A CARBON TAX AS A DRIVER OF GREEN TECHNOLOGY INNOVATION AND THE IMPLICATIONS FOR INTERNATIONAL TRADE

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Synopsis: This article addresses the important role for the United States in developing new technologies that can address climate change by reducing carbon dioxide (CO2) emissions, particularly given its capacity for research and development (R&D) and innovation broadly. The article explains how U.S. climate change policy has begun to grasp this opportunity by supporting clean technology R&D using measures such as grants, subsidies, and low interest loans. Pricing carbon will complement these government policies and further drive green technology development. A price on carbon would also have a range of implications for clean technology innovation and international trade. For instance, a carbon price will lead to growing U.S. demand for green technologies to reduce CO2 emissions, which will incentivize greater levels of global R&D into such technologies. But to maximize the benefits to the United States and globally from the impact of a carbon price on R&D will require a complementary trade policy that lowers barriers to trade in climate change goods and services. At the same time, a carbon price will raise domestic concerns in the United States about carbon leakage and a loss of international competitiveness that is likely to lead to domestic pressure on the government to raise trade barriers on goods from countries not pricing carbon. Effectively managing the global impact from a U.S. carbon price on international trade will determine whether pricing carbon supports trade liberalization and drives greater levels of innovation and R&D or whether it becomes a reason for raising barriers to trade that reduce U.S. and global welfare.

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I. INTRODUCTION

In 2001, President George H.W. Bush announced that the United States would withdraw from the Kyoto Protocol.[1] This decision formalized what had been clear since the 1997 Byrd Hagel Resolution which stated that the Senate would never pass a treaty that did not include binding CO_2 targets for large developing countries like China—something the Kyoto Protocol failed to do.[2]

The Kyoto Protocol commits developed countries to reduce their CO_2 emissions to 5% below 1990 levels by 2012,[3] and international negotiations are underway to determine targets for a second commitment period that will run until 2020.[4] The Kyoto Protocol includes a range of other provisions such as the Clean Development Mechanism, which allows developed countries to reach their targets by purchasing allowances from projects in the developing countries that reduce CO_2 emissions.[5] There are also rules on financing, technology transfer, and CO_2 accounting mechanisms.[6] The Kyoto Protocol, however, says very little about how developed countries should achieve their CO_2 targets.[7] Instead, the Kyoto Protocol leaves it up to each country to determine how this should be done.[8] Underlying this approach was a view that CO_2 emissions targets negotiated and agreed amongst countries would be enough to overcome political opposition to taking action to reduce CO_2 emissions.

When President Bush withdrew the United States from the Kyoto Protocol in 2001, he also inaugurated an alternative approach to mitigation targets as drivers of domestic climate change action.[9] Under the Bush approach, the United States dispensed with legally binding, economy-wide targets and instead focused on developing the green technologies that would allow the United States (and the world) to reduce its CO_2 emissions.[10] Following the election of

1. Letter from President George H.W. Bush, to Senators Hagel, Helms, Craig & Roberts (Mar. 13, 2001) [hereinafter President Bush's Letter to Senators], *available at* http://georgewbush-whitehouse.archives.gov/news/releases/2001/03/20010314.html; *see also U.S. Pulls Out of Kyoto Protocol*, ENV'T NEWS SERVICE (Mar. 28, 2001), http://www.ens-newswire.com/ens/mar2001/2001-03-28-11.asp.

2. S. Res. 98, 105th Cong. (1997).

3. Kyoto Protocol to the United Nations Framework Convention on Climate Change, art. 3, ¶ 1, Dec. 11, 1997, 2303 U.N.T.S. 148, *available at* http://www.kyotoprotocol.com/resource/kpeng.pdf. The Kyoto Protocol commitment period, during which average emissions levels are required to meet targets, was 2008 to 2012. *Id.*

4. CHAD CARPENTER, U.N. DEV. PROGRAM, ENV'T & ENERGY GRP., TAKING STOCK OF DURBAN: REVIEW OF KEY OUTCOMES AND THE ROAD AHEAD 1 (2012), *available at* http://www.undpcc.org/docs/Bali%20Road%20Map/English/UNDP_Taking%20Stock%20of%20Durban.pdf.

5. Kyoto Protocol, *supra* note 3, at art. 12; *Clean Development Mechanism (CDM)*, U.N. FRAMEWORK CONVENTION ON CLIMATE CHANGE, https://unfccc.int/kyoto_protocol/mechanisms/clean_development_mechanism/items/2718.php (last visited Apr. 8, 2014).

6. Kyoto Protocol, *supra* note 3, art. 5, 10, 11.

7. *See generally* Kyoto Protocol, *supra* note 3.

8. *Id.*

9. President Bush's Letter to Senators, *supra* note 1.

10. *Id.*

President Obama, the focus of Congress in terms of climate change was on passing cap and trade legislation. The House passed a bill establishing a cap and trade scheme—the American Clean Energy and Security Act[11]—but the Senate failed to act.[12] Since then, government support for developing green technologies has also been at the core of President Obama's approach to reducing U.S. CO_2 emissions.[13]

Moreover, since the 2008 financial crisis, developing green technologies has become part of the broader U.S. strategy to create new drivers of economic growth and jobs and to be competitive with other countries trying to advance their green technology sectors.[14] As President Obama stated in his 2010 State of the Union address, "the nation that leads the clean energy economy will be the nation that leads the global economy. And America must be that nation."[15] And in Obama's 2013 climate change speech at Georgetown University, he reiterated the need for the United States to win the clean energy race.[16] The development of green technologies is, therefore, not only an environmental goal, but also an important economic and political goal for the United States.[17]

The view that developing green technologies is a matter of international competition and a key source of creating new jobs also has implications for international trade. For instance, the allocation of significant government funding for developing green technologies has come with political pressure to capture the gains for domestic business, which is often understood as limiting the access of foreign companies to U.S. markets.[18] And subsidies to develop green technologies can raise issues regarding their World Trade Organization (WTO) consistency.[19]

The failure of the U.S. Congress to pass a cap and trade system that would have included a cap on U.S. emissions and the U.S. focus on developing technologies to reduce CO_2 emissions has also contributed to a paradigm shift in how climate change is being discussed in the international United Nations (U.N.) climate change negotiations. In particular, the U.N. climate change conference in Copenhagen in 2009 shifted the international negotiations away from the top-down Kyoto Protocol model that required agreement on country-specific targets

11. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong.

12. *American Clean Energy and Security Act of 2009*, AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., http://www.aceee.org/topics/aces (last visited Mar. 31, 2014).

13. Brad Plumer, *Obama Tries the Kitchen-Sink Approach to Global Warming*, WASH. POST WONKBLOG (June 25, 2013, 9:48 AM), http://www.washingtonpost.com/blogs/wonkblog/wp/2013/06/25/obama-tries-the-kitchen-sink-approach-to-global-warming/; *see also* President Barack Obama, Remarks by the President on Climate Change at Georgetown University (June 25, 2013) [hereinafter Remarks by the President on Climate Change], *available at* http://www.whitehouse.gov/the-press-office/2013/06/25/remarks-president-climate-change.

14. President Barack Obama, Remarks by the President in State of the Union Address at the U.S. Capitol (Jan. 27, 2010), *available at* http://www.whitehouse.gov/the-press-office/remarks-president-state-union-address.

15. *Id.*

16. Remarks by the President on Climate Change, *supra* note 13.

17. *See generally id.*

18. *E.g.*, American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, § 1605, 123 Stat. 115, 303 (including a "Buy America" provision).

19. *See, e.g.*, *infra* notes 113-20 and accompanying text.

for reducing their CO_2 emissions towards a "bottom-up" process under which countries determine the cuts in CO_2 emissions they are able to make and then reflect this as a voluntary target in an international agreement.[20] And this approach has been reaffirmed and built upon at subsequent U.N. climate change meetings.[21] However, limits to this approach were highlighted by a recent U.N. Environment Programme (UNEP) report, which concluded that even if nations meet their current climate pledges, greenhouse gas emissions in 2020 will likely be eight to twelve gigatons of CO_2 above the level needed to have a good chance of the global climate change remaining below two degrees Celsius by 2020.[22]

Focusing on developing technologies to address climate change plays to the United States' strengths in innovating, developing, and commercializing new technologies. It also resonates with past large-scale government-led scientific achievements—in particular the Manhattan Project, which developed the nuclear bomb,[23] and the Apollo project, which sent men to the moon[24]—where massive U.S. government-led efforts to develop new technologies produced globally significant outcomes. Indeed, a range of voices in the United States has described the challenges of climate change as requiring a new Manhattan or Apollo project.[25] While some of this is rhetorical, it captures the United States' view that a concerted focus on developing new technologies is the best response to the problem.

