that requires certain percentages of energy to come from renewable sources.[25] Another government program, the Production Tax Credit (PTC), has dramatically benefited the wind industry, but is in need of an overhaul. The PTC provides a 1.9 cent tax credit per kilowatt of wind-generated electricity.[26] This critical subsidy makes wind energy cost competitive with traditional energy sources.[27] The PTC, however, has an on-again-off-again history that devastates investor expectations.[28] The legislation that enacted the PTC requires Congressional renewal every two years, and since 1999, it has expired three times.[29] Predictably, investor enthusiasm closely parallels the status of the subsidy.[30] Wind industry growth shot up in 1999, 2001, 2003, 2005, and throttled downward in 2000, 2002, and 2004.[31] Such volatility shows the remarkable impact of government policy on the private sector and is an example of inefficient policy that the wind industry is lobbying hard to change.

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[20] *Id*. at 6-8.

[21] *Id*. at 7 (quoting Mark Little, director of GE Global Research).

[22] *See, e.g.,* Matthew L. Wald, *Selling Cape Wind's Future Wares*, N.Y. TIMES, May 7, 2010, *available at* http://green.blogs.nytimes.com/2010/05/07/selling-cape-winds-future-wares.

[23] PERNICK & WILDER, *supra* note 12, at 8.

[24] *See, e.g.,* I.R.C. § 30B (2010), Alternative motor vehicle credit.

[25] PERNICK & WILDER, *supra* note 12, at 3.

[26] H.R. 776, ENR, Energy Policy Act § 1914, (102nd Congress).

[27] PERNICK & WILDER, *supra* note 12, at 63.

[28] *Id*.

[29] *Wind Power and the Production Tax Credit: An Overview of Research Results: Hearing on Clean Energy: From the Margins to the Mainstream Before the S. Finance Comm.*, 112th Cong. 5 (2007) (statement of Dr. Ryan Wiser, scientist, Lawrence Berkeley National Laboratory).

[30] PERNICK & WILDER, *supra* note 12, at 63.

[31] *Id*.

Piecemeal incentives like tax credits for hybrids or the PTC can create cost competitiveness and bolster investments in particular markets. The scale of transformation at hand, however, requires a greater, more uniform level of government incentive and regulation. The United States alone spends over a trillion dollars annually on energy.[32] Currently, clean tech energy occupies a tiny percentage of that space. Even optimistic estimates of retooling the energy infrastructure talk in twenty to fifty year blocks.[33] Placing a cost on carbon would apply a relatively hands-off market pressure and would raise the tide to lift numerous clean tech enterprises. A carbon tax could ignite innovation, spur economic growth, and steer the economy in a direction that we thoughtfully choose.

Favoring clean tech, however, does not require the government to meddle where it has not before. Critics often point to clean tech's need for regulatory support, but energy has always been heavily dependent on regulation.[34] The federal government extensively regulates other large industries such as transportation, water, and construction.[35] Governments inevitably regulate major industries, and such regulation unavoidably favors certain markets and guides economic development. A carbon tax would replace one philosophy of regulation with another.

"There is no such thing as a subsidy-free energy, and there never has been in the modern world."[36] The histories of oil, coal, natural gas, hydroelectric, and nuclear power all include direct and indirect financial support from governments that sought to develop them.[37] Nuclear energy in the United States, for example, received $50 billion in direct government funding for research and development between the years 1973 and 2003.[38] Likewise, the oil industry, despite making record profits, still benefited from $73 billion in tax breaks in the last six years.[39] Governments create policies and incentives to encourage the markets they choose. The choice then is not *if* governments should be involved in energy policy, but *how*. Part of encouraging clean tech would mean eliminating long-running incentives for the mature and established energy industries. This Article posits that a carbon tax provides a necessary shift in government energy policy, which would enable private market mechanisms to create vibrant markets in a sensible, predetermined space.

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[32] U.S. Energy Information Administration, STATE-LEVEL ENERGY CONSUMPTION, EXPENDITURES, AND PRICES, 2007, Table 1.6, *available at* http://www.eia.gov/emeu/aer/overview.html.

[33] *See* PERNICK & WILDER, *supra* note 12, at 285.

[34] John Plaza, *The U.S. Government Has a Long History of Financing Energy Infrastructure*, RENEWABLE ENERGY WORLD, Oct. 19, 2009.

[35] *See* Titles 49, 40, and 29, respectively, of the United States Code.

[36] *Id. at* 288.

[37] *Id*.

[38] *Id*.

[39] Plaza, *supra* note 34.

II. IF POLICY, WHICH ONE?

Assuming that encouraging the clean tech revolution is needed to both avoid the negative consequences of depleting the fossil fuel resource and to capitalize on an economic opportunity, the next point of discussion is why a carbon tax is better than other policy proposals. A carbon tax is attractive because it pulls the policy lever only slightly. It nudges natural consumption and development in a sensible direction, but does not require a dramatic alteration people's behavior.[40] A carbon tax avoids mandates that people stop driving their environmentally noncompliant diesel trucks, or that a city buy thirty percent of its electricity from wind turbines. Rather, a small fee on carbon creates greater cost parity between energy sources and operates at the margins of peoples' decision-making. Businesses may tip toward greener ventures if the cost margins are slightly improved. At the consumer level, a difference of five cents on the dollar—not thirty—between clean and carbon energy may allow people to opt for the more environmentally responsible choice. Such a nudge does not tell people what they must not do, but protects our freedom of choice in the marketplace.[41]

An indirect pull approach—like a comprehensive tax—makes the most sense because it simultaneously encourages a variety of innovations. Instead of pushing for particular technologies, where the government must act as an arbiter to favor one kind of technology, the pull approach casts a long shadow and allows the market to reward a variety of innovations that find competitive advantages in particular settings.[42] For example, instead of the government putting all of its eggs in the solar basket, a price on carbon would allow solar energy to take hold in a sunny place like Arizona and wind energy to develop on the less sunny, windy Eastern coasts. A pull approach maximizes the capabilities of markets by providing for incremental innovations and allowing for adaptability in regional markets. Many different technologies can be rewarded and implemented at once, which is exactly what the climate change situation calls for.

Currently, energy provided by clean tech barely registers on the overall energy pie. Transitioning from carbon-based energy to clean technology is a daunting project that will take decades.[43] Some reports estimate that it will take thirty years for renewables to supply 25% of our global energy.[44] A carbon tax, then, properly frames the technological shift in long-term thinking. In retooling our energy supply, there will be no silver bullet but thousands of solutions and

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[40] *See* CASS SUNSTEIN & RICHARD THALER, *NUDGE: IMPROVING DECISIONS ABOUT HEALTH, WEALTH, AND HAPPINESS* (Yale University Press 2008) (explaining the idea of *libertarian paternalism* where people are free to act as they want but are slightly incentivized to make decisions that benefit them).

[41] *See id.*

[42] *See generally* Waggoner, *supra* note 13.

[43] PERNICK & WILDER, *supra* note 12, at 285.

