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I. Introduction

Since the turn of the century, there has been rapidly-increasing awareness of the environmental impact of mankind's modern lifestyle. This impact arises from pollution, consumption, and destruction of natural resources, all of which result in the emission of greenhouse gases.[1] The results of these emissions are climate change and global warming.[2] There is extensive scientific data that demonstrates the scope and the scale the threat that climate change poses to our survival.[3] As awareness of the serious and far-reaching consequences of climate change continues to grow, communities are looking for solutions to slow down, halt, and mitigate these effects. Such solutions give rise to social challenges, including

1. *See* Kyoto Protocol to the United Nations Framework Convention on Climate Change, Annex A, Dec. 11, 1997, U.N. Doc FCCC/CP/1997/7/Add.1, 37 I.L.M. 22, *available at* http://unfccc.int/resource/docs/convkp/kpeng.pdf [hereinafter Kyoto Protocol] (listing the six major greenhouse gases: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), and Sulphur Hexafluoride (SF_6)).

2. *See* Peter G. G. Davies, *Global Warming and the Kyoto Protocol*, 47 INT'L & COMP. L.Q. 447, 447 (1998) (explaining the impact of greenhouse gas emissions on climate change through the "greenhouse effect"); *see also* Corinne D. Scown et al., *Lifecycle Greenhouse Gas Implications of U.S. National Scenarios for Cellulosic Ethanol Production* (2012), *available at* http://iopscience.iop.org/1748-9326/7/1/014011/pdf/1748-9326_7_1_014011.pdf (focusing "on the potential for growing and processing Miscanthus giganteus, a high-yield perennial grass . . . . Scenario analysis provides an opportunity to explore a range of options and to identify which choices will be strongly influential in determining the climate (and other) impacts of ethanol production.").

3. *See* LENNY BERNSTEIN ET AL., CLIMATE CHANGE 2007: SYNTHESIS REPORT: CONTRIBUTION OF WORKING GROUPS I, II AND III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 64 (2009) ("There is medium confidence that approximately 20 to 30% of plant and animal species assessed so far are likely to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C over 1980–1999 levels."); *see also* Estelle Derclaye, *Patent Law's Role in the Protection of the Environment—Re-Assessing Patent Law and its Justifications in the 21st Century*, 40 INT'L REV. INTELL. PROP. & COMPETITION L. 249, 250 (2009) [hereinafter *Patent Law's Role*] (providing statistics about influence of greenhouse gases on the atmosphere).

changes in policy, education, lifestyle, and social habits, as well as initiation and investment in research. Although surmounting each of these challenges will play a significant role in preserving the planet for future generations, the challenges of initiating and investing in research are especially prominent because they can lead to tools that actually facilitate sustainability on a meaningful scale and that constitute important technological advancement for society.

As with all technology, the development of green technology requires investment and initiative to support development projects—yet, without public incentives, such investment and initiative would be hard to come by due to the practical and realistic limitations on what can be achieved by personal passion on its own. Having been discussed and debated at length, it is now almost trite to state that intellectual property laws give value to intellectual products, which, in turn, give incentive for the development and diffusion of technology.[4]

As we move into an age where there is greater awareness of the need for sustainable and environmentally-friendly practices, there is now an intensifying debate with regard to the role that intellectual property rights should play in mitigating climate change. On the one hand, intellectual property rights may be seen as a valuable tool to promote the development and diffusion of green technology.[5] On the other hand, they could stand as a barrier to a global effort in mitigating climate change.[6] Either way, we will see below that intellectual property rights do have an impact on the development of green technology, as well as on the rate of society's adoption of this technology.

This paper explores how intellectual property rights influence the development and diffusion of green technology. It will be seen that, despite positive and negative impacts, the benefits derived from intellectual property rights far outweigh the negative impacts. Furthermore, it will be evident that any perceived impediments as a result are not necessarily

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4. *See* William Dibble, *Justifying Intellectual Property*, 1 UCL JURIS. REV. 74, 74 (1994) ("The need for intellectual goods in contemporary culture means that we place an enormous value on them. The value however can only be realised in the form of a price if it is protected by some form of law or recognised within law.").

5. *See* Russell Thomson & Elizabeth Webster, *The Role of Intellectual Property Rights in Addressing Climate Change: The Case of Agriculture*, 2 WORLD INTELL. PROP. ORG. J. 133, 133 (2010), *available at* http://www.wipo.int/export/sites/www/about-wipo/en/wipo_journal/pdf/wipo_journal_2_1.pdf [hereinafter *Intellectual Property Rights*] ("IP optimists emphasise their function in encouraging investment in research and development (R & D) and commercialisation.").

6. *See id*. at 133 ("The alternative view, principally associated with developing countries, sees the monopoly rights embodied in IP as a barrier to technology adoption and international transfer.").

significant enough to warrant any measures that may undermine such rights and possibly jeopardize the positive impacts.

To contextualize the discussion, Part I sets out the background of green technology and why its development and diffusion are important. Part II explores the relationship between intellectual property and green technology. Part III discusses the effects that intellectual property rights have on green technology generally. Part IV discusses the impact of specific types of intellectual property rights on green technology. Finally, this paper discusses the above findings and draws conclusions.

II. Green Technology

A. What is Green Technology?

Green technology is a general term often used interchangeably with "clean technology."[7] Other terms such as "environmental technologies,"[8] "climate related technologies," and "mitigation and adaptation technologies,"[9] or variations thereof, essentially refer to the same thing. To avoid confusion, the term "green technology" has been adopted in this paper and shall be taken to mean technology which is used, or may be used, to promote sustainability, reduce greenhouse gas emissions, or otherwise assist in the solution to climate change.

Green technology can include a variety of products and systems. The International Patent Classification Committee developed a non-exhaustive "IPC Green Inventory"[10] which facilitates searches for patent information relating to green technology, or what they refer to as "Environmentally Sound Technologies." The Green Inventory includes the following general categories of such technologies: (1) Alternative Energy

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7. It is noted that the term "sustainable technology" is not preferred as it suggests that the technology itself is sustainable rather than the technology being used to achieve sustainability.

8. *See WIPO Green (Pilot) Charter*, WORLD INTELL. PROP. ORG., https://www3.wipo.int/green/green-technology/charter (last visited Sept. 16, 2012) (referring interchangeably to "green" and "environmental" technologies) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

9. *See* AHMED ABDEL LATIF ET AL., INT'L CTR. FOR TRADE & SUSTAINABLE DEV., OVERCOMING THE IMPASSE ON INTELLECTUAL PROPERTY AND CLIMATE CHANGE AT THE UNFCCC: A CALL FOR A REASONABLE AND BALANCED APPROACH (2011), *available at* http://ictsd.org/downloads/2012/02/overcoming-the-impasse-on-intellectual-property-and-climate-change-at-the-unfccc-a-way-forward.pdf (using the term "mitigation and adaptation technologies" throughout in reference to green technology).

10. *IPC Green Inventory*, WORLD INTELL. PROP. ORG., www.wipo.int/classifications/ipc/en/est/ (last visited Sept. 16, 2012) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

Production, (2) Energy Conservation, (3) Nuclear Power Generation, (4) Transportation, (5) Waste Management, (6) Agriculture/Forestry, and (7) Administrative, Regulatory or Design Aspects.[11] The first three topics fall into the "clean energy technology" discussed in Sec. 1 below, whereas the others are considered in Sec. 2.

2. Clean Energy Technology

Perhaps the most significant green technology is that which facilitates clean and renewable energy. Energy supply makes up the largest portion of sources of greenhouse gas emissions globally.[12] The primary contributor to the atmospheric release of man-made CO_2 is the burning of fossil fuels.[13] Eighty percent of such CO_2 arises as a result of burning oil, coal, and gas.[14] It should also be noted that besides the carbon emissions arising from the use of these energy sources, these non-renewable resources are estimated to last only sixty more years.[15] Accordingly, energy alternatives to burning of fossil fuels will need to be adopted.

Existing technologies such as nuclear energy are a much "cleaner" energy source, and do not release any greenhouse gases in their generation of energy.[16] As such, it is an attractive technology for clean energy.[17]

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11. *Id.*

12. *See* CONTRIBUTION OF WORKING GROUP I TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 23 (Susan Solomon et al. eds., Cambridge Univ. Press 2007) (discussing energy sources as the predominant reason for increased greenhouse gas emissions).

13. *See id.* at 25 ("Emissions of CO_2 from fossil fuel use and from the effects of land use change on plant and soil carbon are the primary sources of increased atmospheric CO_2.").

14. *See Patent Law's Role*, *supra* note 3, at 250 ("For instance, about 80% of the extra man-made CO_2 comes from burning oil, coal and gas, and 20% from deforestation or other land changes"); *see also* BJØRN LOMBORG, THE SKEPTICAL ENVIRONMENTALIST: MEASURING THE REAL STATE OF THE WORLD 260 (Cambridge Univ. Press, 2001) ("About 80 percent of the extra CO_2 comes from the combustion of oil, coal and gas whereas the other 20 percent comes from deforestation and other land changes in the tropics.").

15. *See* Michael Moyer & Carina Storrs, *How Much Is Left? The Limits of Earth's Resources*, SCI. AM. (Aug. 24, 2010), *available at* http://www.scientificamerican.com/article.cfm?id=how-much-is-left ("Rutledge concludes that the world will extract 90 percent of available coal by 2072."); *see also* JEFFERY GREENBLATT ET AL., CAL. COUNCIL ON SCI. & TECH., CALIFORNIA'S ENERGY FUTURE—THE VIEW TO 2050: SUMMARY REPORT 41 (2011), *available at* http://www.ccst.us/publications/2011/2011energy.pdf [hereinafter CALIFORNIA'S FUTURE] (identifying changes that California needs to make to reduce its greenhouse gas emissions to 80% below 1990 levels by 2050).

16. *See* KENNETH S. DEFFEYES, HUBBERT'S PEAK: THE IMPENDING WORLD OIL SHORTAGE 180 (Princeton Univ. Press 2001) ("On the other side of the nuclear argument: no carbon dioxide emission to the atmosphere and a 100-year supply of uranium").

However, in light of political and policy factors,[18] nuclear energy is also a good example of the fact that barriers to clean energy technology go beyond intellectual property rights.

Accordingly, in order to meet energy demands, it will be necessary to rely on alternative technologies that facilitate the use of renewable and clean energy sources. At the moment, technological developments in, for example, solar, wind, shale gas, cellulosic biofuels, and geothermal energy, are promising due to their potential to harness energy from existing renewable resources with zero carbon emissions.[19] Load-following technologies are also being developed to make such types of renewable energy sources more feasible.[20] For example, batteries used for storage of reserve energy gathered during "down" periods of intermittent energy sources such as solar and wind are becoming more stable and capable of storing more electricity.[21] Other technologies are also being developed,

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17. *See Uranium (revised)*, ENCYCLOPEDIA.COM, http://www.encyclopedia.com/topic/uranium.aspx (last visited Sept. 16, 2012) (explaining uranium's properties and uses as an energy source) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

18. Nuclear weapons proliferation is a major factor against any call for widespread access to nuclear technology production of energy. Also, there are still concerns with regards to radioactive nuclear waste arising from production of nuclear energy as well as devastating effects to the environment which may arise in the event of any nuclear meltdowns and plant failures such as that which occurred in Fukushima. *See* Treaty on the Non-Proliferation of Nuclear Weapons preamble, Jul. 1, 1968, 21 U.S.T. 483, 729 U.N.T.S. 161, *available at* http://www.un.org/disarmament/WMD/Nuclear/NPTtext.shtml (declaring to end "the nuclear arms race and to undertake effective measures in the direction of nuclear disarmament"); *see also* Agreement Between the Republic of Argentina and the Federative Republic of Brazil for the Exclusively Peaceful Use of Nuclear Energy art. 1, Jul. 18, 1991, INFCIRC/395, *available at* http://www.iaea.org/Publications/Documents/Infcircs/Others/inf395.shtml (agreeing to use nuclear energy for exclusively peaceful purposes); Winifred Bird, *As Fukushima Cleanup Begins, Long-term Impacts are Weighed*, YALE ENV'T 360 (Jan. 9, 2012), http://e360.yale.edu/feature/as_fukushima_cleanup_begins_long-term_impacts_are_weighed/2482/ (expounding upon lasting effects of Fukushima nuclear disaster) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

19. *See* CALIFORNIA'S FUTURE, *supra* note 15, at 22 (citing potential renewable resources that have zero-emissions and that would dovetail with load-balancing initiatives to improve demand management).

20. *See* CALIFORNIA'S FUTURE, *supra* note 15, at 22 ("There is a significant difference between the load following services required for systems that are dominated by intermittent generation, versus those that have significant baseload.").

21. *See* CALIFORNIA'S FUTURE, *supra* note 15, at 22 ("Not only do these resources require more storage to allow the peak of resource availability to be shifted to the time of peak demand, intermittent resources may also require storage that can provide gigawatt-days of energy if, for example, the wind does not blow for many days.").

such as biogas and carbon capture and sequestration for sources such as natural gas.[22]

However, notwithstanding recent advances in clean energy technology, much of the promising research and development is coming from private firms, and the technology developed is proprietary and closely protected, normally by way of patents and proprietary know-how.[23]

2. Other Green Technologies

In light of the importance and effectiveness of clean energy technology, the discussions in this paper will primarily focus on energy-related systems. However, it is noted that, in addition to clean energy solutions, in order to achieve goals for green energy it has been suggested that there will need to be a reduction in electricity demand generally.[24] Such solutions may be a variety of things such as changes in personal habits, sustainable manufacturing procedures, energy-saving products such as energy saving light bulbs, LED light bulbs, materials for building construction,[25] and many more prospective green inventions. Again, much of this technology is, or will be, subject to intellectual property rights.