The first part of this paper will consider how U.S. policy seeks to incentivize innovation in green technologies. This part will analyze the current impact of U.S. climate change policies in promoting innovation in green technologies and will suggest that adopting a carbon tax would be an important complementary driver of growth in green technologies. The second part will consider the implications of U.S. efforts to innovate and to develop new technologies for international trade, including how the United States could adopt a carbon tax that optimizes innovation and green technology development while

20. Conference of the Parties, Fifteenth Session, Copenhagen, Den., Dec. 7-19, 2011, *Decisions Adopted by the Conference of The Parties*, ¶¶ 4-5, U.N. Doc. FCCC/CP/2009/11/Add.1, Accord (Mar. 30, 2010).

21. *See, e.g.*, Conference of the Parties, Sixteenth Session, Cancun, Mex., Nov. 29-Dec.10, 2010, *Decisions Adopted by the Conference of The Parties*, Decision 1/CP.16 § III(A)-(B), U.N. Doc. FCCC/CP/2010/7/Add.1 (Mar. 15, 2011); Conference of the Parties, Seventeenth Session, Durban, S. Afr., Nov. 28-Dec. 11, 2011, *Decisions Adopted by the Conference of The Parties*, Decision 2/CP.17 § II(A)-(B), U.N. Doc. FCCC/CP/2011/9/Add.1 (Mar. 15, 2012); Conference of the Parties, Eighteenth Session, Doha, Qatar, Nov. 26-Dec. 8, 2012, *Decisions Adopted by the Conference of The Parties*, Decision 1/CP.18 § II(A)-(B), U.N. Doc. FCCC/CP/2012/8/Add.1 (Feb. 28, 2013); Conference of the Parties, Nineteenth Session, Warsaw, Pol., Nov. 11-23, 2013, *Decisions Adopted by the Conference of The Parties*, Decision 1/CP.19 ¶ 4, U.N. Doc. FCCC/CP/2009/11/Add.1, Accord (Jan. 31, 2014).

22. U.N. ENV'T PROGRAMME (UNEP), THE EMISSIONS GAP REPORT 2013: A UNEP SYNTHESIS REPORT (2013), *available at* http://www.unep.org/pdf/UNEPEmissionsGapReport2013.pdf.

23. *Manhattan Project*, ENERGY.GOV, http://energy.gov/management/office-management/operational-management/history/manhattan-project (last visited Apr. 8, 2014).

24. *Apollo Program*, NASA, http://www.nasa.gov/mission_pages/apollo/missions/#.U0SxSKhdXHU (last updated Sept. 30, 2013).

25. *See generally* David Sokol, *An Apollo Program for Climate Change*, WASH. POST (June 22, 2007), www.washingtonpost.com/wp-dyn/content/article/2007/06/21/AR2007062101859.html; Chi-Jen Yeng & Michael Oppenheimer, *A Manhattan Project for Climate Change?*, 80 CLIMATIC CHANGE 199 (2007).

minimizing global trade frictions. The third part of the paper will offer concluding thoughts.

II. PART 1: U.S. CLIMATE CHANGE POLICIES

A. What Is Innovation?

Innovation is not a linear process which starts with R&D spending and inexorably leads to new technologies that can then be commercialized.[26] Often the innovation process is more iterative and complex and includes learning-by-doing and regular feedback between the innovators and users of new technologies. The Organization for Economic Cooperation and Development (OECD) has described the innovation process as a "back-and-forth start-and-stop model" that is "hectic, unscripted and collaborative."[27]

For instance, innovation by businesses often does not commence with R&D but involves problem solving that draws on existing knowledge bases that leads to improvements in business processes or incremental changes to existing technologies.[28] In contrast, government-funded R&D in public research institutions and laboratories has been central to producing some of the key breakthrough technologies ranging from nuclear power, to microchips, to the Internet.[29]

This brief description of the innovation process highlights roles for government and business in innovation. Moreover, and as will be discussed in detail, the development of green technologies will follow different trajectories that will require a range of policies to address a series of market failures which act as barriers to green technology innovation. In addition to these market failures, the broader environment within which innovation occurs is also important and includes factors such as the overall level of regulation, education, and infrastructure, support for demonstration projects, and whether there is a culture of risk taking. However, addressing the impact of these environmental factors on innovation is outside the scope of this paper.

There is a range of market failures that lead to underinvestment by the private sector in R&D, and this requires government action to encourage a level of innovation that is socially optimal.[30] One of the market failures arises when the social value of knowledge from innovation—the positive externalities—is higher than its private returns.[31] This arises from the inability of the producers of knowledge to capture all the value, leading to an underinvestment in the R&D

26. Keith Smith, *Climate Change and Radical Energy Innovation: The Policy Issues* 15 (Univ. of Oslo, Working Paper No. 20090101, 2009), *available at* http://www.sv.uio.no/tik/InnoWP/Smith%202009_Climate%20Change%20and%20Energy%20Innovation.pdf.

27. ORG. FOR ECON. CO-OPERATION & DEV., TAXATION, INNOVATION AND THE ENVIRONMENT 25 (2010) [hereinafter OECD 2010].

28. Smith, *supra* note 26, at 14-15.

29. *Id.* at 35-36.

30. Mark A. Dutz & Siddharth Sharma, *Green Growth, Technology and Innovation* 13 (World Bank, Working Paper No. 5932, 2012), *available at* http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2012/02/13/000158349_20120213090547/Rendered/PDF/WPS5932.pdf.

31. OECD 2010, *supra* note 27, at 19-20.

process.[32] One reason for this is that information, once produced, can be consumed by others, and the value of knowledge and innovation to society increases the more it is used by others.[33] As new innovation in technology is incorporated into different production processes, the process of learning-by-using and learning-by-doing can generate dynamic feedback as new knowledge and ways of operating are developed.[34] Moreover, the social value of increasing the supply of innovation is particularly high for green technologies, which also address environmental harms, emphasizing the need for government action to address the social costs of such underinvestment.[35]

Another market failure arises from information uncertainties that lead to suboptimal levels of innovation.[36] For instance, uncertainty due to a lack of information and financial expertise to assess the commercial viability of new green technologies leads to underfunding and a lack of commercialization.[37] Policy uncertainty with regard to climate change action also increases the risk of investing in green technology.[38] For example, in a 2011 survey of businesses, most respondents cited ambiguity in government support as the key risk associated with low-carbon investments.[39] As a result, renewable energy tax credits that need to be annually approved increase the risk of investing in renewable energy projects.[40]

Government action to stimulate innovation in green technologies is also required to address the path dependency created by technology lock-in—the dominance of a market by an inferior technology.[41] Technological lock-in leads investors to continue investing in improving the efficiency of the incumbent technology, particularly where returns remain large and information on the new technology and its operation are limited.[42] The risk of technology lock-in is especially large in the energy market where the costs of shifting away from coal fired power stations with low operating costs creates incentives for owners to update or incrementally adjust their operations rather than moving to zero-carbon alternatives such as renewable energy.[43] This underinvestment in green energy is seen in the private sector's limited spending on energy R&D, which in 2007 was 0.23% of revenues, compared to the industry average of 2.6%.[44]

32. Dutz & Siddharth, *supra* note 30, at 13.

33. OECD 2010, *supra* note 27, at 20.

34. *Id.*

35. *See generally id.*

36. *Id.* at 19.

37. *Id.*

38. *Id.*

39. PEW CTR. ON GLOBAL CLIMATE CHANGE, A SURVEY OF COMPANY PERSPECTIVES ON LOW-CARBON BUSINESS INNOVATION 3 (2011), *available at* http://www.c2es.org/docUploads/survey-results-paper.pdf.

40. *Id.*

41. Dutz & Sharma, *supra* note 30, at 13.

42. *Id.*

43. *Id.* at 14.

44. SAM WURZELMANN, CTR. FOR CLIMATE & ENERGY SOLUTIONS, ADVANCED RESEARCH PROJECTS AGENCY–ENERGY (ARPA-E): INNOVATION THROUGH THE U.S. DEPARTMENT OF ENERGY 2 (2012), *available at* http://www.c2es.org/docUploads/arpa-e-brief.pdf.

B. Technology-Push and Demand-Pull Innovation Policies

Governments have a range of technology-push and demand-pull polices to address these market failures which leads to underinvestment in clean technology R&D by the private sector.[45] Technology-push measures drive the supply of innovation and include policies to support R&D and regulations, such as those that require utilities to use the best available technology.[46] Demand-pull innovation arises in response to market demand, the most obvious one being a carbon price, which by reducing consumer demand for the relatively more expensive carbon intensive goods creates an incentive for firms to produce less carbon intensive ones.[47] This is often referred to as induced innovation where changing the relative price of a factor of production creates an incentive to innovate in order to minimize the use of the relatively more expensive factor.[48] This is a more specific example of the broader economic premise that pricing carbon is the optimal way of encouraging economically efficient abatement to deal with the global commons challenge of climate warming.[49]

The following section will consider the role of technology-push and demand-pull measures in driving innovation in green technologies. The demand-pull measure focused on here will be a carbon tax. This reflects the political reality in the United States that there is no support for a federal cap and trade system and that a carbon tax might be possible as part of broader tax reform aimed at reducing the budget deficit.[50]

There are also good policy reasons for preferring a carbon tax over a cap and trade system.[51] One reason is the tendency to allocate free allowances under cap and trade bills to affected industries, which happened when the European Union passed its cap and trade system and was also the case under the U.S. House-passed cap and trade bill in 2009.[52] Free allocations lead to windfall gains for those receiving them as firms sell excess allowances when abatement costs are lower than the allowance price.[53] Compared to a carbon tax, this reduces the amount of revenues raised that are available to achieve other goals, such as reducing the budget deficit and increasing the efficiency of the tax system.[54]

45. OECD 2010, *supra* note 27, at 24.

46. *Id.*

47. *Id.*

48. Richard G. Newell, Adam B. Jaffe & Robert N. Stavins, *The Induced Innovation Hypothesis and Energy-Saving Technological Change*, 144 Q. J. ECON. 941, 941-42 (1998).