[44] *Id.*

millions of variations that will take decades for robust implementation. "Rather than a swift series of eureka moments, progress [in the clean tech space takes] shape in setting goals, testing, tweaking, and then setting more goals."[45] The solutions, moreover, will come from multiple sectors, such as wind, solar, biofuel, and energy conservation. Each technology, if developed and deployed simultaneously, will play a specific role in meeting future energy needs.[46] This "wedge approach," which Al Gore endorsed in his documentary, *An Inconvenient Truth*, proposes that replacing carbon use will require the utilization of numerous renewable sources at once.[47]

A broad, multi-variant approach presents an ideal situation for government underwriting. Government is at its best when it does not directly act, but puts its thumb on the scale to move society in a responsible direction. In applying diffuse pressure, a carbon tax would create a larger framework for creating and distributing new technologies. Private enterprises across the board would be invited to enter the clean tech space with the promise of making profits. Developed technologies, then, could reach the level of cost competitiveness for widespread adoption and gradual diffusion to other parts of the world.

III. HOW? BIG PICTURE. THUMB ON THE SCALE.

The question is not *if* renewable energies will be embraced but *how rapidly*. The obvious benefits of transitioning away from fossil fuel dependence, discussed above, would mean little if such an evolution were not possible. However, developments in the public consciousness and the private sector make such a transition not only possible, but probable. It is unlikely that individuals and the private sector can usher in a new era without the aid of government policy. The three key levers for change—capital, technology, and policy—must work in concert to effect fundamental change. The interaction is fundamental and cannot be separated. Policy attracts the capital, which elicits the technology. In the case of clean tech, each of the elements is ready to be mobilized. The technology has existed in concept for decades, but was largely shelved until the recent spike in oil costs rekindled interest. Capital investment once trickled in, but is now coming in torrents.[48] And policy can be effected anytime as a matter of political will. The next section of this Article discusses the current state of the main renewable technologies and how capital and policy are needed to push the revolution ahead.

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[45] Jon Gertner, *Capitalism to the Rescue,* NEW YORK TIMES MAGAZINE, Oct. 3 2008.

[46] S. Pacala & R. Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, SCIENCE Aug. 13, 2004.

[47] AN INCONVENIENT TRUTH, *supra* note 11.

[48] *See supra*, Section I.

A. State of the Art

Private developers—from large multinationals like Sharp and G.E., to small-time garage tinkerers—have conceived of and are perfecting staggering new technologies. Dan Arvizu, head of the National Renewable Energy Laboratory, who testifies regularly before Congress on the state of renewables, summarizes: "They always ask the same questions — 'When is this going to be real?' And I say: 'It's real now.'"[49] The next section briefly describes developments in the three major clean technologies: solar, wind, and biofuel.

1. Solar

In the case of solar, established multinationals and nimble entrepreneurs are racing to develop solar technology and bring it to market. It has become big business. In 2007 alone, the global solar industry produced enough cells to power three cities the size of Atlanta, or 3000 megawatts solar.[50] Global sales were $15 billion in 2006, $20 billion in 2007, and are projected to be $70 billion-plus in 2017.[51] The annual growth rate in sales since the mid 1990s has been in the 30-60% range.[52] In North America, venture capitalists invested $300 million in 2006, and $1 billion in 2007.[53]

The explosion can be attributed to technological advances, market growth, increased competition, and economies of scale. Solar technology is moving in a "classic experience curve," where costs fall in direct correlation to increased production volume.[54] Costs have fallen 50% per decade since the 1980s, and analysts predict them to drop faster as the technology advances.[55] Decades-long progress in fabrication technology benefitted solar manufacturing by making them lighter, more adaptable, and more efficient.[56] Many of the manufacturing breakthroughs occurred in the computer and high-tech booms and are being applied to solar manufacturing.[57] Semiconductor-based chips and circuits, which enabled the creation of computers, TVs, and other consumer electronics, "lie at the heart of grid innovation and energy delivery."[58] Investors trust the solar boom because it relies on already tested technology.

Solar's adaptability to rural and developing areas is another advantage that portends massive growth. In many remote places around the world, solar

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[49] Gertner, *supra* note 45.
[50] PERNICK & WILDER, *supra* note 12, at 30.
[51] *Id*. at 31.
[52] *Id*.
[53] *Id*. at 32.
[54] *Id*. at 32-33.
[55] *Id*. at 37.
[56] *Id*.
[57] *Id*. at 34.
[58] *Id*.

technology presents the cheapest and simplest option for electrification.[59] Just as cell phones took hold in many developing areas where satellite technology was more feasible than telephone lines, solar power promises far-reaching applications. Off-grid solar systems present a realistic means of providing electricity in part because these systems cut out the expense of building new power plants and installing a grid infrastructure. In addition to replacing diesel generators and kerosene stoves, countries can use solar powered electricity to connect people to the internet and modernize communities. India, South America, and Africa already have successful solar businesses. Off-grid solar photovoltaic panels are the fastest growing source of electricity in Kenya.[60] Billions of people around the world desire electricity, and the economic and social benefits lay waiting for the companies and governments able to distribute the technology.

Despite the tremendous gains in some markets, solar still lags behind conventional grid power in terms of cost competitiveness. The installed price of solar electricity, which includes converters to AC current, hardware, and installation and service fees, is $6 to $8 dollars per watt in the United States.[61] The price translates to eighteen to thirty-six cents per kilowatt hour—a significant hike from the going utility rate of ten cents per kilowatt hour.[62] However, in certain circumstances, solar rates compare favorably when compared to conventional grid power. For instance, solar power is cheaper in places with extremely high utility costs like Japan and San Diego and in states with generous solar rebates, such as California and New Jersey.[63] In addition, solar power can be a better value during peak demand times.[64] To be generally competitive with fossil fuel derived electricity, the cost of solar needs to drop by half. Of course, a spike in the price of carbon or natural gas would lower the competitive bar. But the industry must progress to be a viable competitor in terms of pure price parity.

2. Wind

"Wind power is no longer a quaint, modest cottage industry, and it's not just some futuristic pipe dream, either. Wind energy is online and producing significant amounts of power right now."[65] By all measures, wind's role as a mainstream power source continues to grow. Worldwide, investment in wind

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[59] *Id*. at 51.

[60] *Id*.

[61] *Id*. at 36.

[62] *Id*.

[63] *Id*. at 36-37.

[64] *Id*.

[65] Doug Moss, *A Mighty Wind*, EMAGAZINE, Vol. XVI, no.1, Jan./Feb. 2005, http://www.emagazine.com/view/?2161.

industry jumped 68% in 2006-2007, from $17.9 billion to $30.1 billion.[66] Insiders predict that the industry will "nearly triple to $83.4 billion by 2017."[67] Domestically, the wind industry invested $17 billion in wind farm construction in 2008.[68] In addition, in 2008, wind power provided the second largest source of new electrical capacity in the United States, providing 42% of the nation's new electric generating capacity.[69] In terms of power, wind energy supplies 94,000 megawatts of installed capacity worldwide, enough to power over 85,000 American homes.[70] Like solar, economies of scale and technological advancements are driving costs down, from more than thirty cents per kilowatt hour to less than four cents in some areas.[71]

Wind energy, because of its massive upfront costs, is a big company's game. Single propeller blades, made of carbon fiber and synthetic resins, can spin with a rotor diameter of over 400 feet and generate seven megawatts of electricity, enough to power more than 5,000 American homes.[72] The enormous size of the operations requires large capital costs, big project finance deals, and large-scale industrial companies to supply the equipment. For this reason, the world's biggest names in manufacturing, finance, and electric power dominate the industry. GE, Xcel, Mitsubishi, and Goldman Sachs, for example, all have major strategic investments in wind energy.[73]

Several different factors contribute to the growing popularity of wind power. Technological advancements in metallurgy, materials science, and manufacturing have produced larger, more efficient, and more reliable turbines.[74] In addition, larger blades spin at a slower rate, which obviates much of the local concern for bird and bat safety because birds and bats have a greater ability to see and avoid the larger, slower blades.[75] Furthermore, newer turbines no longer use trellis-type support towers, which attract birds as a place for perching or nesting.[76] Ultimately, the threat to birds and bats is exaggerated, as studies show that turbines will never account for more than a very small fraction of bird and bat deaths, far less than from other hazards such as flying into

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[66] PERNICK & WILDER, *supra* note 12, at 61.