There are also other environmental technologies falling under the protection of intellectual property law, such as those relating to sewage treatment, solid waste management,[26] sustainable agricultural practices, and environmentally sound materials.

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22. *See* CALIFORNIA'S FUTURE, *supra* note 15, at 44–45 (listing possible technologies that could solve the "problem with decarbonizing fuel").

23. *See* JOHN H. BARTON, INT'L CTR. FOR TRADE & SUSTAINABLE DEV., INTELLECTUAL PROPERTY AND ACCESS TO CLEAN ENERGY TECHNOLOGIES IN DEVELOPING COUNTRIES: AN ANALYSIS OF SOLAR PHOTOVOLTAIC, BIOFUELS AND WIND TECHNOLOGIES 10 (2007), *available at* http://www.iprsonline.org/unctadictsd/docs/BARTON_DEC_2007.pdf [hereinafter ACCESS TO CLEAN ENERGY] ("[F]our leading firms produce about 45 percent of the market."); *see also* Estelle Derclaye, *Should Patent Law Help Cool the Planet? An Inquiry From the Point of View of Environmental Law: Part 2*, 31 EUROPEAN INTELL. PROP. REV. 227, 227–35 (2009) [hereinafter *Cool the Planet?*] (identifying how patent laws can both reduce greenhouse gas emissions and address other environmental concerns); John A. Tessensohn, *Publication Review: Intellectual Property and Climate Change: Inventing Clean Technologies*, 34 EUR. INTELL. PROP. REV. 364, 366 (2012) [hereinafter *Inventing Clean Technologies*] (explaining that private companies "have been vigorously investing in multi-million dollar research collaborations with university scientists and institutions" in the past few years).

24. *See* CALIFORNIA'S FUTURE, *supra* note 15, at 36 (noting that one way to achieve California's emissions target is to "reduce energy demand through ubiquitous behavior change").

25. *E.g.* Breathable, energy-absorbing, and insulating materials.

26. *E.g.* Municipal solid waste may be converted to energy by capturing the biogas from the waste and converting it to energy.

B. Why Is Green Technology And Access To It Important?

1. Fundamental Role And Need For Development And Diffusion

Of the different social challenges in the sustainability revolution, green technology is the tool to make the greatest impact and empowers us to actually reduce greenhouse gas emissions. Such "technological solutions" are well recognized to apply to various dimensions of the climate change problem.[27] Besides providing new solutions, technology also plays a vital role in enhancing clean technologies that currently exist and lowering the costs of the same.[28] The majority of the promising technologies are still in their early stages of development and all bear the potential of becoming more efficient and effective. Furthermore, much of green technology has not gotten to a stage where it is economically feasible to adopt[29] and there is much space for development to bring down the cost of existing technologies.[30]

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27. *See* INT'L CTR. FOR TRADE AND SUSTAINABLE DEV., CLIMATE CHANGE, TECHNOLOGY TRANSFER AND INTELLECTUAL PROPERTY RIGHTS, 1 (2008), *available at* http://ictsd.org/i/publications/31159/?view=document [hereinafter CLIMATE CHANGE, TECHNOLOGY TRANSFER] ("Technological solutions are imperative in meeting the challenges of climate change.").

28. *See id.* at 1 ("A critical factor in greenhouse gas emissions, technology is also fundamental to enhancing existing abilities and lowering the costs of reducing these emissions.").

29. Many countries have not yet reached grid parity for photovoltaic systems to be economically worthwhile. *See* RICHARD DOBBS ET AL., RESOURCE REVOLUTION: MEETING THE WORLD'S ENERGY, MATERIALS FOOD AND WATER NEEDS 86 (McKinsey Global Institute Nov. 2011), *available at* http://www.mckinsey.com/~/media/McKinsey/dotcom/Insights%20and%20pubs/MGI/Research/Resource%20Markets/Resource%20revolution/MGI_Resource_revolution_full_report.ashx ("The cost of scaling up renewable technologies is highly uncertain. We estimate the cost to be between $210 and $305 billion per annum over the next 20 years."); *see also* MICHAEL WOODHOUSE ET AL., AN ECONOMIC ANALYSIS OF PHOTOVOLTAICS VERSUS TRADITIONAL ENERGY SOURCES: WHERE ARE WE NOW AND WHERE MIGHT WE BE IN THE NEAR FUTURE? 1 (Nat'l Renewable Energy Lab. 2011) [hereinafter PHOTOVOLTAICS VERSUS TRADITIONAL ENERGY] (suggesting that "PV systems are already economically viable in select markets, but further cost reductions and efficiency improvements above and beyond the monocrystalline optimistic-case scenarios are necessary in order to be competitive against incumbent electricity production in most markets across the United States"); Stiftung Umweltenergierecht, *PV Support Schemes and Regulations for all Target Countries* (Intell. Energy Europe Jul. 2012), *available at* http://www.pvparity.eu/fileadmin/PVPARITY_docs/documents/120130_WS/Overview_of_PV_markets_and_of_support_schemes.pdf (noting PV economic feasibility).

30. *See* U.S. DEP'T OF ENERGY, $1/W PHOTOVOLTAIC SYSTEMS 2 (2010), *available at* http://www1.eere.energy.gov/solar/sunshot/pdfs/dpw_white_paper.pdf [hereinafter U.S.

The development of green technology will also facilitate accessibility and its adoption. As technological advances in green technology allow for lower costs in production or processing, it will become more accessible. For example, in 2004, the cost of an installed solar cell system[31] was approximately US$8 per watt; yet, it is estimated that the cost of such a system in 2010 was slightly over US$3 per watt.[32] The current goal for 2016 is to have the cost at just slightly over US$2 per watt and for 2017 to be US$1 per watt.[33] The reduction in these costs is expected to come from advances in technologies, including better and easier installation[34] and adoption of better materials.[35] An example of such improvements would be different solar cell designs that operate more efficiently.[36] Such improvements would arise, more likely than not, from research and development that would identify the intellectual property rights as belonging to the developers and/or their investors.[37] Such technologies all seek to improve the efficiency, production, and installation costs of the photovoltaic systems.[38] Under normal circumstances, in jurisdictions where these patent rights are protected, systems purchased would need to be genuine licensed products. It is impermissible to act without appropriate authorization in making, using, offering for sale, selling, or importing products whose subject matter is patented.[39]

There is great potential for improvement of existing technologies, as well as discovery of new technologies. For example, the sun offers the

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DEP'T OF ENERGY] (identifying the potential of making solar energy cost-competitive with other electricity at the cost of one dollar per watt, which is equivalent to 5-6 cents per kWh).

31. The costs are formed from a combination of the PV module, inverter and installation costs, with the module and installation forming the bulk of the costs.

32. U.S. DEP'T OF ENERGY, *supra* note 30, at 3.

33. U.S. DEP'T OF ENERGY, *supra* note 30, at 9.

34. U.S. DEP'T OF ENERGY, *supra* note 30, at Figure 10 (showing snap assembly as an example of easy photovoltaic installation).

35. U.S. DEP'T OF ENERGY, *supra* note 30, at 4 (indicating that earth-abundant, lighter, and non-toxic materials may serve as ways to cut costs).

36. U.S. DEP'T OF ENERGY, *supra* note 30, at 15–16 (explaining that lost energy from reflection and recombination may be reduced through design improvements).

37. *See* PHOTOVOLTAICS VERSUS TRADITIONAL ENERGY, *supra* note 29, at 2 (noting that companies such as NanoSolar and Global Solar have patents on their cells).

38. *See* U.S. DEP'T OF ENERGY, *supra* note 30, at 2 (explaining that meeting the challenge of affordable solar energy could revolutionize the world's relationship with energy use).

39. *See* Patents Act, 1977, c. 37, §§ 60–69 (Eng.) (making the unauthorized use of patented materials illegal); *see also* Agreement on Trade-Related Aspects of Intellectual Property Rights, art. 28, Apr. 15, 1994, 1869 U.N.T.S. 299, 33 I.L.M. 1197, *reprinted in* THE LEGAL TEXTS: THE RESULTS OF THE URUGUAY ROUND OF MULTILATERAL TRADE NEGOTIATIONS 320 (1999) [hereinafter TRIPS Agreement] (conferring on a patent owner the exclusive right to prevent third parties from offering for sale, selling, or importing a patented product without the patent owner's permission).

surface of the earth 120,000 terawatts (TW) of energy,[40] and there are vast numbers of different innovations being developed, and yet to be developed, to help tap into this readily available resource for low-carbon technological solutions.[41] This is not only for obvious areas such as photovoltaic systems, but also for areas such as the discovery of enzymes used for breaking up of perennial grasses (which are grown from the sun) for ethanol—an area of technology that is still quite open for development.[42] There are also numerous routes to different fuels from biomass besides ethanol that can be developed.[43] In fact, at the moment, biomass conversion methods are far from reaching an adequate stage of development and are not yet cost-effective.[44] The potential has been identified, however, at the moment, intellectual property rights are perhaps the driving force to incentivize investment in the technology.[45]

As such, the development and improvement of green technologies is paramount to the solution to climate change, particularly in light of the present state of the environment.

2. Increasing Emissions

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40. *See* U.S. DEP'T OF ENERGY, BASIC RESEARCH NEEDS FOR SOLAR ENERGY UTILIZATION 3 (2005), *available at* http://science.energy.gov/~/media/bes/pdf/reports/files/seu_rpt.pdf ("The sun deposits 120,000 TW [terawatts] of radiation on the surface of the Earth, far exceeding human needs even in the most aggressive energy demand scenarios.").

41. *See id.* at 3–6 **(**explaining that alternative fuels are generally uncompetitive with fossil fuel but that there are several alternative sources, such as solar energy, that could advance to competitiveness).

42. *See* Mathias Hess et al., *Metagenomic Discovery of Biomass-Degrading Genes and Genomes from Cow Rumen*, 331 SCI. 463, 467 (2011) (explaining the potential for their study to be reconstructed for other classes of enzymes).

43. *See* Jeffrey L. Fortman et al., *Biofuel Alternatives to Ethanol: Pumping the Microbial Well*, 26 TRENDS IN BIOTECH. 375, 379 (2008) [hereinafter *Biofuel Alternatives*] (highlighting additional options to ethanol); Joseph B. Binder & Ronald T. Raines, *Simple Chemical Transformation of Lignocellulosic Biomass into Furanics for Fuels and Chemicals*, 131 J. AM. CHEM. SOC. 1979, 1984 (2009), *available at* http://www.biochem.wisc.edu/faculty/raines/lab/pdfs/Binder2009.pdf (detailing the process of converting lignocellulosic biomass into different types of fuel).

44. *See* David Pimentel & Tad W. Patzek, *Ethanol Production Using Corn, Switchgrass, and Wood; Biodiesel Production Using Soybean and Sunflower*, 14 NAT. RESOURCES RES. 65, 65 (2005), *available at* http://www.c4aqe.org/Economics_of_Ethanol/ethanol.2005.pdf (explaining the negative energy return for liquid fuels from biomass).

45. *See* PHOTOVOLTAICS VERSUS TRADITIONAL ENERGY, *supra* note 29, at 2–4 (detailing the competition for solar technology patents among players in the United States).

We are faced with an urgent need to address the climate change problem. With an increasing population[46] and an expectation of sizeable growth in demand for energy, the need for green technology is greater than ever.[47]

To illustrate the alarming rate at which carbon emissions are growing, the U.S. Environmental Protection Agency reported that worldwide carbon emissions from fossil fuels have increased considerably since 1900, with emissions growing by over sixteen times between 1900 and 2008, and even more drastically by about 1.5 times only between 1990 and 2008.[48]

At the moment, the world consumes approximately over 18,456 TW/h of energy per year.[49] It is anticipated that by 2035, if policies do not change, we will need nearly 30,000 TW/h of energy a year.[50] Presently, a substantial part of this consumption comes from the United States, which consumes 3,961.56 TW/h per year, and from developing countries such as China and India, which respectively consume 3,503.40 TW/h and 689.54

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46. *See* United Nations, *World Population Prospects: The 2010 Revision File 20: Average Annual Rate of Population Change by Major Area, Region and Country, 1950-2100 (Percentage) Estimates*, U.N. Doc. POP/DB/WPP/Rev.2010/01/F20 (Apr. 20, 2011), *available at* http://www.scribd.com/doc/95682672/Wpp2010-Db1-f20-Population-Growth-Rate (indicating that the world population increased at the rate of 1.162% per annum from 2005–12); *see* U.N. Dep't of Economic and Social Affairs, *World Population Prospects: The 2010 Revision*, U.N. Doc. ST/ESA/SER.A/313 1 (Apr. 20, 2011), *available at* http://esa.un.org/wpp/Documentation/pdf/WPP2010_Volume-I_Comprehensive-Tables.pdf ("[T]he world population is projected to reach 10.1 billion persons by 2100.").

47. *See Biofuel Alternatives*, *supra* note 43, at 375 (explaining that research on biofuel alternatives has gained momentum due to concerns about energy consumption).