49. William D. Nordhaus, *A Review of the "Stern Review on the Economics of Climate Change,"* 45 J. ECON. LITERATURE 686, 687 (2007).

50. *See generally* WARWICK J. MCKIBBIN ET AL., THE POTENTIAL ROLE OF A CARBON TAX IN U.S. FISCAL REFORM, (2012), *available at* http://www.brookings.edu/~/media/research/files/papers/2012/7/carbon%20tax%20mckibbin%20morris%20wilcoxen/carbon%20tax%20mckibbin%20morris%20wilcoxen.pdf.

51. *Id.*

52. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong.

53. WARWICK J. MCKIBBIN ET AL., CONSEQUENCES OF ALTERNATIVE U.S. CAP-AND-TRADE POLICIES: CONTROLLING BOTH EMISSIONS AND COSTS 8 (2009), *available at* http://www.brookings.edu/~/media/research/files/reports/2009/7/cap%20and%20trade/0727_cost_containment.pdf.

54. *Id.*

More conceptually but no less important, the problem with a cap and trade system is that given the uncertainty with climate change science and the economic costs of reducing greenhouse gas (GHG) emissions, it gets wrong the balance between achieving environmental goals and minimizing economic costs.[55] By setting fixed quantity targets for reducing GHG emissions, a cap and trade system fails to reflect the uncertainty of climate science as to what reductions in GHG reductions are necessary while not effectively addressing uncertainty as to the economic costs of reducing GHG emissions—which could be small or large, depending ultimately on unknown factors such as the rate of economic growth and the speed and cost of developing new clean energy technologies, such as for renewable energy and carbon capture and storage (CCS).[56] In contrast, a carbon tax fixes the economic cost which can be changed if the original tax rate does not lead to the right level of CO_2 mitigation.[57]

Another challenge with carbon pricing is its regressive nature as the burden falls more heavily on poorer households—though this is true for a tax and a cap and trade system.[58] One way of dealing with this is by offsetting other taxes with revenues raised.[59] For instance, Gilbert Metcalf has proposed using the revenues raised to cut the income tax tied to payroll taxes paid by workers.[60]

A carbon tax is most efficient when set at a rate that equates the marginal cost of reducing CO_2 to the marginal social cost of the CO_2 to society.[61] A carbon tax will internalize the environmental costs of CO_2 emissions and send a price signal that should lead to reduced consumption of energy intensive goods.[62] Such a carbon tax should also produce the largest welfare gains.[63] This paper does not address how to design an optimal carbon tax, but in general, a carbon tax should be levied on upstream activities, which minimizes the number of sources with compliance obligations and thereby reduces its administrative costs.[64] Yet, the incidence of a carbon tax will be mostly on downstream consumers as the tax is shifted forward in the form of higher energy and fuel prices.[65]

A carbon tax is also an important incentive for companies to innovate and develop new green technologies that reduce their CO_2 emissions and their costs

55. William D. Nordhaus, *To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming*, 1 REV. ENVTL. ECON. & POL'Y 26, 37 (2007).

56. *Id.*

57. *Id.* at 37, 42.

58. GILBERT E. METCALF, HAMILTON PROJECT, DISCUSSION PAPER 2007-12, A PROPOSAL FOR A U.S. CARBON TAX SWAP: AN EQUITABLE TAX REFORM TO ADDRESS GLOBAL CLIMATE CHANGE 14 (2007).

59. *Id.*

60. *Id.*

61. ORG. FOR ECON. CO-OPERATION & DEV., SOUTHEAST ASIAN ECONOMIC OUTLOOK 2011/12, at 199 (2012), *available at* http://www.keepeek.com/Digital-Asset-Management/oecd/development/southeast-asian-economic-outlook-2011-12_9789264166882-en#page1.

62. Newell, Jaffe & Stavins, *supra* note 48, at 941-42.

63. *See generally* Ian W.H. Parry, William A. Pizer & and Carolyn Fischer, *How Large Are the Welfare Gains from Technological Innovation Induced by Environmental Policies?*, 23 J. REG. ECON. 237 (2003).

64. Kevin A. Hassett, Aparna Mathur & Gilbert E. Metcalf, *The Incidence of a U.S. Carbon Tax: A Lifetime and Regional Analysis* 4 (Nat'l Bureau of Econ. Research, Working Paper No. 13554, 2007), *available at* http://www.nber.org/papers/w13554.pdf?new_window=1.

65. *Id.*

of complying with the tax.[66] A survey of OECD countries using environmental taxes demonstrates a positive effect on innovation.[67] Carbon taxes therefore provide a double dividend—internalizing the cost of the environmental harm from CO_2 emissions and producing green technologies through induced innovation.[68]

However, a carbon tax alone is unlikely to lead to an optimal level of innovation in green technologies. One reason is that the cost to firms of a carbon tax can dominate any return from the development of green technologies.[69] There is also evidence that a carbon price is an effective incentive for incremental innovation but on its own is unlikely to produce the transformative innovation in green technologies that are required to significantly reduce CO_2 emissions.[70]

There are also the types of barriers and market failures outlined above to developing new technologies that a carbon tax would not address. For instance, the gap between the social and private gains from R&D and knowledge uncertainties would not be overcome with a carbon tax.[71] Moreover, to overcome technological lock-in would require such a high carbon tax—particularly when it comes to overcoming the dominance of fossil fuels in the energy sector—that it would likely be politically unfeasible.[72]

C. U.S. Climate Change Policies

U.S. government spending on green technology includes a range of measures, from direct spending on R&D to tax breaks and loan guarantees.[73] Following the 2008 financial crisis and the passage of the American Recovery and Reinvestment Act (ARRA) in 2009, U.S. government spending on developing clean energy more than doubled from $17.895 billion in 2007 to $37.160 billion in 2010.[74]

The following table shows the various forms of U.S. federal government spending on clean energy in 2010.

66. Reyer Gerlagh & Wietze Lise, *Carbon Taxes: A Drop in the Ocean, or a Drop That Erodes the Stone? The Effect of Carbon Taxes on Technological Change*, 54 ECOLOGICAL ECON. 241, 251 (2005).

67. OECD 2010, *supra* note 27, at 72, 74.

68. Lawrence H. Goulder & Koshy Mathai, *Optimal CO_2 Abatement in the Presence of Induced Technological Change*, 39 J. ENVTL. ECON. & MGMT. 1, 2 (2000).

69. Michael Grubb & David Ulph, *Energy, the Environment, and Innovation*, 18 OXFORD REV. ECON. POL'Y 92, 104 (2002).

70. *See generally* Michael Peters et al., *The Quest for Adequate Technology-Push and Demand-Pull Policies: Country-Level Spillovers and Incentives for Non-Incremental Innovation* (Dec. 22, 2010) (under review for Research Policy), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1752414.

71. Grubb & Ulph, *supra* note 69, at 103.

72. *Id.* at 96.

73. OECD 2010, *supra* note 27, at 84.

74. U.S. ENERGY INFO. ADMIN., DIRECT FEDERAL FINANCIAL INTERVENTIONS AND SUBSIDIES IN ENERGY IN FISCAL YEAR 2010, at xi (2011), *available at* http://www.eia.gov/analysis/requests/subsidy/pdf/subsidy.pdf.

Beneficiary	Direct Ex-penditures	Tax Ex-penditures	Research & Develop-ment	DOE Loan Guarantee Program	Federal & RUS Electricity	Total	ARRA Related
2010							
Coal	42	561	663	0	91	1,358	97
Refined Coal	0	0	0	0	0	0	0
Natural Gas and Petroleum Liquids	4	2,690	70	0	56	2,820	0
Nuclear	0	908	1,169	265	157	2,499	147
Renewables	4,696	8,168	1,409	269	133	14,674	6,193
Biomass	57	523	537	0	0	1,117	10
Geothermal	160	1	100	12	0	273	228
Hydro	17	17	52	0	130	216	16
Solar	496	120	348	173	0	1,134	788
Wind	3,556	1,178	166	85	1	4,986	4,852
Other	95	0	205	0	1	302	130
Biofuels	314	6,330	0	0	0	6,644	169
Electricity -Smart Grid & Transmission	461	58	222	20	211	971	495
Conservation	3,387	3,206	0	4	0	6,597	6,305
End-Use	5,705	693	832	1,011	0	8,241	1,549
LIHEAP	5,000	0	0	0	0	5,000	0
Other	705	693	832	1,011	0	3,241	1,549
Total	**14,295**	**16,284**	**4,365**	**1,570**	**648**	**37,160**	**14,786**

Table 1: Subsidies and Support by Energy Type for FY 2010 and FY 2007, in millions of dollars.[75]

Since the ARRA and despite the Bipartisan Budget Act of 2013, which mandates budget cuts of approximately $500 billion in discretionary (nondefense) programs through 2021,[76] clean energy R&D has remained stable.[77] Moreover, the Obama Administration continues to emphasize developing clean energy technologies.[78] For instance, the Administration's fiscal year (FY) 2013 budget includes a 48.6% increase for the DOE's energy program—of which $7.9 billion will go to the DOE Office of Energy Efficiency and Renewable Energy and the Advanced Research Projects Agency–Energy (ARPA-E), which supports cutting-edge projects such as developing thermal

75. *Id.* at xiii.