[67] *Id*.

[68] Tom Weis, *America's Wind Power Imperative: A Call to Action*, THE HUFFINGTON POST, Mar. 6, 2009, http://www.huffingtonpost.com/tom-weis/americas-wind-power-imper_b_172644.html.

[69] *Id*.

[70] PERNICK & WILDER, *supra* note 12, at 66-67.

[71] *Id*.

[72] *Id*. at 66.

[73] *See, e.g.,* Nick Hodge, *A Shift in the Global Wind Industry: Wind Companies to Adapt…or Die*, GREEN CHIP STOCKS (June 9, 2010), *available at* http://www.greenchipstocks.com/articles/shift-in-the-global-wind-industry/988.

[74] Paul Dvorak, *Speed Increasers for Wind Turbines*, WIND POWER ENGINEERING, June 12, 2010, *available at* http://www.windpowerengineering.com/tag/ge/.

[75] PERNICK & WILDER, *supra* note 12, at 68.

[76] *Id.*

windows or being hunted by cats.[77] Wind energy also benefits from detailed mapping systems, which chart wind patterns for finding suitable locations for wind farms. Highly sophisticated computer models predict wind strength and consistency, and wind farms generally deliver on what developers promise.[78] The accurate predictions also contribute to a fundamental advantage of wind power in guarantying a fixed price. Wind projects lock in multi-year contracts, creating consistent fuel prices on which suppliers and end users can depend.[79]

Wind energy is a tremendous domestic resource, which the United States has only begun to tap. Wind currently provides 1% of the United States' electricity needs, but there is enough wind potential in the country to supply several times the nation's total electricity usage.[80] Other countries far outpace the United States' wind industry and demonstrate the tremendous potential of wind energy. Denmark, for example, generates more than 20% of its total electricity from wind power, with a goal of 50% by 2025.[81] Germany's goal is 25% by 2025.[82] However, in order for the United States to realize the potential of wind energy, it must update the current energy grid. Many windy places are far from consuming markets, and transmitting the electricity can represent the greatest cost of a wind farm project. Individual developers often take on the costs of bringing electricity to market, but it is likely that government intervention is needed to modernize and expand the grid for wind to realize its potential.[83] Investment in the wind energy infrastructure, however, could bring good-paying jobs to rural America and the manufacturing sector while providing reliable, cheap, and clean energy.[84]

3. Biofuels

In 1925, Henry Ford said:

> The fuel of the future is going to come from fruit like that sumac out by the road, or from apples, weeds, sawdust—almost anything. There is fuel in

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[77] GLOBAL WIND ENERGY COUNCIL, REPORT ON BIRDS AND BATS, *available at* http://www.gwec.net/index.php?id=144.

[78] PERNICK & WILDER, *supra* note 12, at 70.

[79] *See, e.g.* Matthew L. Wald, *Selling Cape Wind's Future Wares*, N.Y. TIMES, May 7, 2010, *available at* http://green.blogs.nytimes.com/2010/05/07/selling-cape-winds-future-wares/.

[80] Tom Weis, *America's Wind Power Imperative: A Call to Action*, THE HUFFINGTON POST, Mar. 6, 2009, *available at* http://www.huffingtonpost.com/tom-weis/americas-wind-power-imper_b_172644.html.

[81] *Id*.

[82] *Id*.

[83] Peter Behr, *Do the Rules of the Nation's Electric Grid Discriminate Against Wind Power?*, NY TIMES, April 27, 2010, *available at* http://www.nytimes.com/cwire/2010/04/27/27climatewire-do-the-rules-of-the-nations-electric-grid-di-49343.html.

[84] *See, e.g.,* John Collins Rudolf, *Nevada Wind Turbine Factory to Create 1,000 Jobs, Backers Say,* NY TIMES Mar. 15, 2010, *available at* http://green.blogs.nytimes.com/2010/03/15/nevada-wind-turbine-factory-to-create-1000-jobs-backers-say/.

> every bit of vegetable matter that can be fermented. There's enough alcohol in one year's yield of an acre of potatoes to drive the machinery necessary to cultivate the fields for a hundred years.[85]

Ford's prophetic truth was waylaid by a century of cheap oil and an industry lobbying to use lead-based additives, rather than ethanol, for fifty years. His prophecy is now becoming reality as the market for biofuels booms. In 2007, ethanol represented a global market of more than thirteen billion gallons, valued at more than $20 billion.[86] The U.S. market for biodiesel sextupled from twenty-five million gallons in 2004 to 150 million gallons in 2006.[87] In 2008, manufacturers produced 300 million gallons of biodiesel, representing an annual market worth of $5 billion.[88]

Like other clean technologies, the growth of biofuels relates to economies of scale. As production volumes increase and technologies improve, prices drop. Rising fossil fuel costs also benefit the biofuel industry. As biofuels get closer to price parity with fossil fuels, they become more available and attractive to consumers. In the United States, ethanol is blended with gasoline in mixes ranging from 2% to 85% ethanol, with an ever-increasing number of regions offering 5-10% blends for conventional vehicles.[89] Brazil, the world leader in biofuel usage, has a large proportion of vehicles that run on 100% ethanol.[90] Forty percent of Brazil's total automobile fuel comes from ethanol, which can cost half as much as petroleum-based gasoline.[91]

The growing biofuel industry faces a host of challenges. Obvious objections can be raised against the idea of diverting food for energy in a food-constrained world.[92] Biofuels have the potential to raise demand and price for the world's food supply, putting sustenance out of reach for the world's poor.[93] Replacing some forest land with fuel croplands such as sugar cane or soy beans is a possible solution to this problem. However, this may have a net negative effect on carbon emissions and environmental health.[94] Another issue with biodiesel is that many of the crops that support the technology pose other environmental concerns. For example, corn requires a tremendous amount of acreage, is labor

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[85] PERNICK & WILDER, *supra* note 12, at 90.

[86] *Id*. at 84.

[87] *Id*. at 85.

[88] *Id*.

[89] *Id*. at 84.

[90] *Id*.

[91] *Id*. at 86.

[92] C. Ford Runge, *The Case Against Biofuels: Probing Ethanol's Hidden Costs*, YALE ENVIRONMENT E360, Mar. 11, 2010, *available at* http://e360.yale.edu/content/feature.msp?id=2251.

[93] Elisabeth Rosenthal, *U.N. Says Biofuel Subsidies Raise Food Bill and Hunger*, NY TIMES, Oct. 7, 2008, at A8, *available at* http://www.nytimes.com/2008/10/08/world/europe/08italy.html?_r=1&ref=food_prices.