48. *Global Emissions*, EPA (2012), http://www.epa.gov/climatechange/ghgemissions/global.html (last visited Sept. 14, 2012) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment); *see* T.A. Boden, G. Marlan & R. J. Andres, *Global, Regional, and National Fossil-Fuel CO_2 Emissions*, CARBON DIOXIDE ANALYSIS INFO. CTR. (2008), http://cdiac.ornl.gov/trends/emis/overview.html (last visited Sept. 14, 2012) (estimating CO2 emissions throughout history) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

49. 2011 KEY WORLD ENERGY STATISTICS, INT'L ENERGY AGENCY 48 (2011), *available at* http://www.iea.org/textbase/nppdf/free/2011/key_world_energy_stats.pdf [hereinafter ENERGY STATISTICS].

50. *See* Jimmy Eriksson, *Energy of the Future: Conservation + Renewable Energy* RENEWABLE POWER NEWS, (Aug. 20, 2010), http://www.renewablepowernews.com/archives/1675 (**"**Taking into account the current rate of the increase, it is expected that world energy demand will reach 30 TW within three decades.") (on file with the Washington and Lee Journal of Energy, Climate, and the Environment); *see generally* Int'l Energy Agency, *World Energy Outlook Executive Summary* (2011), *available at* http://www.iea.org/Textbase/npsum/weo2011sum.pdf (explaining that world energy policies must be changed to decrease energy usage worldwide).

TW/h per year.[51] In fact, China accounted for 71% of global energy consumption in 2011[52] and, between 1998 and 2009 India's petroleum imports increased three fold.[53] Since production of this energy primarily comes from burning fossil fuels,[54] the release of carbon emissions is alarming. In fact, in 2009, the total world emission of CO_2 was 28,999 metric tonnes.[55]

Approximately only 3.3% of the world's energy comes from renewable energy sources.[56] Accordingly, there is still enormous room for development and diffusion of this technology. If the energy provided can be achieved cleanly and with low or no greenhouse gas output, the nearly 30,000 MT of CO_2 emitted into the environment per year[57] as a result of fuel consumption can be greatly reduced.[58]

3. Global Issues and Access

While technology is important and serves social and practical uses in their own right, the benefits of green technology transcends borders in that use of such technology in one country benefits all others, while pollution in one country adversely affects others.[59]

Intellectual property rights represent one of the hurdles accessing green technology. "Access" in this context refers to the availability to use this technology within the means of those seeking to use it. This does not

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51. ENERGY STATISTICS, *supra* note 49, at 48–56.

52. BP STATISTICAL REVIEW OF WORLD ENERGY, BRITISH PETROLEUM 2 (2012), *available at* http://www.bp.com/assets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2012.pdf [hereinafter BP STAT REVIEW].

53. INDIA: BIOFUELS ANNUAL, USDA FOREIGN AGRIC. SERV. (2009), *available at* http://gain.fas.usda.gov/Recent%20GAIN%20Publications/General%20Report_New%20Delhi_India_6-12-2009.pdf.

54. *See* ENERGY STATISTICS, *supra* note 49, at 48 (noting that their calculated CO_2 emissions were from fuel combustion only).

55. *See* ENERGY STATISTICS, *supra* note 49, at 48.

56. *See* ENERGY STATISTICS, *supra* note 49, at 24 (giving as examples wind, solar, biofuel, geothermal, and waste).

57. *See* ENERGY STATISTICS, *supra* note 49, at 44.

58. *See* Andrew Wait, *Investment in Clean Technologies as a Public Good: a Discussion Paper Prepared for the Clean Energy Council* 4 (2010), *available at* http://www.cleanenergycouncil.org.au/mediaObject/Policy/Investment-in-Clean-Technologies---Discucssion-Paper/original/Investment%20in%20Clean%20Technologies%20-%20Discucssion%20Paper.pdf [hereinafter *Investment in Clean Technologies*] ("The development of new clean energy sources—like wind, solar, geothermal, ocean and other technologies—potentially play a significant role in reducing greenhouse emissions.").

59. *See id.* at 2 ("[I]f climate change is resolved, the benefits will be enjoyed by all countries, even if they did not participate in the solution.").

necessarily require free and unrestricted access. It is important for everybody to be able to use green technology and it should not be unattainable. As will be demonstrated below, global access to green technology is important because (1) green technology is a necessary tool to mitigate climate change; and (2) climate change can best be addressed in a global effort.

As one can imagine, no matter how advanced green technology may become, it will not be particularly useful unless it is actually used. Although adoption of such technologies in certain countries helps to mitigate the increased emissions caused in others that do not adopt such technologies,[60] there will not be a meaningful solution until the world collectively adopts such technologies.

The concept with regards to global access to green technology is not new, particularly by policy makers and stakeholders in developing countries, which have called for flexible access to clean technologies,[61] including free or compulsory licensing of green technology.[62]

The importance of access to green technology has been recognized internationally. The United Nations Framework Convention on Climate Change (UNFCCC) recognizes that technology transfer as fundamental component of its framework.[63] Under the Kyoto Protocol to the UNFCCC, parties are committed to do the following:

> Cooperate in the promotion of effective modalities for the development, application and diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies, know-how, practices and processes pertinent to climate change, in particular to developing countries, including the formulation of policies and programmes for the effective transfer of environmentally sound technologies that are publicly owned or in the public domain and the creation of an enabling environment for the private sector, to

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60. *See id.* at 2–3 (explaining that benefits accrue to all nations when a single nation acts to address climate change).

61. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at vii (explaining that intellectual property laws for biofuel technologies are not holding back countries such as Malaysia, South Africa, and Brazil).

62. *See* Michael A. Levi et al., *Energy Innovation Driving Technology Competition and Cooperation Among the United States, China, India, and Brazil* 27 (2010), *available at* http://i.cfr.org/content/publications/attachments/Energy_Innovation_Report.pdf [hereinafter *Energy Innovation*] ("[China, India, and Brazil] have historically demanded free or compulsory licensing of low-carbon technologies.").

63. *See* United Nations Framework Convention on Climate Change preamble, art. 4, May 9, 1992, S. Treaty Doc No. 102-38, 1771 U.N.T.S. 107, *available at* http://unfccc.int/resource/docs/convkp/conveng.pdf [hereinafter UNFCCC] (committing the UN to the development of technologies designed to reduce greenhouse gas emissions).

> promote and enhance the transfer of, and access to, environmentally sound technologies.[64]

Technology transfer and development was addressed under the Bali Action Plan "in order to promote access to affordable, environmentally sound technologies."[65] Parties to the UNFCCC agreed in 2010 at the Cancun conference[66] to establish a Technology Mechanism comprised of a Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN) to further these objectives and, additionally, are set to deepen discussions at the Bangkok Climate Change Conference with an aim to better understand the mitigation gap and to problem-solve as to how to bridge that gap.[67]

Further, under the UNFCCC, it is acknowledged "that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions."[68] In order to achieve this, it is submitted that in order for **all** countries to **participate**, there must be access to green technology, and this requires the **co-operation** of other countries.[69]

Accordingly, having the means to reduce carbon emissions is one thing, but without a united global effort and adoption of the means, progress in actually reducing global carbon emissions will be impeded.

To put the importance of access to green technology into better perspective, there are presently developments in solar energy technology

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64. Kyoto Protocol, *supra* note 1, at art. 10(c).

65. United Nations Conference on the Framework Convention on Climate Change, Bali, Dec. 3–15, 2007, U.N. Doc. CP/2007/6/Add.1 4 (2007), *available at http://unfccc.int/bodies/body/6383/php/view/reports.php* (follow "FCCC/CP/2007/6/Add.1" hyperlink; then follow "Full versions: En" hyperlink).

66. *See* United Nations Conference on the Framework Convention on Climate Change, Cancun, Mex., Nov. 29–Dec. 10 2010, U.N. Doc. CP/2010/7/Add.1 19 (2010), *available at* http://unfccc.int/resource/docs/2010/cop16/eng/07a01.pdf (establishing the Technology Mechanism).

67. *See* United Nations Framework Convention on Climate Change, *Note by the Co-Chairs of the Ad Hoc Working Group on the Durban Platform for Enhanced Action on the Informal Additional Session to be Held in Bangkok, Thailand from 30 August to 5 September 2012* 1 (Aug. 7 2012), *available at* http://unfccc.int/files/bodies/awg/application/pdf/adp_information_note_for_bangkok[1].pdf (expressing an ambition of better understanding the mitigation gap).

68. UNFCCC, *supra* note 63, at pmbl.

69. *See* UNFCCC, *supra* note 63, at pmbl. (acknowledging "that the global nature of climate change calls for the widest possible cooperation by all countries and their participation in an effective and appropriate international response, in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions").

that are aiming to eventually achieve the ability to provide as much as 25% of the world's energy.[70] Based on current outputs, this equates to avoiding potentially 7,250 MT of carbon emissions per year.[71] Wind power is aimed to provide 20% of the world's energy,[72] equalling a potential savings of 5,600 MT of carbon emissions per year. In order for these figures to be achieved, however, the technology needs to be taken advantage of globally.

Therefore, without green technology, it would be difficult, if not impossible, to meaningfully mitigate climate change. This is notwithstanding the important roles policy, education, and changes of basic habits have to play in the climate change solution equation. This fundamental role of green technology, coupled with the global issue of the climate change problem, distinguishes green technology from other technologies. As a result, there are clear benefits to closing the knowledge gap in terms of such technology between developed, developing, or least-developed countries, and facilitating access to green technology.

III. Intellectual Property and Technology

A. Intellectual Property

Intellectual property rights are central to technology as they are often[73] embodied and conceptualized in the form of proprietary rights, which are transferrable, licensable, and subject to trespass in the form of infringement. Article 7 of the Agreement on Trade-Related Aspects of

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70. *See* SOLAR ENERGY PERSPECTIVES: EXECUTIVE SUMMARY, INT'L ENERGY AGENCY 21 (2011), *available at* http://www.iea.org/Textbase/npsum/solar2011SUM.pdf ("The High-Renewable scenario variant showed that PV and STE together could provide up to 25% of global electricity by 2050.").

71. *See* ENERGY STATISTICS, *supra* note 49, at 44 (providing that there are nearly 30,000 MT of CO_2 emitted into the environment per year).

72. *See* Fiona Harvey, *Renewable Energy Can Power the World, Says Landmark IPCC Study*, THE GUARDIAN, (May 9, 2011), http://www.guardian.co.uk/environment/2011/may/09/ipcc-renewable-energy-power-world ("Wind power, . . . , met about 2% of global electricity demand in 2009, and could increase to more than 20% by 2050.") (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

73. It is noted that not all innovations are commercialized or can be subject to intellectual property rights such as patents, and that innovations often begin with discoveries or concepts prior to patent applications. *See* David Sunding & David Zilberman, *The Agricultural Innovation Process: Research and Technology Adoption in a Changing Agricultural* Sector, *in* HANDBOOK OF AGRICULTURAL ECONOMICS 5 (2000), *available at* http://are.berkeley.edu/~zilber11/innovationchptr.pdf [hereinafter *Agricultural Innovation*]. As this paper's focus is not on non-proprietary inventions and technologies, the discussion shall remain on technology subject of intellectual property.

Intellectual Property Rights[74] (TRIPS) acknowledges this role of intellectual property rights:

> *The protection and enforcement of intellectual property rights should contribute to the promotion of technological innovation and to the transfer and dissemination of technology, to the mutual advantage of producers and users of technological knowledge and in a manner conducive to social and economic welfare, and to a balance of rights and obligations.*

It may be convenient to consider intellectual property as one general unit when discussing its relationship with innovation. However, as each type[75] of recognized intellectual property serves different roles, a general label of "intellectual property" may over-simplify certain matters.[76] Accordingly, it may not do justice to the issues at hand to equate technology to just one type of intellectual property.[77] The fact of the matter is that the role of different intellectual property rights varies between different industries and different technological fields.[78] As will be discussed in more detail below, different types of intellectual property have different relationships with technology; some are more relevant to technology and some are less.

The subject matter of certain types of intellectual property may be more at the forefront of developing technology than others. For example, computer programs, which are normally protected by copyright,[79] are

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74. TRIPS Agreement, *supra* note 39, at art. 7.

75. For a general overview of these categories of intellectual property protection see WORLD INTELLECTUAL PROP. ORG., WIPO INTELLECTUAL PROPERTY HANDBOOK: POLICY, LAW AND USE 17–160 (WIPO, 2d ed. 2004); HECTOR MACQUEEN, CHARLOTTE WAELDE, & GRAEME LAURIE, CONTEMPORARY INTELLECTUAL PROPERTY LAW AND POLICY 4–7 (Oxford, 2d ed. 2011) [hereinafter CONTEMPORARY INTELLECTUAL PROPERTY LAW].

76. With the exception of patents, there is a surprising lack of academic literature that considers individual types of intellectual property and their impacts on green technology.

77. A number of articles have been written on the role of patent rights and their role in addressing climate change. *See, e.g.* CLIMATE CHANGE, TECHNOLOGY TRANSFER, *supra* note 27, at 4 (discussing the impacts of patents on solar, wind, and biofuel technologies). While they may have valid points to make, the answer this paper seeks to achieve suggests something broader.