76. CONG. BUDGET OFFICE, FINAL SEQUESTRATION REPORT FOR FISCAL YEAR 2014 (2014), *available at* http://www.cbo.gov/sites/default/files/cbofiles/attachments/45013-Sequestration.pdf.

77. MEGAN NICHOLSON & MATTHEW STEPP, INFO. TECH. & INNOVATION FOUND., BREAKING DOWN FEDERAL INVESTMENTS IN CLEAN ENERGY (2013), *available at* http://www2.itif.org/2013-breaking-down-investment-energy.pdf.

78. WURZELMANN, *supra* note 44, at 1-2.

storage, electrofuels, and green electricity networks.[79] ARPA-E is modeled on the U.S. Department of Defense's Advanced Research Program, and its goals include reducing energy-related emissions and ensuring that the United States maintains a technological lead in developing and deploying advanced energy technologies.[80] At the same time, despite budget cuts for the Department of Defense, the FY 2013 budget strengthens its role as a driver of advanced energy technologies.[81] Additionally, the 2014 Farm Bill includes funding for biomass R&D and the Rural Energy for America Program,[82] which supports development of energy projects including those using renewable energy.[83]

D. Regulation by the Environmental Protection Agency

In addition to government spending on clean energy, the U.S. government is also incentivizing innovation and green technology through regulations limiting CO_2 emissions.

There are two categories of Environmental Protection Agency (EPA) regulations that are expected to have a material impact on U.S. CO_2 emissions. The first category of regulations requires coal-fired utilities to reduce their emissions of mercury and other toxic air pollutants and acid gases according to technology-based emissions limitation standards.[84] The EPA expects this rule to lead to approximately 4.7 gigawatts (GW) of the coal-fleet shutting down by 2015,[85] though others have estimated that this could be as high as 70 GW to 80 GW of the total U.S. coal fleet capacity of approximately 318 GW.[86]

The EPA has also commenced directly regulating sources of CO_2 emissions. These CO_2 regulations are in response to the Supreme Court decision in *Massachusetts v. EPA*, which required the EPA to determine under the Clean Air Act whether CO_2 emissions threaten public health and welfare.[87] The EPA issued an endangerment finding in 2009, concluding that passenger vehicles contribute to air pollution that "is reasonably anticipated to endanger public health and welfare."[88] Following this in a joint ruling with the National Highway Traffic Safety Administration, new regulations were applied to new

79. *Id.*; MATT HOURIHAN, AM. ASS'N FOR THE ADVANCEMENT OF SCI., AAAS REPORT XXXVIII: RESEARCH AND DEVELOPMENT FY 2014, at 4, 12 (2013) [hereinafter HOURIHAN AAAS REPORT].

80. WURZELMANN, *supra* note 44, at 1-2.

81. HOURIHAN AAAS REPORT, *supra* note 79, at 12.

82. *Rural Energy for America Program—Renewable Energy System and Energy Efficiency Improvement Guaranteed Loan and Grant Program*, U.S. DEP'T AGRIC., http://www.rurdev.usda.gov/bcp_reapreseei.html (last updated Jan. 14, 2013).

83. Agricultural Act of 2014, H.R. 2642, 113th Cong. §§ 9007-9008.

84. National Emission Standards for Hazardous Air Pollutants from Coal- and Oil-Fired Electric Utility Steam Generating Standards, 77 Fed. Reg. 9304 (Feb. 6, 2012) (to be codified at 40 C.F.R. pts. 60, 63).

85. *Id.* at 9407.

86. *See generally* BLAIR BEASLEY ET AL., DISCUSSION PAPER NO. RFF DP 13-10, MERCURY AND AIR TOXICS STANDARDS ANALYSIS DECONSTRUCTED 15-17 (2013), *available at* http://www.rff.org/RFF/Documents/RFF-DP-13-10.pdf; *27 Gigawatts of Coal-Fired Capacity to Retire over Next Five Years*, U.S. ENERGY INFO. ADMIN. (July 27, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=7290#.

87. Massachusetts v. EPA, 549 U.S. 497 (2007).

88. Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Feb. Reg. 66,496, 66,499 (Dec. 15, 2009).

passenger cars, light-duty trucks, and medium-duty passenger cars that require these vehicles to meet an estimated combined average emissions level of 250 grams of CO_2 per mile in model year 2016 and 163 grams of CO_2 per mile in model year 2025—equivalent to 54.5 miles per gallon if the automotive industry were to meet this CO_2 level solely through fuel economy standards.[89] Tighter fuel efficiency and greenhouse gas emissions standards for medium- and heavy-duty trucks and buses have also been developed.[90]

The EPA finding that CO_2 from mobile sources endangers public health and welfare triggered a requirement under the Clean Air Act (CAA) to regulate CO_2 emissions from stationary sources.[91] EPA has proposed that as part of the permitting process for a proposal to construct or operate new and modified stationary sources emitting at least 75,000 tons per year of CO_2 emissions, there must be a demonstration that the applicant is using the best available control technology (BACT) to limit its emissions.[92] What constitutes BACT would be assessed on a case-by-case basis, taking into account the commercial viability and availability of the technologies for reducing GHG emissions.[93] In the near term, BACT is unlikely to require adopting technologies such as carbon capture and sequestration that have yet to be technically and economically proven and instead will drive a transition toward energy efficient technologies.

Most recently, in September 2013, the EPA proposed new source performance standards (NSPS) for CO_2 emissions from fossil fuel-fired power plants with separate standards for natural gas and coal-fired units.[94] Under these proposed standards, CO_2 emissions from new (and modified) fossil fuel-fired plants will be limited to 1,100lb CO_2 per megawatt-hour (CO_2/MWh).[95] And as coal plants emit on average 1,800lb CO_2/MWh, only coal plants with (at least partial) CCS will meet this standard.[96]

Moreover, regulating new sources of CO_2 emissions requires the EPA to also regulate existing sources.[97] President Obama has directed EPA to develop

89. 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624, 62,635-36, 62,772 (Oct. 15, 2012) (to be codified at 40 C.F.R. pts. 85, 86, 600).

90. Heavy-Duty Engine and Vehicle, and Nonroad Technical Amendments, 78 Fed. Reg. 36,370 (June 17, 2013) (to be codified in scattered parts of 40 and 49 C.F.R.).

91. Clean Air Act, 42 U.S.C. §§ 7401-7671q (2012); *see generally* NATHAN RICHARDSON, ART FRASS & DALLAS BURTRAW, DISCUSSION PAPER NO. RFF DP 10-23, GREENHOUSE GAS REGULATION UNDER THE CLEAN AIR ACT (2010), *available at* http://www.rff.org/documents/RFF-DP-10-23.pdf.

92. Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule, 75 Fed. Reg. 31,514 (June 3, 2010) (to be codified at 40 C.F.R. pts. 51-52, 70-71).

93. *Id.* at 31,588.

94. Standards of Performance for Greenhouse Gas Emissions from New Stationary Sources: Electric Utility Generating Units, 79 Fed. Reg. 1430 (Jan. 8, 2014) (to be codified at 40 C.F.R. pts. 60, 70, 71, 98).

95. ENVTL. PROT. AGENCY, EPA FACT SHEET: REDUCING CARBON POLLUTION FROM POWER PLANTS: MOVING FORWARD ON THE CLIMATE ACTION PLAN (2013), *available at* http://www2.epa.gov/sites/production/files/2013-09/documents/20130920factsheet.pdf.

96. JAMES E. MCCARTH, CONG. RESEARCH SERV., R43127, EPA STANDARDS FOR GREENHOUSE GAS EMISSIONS FROM POWER PLANTS: MANY QUESTIONS, SOME ANSWERS 5 (2013), *available at* https://www.fas.org/sgp/crs/misc/R43127.pdf.

97. American Elec. Power v. Connecticut, 131 S. Ct. 2527, 2537 (2011) (finding that CAA section 111(d) requires the EPA to regulate existing sources once the EPA regulates new sources under CAA section 111(b)).

standards for existing sources of CO_2 by 2016.[98] As this discussion demonstrates, most U.S. climate change policies involve technology-push measures. The EIA table above illustrates the United States' bias toward technology-push measures and includes U.S. spending on R&D, loan guarantees, and tax credits for suppliers of renewable energy projects. Additionally, the increased fuel efficiency standards that apply to vehicle manufacturers and proposed new CO_2 standards for stationary sources also operate as technology-push incentives.