[94] Runge, *supra* note 92.

intensive, and is very dependent on pesticides.[95] However, a range of innovative companies are taking notice of these concerns and are developing ways to make ethanol from nonfood crops, such as agricultural waste and switchgrass.[96] Many from the environmental and technological lobbies see the use of food crops such as corn as a necessary evil that will lead to eventual mainstream fuel production from waste streams or less intensive crops.[97]

Much of biofuels' success is attributable to their wide-ranging political palatability. Biofuels please such diverse constituents as farmers, investors, corporations, and environmentalists. In a recent congressional hearing regarding biofuels, a DuPont executive stated, "[o]n one side of me were the red-state corn growers, and on the other side were the blue-state edgy, Ivy League-educated NGO types. And they were all in support. This is the only truly bipartisan issue that I've seen in years."[98] Regionalized production is another attractive aspect of biofuels. A number of companies are calling for locally harvested crops, capitalizing on the strengths of each climate and bringing jobs to numerous localities.[99] Instead of importing oil from the Middle East and Venezuela, local communities can produce biofuel, which reinvests money in local jobs and products.

For the biofuel market to truly succeed, it must overcome the classic chicken-and-egg dilemma. For a robust market to develop, the vehicles and fuel must be readily available to consumers with the distribution channels in place. However, private industry will not invest in research, development, and distribution channels until it sees strong market potential. The shift in infrastructure would be great. The different fuel source requires a new generation of vehicles and gas stations. Despite the high barrier to entry, biofuels present an intriguing mix of interests that could find salience in the current political environment. Its success will depend on a concerted effort from policy makers, investors, innovators, and farmers.

Despite their promise and rapid development, the solar, wind, and biofuel industries still need governmental support to nudge them over the tipping point. The industries are in their nascent stages, and the implementation of a carbon tax could create a powerful incentive for interest and investment. A carbon tax would affect a clear price signal to put downward pressure on carbon consumption and upward pressure on the adoption of clean technologies.

B. Capital

To understand how a carbon tax would drive a clean tech revolution, we must

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[95] *Id.*

[96] PERNICK & WILDER, *supra* note 12, at 95-96.

[97] *Id.* at 95.

[98] *Id.* at 106-07.

[99] *Id*. at 102.

first understand the process of business development and the problems facing capital investment. The private sector, while capable of profit and success without any changes to public policy, must overcome numerous obstacles in bringing a business to market. A carbon tax has the potential to harness innovation and ease distribution bottlenecks, making clean tech a more attractive industry. The overall process of business development often begins with new ideas and new technologies. Or, in the case of many clean technologies, the ideas have existed for years but were unappealing to investors until the price of oil spiked and climate change became a concern. Now, places like the Silicon Valley are abuzz with private investment, as numerous firms vie to create the next clean tech Google. Many investment firms, like Kleiner Perkins Caufield & Byers (KPCB)—the company behind Google—have made a trade of finding the next big thing, often developing their projects in secret.

> [M]ost of the Kleiner's green-tech investments are not publicly discussed. . . . [T]he firm has acknowledged 15 of its 40 investments. The rest are in what [Venture Capitalists or] V.C.'s call "stealth" mode, hidden from the press (and copycat V.C.'s) until they are on sounder footing. Last summer, the growing number of stealth companies involved with clean energy formed a kind of dark matter in the Silicon Valley universe, businesses that could not be seen yet nevertheless exerted a discernible gravitational pull. Executives would suddenly leave jobs at established companies to join ventures with no official name. Manufacturing facilities would set up shop in cheap, anonymous buildings in towns like Santa Clara, Calif., then begin round-the-clock operations.[100]

Already, without major policy incentives, many investors are betting their portfolios on the promise of clean technology. The amount of money changing hands is staggering. Al Gore, a partner of KPCB, who increasingly devotes his energy to the private arena, recently stated that "more money is allocated in the private markets in one hour than in all of the budgets of all of the governments of the world in a year's time."[101]

Even great ideas with successful proofs of concept have a high probability of failure. Entrepreneurs refer to the phase between a project's origins and its commercial deployment as "the valley of death."[102] Ideas must overcome numerous obstacles to make it to the market. Among the main risks are: (1) technological scalability—can the idea be reproduced and can others easily learn the process; (2) personnel—are the people behind the idea capable in their sales pitches and executions of the idea; (3) market receptiveness—even if the product is offered, will people buy it; and (4) financing—have all the stages thus

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[100] Gertner, *supra* note 45.

[101] *Id*.

[102] *Id*.

far proven promising enough to earn continued investment?[103] Financing typically comes is several rounds, and businesses that have problems with their technology, management, or marketing have difficulty attracting more financing.[104]

Another inescapable challenge associated with the above risks is the innovator's paradox. Many clean-tech companies are developing products that require new industrial processes. At the beginning, developers face a challenge in reaching mass production "because not enough buyers are willing to pay for the costly products.[105] On the other hand, the products cost so much because they are not being mass-produced."[106] The historical pattern of innovation indicates that novel products can overcome this paradox and succeed in the marketplace by exploiting a niche market. As sales expand and performance improves, the costs drop to a level that allows widespread affordability.[107] Cell phones are an example of this phenomenon. Initially balky and expensive, only a niche market of business people in the developed world appreciated cell phones. As the market gradually expanded, costs decreased, reliability improved, and eventually, governments and entrepreneurs in developing countries found it cheaper to build cellular networks than landlines.[108] Many clean tech entrepreneurs have similar ambitions. They envision that fuel cell and solar technologies will gradually disseminate from cutting edge centers like Silicon Valley to places around the world that have never had access to a grid.

The dissemination of clean technology from cutting edge centers into the mainstream poses a unique challenge because of the energy market's vast scale. Unlike personal computers or software, which have traditionally moved into the mainstream relatively quickly, the dissemination of energy technology may take much longer. Google, for example, took $25 million and five years to reach its initial public offering.[109] A medical venture can take $100 million in investment and ten years to mature.[110] A clean tech company that requires a new industrial process like solar panels could take $500 million and fifteen years to reach market.[111]

Energy, in other words, operates on a different scale than other industries and requires its own treatment. Projects like commercializing fuel cells or equipping gas stations with ethanol pose an investment risk too great to invite numerous business models. A price on carbon is needed to tip the scales of risk to attract

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[103] *Id*.
[104] *Id*.
[105] *Id*.
[106] *Id*.
[107] *Id*.
[108] *Id*.
[109] *Id*.
[110] *Id*.
[111] *See id*.

investors to the higher stakes.

C. Policy

In shaping technological advancement, governments have a range of policy methods at their disposal. At one end is the laissez faire approach where governments simply allow the free market system to run its course.[112] In a laissez faire approach, private investors will continue to be drawn to a growing market for clean technology to some degree. Use of legal frameworks to indirectly signal the increasing value of cleaner technology to private investment falls closer to the middle of the spectrum.[113] By assigning costs to environmentally unsound practices, such as fining companies for illegal dumping, incentives are formed to create easier and cheaper environmental compliance. A third approach involves a more proactive governmental role by directly funding the research and development of technological advancement.[114] The United States, for example, pushed along nuclear energy technology through direct funding.[115] At the far end of the spectrum is an intense and focused government-initiated method, where the government establishes a specialized institutional structure to develop a specific solution.[116] The Manhattan Project and the Apollo Program are examples of the U.S. government meeting specific, extraordinary goals.

For a project of this magnitude, the second option—creating a legal framework to guide the private sector—is the wisest policy. A framework of incentives strikes the right balance of not calling on the government to innovate, but instead to facilitate private innovation. The other options on the spectrum pose significant drawbacks. As discussed above, a laissez faire approach is not a true possibility in the energy field. The U.S. government has extensively subsidized the development of fossil fuels through direct tax breaks or indirect subsidies like the creation of a massive road network. Moreover, a decision to maintain the current course is less laissez faire than a continuation of policy directives that favor the mature, established industries.