78. *See Intellectual Property Rights*, *supra* note 5, at 134 (noting that "it has long been recognised that the potential role of IP rights varies between technological fields and between industries").

79. *See* TRIPS Agreement, *supra* note 39, at art. 10.1 ("Computer programs, whether in source or object code, shall be protected as literary works under the Berne Convention (1971)."); Copyright, Designs and Patents Act, 1988, c. 1 § 3 (Eng.) [hereinafter CDPA] (stipulating that protected literary works include computer programs); Council Directive 2009/24/EC of the European Parliament and of the Council of 23 April 2009 on the Legal

usually technical in nature. Also, patents have traditionally been considered the type of intellectual property that best relates to technology since only new inventions are patentable.[80] In fact, the relationship between patents and innovations has attracted much attention and is currently a common subject of discussion.[81]

In order to distinguish technical types of intellectual property and non-technical types of intellectual property, they may be broadly categorised as "Technological IP" and "Non-Technological IP" respectively. Such a distinction can be seen as akin to what Hughes identified in his article *The Philosophy of Intellectual Property*[82] as non-expressive and expressive intellectual property. Hughes discussed whether the former is more deserving of legal protection than the latter.[83] More technical subject matter, such as patents, would require less expressive activities in their creation, whereas artistic works, literary works (not being computer programmes or circuit drawings), and trademarks are less technical and as a consequence would require more expressive activities in their creation.

Accordingly, Technological IP (the more technical subject-matter of the two categories) may include patents, integrated circuit designs, copyright in relation to computer programs, and protection against unfair competition (including trade secrets and confidential information). In contrast, Non-Technological IP, on the other hand, may include copyright (not including computer programs or circuit drawings), trademarks, industrial designs, geographical indications, and protection against unfair competition (including trade secrets and confidential information).

The distinction between the two categories is relevant to the present discussion because their impact on the development and diffusion of green

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Protection of Computer Programs, art. 1.1, 2009 O.J. (L 111) 16, 18 (EC), *available at* http://www.wipo.int/wipolex/en/text.jsp?file_id=208108#LinkTarget_145 [hereinafter Software Directive] (noting that the Directive "shall protect computer programs, by copyright, as literary works within the meaning of the Berne Convention for the Protection of Literary and Artistic Works").

80. *See* TRIPS Agreement, *supra* note 39, at art. 27 (stipulating that "patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application"); Patents Act, 1977, c. 1 § 1 (Eng.) **(**requiring that, in order to receive a patent, an invention be new, involve an inventive step, and be applicable for industrial use).

81. This paper does not seek to enter into a drawn-out discourse on the relationship between patents and innovation. However, for our purposes, it is accepted that patent laws promote innovation, and as such it is helpful to understand the justifications of patent laws, much of which is based on promoting innovation.

82. Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L. J. 288, 330–66 (1988) [hereinafter *Philosophy of Intellectual Property*].

83. *See id.* at 295–365 (justifying the denial of legal protection of expressive intellectual property through Lockean and Hegelian theories).

technology differ; as a consequence justifications may, therefore, also differ. While there may be personality and labour justifications in connection with intellectual property, insofar as green technology is concerned, entitlement or deservedness of greater or lesser legal protection is beside the point. Rather, due to the state of the climate change emergency and the impact intellectual property laws have on the development and adoption of green technology, no matter how much investors and inventors *deserve* to reap the fruits of their labour, such entitlement should not outweigh the benefit of flexible access to them. However, as will be seen below, notwithstanding the moral argument, the benefits of commercial incentives may outweigh any negative consequences of intellectual property rights.

B. Technology

Technology is given many definitions. It has been defined as "*the application of scientific knowledge to the practical aims of human life or, as it is sometimes phrased, to the change and manipulation of the human environment.*"[84] In general, technology is the result of innovation and applied knowledge that is the direct or indirect result of the human mind, and technology may be categorized as "low,"[85] "medium,"[86] and "high."[87]

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84. *Technology*, ENCYCLOPEDIA BRITANNICA, http://www.britannica.com/EBchecked/topic/585418/technology (last visited Oct. 13, 2012) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

85. For example, manufacturing; recycling; wood, pulp, paper, and paper products; printing and publishing; food products, beverages and tobacco; textiles, textile products, leather and footwear. *See STAN Indicators*, ORG. FOR ECON. CO-OPERATION & DEV. (2005), http://stats.oecd.org/Index.aspx?QueryId=10420 [hereinafter *STAN Indicators*] (on file with the Washington and Lee Journal of Energy, Climate, and the Environment); Paul L. Robertson & Keith Smith, DISTRIBUTED KNOWLEDGE BASES IN LOW AND MEDIUM TECHNOLOGY INDUSTRIES 27 (eds. Hartmut Hirsh-Kreinsen & David Jacobson 2008) [hereinafter *Distributed Knowledge Bases]*; Howard Cox, Marion Frenz, & Martha Prevezer, *Patterns of Innovation in UK Industry Exploring the CIS Data to Contrast High and Low Technology Industries*, 13 J. OF INTERDISC. ECON. 267, 291 (2002), *available at* http://eprints.worc.ac.uk/223/1/Patterns_of_innovation.pdf [hereinafter *Patterns of Innovation*].

86. For example, building and repairing of ships and boats, rubber and plastics products, Coke, refined petroleum products and nuclear fuel, other non-metallic mineral products, basic metals and fabricated metal products; "medium-high technology" such as electrical machinery, motor vehicles, chemicals excluding pharmaceuticals, railroad equipment and transport equipment. *See STAN Indicators*, *supra* note 85; *Distributed Knowledge Bases*, *supra* note 85, at 27; *Patterns of Innovation*, *supra* note 85, at 291.

87. For example, aircraft and spacecraft, pharmaceuticals, office, accounting and computing machinery, radio, TV and communications equipment, medical, precision and optical instruments. *See STAN Indicators*, *supra* note 85; *Distributed Knowledge Bases*, *supra* note 85, at 27; *Patterns of Innovation*, *supra* note 85, at 291; *see also* Richard J.T. Klein et al., *Application of Environmentally Sound Technologies for Adaptation to Climate*

The driving force behind technology is innovation.[88] The OECD defines innovation as "*the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations*."[89] Innovation is not confined to the research and development of technology, but includes its adoption and diffusion.[90] Accordingly, the impact on green technology we are considering in this paper is the impact of intellectual property rights on innovation of technology.[91]

1. IP and Green Technology (Generally)

Interestingly enough, the greatest contributing factor to the increase in greenhouse gas emissions arises from industrial development; patent laws encouraged industrial development because both were developed during the commencement of industrialisation.[92] Although technology is blamed for the cause of "man-made" climate change, it is also widely

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Change, U.N. Framework Convention on Climate Change Technical Paper, at 18, U.N. Doc. FCCC/TP/2006/2 (2006), *available at* http://unfccc.int/resource/docs/2006/tp/tp02.pdf.

88. *See Energy Innovation, supra* note 62, at 15 (discussing how governments that invest in innovation through research and development, demonstration projects, or commercialization efforts create a greater capacity to absorb new technology and create new partnerships for further technological progress)**.**

89. Osamu Onodera, *Working Party of the Trade Committee Trade and Innovation Project: A Synthesis Paper*, 6–7 (Org. for Econ. Co-operation & Dev. Trade Policy Working Paper No. 72, 2008), *available at* http://www.oecd.org/trade/benefitsoftradeliberalisation/41105505.pdf [hereinafter *Trade Committee Paper*].

90. *See id.* at 8 (stating that innovation is not limited to research and development but covers implementation or commercialisation of advances in technology).

91. It is noted that there are 3 stages to change in technology: (1) invention, (2) innovation, and (3) diffusion. *See* NAT'L ENDOWMENT FOR SCI., TECH., & THE ARTS, SOFT INNOVATION TOWARDS A MORE COMPLETE PICTURE OF INNOVATIVE CHANGE 14–15 (2009) (citing JOSEPH A. SCHUMPETER, CAPITALISM, SOCIALISM AND DEMOCRACY 14 (Harper-Collins, 3d ed. 1950)). For the purposes of this paper, I shall avoid a complicated dissection on the stages of technology change, but to focus on how the development (i.e. invention and innovation) and adoption (i.e. diffusion) is impacted by intellectual property. *See Trade Committee Paper*, *supra* note 89, at 8 n.3 (dividing the process of technological change into invention, innovation, and diffusion of innovation).

92. *See Patent Law's Role*, *supra* note 3, at 250 (stating that the main cause of the increase in greenhouse gases is industrial development and that the law itself induced such development); *see also* PAUL TORREMANS, HOLYOAK AND TORREMANS INTELLECTUAL PROPERTY LAW 20 (Oxford Univ. Press, 6th ed. 2010) [hereinafter HOLYOAK AND TORREMANS] (noting that there is a substantial amount of empirical economic evidence that justifies the existence of intellectual property law).

recognized as a solution to the same.[93] This reasoning also applies to intellectual property rights, which may have contributed to climate-changing technologies but may also have spurred the development of green technology.[94]

There is a growing discussion regarding how intellectual property rights affect the development of green technology and how such rights can be used to facilitate the diffusion and development of such technology.[95] The Intergovernmental Panel on Climate Change has highlighted that, of the different technologies[96] that have significant roles in mitigating climate change, each varies in the degree of assistance that it requires to become developed and diffused. Some require substantially further research and development, while others just need a market incentive.[97] Either way, it is quite clear that intellectual property rights are a key to the solution in light of the influence it has on research and development as well as market incentives.[98]

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93. *See* AHMED LATIF ET AL., OVERCOMING THE IMPASSE ON INTELLECTUAL PROPERTY AND CLIMATE CHANGE AT THE UNFCCC: A CALL FOR A REASONABLE AND BALANCED APPROACH, INT'L CTR. FOR TRADE & SUSTAINABLE DEV. POLICY BRIEF NO. 11 at 1 (Nov. 2011), *available at* http://ictsd.org/downloads/2012/02/overcoming-the-impasse-on-intellectual-property-and-climate-change-at-the-unfccc-a-way-forward.pdf (asserting that the rapid development and diffusion of mitigation and adaptation technologies is a critical component of the global response to climate change).

94. *See* Anthony Taubman & Jayashree Watal, *Strategies for Promoting Green Innovation and Disseminating Environmentally Friendly Technologies—What Role for Intellectual Property?* WORLD TRADE ORGANIZATION PUBLIC FORUM Session 38 (Sept. 21, 2011), *available at* https://www.wto.org/audio/forum11_session38.mp3 [hereinafter *Promoting Green Innovation*] (arguing that while intellectual property developments resulted in technologies that contributed to climate change, they can also, conversely, have a beneficial impact in combating climate change).

95. *See id*. (advising that intellectual property rights be used cautiously and strategically to promote innovation and to diffuse climate-friendly technology).

96. *See* Stephen Pacala & Robert Socolow, *Stabilization Edges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 SCI. 968, 970, tbl.1 (2004), *available at* http://www.princeton.edu/mae/people/faculty/socolow/Science-2004-SW-1100103-PAPER-AND-SOM.pdf [hereinafter *Stabilization Edges*] (listing various technologies and their limitations, requirements, and issues).

97. It is well recognised that in addition to research and development, there needs to be effective climate change policies. *See, e.g.*, H-HOLGER ROGNER ET AL., CLIMATE CHANGE 2007: MITIGATION OF CLIMATE CHANGE 97 (Bert Metz et al. eds., 2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-chapter1.pdf [hereinafter CLIMATE CHANGE 2007] (projecting that if current policy settings were maintained, global energy demand and associated supply patterns will continue to grow and to drive greenhouse gas emissions).

98. *See Stabilization Edges*, *supra* note 96, at 970, tbl.1 (listing potential beneficial results from energy efficiency and conservation, fuel-shifting, carbon dioxide capture and storage, nuclear fission, renewable sources of electricity, and forest and agricultural soils, as a result of innovations and new strategies).

C. Intellectual Property Impacts Green Technology

Intellectual property laws have a distinct role in shaping both the development of technology in general as well as green technology.[99] However, the precise extent intellectual property rights shape the development of and diffusion of green technology is not entirely clear because few comprehensive studies have been conducted assessing the impact intellectual property rights have on the various categories of clean technologies.[100] In fact, due to the nature of the issue, it would be a difficult, if not an impossible, task to ascertain in empirical terms, the extent to which intellectual property rights have hindered (or encouraged) the development of and diffusion of green technologies.[101]

The role of intellectual property rights in shaping the development and diffusion of green technology is well recognized, as demonstrated below. So far, the approach has resulted in both *positive* strategies[102] aimed to encourage the development of green technology and *negative* strategies[103] to prevent the development of environmentally unfriendly technology.

D. Strategies

1. Positive Strategies

The underlying and most apparent reason why intellectual property has a bearing on the development and diffusion of green technology is quite simple: research and development will only be procured on a meaningful

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99. While technology also has a role in shaping law (e.g. development of the internet and file sharing technologies and copyright law), this is outside the scope of this paper.

100. *See* CLIMATE CHANGE, TECHNOLOGY TRANSFER, *supra* note 27, at 4 (noting that the exact role of intellectual property in the transfer of climate-related technologies is unclear and no comprehensive study has been conducted on its potential impact).

101. *See* CLIMATE CHANGE, TECHNOLOGY TRANSFER, *supra* note 27, at 4 (highlighting conflicting studies on the impact of IP rights in wind, energy, and biofuel technologies and suggesting that the precise impact remains uncertain).