That said, not all U.S. climate change policy seeks to encourage the innovation and production of green technologies through supply-side policies. There are some demand-pull measures though these are piecemeal and mostly at the state level, such as California's cap and trade system.[99] For the reasons outlined above, a more comprehensive demand-pull measure such as a federal carbon tax would, in addition to reflecting the environmental externalities of carbon, induce greater innovation and thereby complement the range of technology-push measures already in place.

III. PART 2: GREEN TECHNOLOGY AND INTERNATIONAL TRADE

A. Introduction

The development of green technologies and the pricing of carbon have a range of international trade implications. First, a carbon tax will incentivize innovation domestically as well as overseas. Liberalizing trade in green technologies also maximizes these gains for the United States in terms of welfare and innovation. Secondly, separate from where the innovation occurs, these green technologies are going to be produced globally, with different components being sourced and assembled in countries largely located in the Asia-Pacific region, and reducing trade barriers to green technologies will also reduce the costs of these goods and services. Finally, a carbon tax will raise concerns about its competitiveness and carbon leakage impacts and lead to demands for a border tax adjustment.[100] Managing this process and its impact on trade will also be important. The following section addresses these issues in more detail.

B. Impact of a Carbon Tax on Innovation in Countries in the Asia-Pacific Region

The adoption by the United States of a carbon tax will create an incentive for both U.S. and overseas firms to innovate and develop green technologies. As outlined above, a carbon tax can induce innovation by incentivizing U.S. firms to innovate and produce green technologies that reduce the impact of the tax. Not all firms will be innovators, and many will instead turn to the market to obtain the latest green technologies to reduce their CO_2 emissions. This demand for

98. Press Release, White House, Fact Sheet: Opportunity for All: Improving the Fuel Efficiency of American Trucks—Bolstering Energy Security, Cutting Carbon Pollution, Saving Money and Supporting Manufacturing Innovation (Feb. 18, 2014), *available at* http://www.whitehouse.gov/the-press-office/2014/02/18/fact-sheet-opportunity-all-improving-fuel-efficiency-american-trucks-bol.

99. CAL. CODE REGS. tit. 17, §§ 95800-96022 (2013).

100. *Infra* Part III.D.

green technologies by the world's largest economy will also create a strong global incentive for the development of new green technologies in other countries.

Increased global innovation in green technologies will also have a range of positive spillovers. As new sources of R&D and opportunities for scientific collaboration open up, greater resources become available to fund the innovation process and the knowledge and skills to assess the commercial viability of green technologies increases the access to and reduces the costs of finance. These factors should drive down the costs of innovation and development of green technologies.

A carbon tax will also incentivize the development of green technologies that can be used to reduce CO_2 emissions in the country applying the tax as well as overseas. This is because a carbon tax, unlike a technology standard, creates an incentive to find multiple ways of reducing CO_2 emissions. As a result, a carbon tax should lead to a broader range of innovations that could also be applicable in other countries.[101]

The increase in innovation that would follow the introduction by the United States of a carbon tax should lead to new opportunities for international collaboration and cooperation. In some areas, the United States has already forged these ties, such as with the U.S.-China Clean Energy Research Center, and has clean energy partnerships with Australia, Japan, and India, to name a few countries in the Asia-Pacific region.[102] Asia-Pacific Economic Cooperation (APEC) is also working on energy issues, including promoting the development of energy efficiency technologies.[103]

Additional areas where governments could make progress in promoting cooperation to develop green technologies should be in services trade. Indeed, access to the skills of researchers, policymakers, or venture capitalists with expertise in green technology will be as important for developing and commercializing it as will be access to the technologies themselves. For instance, countries could develop new and flexible visas aimed specifically at facilitating collaboration among people with green technology expertise. Expanding the General Agreement on Trade in Services (GATS) mode 4 commitments for services delivered by the presence of the service suppliers from another WTO Member would also support this outcome.

101. OECD 2010, *supra* note 27, at 90.

102. Protocol for Cooperation on a Clean Energy Research Center, U.S.-China, Nov. 17, 2009, T.I.A.S. No. 09.1117.1; *see also Australia, US Clean Energy Bodies Announce Partnership*, AUSTRALIAN TRADE COMMISSION (Mar. 19, 2013), http://www.austrade.gov.au/Invest/Investor-Updates/2013/0319-Australia-US-clean-energy-bodies-announce-partnership; *Japan-U.S. Clean Energy Technologies Action Plan*, MINISTRY ECON., TRADE & INDUSTRY (Nov. 2009), http://www.meti.go.jp/english/policy/energy_environment/global_warming/e20091113a02.html; Press Release, White House, Fact Sheet: U.S.-India Green Partnership to Address Energy Security, Climate Change, and Food Security (Nov. 24, 2009), *available at* http://www.whitehouse.gov/sites/default/files/Green_Partnership_Fact_Sheet.pdf.

103. *About APEC*, ASIA-PACIFIC ECON. COOPERATION, http://www.apec.org/About-Us/About-APEC.aspx (last visited Apr. 5, 2014).

C. The Production of Green Technologies in the Asia-Pacific Region

As discussed, a combination of technology-push and demand-pull measures is the optimal driver of U.S. innovation in green technology. It does not follow, however, that green technologies will necessarily be manufactured in the United States. Like many other goods, firms can be expected to source inputs at lowest cost, leading to disaggregated global supply chains. The iPod is one example, where ownership remains with Apple but its components are manufactured in the United States, the European Union, Japan, South Korea, Taiwan, and China.[104] This has produced an iPod that is cheaper for consumers than if it had been manufactured only in the United States, while most of the profits have remained with Apple—an American company.[105]

The same will be true for green technologies, where the ability to manufacture and assemble outside the United States will drive down costs for American consumers. For instance, the wind power sector is already globally integrated.[106] And the scaling-up of production of solar photovoltaic cells in countries such as China, Malaysia, and the Philippines has been key in reducing its costs.[107] The challenge for the United States will be squaring the political focus on linking green technology with jobs and domestic manufacturing with the welfare gains from allowing least cost-manufacturing in other countries.

One way forward is to demonstrate that the production of green technologies outside the United States will still produce significant economic gains for the United States, both in terms of consumer welfare from access to cheaper green technologies and improved environmental outcomes, and also in terms of jobs. In this regard, many green technologies produce high-skilled services jobs that will be located close to the market demanding the technology. For instance, the downstream end of the supply chain for wind energy is heavily services driven and includes marketing, sales, financing, transportation and logistics, and wind park operations and maintenance.[108] These are also sectors where the United States retains a comparative advantage.

These benefits from a carbon tax will be maximized under conditions of liberalized trade. Therefore, a carbon tax should also drive increased cooperation among governments to reduce barriers to trade. Trade liberalization of environmental goods is already happening. In the World Trade Organization Doha Round, the Committee on Trade and Environment in Special Session is tasked with reducing tariffs on green goods.[109] But the current impasse in the

104. Yuqing Xing & Neal Detert, *How the iPhone Widens the United States Trade Deficit with the People's Republic of China* 3-4 (Asian Dev. Bank Inst., Working Paper No. 257, 2010), *available at* http://www.adbi.org/files/2010.12.14.wp257.iphone.widens.us.trade.deficit.prc.pdf.

105. *Id.*

106. Jacob Funk Kirkegaard, Thilo Hanemann & Lutz Weischer, *It Should Be a Breeze: Harnessing the Potential of Open Trade and Investment Flows in the Wind Energy Industry* (Peterson Inst. for Int'l Econ., Working Paper No. 09-14, 2009), *available at* http://www.iie.com/publications/wp/wp09-14.pdf.

107. ECONOMIST INTELLIGENCE UNIT, CATCHING RAYS: FIVE SUCCESS FACTORS IN AN EXPLOSIVE SOLAR MARKET 5 (2010), *available at* http://www.economistinsights.com/sites/default/files/SAP%20-%20EIU%20Solar%20power%20article%20-%20WEB%20version.pdf.

108. Kirkegaard, Hanemann & Weischer, *supra* note 106, at 39.

109. SIMI T.B., CUTS CTR. FOR INT'L TRADE, ECON. & ENV'T, DOHA ROUND OF NEGOTIATIONS ON TRADE AND ENVIRONMENT (2008), *available at* http://www.cuts-citee.org/pdf/VP0208.pdf.