Subsidies, further down the spectrum, are undesirable for a number of reasons. Direct subsidies provide funds to encourage transactions that might not otherwise occur. In addition, they can prop up industries that would otherwise fail. While subsidies are valuable for this very reason—keeping projects afloat that the political process deems worthwhile—they create market distortions and

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[112] Daniel Van Fleet, *Legal Approaches to Promote Technological Solutions to Climate Change*, 2008 DUKE L. & TECH. REV. 8, 15 (2008).

[113] *Id*.

[114] *Id*.

[115] PERNICK & WILDER, *supra* note 12, at 289.

[116] Van Fleet, *supra* note 112, at 15.

provide arbitrary windfalls to certain companies. A tax credit for hybrid cars,[117] for example, may have the desired effect of stirring interest in hybrids, but it may also create an unintended windfall for the hybrid manufacturers who experience an artificially inflated demand. Assuming they are already producing hybrids at peak capacity, the subsidy does not put more hybrids on the road, just more expensive ones. Another common flaw of direct subsidies is that they do not create sustainable demand, but only an interest to the maximum subsidized level.[118] Once a subsidy amount for a particular industry is drawn down, the motivation for future innovation may no longer exist.

Subsidies are also flawed because they do not capitalize on the commercial expertise of the private sector. Investors who have dollars at stake have strong incentives and developed business practices to monitor their investments. Subsidized projects, on the other hand, are typically subject to political pressure and are not monitored with the same kind of bottom-line pressure.[119] Without the capital inputs that are typical of a private funding arrangement, innovators may struggle with a lack of guidance.

The main concern with subsidies is the governmental role as arbiter. A subsidized interest gains a competitive advantage over other interests, and politically made energy policies rarely follow economic realities. A myriad of questions must be asked and answered before a government can responsibly enact a subsidy.[120] Is it better, for example, to favor home solar installations or larger, more efficient industrial facilities?[121] Should the policymakers choose hybrid cars over biodiesels? Even if industrial installations are more efficient or electric cars are more adoptable, a government may choose to support a particular policy for political reasons.[122] Many of these policy questions are difficult to answer, and these subsidies often lead to unintended consequences, like windfalls for particular manufacturers. A better approach is to encourage a range of activities and allow the natural selection of the market to determine which technology will prevail.

Along similar lines, specific government projects like Apollo present the same drawbacks as subsidies but to a higher degree. To justify such a project, the end goal of the project must be ascertainable. The concrete objective of the Apollo Project, for instance, was to put a man on the moon. No such single goal presents itself in the energy revolution. Despite the challenges presented by subsidies, however, direct government support may have a limited role to play

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[117] *See* 26 U.S.C. § 30(a) (2007).

[118] BERNARD S. FRIEDMAN, SUBSIDIES, IN THE MCGRAW-HILL ENCYCLOPEDIA OF ECONOMICS 964, 966 (Douglas Greenwald ed., 2d ed. 1994).

[119] Ronald J. Gilson, *Engineering a Venture Capital Market: Lessons from the American Experience*, 55 STAN. L. REV. 1067, 1100 (2003).

[120] *See* Waggoner, *supra* note 13, at appendix.

[121] *Id*.

[122] *Id*.

within a larger carbon tax framework. The private market will be the predominate engine of change, but some well-placed subsidies could provide a shot in the arm, speeding up the shift to renewable energy. For example, the upfront capital costs and logistical complexity of developing a new grid present a compelling situation for government initiative and support.

IV. HOW. LITTLE PICTURE.

A carbon tax can maximize the objectives discussed above because it fosters experimentation and rewards numerous solutions simultaneously. The exact method of implementing a carbon tax is the subject of a different article.[123] There are many possibilities, such as an add-on tax or a revenue neutral tax. One important idea in any approach is the imposition of a variable tax rate that fluctuates to keep the price of oil stable. The tax should be higher when oil prices drop and lower when prices rise.[124] Keeping the price of oil at a stable, high price creates a consistent benchmark that new energy sources can aim for in achieving price parity.[125] Such a system would dampen the boom and bust volatility of innovation that drives investors away.[126] For example, renewable energy exploded in the 1970s when oil prices skyrocketed.[127] Much of the solar and wind technology being pursued today originated from the '70s energy crisis. That technology, however, was largely shelved until recent record oil prices of $150 per barrel rekindled interest.[128] As if to prove the point, a 2008 plunge in oil prices swiftly dampened the prospects of many renewable energy businesses.[129]

The government could employ numerous mechanisms to make the imposition of a carbon tax more efficient and fair. The tax, for instance, could be phased-in gradually to ease the impact on consumers and producers, creating a smooth transition to new sources of energy.[130] The tax could also be phased-out gradually if it proves no longer effective. A carbon tax should contemplate exemptions and credits to lower income consumers to combat regressive effects.[131] Incentives to promote carbon sequestration should also be considered.[132] The tax, if it were to be added-on, would generate revenue that

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[123] *See generally* Waggoner, *supra* note 13.

[124] *See id*. at 8 (explaining that a carbon tax could be reduced or suspended during an energy emergency).

[125] *Id*.

[126] *Id*.

[127] P.C. SINHA, ENERGY CRISIS 184, (Anmol Publications 2004).

[128] Gertner, *supra* note 45.

[129] *See* Clifford Kraus, *Alternative Energy Suddenly Faces Headwinds*, N. Y. TIMES, Oct. 20, 2008, *available at* http://www.nytimes.com/2008/10/21/business/21energy.html?em.

[130] Waggoner, *supra* note 13, at 15.

[131] *See id*. at 16-17.

[132] *See id*. at 12-14.

the political process must allocate somewhere, such as paying off the national deficit, weaning producers and consumers away from oil, or funding environmental friendly programs. Alternatively, if the tax were designed to be revenue-neutral, it makes sense to introduce it along with a Value Added Tax, which would provide a convenient counterbalancing mechanism to offset variations in the carbon tax while leaving other tax systems unaffected.[133]

To successfully implement a carbon tax, the government must overcome the public's aversion to taxes. The word tax triggers a knee-jerk reaction in much of the American public. For this reason, many tax-like programs seek to manipulate public perception by avoiding the word tax. Seattle, for example, places what amounts to a twenty-cent tax on plastic grocery bags and calls it an "advance disposal fee."[134] California and Oregon collect a "system benefit charge" as part of utility bills.[135] In California, the fee is a small monthly surcharge that finances programs for energy efficiency, clean-tech R&D, consumer rebates, and education.[136] Such efforts suggest that political strategists take the public distaste for taxes seriously and create alternatives to sell their tax-like programs.

Continuing this trend, carbon tax advocates have proposed "fee and dividend" as an alternative label for what amounts to a form of taxation. In a New York Times editorial, James Hansen, NASA climatologist and vocal cap-and-trade opponent, laid out the fee and dividend proposal.[137] Hansen suggests imposing a gradually rising fee for each ton of carbon that the United States extracts or imports.[138] The fee would raise the price of goods that utilize carbon energy in their production, but it would also be redistributed as dividends to individuals in proportion to their reduction in carbon emissions.[139] The United States Tax Code could pull these same policy levers, through taxing, offsets and grants,[140] but there would be no getting around the word "tax."