102. *See Investment in Clean Technologies, supra* note 58, at 2 (noting that the government can implement subsidies, grants, tax incentives or other incentive schemes to address and promote the research and development of new technologies).

103. See *Cool the Planet?*, *supra* note 23, at 227 (explaining that penalties, such as a tax for failing to reduce carbon dioxide emissions, encourage compliance and prevent harmful practices).

level if there are financial incentives to do so.[104] Intellectual property rights provide these incentives. The Intergovernmental Panel on Climate Change put it succinctly:

> Technology research and development (R&D) are important for altering the emission trends shown in the previous sections. In the absence of measures fostering the development of climate-friendly technologies and/or a lack of incentives for their deployment, however, it is not a priori obvious in which direction R&D will influence emissions. Because of the longevity of energy infrastructures (lock-in effect), it is the near-term investment decisions in the development, deployment and diffusion of technologies that will determine the long-term development of the energy system and its emissions (Gritsevskyi and Nakicenovic, 2002).
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> Generally speaking, it would be economically impossible without technology research, development, demonstration, deployment and diffusion (RDDD&D) and induced technology change (ITC), to stabilize GHG concentrations at a level that would prevent dangerous anthropogenic interference with the climate system. Government support is crucial at the development stage, but private investment will gradually replace the former for deployment (creating necessary market transformation) and for diffusion (successful market penetration).[105]

In short, intellectual property laws provide a guarantee to technology developers (which may include government research programs,[106] private companies, as well as universities which normally collaborate with the private sector and bring their innovations to the industry through technology transfer)[107] that their investment in developing

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104. *See* CLIMATE CHANGE, TECHNOLOGY TRANSFER, *supra* note 27, at 2 (asserting that "incentives are generally required to achieve the most effective rate and approach for transfer of technology in relation to national and international needs and objectives").

105. CLIMATE CHANGE 2007, *supra* note 97, at 112.

106. Examples of government research programs include the Chinese Government's Ministry of Science and Technology (MOST), India's government-sponsored Center for Wind Energy Technology (CWET), and Brazil's Brazilian Bioethanol Science and Technology Laboratory (CBTE). *See Energy Innovation*, *supra* note 62, at 15–20 (detailing the Chinese, Indian, and Brazilian governments' involvement in the development and implementation of clean energy technologies).

107. 21 ENCYCLOPEDIA OF FORMS AND PRECEDENTS pt. 2 (2010) [hereinafter FORMS AND PRECEDENTS]

technology will result in guaranteed rights to exploit them exclusively and rights to prevent others from using their technology without authority. Works and inventions may be created by the "talented" in circumstances where the work or invention did not come about with a view for financial gain. However, it is well accepted that businesses drive innovation,[108] and a good portion of intellectual property is produced as a result of financial investment.[109]

This commercial role of intellectual property is well recognized and its use is not necessarily in contravention with the ideal of global access to green technology.[110] The World Intellectual Property Organization (WIPO) has launched a pilot platform, which acts as a sustainable energy exchange known as WIPO GREEN.[111] The platform aims to "accelerate the adaptation, adoption and deployment of green technologies" and "promises to help facilitate the adaptation, adoption and deployment of climate-friendly technologies, particularly in developing countries and emerging economies."[112] Such a program leverages the benefits provided by intellectual property and facilitates its diffusion by providing an international forum for exchange.[113]

2. Negative Strategies

Besides the aforesaid positive strategies used to promote green technology, there are existing obligations under regional and international treaties which use negative strategies to prevent the creation of technology, which may damage the environment, or to limit polluting substances from

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108. *See Trade Committee Paper*, *supra* note 89, at 6 (stating that, while governments have an important role, businesses are the main drivers of innovation).

109. See *Philosophy of Intellectual Property*, *supra* note 82, at 291 (asserting that "much intellectual property is produced only after considerable financial investment, whether it be in the research laboratory or in the graduate education of the scientist using the facility").

110. *See* A. von der Ropp, *WIPO GREEN: Facilitating Dissemination of Green Technology* WIPO MAG., (Jun. 2012), *available at* http://www.wipo.int/wipo_magazine/en/2012/03/article_0006.html [hereinafter *WIPO GREEN*] (characterizing the commercialization of technologies as a platform for enhancing environmental activities).

111. *See id.* (detailing the WIPO pilot platform).

112. *Id.*; *WIPO GREEN—The Sustainable Technology Marketplace* (Pilot Version), https://www3.wipo.int/green/green-technology/techOverview (last visited Nov. 18, 2012) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

113. *See WIPO GREEN*, *supra* note 110 (creating an international forum for exchange of IP rights).

being released into the environment.[114] Such strategies stem from reasons based on morality.[115]

Traditionally, a moral element has always been included in the construction of intellectual property rights.[116] Intellectual property rights are often justified on moral grounds that it is just to credit one's effort in production.[117] Specific rights and limitations with regards to intellectual property are also founded on reasons of morality.[118] For example, authors of copyrighted works are afforded moral rights with regards to their works.[119] Such rights have their roots in the "*droit moral*," which authors enjoyed in France, Germany and Italy.[120] Such rights are now recognized internationally and are generally inalienable.[121] While different jurisdictions implement the moral rights provisions, as obligated under the Berne

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114. *See* Kyoto Protocol, *supra* note 1 (listing the obligations of party countries to limit the creation of technology that damages the environment); Convention on the Grant of European Patents art. 53(a), Oct. 5, 1973, 1065 U.N.T.S. 199 [hereinafter Convention on Patents]; Directive 98/44/EC of the European Parliament and of the Council of 6 July 1998 on the Legal Protection of Biotechnological Inventions, art. 6.1, 1998 O.J. (L 213) 1, 13 (1998) [hereinafter Directive 98/44] ("Inventions shall be considered unpatentable where their commercial exploitation would be contrary to *ordre public* or morality."); TRIPS Agreement, *supra* note 39, at art. 27(2) (providing for member countries to disallow patents for certain inventions in order to protect "*ordre public* [sic] or morality, including to protect human, animal or plant life or health or to avoid serious prejudice to the environment"); *Plant Genetic Sys./Glutamine Synthetase Inhibitors v. Greenpeace*, T356/93, 1995 E.P.O.R. 357 (Technical Bd. App. 1995) (interpreting the European Patent Convention as "prohibiting the patenting of plants or their propagating material in the genetically fixed form of the plant variety"); *see also Patent Law's Role*, *supra* note 3, at 263 (stating the that one role of patent law is to protect the environment).

115. *See* Peter Drahos, *Biotechnology Patents, Markets and Morality*, 21 EUR. INTELL. PROP. REV. 441, 441 (1999) (stating that the European Patent Convention disallows the grant of patents for inventions that are contrary to "ordre public" or morality).

116. *See id.* (stating that morality is a consideration).

117. *See* William Dibble, *Justifying Intellectual Property*, 1 UCL JURIS. REV. 74, 74 (1994) (discussing the need to protect intellectual property); CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 8–9.

118. *See* 1 KEVIN GARNETT ET AL., COPINGER AND SKONE JAMES ON COPYRIGHT 709 (Sweet & Maxwell, 16th ed. 2011) (stating the authors' rights are based upon moral rights with regard to their work, as stated in the 1988 CDPA, *supra* note 79).

119. *See id.* (stating that authors' rights are based upon moral rights).

120. *Id.* at 707 (indicating that the term "moral rights" is derived from "droit moral" which was a concept invoked by authors in France, Germany, and Italy); *see also* GILLIAN DAVIES & KEVIN GARNETT, MORAL RIGHTS 3 (Sweet & Maxwell, 2010) [hereinafter MORAL RIGHTS] (explaining that "droit moral is not concerned with morality but with the non-pecuniary interests of authors").

121. *See* Berne Convention for the Protection of Literary and Artistic Works, Sept. 9, 1886, S. Treaty Doc. No. 99-27, arts. 6*bis*, 14*ter* (1986) [hereinafter Berne Convention] (defining the scope of moral rights in intellectual property); *see also* CDPA, *supra* note 79, at pt. I. c. IV, §§ 77, 80, pt. I. c. V, § 94 (stating moral rights that authors of copyrighted work are entitled to under the Convention).

Convention to differing degrees, nonetheless the existence of moral rights of authors (i.e. paternity and integrity) in relation to copyright have long been accepted and recognized.[122] Such rights are connected with personality justifications, which largely arise from expressive works such as novels and works of art.[123] While such personality justifications are not so strongly connected with less expressive works, such as those for patents (and literary works in terms of computer programs), nevertheless policies and legislation have been implemented as a result of these moral drivers. [124]

Negative strategies based on moral principles have also shaped patent laws in terms of patentable subject matter.[125] It had been suggested that the patent system behaves in a "public sanction" manner, which indicates what inventions the state deems to be deserving of protection.[126] Provisions presently exist in international treaties and national legislation, which preclude patentability on moral grounds and debates on these issues, such as genetically modified humans, animals, and plants, have been argued extensively.[127] Both of these strategies are uses of intellectual property laws to result in positive *impacts* on development of green technology.[128] Such positive benefits are closely connected to justifications made for intellectual property rights, which may broadly be categorized as (1) reward for

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122. *See* CDPA, *supra* note 79, at pt. I. c. IV, §§ 77, 80, pt. I. c. V, § 94 (stating that authors' moral rights to copyright accepted).

123. *See Philosophy of Intellectual Property*, *supra* note 82, at 330–66 (explaining different personality justifications).

124. *See Patent Law's Role*, *supra* note 3, at 249 (acknowledging that morality plays a role in patent law).

125. *See Patent Law's Role*, *supra* note 3, at 258–59 (revealing patent law's negative treatment of inventions contrary to "ordre public").

126. *See Patent Law's Role*, *supra* note 3, at 255 (recognizing a public sanction function of patent system).

127. *See Patent Law's Role*, *supra* note 3, at 255 (citing LIONEL BENTLY & BRAD SHERMAN, INTELLECTUAL PROPERTY LAW 328 (Oxford Univ. Press, 2d ed. 2004)); *see also President & Fellows of Harvard College v. British Union for the Abolition of Vivisection*, T315/03 EPOR 5 (2004) (deciding whether a patent for genetically modified mouse was allowable); *see also* Peter Drahos, *Biotechnology Patents, Markets and Morality*, 21 EUR. INTELL. PROP. REV. 441, 441 (1999) (illuminating the link between patent laws and morality); *see also* U.K. Patent Office, *Inventions Involving Human Embryonic Stem Cells* (May 17, 2012) (isolating elements in the human body to treat disease "should be encouraged by means of the patent system"); *see also* Directive 98/44, *supra* note 114, at art. 6(2)(c) (using "human embryos for industrial or commercial purposes" is unpatentable); *see also Oliver Brüstle v. Greenpeace eV*, C-34/10 ECR 0 (2011) (determining that a process that "necessitates the prior destruction of human embryos" is unpatentable); TRIPS Agreement, *supra* note 39, at art. 27.2 (providing for members to disallow patents in order to "protect human, animal, or plant life or health"); *see also* Convention on Patents, *supra* note 114, at art. 53(a) (prohibiting patents from being granted for inventions contrary to morality).

128. *See supra* notes 104–13 and accompanying text.

innovation,[129] (2) natural justice (i.e. it is fair that the inventor have the monopoly right to his/her invention),[130] (3) the utilitarian rationale that there must be an incentive to encourage innovation, and (4) social contract pursuant to patent rights—an inventor, for example, is granted exclusive rights in exchange for sharing/disclosing how the invention works to the public.[131] A number of studies had been carried out in the past to quantify and identify the impact patent laws have on innovation.[132] Studies have shown that patent laws have motivated increased research and development activity.[133] While there are a number of other factors that arise from patent laws, such as the direction of innovations and the attraction of applications for jurisdictions where there are no patent laws, it is a fact that patent laws provide an incentive for innovation, which, consequently results in increased innovation.[134] Also, there are some who argue that intellectual property law has "*become detached from its central concern with promoting innovation*."[135] Notwithstanding arguments that intellectual property rights may be exploited for reasons beyond those as initially conceived, it should be accepted that the existence of intellectual property rights promotes innovation, which provides a positive justification for patent laws and, indeed, intellectual property laws.[136]

E. Impacts

Accordingly, there is little doubt that intellectual property rights have an impact on the development and diffusion of green technology. The question now is how those rights affect green technology and to what extent? We will now consider how intellectual property rights impact the

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129. *Patent Law's Role*, *supra* note 3, at 252; *see also* Fritz Machlup & Edith Penrose, *The Patent Controversy in the Nineteenth Century*, 10 J. ECON. HIST. 1, 10 (1950) (stating that a man should be rewarded for his innovative service to society).

130. This broad justification is in line with labour theory, and variations thereof, the first occupancy theory.

131. It has also been said that certain rights accompany these justifications. *See* PETER DRAHOS, A PHILOSOPHY OF INTELLECTUAL PROPERTY 73 (Dartmouth Pub. Co. 1996) (identifying role of property to be "active in the individual will and the state"); *see also Philosophy of Intellectual Property*, *supra* note 82, at 295 (revealing a patent holder's rights).

132. *See, e.g.*, Petra Moser, *How Do Patent Laws Influence Innovation? Evidence from Nineteeth-Century World Fairs*, 1–6 (NBER Working Paper No. 9909 Aug. 2003) [hereinafter *Laws Influence Innovation?*] (demonstrating the increased research and development activity resulting from patent laws).