Doha Round has placed this work on hold.[110] At the 2012 APEC Summit in Vladivostok, leaders agreed to a list of fifty-four environmental goods on which they would reduce tariffs to an average of 5% by 2015.[111] This included goods such as gas turbines and technologies used to produce energy from wind and solar.[112] But this is a narrow list of goods, and further work on expanding the list should be pursued. At the World Economic Forum in January 2014, the United States and fourteen other WTO members (including China and the European Union (EU) representing its twenty-eight Member States) announced their commitments to global free trade in environmental goods and to expanding upon the APEC list of fifty-four environmental goods.[113]

There is also more that governments could do to reduce the costs of green technologies. For some green technologies, such as those used in wind and solar energy, the applied tariffs in the developed world are already low and are not the main trade barriers that need to be addressed. Instead, there are a range of non-tariff barriers that have a significant impact on the costs of production. Some of the most important include different standards and certification requirements. These may be justified where they respond to different local conditions. For instance, countries that experience particularly strong and variable wind conditions can be expected to require stronger and more stable wind towers. However, gratuitous regulatory diversity will increase investment costs, reduce efficiencies that can be achieved from economies of scale, and increase the overall costs of green technologies.

The WTO Agreement on Technical Barriers to Trade (TBT) already addresses some of these challenges. For instance, TBT Article 2.2 requires that technical regulations not have the effect of creating unnecessary barriers to international trade.[114] And where international standards exist, TBT Article 2.4 requires WTO Members to base their regulations on them unless the international standard would be an ineffective or inappropriate means to achieving the legitimate objective pursued.[115] More work on developing international standards for green technologies would therefore underpin greater regulatory harmony among WTO members in this area.

Countries are also providing significant subsidies to develop green technologies. Only certain subsidies are prohibited under the WTO Subsidies Agreement, such as those that are contingent on export or the use of local

110. *See generally* SIMON J. EVENETT, THE DOHA ROUND IMPASSE (2012), *available at* http://graduateinstitute.ch/files/live/sites/iheid/files/shared/summer/WTO2012/protected/SE1.pdf.

111. RENE VOSSENAAR, INT'L CTR. FOR TRADE & SUSTAINABLE DEV., THE APEC LIST OF ENVIRONMENTAL GOODS vi (2013), *available at* http://ictsd.org/downloads/2013/06/the-apec-list-of-environmental-goods.pdf.

112. *Id.* at 4-5.

113. Press Release, World Economic Forum, Joint Statement Regarding Trade in Environmental Goods (Jan. 24, 2014), *available at* http://www.ustr.gov/sites/default/files/EGs-Announcement-joint-statement-012414-FINAL.pdf.

114. WORLD TRADE ORG., AGREEMENT ON TECHNICAL BARRIERS OF TRADE art. 2.2 (1995), *available at* http://www.wto.org/english/docs_e/legal_e/17-tbt.pdf.

115. *Id.* art. 2.4.

content.[116] Local content requirements (LCRs) have been particularly popular here because they bring together the political demand for job creation and support for developing green technologies locally.[117] The problem with LCRs is that they affect trade and increase the costs of producing green technologies.[118] By forcing firms to source locally, they are unable to purchase from the lowest cost supplier, raising the overall costs of green technologies.[119] Canada, for instance, has adopted LCRs for its renewable energy sector.[120] In addition to raising the cost of producing green technologies, these measures reduce market access for goods and services and raise trade tensions.[121] The European Union and Japan challenged the WTO consistency of Canada's LCR at the WTO, and in 2013, the WTO Appellate Body found that Canada had acted inconsistently with its WTO commitments.[122] China is also challenging at the WTO LCRs used by the European Union in its solar industry.[123]

Governments are also using their purchasing power to support the development of green technologies. For instance, President Obama has transformed the U.S. government into a key source of demand for green technologies that can improve the energy efficiency of government buildings to renewable energy for the U.S. army and biofuels for the air force.[124] However, government procurement that discriminates in favor of domestically produced goods can raise international trade issues. For instance, the U.S. 2009 stimulus bill—the ARRA—includes a "Buy American" provision that requires funds to be spent on goods produced in the United States.[125] In addition to being a trade barrier, such measures drive up the prices that governments pay for these goods.[126]

The WTO Government Procurement Agreement (GPA) already includes rules that prohibit WTO members from discriminating in their procurement decisions against imported goods and services based on their origin.[127] For

116. *Agreement on Subsidies and Countervailing Measures*, WORLD TRADE ORG., http://www.wto.org/english/tratop_e/scm_e/subs_e.htm (last visited Apr. 5, 2014).

117. SHERRY M. STEPHENSON, INT'L CTR. FOR TRADE & SUSTAINABLE DEV., ADDRESSING LOCAL CONTENT REQUIREMENTS: CURRENT CHALLENGES AND FUTURE OPPORTUNITIES (2013), *available at* http://www.scribd.com/doc/154300730/Addressing-Local-Content-Requirements-in-a-Sustainable-Energy-Trade-Agreement.

118. *Id.* at 6.

119. *Id.* at 5.

120. *Id.* at 9.

121. *Id.* at 5-6.

122. Appellate Body Report, *Canada—Certain Measures Affecting the Renewable Energy Generation Sector, Canada—Measures relating to the Feed-In Tariff Program*, ¶ 5.80-.85, WT/DS412/AB/R, WT/DS426/AB/R (May 24, 2013).

123. Request for Consultations by China, *European Union and Certain Member States—Certain Measures Affecting the Renewable Energy Generation Sector*, WT/DS452/1 (Nov. 7, 2012).

124. WHITE HOUSE, THE BLUEPRINT FOR A SECURE ENERGY FUTURE: PROGRESS REPORT 13, 15 (2012), *available at* http://www.whitehouse.gov/sites/default/files/email-files/the_blueprint_for_a_secure_energy_future_oneyear_progress_report.pdf.

125. American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, § 1605, 123 Stat. 115, 303.

126. *See generally* STEPHENSON, *supra* note 117, at 5-6.

127. Agreement on Government Procurement art. III, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, annex 4(b), 1915 U.N.T.S. 103 [hereinafter WTO GPA], *available at* http://www.wto.org/english/docs_e/legal_e/gpr-94_e.pdf.

instance, article III of the GPA requires that all laws and regulations regarding government procurement do not treat one locally established supplier any less favorably than another supplier on the basis of its degree of foreign ownership.[128] However, there are limits to the GPA, the most significant one being that it is a plurilateral agreement with only twenty-four WTO members.[129] For instance, in the Asia-Pacific region only the United States, Korea, Taiwan, and Singapore are parties to this agreement, and China is in the process of acceding to it.[130] The GPA is also limited in its coverage. For instance, some U.S. states are not subject to the GPA disciplines, and for those that are, the coverage is often limited.[131]

Some of these limits are being addressed in free trade agreements (FTAs), where countries are agreeing to rules on government procurement that go beyond what has been agreed to at the WTO. For example, Australia accepted government procurement commitments in the Australia-U.S. FTA, and the more recent Korea-U.S. FTA commitments expanded government procurement commitments to sub-central entities such as states.[132] Additionally, rules on government procurement will be part of the Trans-Pacific Partnership (TPP) agreement—a regional FTA that includes the United States and eleven other countries in the Asia-Pacific region.[133] Accession by other countries in the Asia-Pacific region to the WTO GPA would be an important step toward supporting the ongoing globalization of the green technology sector and its low-cost development.

Countries need to find ways to manage government support for green technologies and to address the trade tensions that this can create. Given the range of trade issues raised, there is a need for a comprehensive approach. The WTO would be the most obvious place to discuss these issues. Securing China's accession to the WTO GPA would represent significant progress here.[134] And following the WTO Ministerial Meeting in Bali in December 2013, WTO Members are currently taking stock of what additional parts of the round can be

128. *Id.*

129. *Parties and Observers to the GPA*, WORLD TRADE ORG., http://www.wto.org/english/tratop_e/gproc_e/memobs_e.htm (last visited Apr. 5, 2014).

130. *Id.*

131. WTO GPA, United States app. I, annex 2, *available at* http://www.wto.org/english/tratop_e/gproc_e/usa2.doc.

132. Free Trade Agreement, U.S.-S. Kor., June 30, 2007, *available at* http://www.ustr.gov/trade-agreements/free-trade-agreements/korus-fta/final-text; Free Trade Agreement, U.S.-Austl., May 18, 2004, *available at* http://www.ustr.gov/sites/default/files/uploads/agreements/fta/australia/asset_upload_file148_5168.pdf.

133. *Outlines of the Trans-Pacific Partnership Agreement*, OFF. OF THE U.S. TRADE REPRESENTATIVE (Nov. 12, 2011), http://www.ustr.gov/about-us/press-office/fact-sheets/2011/november/outlines-trans-pacific-partnership-agreement; *The United States in the Trans-Pacific Partnership*, OFF. U.S. TRADE REPRESENTATIVE, http://www.ustr.gov/about-us/press-office/fact-sheets/2011/november/united-states-trans-pacific-partnership (last visited Apr. 5, 2014).