Alternatively, casting the carbon tax as a "sin" tax may be an option. Sin taxes in the past have been politically palatable in the United States. People seem to agree with the idea of shifting revenue from a "public bad" (tobacco) and to a "public good" (cancer research and health care).[141] As public

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[133] *See id*.

[134] Amy Goodman, *Sustainable Seattle: City Launches New Compost Pickup Program as Part of Zero Waste Strategy : an interview with Richard Conlin, Seattle City Council President*, DEMOCRACY NOW, March 30, 2009, *available at* http://www.democracynow.org/2009/3/30/ sustainable _seattle_ group_part_of _movement.

[135] PERNICK & WILDER, *supra* note 12, at 290.

[136] *Id*. at 290-91.

[137] James Hansen, *Cap and Fade*, N. Y. TIMES, Dec 6, 2009, *available at* http://www.nytimes. com/2009/ 12/07/opinion/07hansen.html.

[138] *Id*.

[139] *Id.*

[140] *See infra*, Section V, Subsection iii.

[141] PERNICK & WILDER, *supra* note 12, at 290-91.

consciousness around climate change develops, it is conceivable that citizens could impose a form of sin tax on carbon use.

V. WHY CARBON TAX OVER CAP-AND-TRADE

In theory, a carbon tax and a cap-and-trade system foster economically and environmentally efficient outcomes by placing a premium on carbon. Both are a step in the right direction, and nothing inherent in either program makes them mutually exclusive. Political history and realities of the marketplace, however, suggest that only one system will gain the necessary traction to be successful in the current climate. Although a cap-and-trade system has more political momentum, a carbon tax presents better policy. The next section of this Article briefly describes the two systems and explains why a carbon tax should carry the day.

Fundamentally, the two mechanisms differ in their response to future uncertainty. A cap-and-trade system values the certainty of a particular environmental outcome over the certainty of the price of carbon.[142] This approach aims to set a scientifically determined limit on how much carbon emissions must be reduced to stabilize the climate.[143] The price of carbon, then, will fluctuate with demand changes under the cap. Conversely, a carbon tax places certainty on the price of carbon while yielding uncertainty in a particular environmental outcome. The tax does not place an explicit cap on carbon emissions but applies a general downward pressure on emissions by increasing the cost of carbon.[144]

A. Advantages of a Cap-and-Trade System

In 2008, there were nine cap-and-trade bills before the U.S. Congress and no carbon tax bills.[145] The political atmosphere clearly favors a cap-and-trade system and support revolves around several main arguments. A primary argument for cap-and-trade is its ability to actively control emissions. A cap offers a specific limit on carbon emissions that achieves a "benefit certainty".[146] The premise is that scientific inquiry can determine the "correct" amount of emissions a healthy planet can tolerate, which the political process then

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[142] Jeff Bingaman, U.S. Senator and Chairman of the Senate Committee on Energy and Natural Resources, *Leading the Way: A U.S. Carbon Cap and Trade System*, 4 BUS. L. BRIEF (AM. U.) 2 (Spring 2008).

[143] *Id*.

[144] *Id*.

[145] Jillian Button, *Carbon: Commodity or Currency? The Case for an International Carbon Market Based on the Currency Model*, 32 HARV. ENVTL. L. REV. 571 (2008).

[146] *See* Reuven S. Avi-Yonah & David M. Uhlmann, *Combating Global Climate Change: Why a Carbon Tax is a Better Response to Global Warming than Cap and Trade*, 28 STAN. ENVTL. L.J. 3 (2009).

enforces. Another main argument is international scalability. Proponents argue that U.S. reductions will have little global impact unless such limitations are reciprocated by other nations, including major emerging economies like China, Brazil, and India. A cap-and-trade system, proponents argue, is more inviting to more countries. Implementation may be easier because several countries have previous experience with cap-and-trade systems. For instance, the European Union's recent implementation of a carbon cap-and-trade system could provide practical guidance for an implementation within the United States.[147] The United States has also implemented a sulfur dioxide trading program, which has built confidence and political support for trading systems.[148]

Somewhat perversely, the loudest rationale asserted by cap-and-trade supporters is that it already has political traction. Proponents often point not to the theoretical advantages but to the fact that a cap-and-trade system is more likely to be politically accepted. The private sector, propped by its influential lobbies, began backing cap-and-trade systems in the late 1990s, which helped generate the political momentum at work today.[149] The explanations as to why the private sector prefers cap-and-trade range from cynical to very cynical.

Cap-and-trade supporters value its opaqueness. One argument suggests that a cap-and-trade system may be more politically acceptable because it obscures the imposition of a carbon cost on society.[150] This argument resonates with the main criticism of a carbon tax—that it is a tax—and holds some water. Unlike a carbon tax, which makes clear that society is carrying the burden of consuming carbon, a cap-and-trade system integrates costs at the production level, outside the of the eye of public scrutiny. In a cap-and-trade system, higher carbon costs are negotiated on market floors and behind political and corporate doors. Those costs are then passed to the consumer as higher packaged prices for goods and services. The public is less aware of its role in paying for carbon emissions than if its elected representatives used political capital to enact a new tax. Ultimately, Americans' tried-and-true resistance to new taxes is a material obstacle that may necessitate a search for alternative forms of cost imposition.

A more cynical explanation for the private sector's preference is that a cap-and-trade system will be less effective in regulating private companies. Caps must be negotiated. Implementation of a cap-and-trade system presents a maze of new bureaucracy, cost-partnerships, lobbying, and special breaks for vocal constituents. At the outset, the cap must be determined through a scientific consensus, which may result in a compromise solution based on a battle of experts. Further, by enacting the cap as a quantity-based approach, as opposed

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147 *See, e.g.,* Gerald Wynn & Pete Harrison, *U.S. Cap and Trade Plans Risk European Mistakes*, REUTERS, May 15, 2009.

148 Bingaman, *supra* note 142, at 2.

149 Button, *supra* note 145, at 582.

150 *See* Michael J. Zimmer, *Carbon Tax: Ready for Prime Time*, 8 SUSTAINABLE DEV. L. & POL'Y 67, 69 (2008).

to a price-based approach, the incentives to reduce emissions are weaker.[151] "[E]xperience in some of the European Union countries indicates that political pressures can lead to pull-backs and concessions in cap targets."[152] A cap-and-trade system would require the formation and operation of a new, massive national bureaucracy. Private players may see more opportunity for political manipulation in this model.

B. Counter-arguments to Cap-and-Trade

Each argument for cap-and-trade can be met with compelling counter-arguments. Many supporters subscribe to a theory called "benefit certainty". This theory assumes that scientific inquiry can ascertain the correct level of carbon emissions. However, scientists may not, in reality, be able to determine the "correct" level of carbon emissions. In the vastness of our complicated ecosystem, such a standard may be beyond our current or ultimate scientific comprehension. Even if such an answer were determinable, political compromise will likely affect the process of reaching such a conclusion. Limiting emissions directly impacts human activity and negotiating emission rates will be an unavoidably politicized process. Various allowances and compromises necessary to push through such overarching legislation will invariably compromise a rigid scientific effort. Lastly, once a cap is in place, it will be difficult to change. Reliable, built-in mechanisms to adjust the system according to new experiences should be in place in undertaking such a massive and uncertain project. The push to settle on a cap, however, will expend tremendous political energy. While small safety-valve manipulations will be possible, making adjustments to the overall cap, or the larger frame of reference, will be against political inertia.