133. *Id.*

134. *Id.*

135. CHRISTINA BOHANNAN & HERBERT HOVENKAMP, CREATION WITHOUT RESTRAINT: PROMOTING LIBERTY AND RIVALRY IN INNOVATION 39 (Oxford Univ. Press 2012).

136. *Laws Influence Innovation?*, *supra* note 132.

development and diffusion of green technology generally (below) and specifically (in the next Part).

1. Positive Impact

a. Encourage Innovation by Incentives

A substantial proportion of funding for green technology comes from the private sector.[137] As with all other types of technology, "strong and predictable intellectual property rights protection" will attract private investment and, in turn, will attract research and innovation.[138] Further, as it does for all types of technology, intellectual property laws also facilitate the dissemination of green technology by way of publication, which consequently should encourage development of more technology.[139] It is risky to propose a solution that protects other interests and undermines an intellectual property protection system because this may discourage investors from supporting the technology in the first place, thereby running the risk of losing research and development dollars.[140] Some estimates put the ratio of private-to-public funding of green technology at 70:30.[141] Without strong and predictable intellectual property rights to encourage private investors, there would be reduced development of green technology.[142] Accordingly, intellectual property rights have a positive impact on green technology in that they provide financial encouragement for innovation and the creation of new technologies.[143]

Furthermore, incentives provided by intellectual property laws encourage the commercialization of the technology, which will result in its broad dissemination,[144] and will further encourage improvements, which, in

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137. World Energy Council, *Energy Sector Environmental Innovation: Understanding the Roles of Technology Diffusion, Intellectual Property Rights, and Sound Environmental Policy for Climate Change*, 2 (2011) available *at* http://www.worldenergy.org/publications/3831.asp (follow "Rules of Trade Paper" hyperlink) [hereinafter *Energy Sector Environmental* Innovation].

138. *See id.* at 2 ("Private sector engagement requires strong and predictable IPR protection.").

139. *See id.* at 10–11 (explaining how intellectual property rights encourage development).

140. *See id.*at 19 (stating that "robust [intellectual property rights] protection is essential").

141. *Promoting Green Innovation*, *supra* note 94, at 3.

142. *See Energy Sector Environmental Innovation*, *supra* note 137, at 12 (revealing that insufficiently robust intellectual property rights regimes may impede innovation).

143. *See Energy Sector Environmental Innovation*, *supra* note 137, at 10 (stating that intellectual property rights support innovation).

144. *See Energy Sector Environmental Innovation*, *supra* note 137, at 10 (stating how entities can best realize their commercial potential with access to patent information).

turn, facilitates diffusion as innovation improves technology.[145] Such improvements may result in more marketable features for green technology.[146] For example, incentives provided by intellectual property law may improve the design of integrated circuits, which will simplify their components, may facilitate more attractive designs, and will ultimately encourage sales, which will further encourage improvement, innovation and the adoption of the subject green technology.[147]

b. Discourage Delay in Investment and Technology Transfer

With the protection offered by a strong intellectual property system and the incentives that come with it, there is a decline in the "second-mover advantage;" this occurs when research and development firms wait for innovations and proceed to imitate them.[148] Such "free riding" is seen as a cause of delay to investment in and development of technology.[149]

Accordingly, some have argued that strengthened intellectual property protection will facilitate the enlargement of green technology markets, and, in particular, will encourage firms from countries such as the United States to become more open to the commercial transfer of their green technology.[150] Such an environment will facilitate more markets to absorb green technology and promote innovation through this second-mover advantage.[151]

c. Improvement of the Intellectual Property System

The benefit of intellectual property laws has been particularly recognized in relation to patent rights.[152] In order to advance the use of

145. *See Energy Sector Environmental Innovation*, *supra* note 137, at 11–12 (providing examples of how patents support technology dissemination).

146. *See Energy Sector Environmental Innovation*, *supra* note 137, at 12–13 ("[P]artnerships, reinforced by IPR, enable faster technology development and diffusions in a dynamic innovation environment.").

147. *See Energy Sector Environmental Innovation*, *supra* note 137, at 10 (asserting that technological advances will increase innovation).

148. *See Investment in Clean Technologies*, *supra* note 58, at 5–6 (discussing "second mover" advantage).

149. *See Investment in Clean Technologies*, *supra* note 58, at 5–7 (discussing the practice of free-riding on the innovations of others).

150. *See Energy Innovation, supra* note 62, at 20–23 (stating that "property protection encourages firms to allow others access to their technological knowledge.").

151. *See Energy Innovation, supra* note 62, at 20–23.

152. Press Release, Intellectual Property Office: UK to Fast-track International Patent Applications (May 28, 2010), *available at* http://www.ipo.gov.uk/about/press/press-release/press-release-2010/press-release-20100528.htm.

patent rights to promote innovation in green technology, a number of jurisdictions have launched "fast-track" schemes for patent applications, which involve a green technology subject matter.[153]

In June 2012, the People's Republic of China's State Intellectual Property Office (SIPO) initiated its fast-track examination scheme for inventions related to green development, which will cover inventions relating to low-carbon emissions, energy and resource conservation, and environmental protection.[154] Under SIPO's "Administrative Measures on Prioritized Examination of Patent Applications," applicants would be able to request prioritized examination of their applications, and such an examination may be completed within one year from application. Japan and the United Kingdom's Green Channel scheme, launched on May 12, 2009,[155] implemented accelerated examination procedures for inventions involving green technology.[156] The United States Patent and Trademark Office ran a Green Technology Pilot Program said to "*encourage [their] brightest innovators to invest needed resources in developing new technologies and help bring those technologies to market more quickly*."[157] Under that program, which started on December 8, 2009 and ended on March 30, 2012, 3533 patents were granted out of 5550 applications "pertaining to green technologies including greenhouse gas reduction (applications pertaining to environmental quality, energy conservation, development of renewable energy resources or greenhouse gas emission reduction)."[158] One company which had taken advantage of the program is

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153. *Id.*

154. Peter Leung, Managing Intellectual Property, *How China's New Fast Track for Green Patents Compares* (2012), *available at* http://www.managingip.com/Article/3064265/How-Chinas-new-fast-track-for-green-patents-compares.html.

155. U.K. Intellectual Property Office, *Green Channel for Patent Applications*, http://www.ipo.gov.uk/pro-types/pro-patent/p-law/p-accelerated/pro-p-green.htm (last visited Nov. 18, 2012) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

156. Japan Patent Office, *Outline of Accelerated Examination and Accelerated Appeal Examination* (2010), http://www.jpo.go.jp/cgi/linke.cgi?url=/torikumi_e/t_torikumi_e/outline_accelerated.htm (last visited Nov. 18, 2012) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

157. Press Release, U.S. Secretary of Commerce Gary Locke: United States Patent and Trademark Office, The U.S. Commerce Department's Patent and Trademark Office (USPTO) will pilot a program to accelerate the examination of certain green technology patent application (Dec. 7, 2009) (quoting U.S. Secretary of Commerce).

158. United States Patent and Trademark Office, *Green Petition Report Summary* (Apr. 26, 2012), *available at* http://www.uspto.gov/patents/init_events/green_report_summary20120426.pdf; United States Patent and Trademark Office, *Pilot Program for Green Technologies Including*

Calera Corporation, a California-based company, which had developed technology to turn gas plant CO_2 emissions to cement.[159] Their product also replaces traditional "Portland cement," which is a major source of carbon emissions.[160]

2. Negative Impacts

a. Restrictions

One of the inevitable consequences of intellectual property rights is the restriction from using such rights without the authorization of their owners.[161] If it is accepted that intellectual property laws work, then it must follow that the exclusive rights afforded by intellectual property laws will act as an obstacle to access the technology protected by such rights.[162] Even if such an obstacle is not absolute, there will always be some degree of compromise to the development of access to the technology.[163]

As one can imagine, the direct barriers to accessing green technology are money, infrastructure, skill, and know-how. In broad terms, the result of this is that richer developed countries are normally the proprietors of green technology, intellectual property with the infrastructure, and skills to apply the technology in their own countries; poorer developing and least-developed countries will not have the resources to adopt the technology, and, even if they can, may not have the technological skills and infrastructure to do so.[164]

Greenhouse Gas Reduction (Notice Docket No. PTO-P-2009-0038), 74 Fed. Reg. 64,666 (Dec. 8, 2009).

159. David Biello, *Cement from CO_2: A Concrete Cure for Global Warming?*, SCI. AM., (Aug. 7, 2008) *available at* www.scientificamerican.com/article.cfm?id=cement-from-carbon-dioxide.

160. United States Patent and Trademark Office, *IP in Motion* (USPTO), www.uspto.gov/about/ipm/calera.jsp (last visited Nov. 18, 2012) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

161. *See* WIPO: *Understanding Copyright and Related Rights*, http://www.wipo.int/freepublications/en/intproperty/909/wipo_pub_909.html#reproduction (last visited Nov. 18, 2012) (acknowledging that an owner has power to prohibit or to authorize the use of his work) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

162. *Id.*

163. *Id.*

164. *See Inventing Clean Technologies*, *supra* note 23, at 365 (describing the advantage developed countries have over developing countries in gaining access to clean technologies in part due to the concentration of patent ownership in developed nations); *see also* Peter K. Yu, *A Tale of Two Development Agendas*, 35 OHIO N.U. L. REV. 465, 466–67 (2009) (comparing development in the twentieth century with development today in developed countries and less developed countries); *see also* Laurence R. Helfer, *Toward a Human*

It would be fair to note that for some countries, intellectual property rights do not pose as a barrier to accessing green technology since such technology may not even be protected in that country in the first place.[165] In those cases, use of the technology in the country would essentially be free.[166] That said, technological "know-how" is often a necessary factor for the adoption of technology and a lack of such "know-how" may itself remain a barrier.[167] Accordingly, such countries should have much to gain by building a stronger intellectual property system, as this would encourage technology transfer (including know-how).[168] While this will create certain rights for technology owners, the situation should not be any worse than it may already be.[169]

b. Delays to Technology Transfer Acceptance

Intellectual property rights have often been viewed by developing countries as a tool for developed countries to tap into the developing countries' resources and prevent the emergence of indigenous innovations.[170] Despite being unpalatable to some, the stunting of indigenous innovation is not necessarily a negative impact on the

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Rights Framework for Intellectual Property, 40 U.C. DAVIS L. REV. 971, 973–74 (2007) (discussing the challenge developing countries face in attempting to give greater public access to knowledge and innovation while industrialized nations seek to increase patent rules).

165. For example, Bangledesh. *See* Rafiqul M. Islam & M. K. Zaman, *Looming Global Warming-Induced Sea Rise and Transfer of Green Technology to the Least-Developed-Countries: Challenges and Options for Submersible Bangladesh*, 32 EUR. INTELL. PROP. REV. 643, 644 (2010) [hereinafter *Looming Global Warming*] (listing Bangladesh as a country where intellectual property rights are not a barrier to access to green technology because the country imitates patented technology without authorization).

166. *Inventing Clean Technologies*, *supra* note 23, at 365 ("[T]here is untrammeled troll-free access to clean technology.")

167. *See Energy Innovation*, *supra* note 62, at 69 (referring to importance of know-how in competing with bigger firms for solar energy contracts).

168. *See Energy Innovation*, *supra* note 62, at 35 (using Brazil as an example).

169. *See Energy Innovation*, *supra* note 62, at 35.

170. *See* Laurence R. Helfer, *Regime Shifting: The TRIPs Agreement and New Dynamics of International Intellectual Property Lawmaking*, 29 YALE J. INT'L L. 1, 28 (2004) [hereinafter *Regime Shifting*] (discussing negotiations for the Convention on Biological Diversity whereby bio-diversity poor, but technology rich, countries sought minimal technology transfers but maximum access to biodiversity rich, but technology poor, countries); *see also* Peter K. Yu, *Currents and Crosscurrents in the International Intellectual Property Regime*, 38 LOY. L.A. L. REV. 323, 419–20 (2004) [hereinafter *Currents and Crosscurrents*] (revealing developed countries self-interest in intellectual property).

development of green technology in general.[171] That said, from a long-term view it may arguably be beneficial to technology if markets were more competitive, and it would be conducive to the future of the technology if there were more innovation globally.[172] However, it may also be argued that there is enough competition amongst existing developers of green technology and the whole world does not need to join.[173]

In any event, developing countries are now realizing that they have the potential to exploit intellectual property rights to further their own interests.[174] As a result, the concept of intellectual property rights has prompted developing countries wishing to develop indigenous innovation to conscientiously weaken their intellectual property systems to allow for growth of indigenous innovation.[175] This inherently limits technology transfer and may ultimately stunt indigenous innovation.[176]

c. Exceptions

It is not always the case that developing countries are lacking in their capability to develop green technology. In fact, from looking at the progress of emerging economies such as China, India, and Brazil, the opposite holds true.[177] For example, Brazil is one of the world's leading

171. *See Regime Shifting*, *supra* note 170, at 28 (arguing that intellectual property rights allow "industrialized countries to support the transfer of proprietary technologies to developing states").