134. PING WANG, CHINA POL'Y INST., UNIV. OF NOTTINGHAM, BRIEFING SER. NO. 48,CHINA'S ACCESSION TO WTO'S GOVERNMENT PROCUREMENT AGREEMENT: DOMESTIC CHALLENGES AND PROSPECTS IN NEGOTIATION (2009), *available at* http://www.nottingham.ac.uk/cpi/documents/briefings/briefing-48-china-gpa-ascension.pdf.

finalized.[135] In this regard, seeking an outcome in the WTO that liberalizes barriers to trade in environmental goods and services should be part of the WTO's work program. As discussed above, on the environmental goods side, progress has already been made in the WTO Committee on Environment and Trade in Special Session.[136] There has also been progress outside of the WTO in APEC, and the recent announcement at the World Economic Forum of a commitment to liberalizing environmental goods is building a critical mass of countries representing most trade in these goods that could be the beginning of a plurilateral agreement at the WTO.[137]

FTAs are another place where at least some of these issues can be handled. The TPP negotiations could be a good place to start.[138] The United States also supports building out the TPP into an FTA of the Asia-Pacific region, so getting the rules right in the TPP would be an important step.[139] The negotiations for a United States-European Union Transatlantic Trade and Investment Partnership (TTIP) are another significant opportunity to make progress.[140]

D. The Impact of a Carbon Tax on Competitiveness and Carbon Leakage

Should the United States adopt a carbon tax, this can be expected to raise carbon leakage and competiveness concerns from the energy intensive trade exposed (EITE) sectors—firms that have energy intensive production processes and are exposed to competition from imports.[141]

Carbon leakage arises when a carbon price causes domestic businesses to relocate to countries not pricing carbon or to increase imports of goods from countries not pricing carbon.[142] As a result, there is no net reduction in global CO_2 emissions. Leakage can also arise as a carbon tax reduces U.S. consumption which reduces global oil prices, leading to increased consumption and even higher CO_2 emissions globally.[143] Competitiveness issues occur when

135. World Trade Organization, Bali Ministerial Declaration of 7 December 2013, ¶ 1.11, WT/MIN(13)/DEC, (Dec. 11, 2013), *available at* http://wto.org/english/thewto_e/minist_e/mc9_e/balipackage_e.htm.

136. Ambassador Froman, U.S. Trade Representative, Annual Meeting of the World Economic Forum, Launch of the Joint Statement Regarding Trade in Environmental Goods (Jan. 24, 2014), *available at* http://www.trademinister.gov.au/transcripts/2014/ar_tr_140124a.html.

137. *Id.*

138. Joshua Meltzer, *The Trans-Pacific Partnership Agreement, The Environment and Climate Change*, *in* TRADE LIBERALISATION AND INTERNATIONAL CO-OPERATION: A LEGAL ANALYSIS OF THE TRANS-PACIFIC PARTNERSHIP AGREEMENT 207 (Tania Voon ed., 2013).

139. ROBERT G. SUTTER ET AL., BALANCING ACTS: THE U.S. REBALANCE AND ASIA-PACIFIC STABILITY 13-14 (2013), *available at* http://www2.gwu.edu/~sigur/assets/docs/BalancingActs_Compiled1.pdf.

140. Press Release, Office of the U.S. Trade Representative, Update on the Third Round of Transatlantic Trade and Investment Partnership Negotiations (Dec. 19, 2013), *available at* http://www.ustr.gov/about-us/press-office/press-releases/2013/December/Readout-TTIP-third-round-update.

141. LIWAYWAY ADKINS ET AL., DISCUSSION PAPER NO. 10-47, THE IMPACT ON U.S. INDUSTRIES OF CARBON PRICES WITH OUTPUT-BASED REBATES OVER MULTIPLE TIME FRAMES 1 (2010), *available at* http://www.rff.org/RFF/Documents/RFF-DP-10-47.pdf.

142. *Id.* at 22.

143. WARWICK J. MCKIBBIN & PETER J. WILCOXEN, THE ECONOMIC AND ENVIRONMENTAL EFFECTS OF BORDER TAX ADJUSTMENTS FOR CLIMATE POLICY 4 (2008), *available at* http://wilcoxen.maxwell.insightworks.com/pages/2855/McKibbinWilcoxenBorder-v12b.pdf.

a carbon price increases the price of domestically produced goods, causing consumers to substitute them with cheaper imports from countries not pricing carbon, ultimately harming domestic industry and undermining support for these policies.

The pressures on governments to address these concerns are real. And failure to address them is likely to undermine the political prospects of introducing a carbon tax in the United States. For instance, when Congress was developing a cap and trade system in 2009 and 2010, the provision of subsidies to EITE firms and application of the domestic carbon price to imports was included in the cap and trade bill that passed the House in 2009 and that was developed in the Senate.[144] Concerns about the impact on competitiveness and carbon leakage also lead the European Union to extend its cap and trade system to include CO_2 emissions from international as well as domestic aviation.[145]

The application of a border tax to imports will be controversial. Indeed, the inclusion of non-E.U. airlines in the E.U. emissions trading scheme provides insight into how other countries might react.[146] For instance, China and India have prohibited their airlines from complying with the E.U. aviation scheme.[147] And the United States has demanded that the European Union halt, suspend, or delay application of the E.U. cap and trade system to U.S. airlines.[148]

Applying a border tax adjustment would raise important administrative and legal questions. From an administrative perspective, a key challenge will be deciding how to tax imports.[149] The optimal environmental outcome would be for a carbon tax to apply to the carbon content in each imported product. However, the administrative burdens to achieving this are formidable, including access to information on the carbon content from the production of all imports.[150] Another approach would be to apply the tax to imports at a rate that would apply if they had been produced in the United States.[151] This begs the question of produced by whom in the United States? For instance, the carbon produced from making steel in the United States will vary according to the steel plant and the furnace it uses. The most efficient U.S. steel plants would face a lower carbon price than the less efficient ones.[152] One way of answering this

144. American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong.; Clean Energy Job and American Power Act, S. 1733, 111th Cong. (2009).

145. Joshua Meltzer, *Climate Change and Trade-The EU Aviation Directive and the WTO*, 15 J. INT'L ECON. L. 111 (2012).

146. *Id.*

147. Joshua Meltzer, *Regulating CO_2 Emissions from Aviation in the EU*, AM. SOC'Y INT'L L. INSIGHTS, Aug. 31, 2012, http://www.asil.org/insights/volume/16/issue/27/regulating-co2-emissions-aviation-eu.

148. Letter from Hillary Clinton, Sec'y of State, & Ray LaHood, Sec'y of Transp., to Minister of the European Union (Dec. 16, 2011), *available at* http://www.nbaa.org/ops/environment/eu-ets/20111216-eu-ets-us-state-department-clinton.pdf.

149. CONG. BUDGET OFFICE, BORDER ADJUSTMENTS FOR ECONOMYWIDE POLICIES THAT IMPOSE A PRICE ON GREENHOUSE GAS EMISSIONS 13 (2013), *available at* http://www.cbo.gov/sites/default/files/cbofiles/attachments/44971-GHGandTrade.pdf.

150. *Id.*

151. Gilbert E. Metcalf & David Weisbach, *The Design of a Carbon Tax*, 33 HARV. ENVTL. L. REV. 499, 549 (2009).

152. *Id.* at 550-51.

would be to apply a carbon tax to imports based on U.S. industry averages.[153] This would reduce the information challenge, but such a border tax would be either too high or too low as some imports will be more or less carbon intensive than the U.S. average for that sector.[154] Such a tax would also not create an incentive for overseas producers to reduce their CO_2 emissions below the average U.S. level.[155] A third approach would be to apply a border tax based on the average carbon emissions from the production of the imported good.[156] This would require information on national level emissions instead of each product—a less information intensive process than having to collect it for each product—but would not create an incentive for firms to reduce emissions below the national average.[157]

The impact of a border tax on international trade will also raise concerns about its consistency with U.S. commitments under the WTO.[158] A carbon tax which externalizes the environmental harm of climate change is a globally efficient outcome consistent with the theory of comparative advantage and should, therefore, be WTO consistent.[159] Unfortunately, WTO rules do not readily lead to this conclusion.[160] In particular, it remains unclear as to what extent a WTO member can impose a border tax on carbon that is not incorporated into the imported product but is instead a by-product of the production process.[161] In the event that such a border tax is inconsistent with the non-discrimination disciplines in GATT Article I (Most-Favoured-Nation Treatment) and Article III (National Treatment), GATT Article XX is an exceptions provision that includes measures relating to the conservation of exhaustible natural resources,[162] within which action to address GHG emissions would fall.[163] However, in order for a border tax to fit within the GATT Article XX it would also need to meet the disciplines in the chapter which require that such measures are not applied in a way that leads to "arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade."[164] As outlined above, the

153. *Id.* at 549.

154. *Id.*

155. *Id.* at 550.

156. *Id.*

157. *Id.*

158. Joost Pauwelyn, *U.S. Federal Climate Policy and Competitiveness Concerns: The Limits and Options of International Trade Law* 17 (Nicholson Inst. for Envtl. Policy Solutions, Working Paper No. 07-02, 2007), *available at* http://nicholasinstitute.duke.edu/sites/default/files/publications/u.s.-federal-climate-policy-and-competitiveness-concerns-the-limits-and-options-of-international-trade-law-paper.pdf.

159. *Id.* at 26.