Another main support for cap-and-trade—its international scalability—rests on the assumption that previous experience with cap-and-trade systems will make them easier to implement in the future. Some proponents contend that because existing trading systems have achieved some success in the United States and Europe, other governments will be more likely to join such a regime. However, a closer look at the previous attempts of cap-and-trade does not portend future success. The European model, as discussed above, revealed some of the political disadvantages at work in a cap-and-trade system.[153] In the United States, the recognized success of the sulfur dioxide cap-and-trade system may not necessarily translate into larger scale success.

The trading system for sulfur dioxide, aimed at curbing acid rain, focused on

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[151] Harry W. Richardson, *The Implications of Breaking the Logjam Project for Smart Growth and Urban Land Use*, 17 N.Y.U. ENVTL. L.J. 529, 554 (2008).

[152] *Id*.

[153] *See, e.g.,* Wynn & Harrison, *supra* note 147.

111 facilities in the Midwest.[154] However, the United States has no experience with an economy-wide cap-and-trade system. Furthermore, some commentators believe that basing expectations for a carbon tax—something that impacts every sector of the U.S. economy—on past experience with small-scale, targeted policy instruments is misleading.[155] Lastly, the argument that cap-and-trade is advantageous because countries have previous experience with the idea is neutralized by recent experimentation in many countries with carbon taxes. Denmark, Finland, Italy, the Netherlands, Norway, and Sweden have implemented some form of a carbon tax.[156] British Columbia and Quebec also impose carbon taxes.[157] While the programs are too recent to draw meaningful, long-term conclusions, the efforts promise to yield practical experience and valuable information.

The final argument in support of cap-and-trade—its political complexity and opacity—is a disadvantage when properly understood. Cap-and-trade, as opposed to a carbon tax, is inherently complicated. A myriad of considerations must be addressed, including (1) establishing the baseline for the cap; (2) determining how allowances will be created and distributed; (3) devising a system for trade that prevents cheating and punishes those out of compliance; (4) creating systems of international trade and supervision; (5) establishing the use of variances and safety-valve mechanisms; (6) and rewarding offsetting projects like carbon sequestration.[158] A cap-and-trade system also poses difficulties and high costs in enforcement. The mechanisms for distributing allowances and preventing abuse would require a new administrative body or a new office within an existing department like the Environmental Protection Agency. Cap-and-trade may also pose collateral issues that are not present with a carbon tax, such as Securities and Exchange Commission oversight for futures trading in allowances and complex tax considerations.[159]

C. Advantages of a Carbon Tax

A carbon tax poses few of the problems associated with a cap-and-trade system and offers many more benefits. Unlike a cap-and-trade system, a carbon

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[154] Avi-Yonah & Uhlmann, *supra* note 146, at 34.

[155] Jason Scott Johnston, *Climate Change Confusion and the Supreme Court: The Misguided Regulation of Greenhouse Gas Emissions Under the Clean Air Act*, 84 NOTRE DAME L. REV. 1, 62 (2008) (stating "the widespread preference for cap and trade global warming regulatory regimes is, in my view, based on an overly facile belief that a policy instrument that has seemed to work relatively well for some air pollutants (in the United States, sulfur dioxide and nitrous oxides) will also be appropriate for a radically different set of air emissions whose reduction involves virtually every sector of the U.S. economy.").

[156] Avi-Yonah & Uhlmann, *supra* note 146, at 34.

[157] *Id*.

[158] *See id.* at 39.

[159] *Id*.

tax is fundamentally simple. Numerous characteristics beneficial to many tax systems are also at work in a carbon tax. For one, a carbon tax can be easily implemented, administered, and overseen. The administrative infrastructure already exists to levy taxes on fossil fuels, and the United States has extensive experience with economy-wide excise taxes on a wide variety of products, including gasoline.[160] The government could conceivably implement a carbon tax with minor additions to the Internal Revenue Code.[161] In fact, a carbon tax bill proposed by Representative John Larson, Connecticut, proposes adding three relatively short sections to the existing excise portion of the Code.[162] Unlike cap-and-trade implementation—which would require new and extensive legislation—a carbon tax could apply broadly to all sectors in the economy with relative ease. Additionally, the administrative advantages could be heightened if the tax occurred at the source, such as the wellhead, mine, or port of entry. Taxing fewer entities that expect strong supervision could pass the costs downstream and would limit leakage. Lastly, the existing staff of the Internal Revenue Service, which has expertise in enforcing excise taxes, could oversee tax collection.

Another characteristic that makes a carbon tax attractive is the predictability and transparency it offers to private investors. Unlike a cap-and-trade market where carbon allowances could experience extreme volatility, a tax provides long-term predictability for the price of emissions. Such a market constant would provide a steady benchmark against which new technologies must compete. Companies could implement more effective long-range plans for investing in the best technologies that reduce emissions. Furthermore, a carbon tax could be more predictable if the tax was self-adjusting and could counteract fluctuations in the price of carbon.[163] The tax could conceivably be held in trust to ensure consistency and avoid politically motivated adjustments.[164] Despite offering a steady carbon price, a carbon tax would still allow regulators to adjust the rate relatively easily if the price signal was understood to be too weak or too strong.

Other major benefits of a carbon tax include quicker implementation and the ability to raise revenue. In terms of speed, the government could implement a carbon tax to take immediate effect, making it a much quicker method of reducing greenhouse gas emissions than a cap-and-trade system.[165] A quick response is critical, as numerous commentators warn that the planet sits at a pivotal moment where immediate action may be necessary to prevent abrupt

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160 *Id.*

161 *Id*.

162 *Id*.

163 *See supra*, section II.

164 *See* Zimmer, *supra* note 150, at 69.

165 Avi-Yonah & Uhlmann, *supra* note 146, at 39.

climate change.[166] A cap-and-trade system would cause undue delay because it requires time-consuming efforts in scientific inquiry and policy making. Furthermore, because cap-and-trade lacks transparency, it would not provide a clear, stable price signal to influence investment decision-making until years down the road, possibly 2020.[167] A quick restoration of United States' credibility in the global environmental discussions is another benefit of a speedy response to climate change. Because a carbon tax could be effective before the next international treaty on greenhouse gas emissions, the United States could come to the table with a seriousness that is tantamount to the task at hand.[168] Additionally, an in-place tax would bring practical experience and a focal point to the next round of international talks.

A carbon tax could also generate substantial government revenue. The government could use the revenue to reduce other taxes and offset any regressive effects, making the tax imposition more neutral. Alternatively, carbon tax revenue could be channeled toward environmentally beneficial programs. Newer cap-and-trade proposals, it should be noted, often include government auctions of permits to raise revenue, which are aimed at emulating this inherent advantage of a carbon tax.[169] However, an auctioning system necessarily implicates a middle-man and raises transaction costs. A carbon tax generates government revenue more simply and reliably.

D. Disadvantage of a Carbon Tax

A carbon tax, however, comes with one major disadvantage—the practical challenge of enacting tax legislation in the United States, especially during a recession that features unstable energy prices. The transparency and easy implementation of a carbon tax ironically serve to undermine its political attractiveness. A carbon tax makes it clear that society is paying the costs of carbon pollution, and the very word "tax" raises American hackles. A cap-and-trade system may be more politically viable because it is not called a tax and is more obscure about its effect on energy prices. The political advantages of cap-and-trade, however, may be more illusory than real. Opponents will challenge any proposal—including a cap-and-trade regime—that increases energy costs at the expense of businesses in an already weakened economy.[170]

Moreover, this criticism of a carbon tax does not ring true. Endorsing an inferior cap-and-trade system simply because it appears more politically viable amounts to an acceptance of political failure. The lobbying process, in large part, manufactured political approval for cap-and-trade, and nothing prevents it

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166 *See, e.g.,* SCHWARTZ & RANDALL, *supra* note 7, at 2.