172. *See* Takahiro Ueno, *Technology Transfer to China to Address Climate Change Mitigation* 15 (Resources for the Future Issue Brief Sept. 9, 2009), *available at* http://www.rff.org/RFF/Documents/RFF-IB-09-09.pdf [hereinafter *Transfer to China*] (describing the positive effect competition has on production in China).

173. Note, however, that emerging economies will participate or "play" in the green technology marketplace, including the ownership of intellectual property in green technology. *See Energy Innovation*, *supra* note 62, at 26–27 (citing *Transfer to China*, *supra* note 172, at 15).

174. *See* Jonathan M.W.W. Chu, *Something to Copy? A Critical and Comparative Review of Damages Assessment in Copyright Infringement Actions in China and England and Wales*, 34 EUR. INTELL. PROP. REV. 444, 445–46 (2012) (discussing China's recent introduction of new copyright laws in order to promote Chinese interests); *see also Currents and Crosscurrents*, *supra* note 170, at 347, n. 118 (citing 1 STEPHEN LADAS, PATENTS, TRADEMARKS, AND RELATED RIGHTS 43–55 (Harvard Univ. Press 1975)).

175. *See Energy Innovation*, *supra* note 62, at 21, 43 (arguing that China's weak intellectual property regime, while intended to spur indigenous innovation, has had significant, negative effects on such innovation, particularly regarding low-carbon technology).

176. *See Energy Innovation*, *supra* note 62, at 21, 43 (discussing the effect of the Chinese intellectual property regime on the growth of indigenous innovation).

177. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at 17 (noting that China and India have been very successful at developing green technology); *see also Energy Innovation, supra* note 62, at xii–xiv (discussing the variety of government programs in place to develop green technology in China, Brazil, and India).

producers of biofuels.[178] Similarly, the photovoltaic and wind power markets are recently dominated by China.[179] In fact, China's contributions to the manufacture and development of renewable energy have resulted in prices in certain market sectors to come down drastically.[180]

Furthermore, it is recognied that developing countries do not necessarily have a problem with accessing current generation technologies in light of the fact that most of them are quite traditional.[181] Having said this, most of the technology being developed in developing countries is not the most advanced, and this is expected to be a hurdle despite the strides in technology currently being made.[182] In fact, much of the production in China is for components where the focus is on production processes rather than product innovation.[183] Therefore, although access to current generation green technology is not a major barrier to developing countries, there are

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178. *See Brazilian Brew: America Opens Up to Brazilian Ethanol*, THE ECONOMIST, (Jan. 7, 2012), *available at* www.economist.com/node/21542431 (highlighting the Brazilian sugarcane ethanol industry and the end of trade restrictions with the United States); *Energy Innovation*, *supra* note 62, at 76 ("Brazil is the largest ethanol exporter in the world and is second only to the United States in ethanol production.")**.**

179. *See Energy Innovation*, *supra* note 62, at 37 (stating that China currently exports 90% of photovoltaic cells and modules and is the second largest producer of wind turbines in the world).

180. *See* David Biello, *China's Big Push for Renewable Energy*, SCI. AM., (Aug. 4, 2008), *available at* http://www.scientificamerican.com/article.cfm?id=chinas-big-push-for-renewable-energy [hereinafter *China's Big Push*] (discussing the Chinese goal to significantly reduce reliance on burning coal for energy); *see also China Raises 2015 Solar Power Installation Target*, CHINA DAILY, (Jul. 3, 2012), www.chinadaily.com.cn/business/2012-07/03/content_15545374.htm (stating that a drop in photovoltaic prices has led China to raise solar energy targets for 2015).

181. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at viii (arguing that developing nations are not necessarily at a disadvantage regarding clean energy patents because most clean energy patents do not prevent the development of the technology altogether but only prevent specific improvements to the technology); Frederick M. Abbott, *Innovation and Technology Transfer to Address Climate Change: Lessons from the Global Debate on Intellectual Property and Public Health*, INT'L CTR. FOR TRADE & SUSTAINABLE DEV., v (Jun. 2009), http://ictsd.org/i/publications/50454/?view=document [hereinafter *Lessons from the Global Debate*] (comparing and contrasting the intellectual property regimes of the pharmaceutical industry with the clean energy industry) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

182. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at 18 (displaying a chart showing the intellectual property implications for photovoltaic, biofuel, and wind with respect to developing nations); *Energy Innovation*, *supra* note 62, at xiii, 13 (discussing the limited nature of cutting-edge innovation in clean energy technology in India, China, and Brazil).

183. *See China's Big Push*, *supra* note 180 ("Regardless, China remains among the world leaders in building wind turbines, or at least their components."); *see also Energy Innovation*, *supra* note 62, at 26–27 (citing a list by Zou Ji, a professor at Renmin University, indicating that there are at least forty technologies that China is seeking to procure in order to reach its greenhouse gas emissions goals by 2030).

clear limitations to access when considering more advanced green technology.[184] Accordingly, the present lack of negative impact in this regard, may only be temporary.[185] It would be naïve to believe that there are no real practical barriers to the access of green technology for the future.[186] At the same time, intellectual property laws should not be viewed as the "be all and end all" to the climate change problem.[187] There are numerous challenges that society faces to mitigate climate change, therefore, the development and diffusion of green technology is not a complete solution to the climate change problem.[188] It is well recognized that in addition to research and development, there needs to be effective climate change policies.[189]

In fact, intellectual property rights may not necessarily be preventing the adoption of environmentally friendly solutions. For example, in Brazil, a developing country, in June 2012, 93% of new vehicle sales are flexible fuel vehicles,[190] in that they can run gasoline or ethanol, and it is projected that in 2020, 81% of all vehicles will be flexible fuel vehicles.[191] To convert a vehicle to be able to run E85 fuel (85% ethanol and 15% gasoline) can cost as little as under US $300.[192]

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184. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at viii, 18 (discussing the structure of the current intellectual property regime on clean energy innovation and how it affects access to such technology in developing nations).

185. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at 18 (noting that in photovoltaics, wind, and biofuels, firms in developing nations have successfully entered industry leadership and that intellectual property rights may have in part facilitated this entry).

186. *See Inventing Clean Technologies*, *supra* note 23, at 365–66 (critiquing Matthew Rimmer's holistic approach to the relationship between intellectual property and climate change).

187. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at viii (noting that "[t]he development and diffusion of renewable energy technologies is only one part of the challenge of bringing down emissions from the energy sector. Much needs to be done to harvest the largest potential in energy efficiency improvements.").

188. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at viii.

189. *See* CLIMATE CHANGE 2007, *supra* note 97, at 112 (arguing that research, development, demonstration, deployment, and diffusion of clean energy technology "alone [are] insufficient, and [that] effective climate policies are also required").

190. *Monthly Registration of New Vehicles in Brazil (Otto cycle)*, UNICA (2012), http://www.unicadata.com.br/listagem.php?idMn=30 (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

191. *Brazilian Transportation Fleet*, SUGARCANGE.ORG (2012) sugarcane.org/the-brazilian-experience/brazilian-transportation-fleet (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

192. *Throttle Body (TBI),* FUEL FLEX INT'L (Aug. 12, 2012), http://www.fuelflexint.net/cart/index.php?main_page=product_info&cPath=1&products_id=2 (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

IV. IP and Green Technology (Specific)

The discussion in Part III illustrated that intellectual property affects the development and diffusion of green technology. When considering intellectual property and green technology, all types of intellectual property are relevant to some extent. However, as can be seen below, they may not all play a relevant role in the development and adoption of green technology. Some rights, or variations thereof, have more of an impact on green technology than others. Also, insofar as they are relevant, the impact each has on the development and diffusion of green technology may be positive or negative.

There is a distinction which may be drawn between intellectual property rights *in* green technology and intellectual property rights *in relation* to green technology.[193] The former is normally connected with Technological IP, whereas the latter is connected with Non-Technological IP.[194] Their respective impacts on the development and diffusion of green technology also vary, but, as can be seen below, have similar relationships with their impact on the development and diffusion of intellectual property.

A. Technological IP

Technological IP, or technological intellectual property rights, by their nature, restricts access to the technology.[195] As mentioned above, impacts vary depending on the right and the technology in question.[196] While intellectual property rights do have a positive impact on the development and diffusion of green technology generally, as identified in Part III, a natural impediment to access green technology arises with regards to Technological IP as use must be authorized by the right owner, and normally authorization comes (if granted) with the payment of a premium to use the right.[197] As a result, those who cannot afford the

193. *See* MATTHEW RIMMER, INTELLECTUAL PROPERTY AND CLIMATE CHANGE: INVENTING CLEAN TECHNOLOGIES 202 (Edward Elgar Pub. 2011) [hereinafter RIMMER, INVENTING CLEAN TECHNOLOGIES] (noting Toyota's trademark registration for 'Prius' to protect their intellectual property rights over a name in relation to a green technology).

194. *See* TRIPS Agreement, *supra* note 39, at art. 15–16, 27–28 (defining the requirements for trademarked non-technological materials and the requirements for patentable technology).

195. *See* CLIMATE CHANGE, TECHNOLOGY TRANSFER, *supra* note 27, at 3 (discussing the inherent access limitations that come with a strong intellectual property regime).

196. *See Lessons from the Global Debate*, *supra* note 181, at 9–11 (comparing intellectual property in the areas of green technology and pharmaceuticals).

197. *See RIMMER,* INVENTING CLEAN TECHNOLOGIES, *supra* note 193, at 83–119 (discussing arguments for and against intellectual property rights as they relate to the

technology are precluded from using it, resulting in the negative impacts identified in Part III.[198]

1. Patents

Patent rights are the most obvious rights that propel the development of technology.[199] These exclusive rights to use inventions[200] in jurisdictions where they are granted[201] are at the forefront of protection of technology as intellectual property since they are conferred to inventions which are products or processes, in all fields of technology, provided that they are new and involve an inventive step.[202]

There are a host of patents registered for a variety of green technology. For example, a PCT full text search for "solar cell" on the World Intellectual Property Office's "Patentscope" search system yielded over 26,000 results.[203]

In fact, it is well recognized that of the various types of intellectual property rights, patent rights play a pertinent role in the impact on green technology[204] and are, together with know-how, normally the subject of

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transfer of new green technologies); *Looming Global Warming*, *supra* note 165, at 645 (addressing the effect of intellectual property rights on least-developed countries).

198. *See* Access to Clean Energy, *supra* note 23, at vii (noting the high transaction costs that intellectual property rights create).

199. *See Patent Law's Role*, *supra* note 3, at 253–56 (discussing the various justifications for intellectual property rights, highlighting development incentives as the primary justification).

200. *See* TRIPS Agreement, *supra* note 39, at art. 28 ("A patent shall confer on its owner the following rights: . . . making, using, offering for sale, selling, or importing for these purposes that product."; *see also* Patents Act, 1977, c. 37, §§ 60–69, (Eng.) (laying out what constitutes infringement of a patent right).

201. Patent rights, like other intellectual property, are territorial and limited to the jurisdiction in which they are recognized under that jurisdiction's law. *See generally*, DANIEL C.K. CHOW & EDWARD LEE, INTERNATIONAL INTELLECTUAL PROPERTY—PROBLEMS, CASES AND MATERIALS 2 (Thomson West 2006); THE ROLE OF PRIVATE INTERNATIONAL LAW AND ALTERNATIVE DISPUTE RESOLUTION IN INTELLECTUAL PROPERTY ON THE INTERNET: A SURVEY OF ISSUES WIPO REPORT, 120 (2002), http://www.wipo.int/copyright/en/ecommerce/ip_survey/chap4.html (discussing the territorial nature of intellectual property rights) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

202. *See* Patents Act, 1977, c. 37, §§ 1–6 (Eng.) (requiring that an invention be new, involve an inventive step, and be capable of industrial application for patentability); *see also* TRIPS Agreement, *supra* note 39, at art. 27 (setting out what is patentable subject matter).

203. PatentScope, WORLD INTELL. PROP. ORG., (last visited Aug. 13, 2012), http://patentscope.wipo.int/search/en/structuredSearch.jsf.

204. *See Patent Law's Role*, *supra* note 3, at 264–73 (arguing that patent rights play an important role in safeguarding the environment).

discussion with regards to technology transfer of green technology.[205] Patent rights are normally exploited commercially by licensing and/or technology transfer.[206] They are a vehicle for proprietary rights in technology to be embodied and offer benefits of protection and control, as opposed to unregistered technology, in the form of confidential information and know-how.[207] Patent rights also benefit the public and promote innovation as inventions are published.[208]

Intellectual property for green technology is different than intellectual property for pharmaceuticals because a patented drug may not have any alternatives.[209] Accordingly patent rights will not necessarily prevent a class of green technology from being adopted, but will prevent the wide-spread adoption of better or higher quality incarnations of the technology.[210] An example of this is the use of garnet-based phosphors for LED lighting.[211] Such phosphors are used to improve the warmth and colour of LED lighting and the use of this technology is heavily controlled by the LED firm, Nichia.[212] Technology in relation to the use of Nitrides and oxynitrides for LED lights are used by Intematix and Mitsubishi Chemical Corporation, which also improves the warmth and quality of LED lighting.[213] All this technology is not necessary for the manufacture of LED lighting, and will not necessarily stop the wide-spread adoption of LED

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205. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at vii–ix (discussing the asymmetrical availability of information about intellectual property between developed and developing nations); *see also Promoting Green Innovation*, *supra* note 94, at 3 (discussing the lack of legal options in the TRIPS agreement for developing nations to gain access to patented intellectual property).