160. ROBERT HOWSE & ANTONIA L. ELIASON, DOMESTIC AND INTERNATIONAL STRATEGIES TO ADDRESS CLIMATE CHANGE: AN OVERVIEW OF THE WTO LEGAL ISSUES 60 (T. Cottier et al. eds., 2009); Pauwelyn, *supra* note 158, at 12.

161. Patrick Lowe, Gabrielle Marceau & Julia Reinhaud, *The Interface Between the Trade and Climate Change Regimes: Scoping the Issues* 7 (WTO Staff Working Paper ERSD-2011-1, 2011), *available at* http://www.wto.org/english/res_e/reser_e/ersd201101_e.pdf.

162. General Agreement on Tariffs and Trade art. XX(g), Oct. 30, 1947, 61 Stat. A-11, 55 U.N.T.S. 194 [hereinafter GATT].

163. Meltzer, *Climate Change and Trade*, *supra* note 145.

164. GATT, *supra* note 162, art. XX.

complexities involved with determining the carbon content of imports could mean that the application of the border tax is done in ways that fails these tests and is, therefore, WTO inconsistent.

The key point is that there is legal uncertainty about how to apply a carbon tax on imports that would be WTO consistent. Whether a border tax adjustment breaches a WTO commitment would need to be determined by the organization's dispute settlement mechanism.[165] Should the tax be found to be WTO inconsistent, the United States could be required to pay compensation, amend, or remove the tax.[166] Failure to do so could lead to countries retaliating by raising their barriers to trade.[167] Moreover, WTO dispute settlement can take up to three years to complete, during which time countries whose imports are subject to the border tax could retaliate by applying their own border taxes based on their own conception of what level of effort the United States should be making to reduce its CO_2 emissions.[168] Thus, the application of a carbon tax to imports raises the risk of tit-for-tat trade retaliation that could harm economic growth.[169] Under such a scenario, the benefits for global innovation from a U.S. carbon tax would also be undermined.

These risks point to the need to find a cooperative solution to the problem. The best outcome would be a globally harmonized carbon tax. For instance, William Nordhaus has proposed a harmonized carbon tax under which countries would "agree to penalize carbon emissions at an internationally harmonized 'carbon price' or 'carbon tax.'"[170] However, despite some of the advantages of such an approach to the current focus of the U.N. climate change negotiations on agreeing to limits on the quantity of GHG emissions, such an outcome, at least within the current U.N. climate change framework, is unrealistic.[171]

A successful outcome from the U.N. climate change negotiations on reducing CO_2 emissions would also lead to a price on carbon. Though even here, this would not address carbon leakage and competitiveness concerns, as any agreement in accordance with the principle in the United Nations climate change negotiations of common, but differentiated, responsibilities, would see developing countries undertaking less mitigation efforts than the United States.[172] As a result, U.S. carbon intensive industries would still be faced with higher costs than competitors in developing countries. Additionally, even a successful outcome in these negotiations is not going to be implemented until 2020 at the earliest.[173]

165. Understanding on Rules and Procedures Governing the Settlement of Disputes art. 19, Apr. 15, 1994, Marrakesh Agreement Establishing the World Trade Organization, Annex 2, 1869 U.N.T.S. 401 [hereinafter DSU].

166. *Id.*

167. *Id.* art. 22.

168. Pauwelyn, *supra* note 158, at 6.

169. *Id.*

170. WILLIAM NORDHAUS, A QUESTION OF BALANCE: WEIGHING THE OPTIONS ON GLOBAL WARMING POLICIES 149 (2008).

171. Metcalf & Weisbach, *supra* note 151, at 540.

172. *Id.* at 551.

173. Conference of the Parties, Seventeenth Session, Durban, S. Afr., Nov. 28-Dec. 11, 2011, *Decisions Adopted by the Conference of The Parties*, U.N. Doc. FCCC/CP/2011/9/Add.1 (Mar. 15, 2012).

In the absence of a global outcome to address the impact of a carbon tax on carbon leakage and competitiveness, the next best option is for the United States to engage in regional and bilateral negotiations. These negotiations could be divided between countries with and without a carbon price. For countries already pricing carbon, such as the European Union, the first step would be to reach an agreement that the carbon prices are equivalent in terms of effort. Secondly, in a situation, for example, where the United States applies a border tax and the European Union does not, there will be a need to prevent double taxation of E.U. exports to the United States, either by rebating on E.U. exports its domestic carbon price, which are then subject to the U.S. carbon tax, or by not applying the U.S. carbon tax to E.U. exports.[174] While the impacts on trade should be the same, rebating the E.U. carbon price on exports will reduce E.U. revenues while increasing the U.S. government's share and the opposite would occur should E.U. exports not be subject to a U.S. carbon tax.[175]

There are two arguments in favor of an approach that avoids application of the U.S. border tax to E.U. exports. One is that this is consistent with the country of origin being responsible for its CO_2 emissions. This is the basis of the U.N. climate change negotiations and underlies the reality that the country where the emissions occur is best placed to address them. A second and related point is that the country of origin can use the revenue raised from a carbon tax to reduce its CO_2 emissions.

For countries not pricing carbon, a border tax will create an incentive to price carbon to avoid application of a border tax.[176] Again, bilateral or regional negotiations aimed at deciding whether other countries are undertaking comparable efforts would not necessarily require demonstration of a direct carbon price and could include consideration of whether a suite of policies represent enough effort at reducing CO_2 emissions to justify an exemption from the U.S. border tax. These negotiations could also seek agreement that a border tax adjustment is WTO consistent or at least would not be litigated at the WTO.[177] A process for managing this could be institutionalized in trade agreements, and the TPP is one candidate; the TTIP is another.

III. PART 3: CONCLUSION

The United States should introduce a carbon tax. This would be a means to raise revenues to address the fiscal deficit and complement bipartisan efforts to incentivize innovation in the green technology sector in an effort to reduce CO_2 emissions. In fact, U.S. capacity on the innovation front could end up being the greatest contribution the United States makes to reducing global CO_2 emissions.

Should the United States succeed in pricing carbon, a range of international trade issues will arise. Some of these are positive as they reinforce the need for liberalized trade as a driver of innovation and the production of cheap green

174. Metcalf & Weisbach, *supra* note 151, at 544, 552.

175. *Id.* at 546.

176. Aaditya Mattoo et al., World Bank, *Reconciling Climate Change and Trade Policy* 15 (Policy Research, Working Paper No. 5123, 2009), *available at* http://elibrary.worldbank.org/doi/pdf/10.1596/1813-9450-5123.

177. *Id.* at 20.

technology.[178] For instance, a carbon price in the United States would send a strong market signal that there are commercial opportunities in finding cost-effective ways to reducing CO_2 emissions, whether through incremental improvements in energy efficiency or the development of breakthrough technologies which change the energy paradigm. Maximizing this signal will require an international system that promotes international scientific collaboration but also facilitates the free flow of people, ideas, and capital to countries where they can be best used. In this world, the United States could expect to be a significant beneficiary, not only from reduced CO_2 emissions but also as the world's talent migrates to places like Silicon Valley to produce another high-tech sector in clean energy technologies.

Currently, there is also significant government involvement in the clean energy space, and this is likely to continue for some time. This involvement has raised a range of trade concerns and in a number of instances has been challenged at the WTO.[179] Balancing efforts to stimulate green technologies with the gains from an open trading system based on WTO rules is an ongoing challenge. There is no reason climate change needs to be tackled at the expense of liberalized trade, an outcome which would make developed countries and in particular developing countries significantly worse off. This is particularly true in the Asia-Pacific region that is deeply enmeshed in global supply chains.[180] Ensuring that government support is developed in ways that are WTO consistent will leave governments with plenty of room to promote ambitious climate change action but in ways that do not discriminate against goods and services based on their country of origin. Moreover, as outlined above, climate change policies that are also WTO consistent will lead to the production of green technologies at lower costs. That said, the global impact of climate change suggests that there is need for negotiation to ensure that the WTO rules do not raise unnecessary legal risks for government when considering how best to act.

A carbon tax in the United States will also inevitably raise domestic concerns about carbon leakage and the impact on the competitiveness of U.S. industry.[181] These concerns were prominent during the debate in 2009 and 2010 over a cap and trade system, and there is no reason to think that similar concerns would not be raised by a carbon tax.[182] Addressing these concerns will likely lead to some form of border tax adjustment. This will raise trade tensions that will need to be navigated. And resolving these issues through negotiation rather than WTO dispute settlement is the preferred path.

In many respects, what the United States does will be central to how the development of green technologies and trade proceeds. As the world's largest economy with an unrivalled capacity for innovation and R&D, should the United States price carbon, how this incentivizes clean technology R&D and manages the implications for international trade will largely define whether the climate

178. *See generally* Metcalf & Weisbach, *supra* note 151.

179. Pauwelyn, *supra* note 158, at 8.

180. *Id.*

181. Pauwelyn, *supra* note 158.

182. Metcalf & Weisbach, *supra* note 151, at 503.

change and trade regimes are mutually supportive or are developed at the expense of each other.