167 Avi-Yonah & Uhlmann, *supra* note 146 at 39.

168 *Id*.

169 Zimmer, *supra* note 150, at 69.

170 Avi-Yonah & Uhlmann, *supra* note 146 at 39.

from being reversed. In his remarks to Congress in March, 2007, Al Gore stated, "I fully understand that [taxing the carbon content of fuels] is considered politically impossible, but part of our challenge is to expand the limits of what is possible."[171] Politicians have a responsibility to resist lobbying pressure from the private sector and convince their constituents to join them in doing what is right, not just what is popular. Anything less is a failure of leadership in a period of crisis.

E. International Implications

Finally, because the solution to the climate change crisis must succeed on a global scale, a discussion of the relative values of a tax versus cap-and-trade systems must address international implications. The difficulties in enacting a price on carbon are multiplied on the world scale but so too are the advantages. For the same reasons that a carbon tax appeals domestically, it is attractive at the world level. A carbon tax, for one, presents a more practical approach to the major collective action problem facing the international community.[172] The inherent simplicity of a tax and the institutional familiarity with taxing make a carbon tax more replicable across numerous countries. A leading cap-and-trade proposal in the United States, the Leiberman-Warner Climate Security Act of 2008,[173] is an "exceedingly long and complicated bill of over three hundred pages."[174] Other cap-and-trade proposals are similarly complex, dwarfing their carbon tax counterparts, which are on the order of ten to twenty pages.[175] The specter of creating and regulating a cap-and-trade system in the United States alone raises considerable practical limitations. Less industrialized countries with less sophisticated regulatory control would face seemingly insurmountable challenges in imposing an economy-wide regulation. A carbon tax, in contrast, has the potential to focus on the multinational extraction industries at the wellhead, which resource-poor countries could administratively manage as a revenue-generating resource.

The benefits of a carbon tax, furthermore, do not necessarily depend on

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[171] Al Gore, Testimony before the House of Representatives, House Energy & Science Committees, March 21, 2007.

[172] Daniel Esty, *Breaking the Environmental Law Logjam: The International Dimension*, 17 N.Y.U. ENVTL. L.J. 836, 843 (2008) (stating "the impediments to effective collective action are real. There is no overarching sovereign to set standards, limit spillovers of harm, or impose penalties on 'free riding.' This makes a 'tragedy of the commons' much more likely and creates a magnified risk of overexploitation of shared resources including the atmosphere and the oceans. Elections are not available to discipline decision makers. The lack of a political community means key public officials end up being appointed rather than elected, and the mechanisms for holding policymakers accountable are attenuated. Designing alternative institutional mechanisms to overcome this democratic weakness becomes essential.").

[173] Proposed Bill, S. 3036, 110th Congress (2007-2008).

[174] Avi-Yonah & Uhlmann, *supra* note 146 at 37.

[175] *Id*.

international cooperation. While global cooperation is the ultimate goal, a well-designed carbon tax could benefit an individual country by fostering domestic innovation without driving out industry. Observable benefits may make a carbon tax attractive for self-adoption in numerous countries vying to be the next growth centers for clean tech. A U.S. carbon tax, for example, could tax fossil fuels, both domestically produced and imported, while rebating the tax on exports. Such a system would provide a clear signal to domestic innovation while eliminating the incentive for companies to outsource or relocate. Other countries, without being compelled by a supra-national agency, may adopt their own carbon tax with similar protectionist measures to capitalize on the upside of new technology market growth.[176] On the other hand, a more complicated cap-and-trade system may eventually provide similar market signals, but because it relies more heavily on international cooperation, countries opting to not bind themselves present more opportunity for overall leakage and avoidance.

Lastly, carbon taxes may benefit the global effort in preventing climate change without requiring participation from all countries. Carbon taxes that fuel innovation in the leading industrialized countries like the United States, Denmark, Germany, Japan, and Canada can spur clean technologies to the point of economic scale when distribution to less industrialized countries becomes cost effective. Just as Chinese automakers are aiming to skip the current technology of gas-powered vehicles by jumping to newer electric technologies,[177] many countries that lag technologically can make a virtue of a liability. Emerging market powers like India, Brazil, and China may have the option of implementing new solar and wind technologies without ever investing in conventional grid infrastructure. Furthermore, given the size of these markets, even modest adoption rates of solar, wind, and other renewables could result in significant global reductions in clean tech costs.[178] China, for example, despite its poor environmental track record and reputation for polluting, just overtook the United States as the world's third largest producer of solar panels, after Germany and Japan.[179]

The United States and other clean tech leaders have a significant role to play in providing funding, technology, and knowledge in the diffusion of clean tech. A carbon tax, regardless of whether countries like China and India are among the first to adopt it, feeds the dynamic of the innovation-based environmental

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[176] *See* T. Pick Irvin, *Kyoto Comes to Georgia: How International Environmental Initiatives Foster Sustainable Commerce in Small Town America*, 36 GA. J. INT'L & COMP. L. 559, 577 (2008) (discussing how government bodies are positioning themselves to take advantage of new global market growth).

[177] Keith Bradsher, *China Vies to Be World's Leader in Electric Cars*, N.Y. TIMES, Apr. 1, 2009, *available at* http://www.nytimes.com/2009/04/02/business/global/02electric.html?em.

[178] Margret J. Kim & Robert E. Jones, *China: Climate Change Superpower and the Clean Technology Revolution*, 22-WTR NAT. RESOURCES & ENV'T 9, 13 (2008).

[179] *Id*.

protection model. Spillover from industrialized to industrializing markets contributes to the creation of a worldwide clean tech market. Both types of markets benefit from competition and collaboration, and a worldwide market creates greater scale and diversity in technology developments. The United States has already experienced the benefit of Chinese interest in clean tech and can expect more to come. "Companies from China are already tapping American equity markets, creating [a] frenzy over Chinese solar stocks, reflecting the confluence of two major trends: [China's] growing interest in clean technology stocks and demand from investors for more plays on China's booming economy."[180] A worldwide clean tech market invites new opportunities for entrepreneurial companies across the globe. Including India and China in the market-based solution to climate change is critical to the international negotiation dynamic. These countries, as an inescapable part of the global problem, must be part of the global solution.

CONCLUSION

The end of the era of cheap fossil fuels presents us with an unprecedented opportunity. The transition to alternative energy sources could be clean or messy. Fortunately, the agents of change are within our control. Nothing new is needed to realize the vision of a clean tech revolution. The necessary levers for change—capital, technology, and policy—exist and the government can deploy them in a way that avoids the downside and capitalizes on the upside. Favorable government policy is essential in smoothing and steering the transition from carbon fuels to clean forms of energy. Ultimately, a carbon tax presents the most sensible policy. It provides a market-based solution that harnesses people's irrepressible entrepreneurial spirit and rewards innovation in a pre-determined, environmentally responsible space. Recasting our energy usage will be a monumental challenge, but the benefits are obvious, and a carbon tax is a small yet assured step forward.

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[180] *Id*. at 12.