206. *See* FORMS AND PRECEDENTS, *supra* note 107.

207. *See* CLIMATE CHANGE, TECHNOLOGY TRANSFER, *supra* note 27, at 3 (arguing that intellectual property rights facilitate the transfer of technology by offering a right of control).

208. *See* TRIPS Agreement, *supra* note 39, at art. 29 ("Members shall require than an applicant for a patent shall disclose the invention in a manner sufficiently clear for the invention to be carried out by a person skilled in the art.").

209. *See Lessons from the Global Debate*, *supra* note 181, at 9–11 (distinguishing the need for strong patent protection in the pharmaceutical industry because of the high research and development costs, and low reverse engineering costs, from the need for strong patent protection for the clean energy industry).

210. *See* LED LIGHTING DRIVING DEMAND FOR NEW PHOSPHORS, NANOMARKETS 2–3 (Aug. 2012), *available at* http://www.nanomarkets.net/Downloads/LEDPhospors.pdf (noting that companies will opt for cheaper alternatives because of Nichia's heavy control over intellectual property in garnet phosphors).

211. *See id.* at 2–3 (explaining why the garnet phosphor is used in LED lighting).

212. *See id.* at 2–3 (discussing the need for phosphors in order to allow LED lighting to be competitive with non-LED lighting options).

213. *See id.* at 3–4 (discussing specific phosphors and the companies that use them in LED light production).

lighting.[214] However, without the better performance offered by such technology, one can see how lesser quality LED lighting may fail to encourage the conversion from less energy-efficient lighting to LED lighting, or may even deter such conversion.[215] Yet, the matter is not so simple.

While there may be circumstances where intellectual property rights limit accessibility to the technology, as we can see from the LED lighting market, a number of firms are developing alternative solutions to improve the technology.[216] In these circumstances, development of the technology is impacted positively.[217] Also, while the continued innovation in the technology will likely result in lowered costs, the more immediate and direct impact of the intellectual property still appears to negatively impact diffusion of the technology.[218]

It has also been acknowledged that, although present generation green technology is generally accessible, access to future green technology will be somewhat hindered.[219] Examples of such future technology are expected advances and discoveries in technology such as enzymes and conversion organisms for biofuel, and advanced technologies for wind and solar power.[220] Although these barriers are not presently viewed to be significant,[221] with green technologies becoming more refined and focused, the narrowing of available technologies will increase the likelihood of a patent covering and controlling a single technology.[222]

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214. *See id.* at 1 (noting the worldwide trend toward governmental regulations that are preferential to LED lighting).

215. *See id.* at 2 (highlighting the need for phosphor technologies to keep up with LED technology in order for LED lighting demand to continue to grow at its present rate).

216. *See id.* at 7–8 (displaying a table of the key market players in LED phosphor technology, and noting the developments that these players have been making).

217. *See id.* at 4 ("[T]he LED phosphors business is exciting . . . because it is a business in which there is still plenty of room for phosphor firms to create proprietary, IP-protected products. In fact, IP development is a cornerstone of the competitiveness of this industry.").

218. *See id.* at 2–3 (noting that Nichia's control of garnet phosphor intellectual property rights has the effect of requiring licensure in order to access this type of phosphor).

219. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at x–xii (discussing the nature of intellectual property rights in green technology as compared to other areas where intellectual property rights are important).

220. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at 18–19 (summarizing the intellectual property implications that arise from the current system of intellectual property rights, and how thee rights affect developing nations).

221. *See* ACCESS TO CLEAN ENERGY, *supra* note 23, at 11–19 (discussing the strides that developing nations like China, Brazil, and India have made in photovoltaic, wind, and biofuel technology without having transferred technology from developed nations).

222. *See Energy Innovation*, *supra* note 62, at 46 (discussing the advantages and disadvantages of the standardization of technologies with respect to intellectual property rights).

2. Computer Programs

Computer programs are normally protected by copyright laws.[223] Note that patents for computer programs are less common.[224] Computer programs are more relevant to the development of green technology than other types of copyright as their subject matter is normally the technology in question.[225] Computer programs can either directly relate to green technology or indirectly relate to green technology.[226] The former would be software where the operation of other green technology is dependent on the software ("Green Operation Software"), or can be a green solution themselves ("Green Software").[227] The latter would be software which is not specifically applicable to green technology, but may be used in the course of operating or creating green technology.[228]

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223. *See* Copyright, Design, and Patent Act, 1988, ch. 1, § 3 (Eng.) (protecting computer programs as literary, dramatic, and musical works); *see also* WIPO Copyright Treaty, art. 4, Dec. 20, 1996, S. Treaty Doc. 105-17, 36 I.L.M. 65 (protecting computer programs as literary works); *see also* TRIPS Agreement, *supra* note 39, at art. 10 (protecting computer programs as literary works under the 1971 Berne Convention); *see also* GUIDELINES FOR EXAMINATION IN THE EUROPEAN PATENT OFFICE, pt. C, c. IV, ¶ 2.3.6 (2012) (protecting computers as a form of "computer-implemented invention").

224. *See Symbian Ltd. v. Comptroller Gen. of Patents, Designs and Trademarks*, [2008] EWCA (Civ) 1066 (Eng.) (finding that a data access computer program is patentable because of its contribution to making a computer run better); *see also* Aerotel *Ltd. v. Telco Holdings Ltd.*, [2006] EWCA (Civ) 1371 (Eng.) (finding in the Macrossan's appeal that a computer program, which collects and organizes documents, is not patentable because it falls in the business exclusion and because there is nothing technical about the program); *see also In re Patents Act, 1977 and Patent Application GB 0017772.5 by Shopalotto.com Ltd.,* [2005] EWHC (Pat) 2416, [2006] R.P.C. 293 (Eng.) (finding that a web-based gambling computer program was not patentable because it did not provide "a technical effect over and above that to be expected from the mere loading of a program into a computer"); *see also* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 11.33–11.38 (summarizing the current approach to patent rights and computer programs).

225. *See* Paulo T. de Souza Nascimento et al., *Exogenous Factors in the Development of Flexible Fuel Cars as a Local Dominant Technology* (2009) 4 J. TECHNOLOGICAL MANAG. INNOV. 110, 112–14 [hereinafter *Exogenous Factors*] (reciting the history of the Software Fuel Sensor system that led to flex fuel cars).

226. *See id.* at 112–14 (describing the Software Fuel Sensor System, a program that directly relates to green technology); *see also* RIMMER, INVENTING CLEAN TECHNOLOGIES, *supra* note 193, at 230–32 (discussing Sipco LLP's remote monitoring and control systems, and computer programs that relate to green technology).

227. *See Exogenous Factors*, *supra* note 225, at 112–14 (discussing the operation of the Software Fuel Sensors system).

228. *See* RIMMER, INVENTING CLEAN TECHNOLOGIES, *supra* note 193, at 230–32 (mentioning a software program that is not specifically applicable to green technology but has been appropriated for that use).

Green Operation Software refers to software that runs climate-change mitigating machinery and equipment such as hybrid or electrical cars; software which runs flexible fuel components in cars (e.g. Software Fuel Sensor);[229] wind turbine generators, as well as smart grid control software (e.g. the Voltage Stability Monitoring & Control system).[230]) It is either built into the underlying technology itself or is operated separately.[231] Either way, Green Operation Software is necessary to use the underlying technology in question, and may be necessary for the use of an entire class of a technology. Green Operation Software has the same negative effects as those identified for patents above.

Green Software has emerged only recently.[232] Generally, it is independent of hardware and may be applied to an underlying technology to improve the operation and efficiency of the underlying technology.[233] The applications of Green Software range from determining the optimal placement of solar panels, to calculating the optimal time for farmers to harvest, to building control software which monitors and adjusts energy consumption.[234] The negative impact of copyright in this type of computer program on the development and diffusion of green technology is like that of patents above, as such programs are not a specific class of technology, but have the potential to improve existing technology.[235]

Green Software also plays a fundamental role in the implementation of green technology. For example, the software may be used to determine the optimal placement of solar panels, to calculate and

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229. *See Exogenous Factors*, *supra* note 225, at 113 (discussing the historical development of green technologies like the software fuel sensor for use with biofuels).

230. *See* Jinquan Zhao et al., *On-Line Voltage Stability Monitoring and Control (VSMC) System in Fujian Power Grid*, Power Engineering Society General Meeting, INST. OF ELEC. & ELECS. ENG'RS 1 (2007), *available at* http://www.hhu-pes-pssc.com/upload/file/20110729/20110729194829.pdf (discussing the basic function of a Voltage Stability Monitoring and Control System as it pertains to modern power systems).

231. *See generally id.* (relating the functions of the Fujian power grid); *Exogenous Factors*, *supra* note 225 (explaining flexible fuel technology and design).

232. *See* Michael Kanellos, *The Top Ten in Green Software*, GREENTECH MEDIA (Aug. 10, 2009), www.greentechmedia.com/articles/read/the-top-ten-in-green-software/ ("While software developers arguably arrived late to the greentech party, their presence and importance grows daily.") (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

233. *See id.* ("[Green software] largely exists to accomplish two goals: to make it easier to get complex data and to fine-tune the control over computers, industrial equipment and other devices.").

234. *See generally id.* (describing fifteen varieties of green software and their uses).

235. *See* LIONEL BENTLY & BRAD SHERMAN, INTELLECTUAL PROPERTY LAW 343–44 (Oxford Univ. Press, 2d ed. 2004) [hereinafter INTELLECTUAL PROPERTY LAW] ("One of the criticisms made of patent protection for computer-implemented inventions . . . is that it restricts access to information and that it stifles innovation.").

reduce the costs of installing clean technology.[236] Intellectual property rights may hinder access to this category of software, thereby negatively affecting the development and diffusion of green technology, especially where such software is pertinent to the use of a particular class of green technology.[237]

3. Layout-Designs (Topographies) of Integrated Circuits and Circuit Diagrams

Semi-conductor topography, also known as integrated circuit layout-designs, is a type of sui generis rights protected by law.[238] Electronic circuit diagrams, which use symbols to set-out the connections between components of electronic circuits, are protected as literary works under copyright law in the United Kingdom.[239] These works may additionally be protected as artistic works.[240]

Integrated circuit (IC) designs and circuit diagrams may be used for applications in clean technology. These intellectual property rights are not likely to prevent access to green technology because circuit designs and diagrams typically improve upon technology and alternatives are

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236. ETAP, for example, is a software company that develops programs to design, analyze, and operate green energy power systems. *See Renewable Energy Software*, ETAP (2012), http://etap.com/renewable-energy/renewable-energy.htm (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

237. *See* INTELLECTUAL PROPERTY LAW, *supra* note 236, at 343–44 ("One of the criticisms made of patent protection for computer-implemented inventions . . . is that it restricts access to information and that it stifles innovation.").

238. *See* Semiconductor Chip Protection Act, 17 U.S.C. §§ 901–914 (2012) (establishing protections for semiconductor products in the United States); The Design Right (Semiconductor Topographies) Regulations, 1989, S.I. 1989/1100, arts. 1–10 (U.K.), *available at* http://www.wipo.int/wipolex/en/text.jsp?file_id=127425 (establishing protections of semiconductor products in the United Kingdom); TRIPS Agreement, *supra* note 39, at art. 36–38, (establishing protections of layout-designs of integrated circuits); Council Directive 87/54, 1986 O.J. (L24) 36 (EC), *available at* http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1987:024:0036:0040:EN:PDF (addressing the need for uniform protections for semiconductor products across the European Union); CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 6 (stating that semi-conductor topography is an example of sui generis rights protected by law in the United Kingdom, United States, and the European Union).

239. *See* Hector L. MacQueen, Copyright Law Reform: Some Achievable Goals? 41, n. 71 (Nov. 15, 2005) (unpublished manuscript), *available at* http://www.oiprc.ox.ac.uk/papers/EJWP0406.pdf (stating that British case law protects circuit diagrams as literary works).

240. *See* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 70 ("Electronic circuit diagrams have been held to be literary works without excluding the possibility that they also incorporate artistic works.").

feasible.[241] For example, ICs for LED lighting may simplify components for more efficient and less expensive products.[242]

4. Confidential Information

Confidential information such as trade secrets and know-how relating to technology may be protected under common law in the United Kingdom, and constitutes a subject matter warranting protection that is required under TRIPS.[243] Owners of technology may protect their technology with trade secret rights.[244] Owners can protect their technology so long as the protected information provides a commercial advantage to a business and the owner has not disclosed the information except pursuant to confidentiality agreements.[245] Relevant confidential information for green technology may include production process technologies that are used in the making of new materials.

For innovators, protections for confidential information may be more beneficial than patent protections[246] given that such protections are infinite in duration, automatic, and require no registration.[247] However, this class of intellectual property rights may have the greatest negative impact on green technology for two reasons. First, under such strong protections, the public cannot obtain any information regarding how the technology works or can even discuss the existence of the technology.[248] Second, this type of

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241. *See* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 70 (stating that circuit diagrams may indicate the circuit configuration in which a given component will offer its best performance).

242. *See* Press Release, Marvell Semiconductor Inc., Marvell's Breakthrough Deep Dimming LED Driver IC Accelerates Mass Adoption of Energy Efficient LED Retrofit Bulbs (Feb. 7, 2012), http://www.marvell.com/company/news/pressDetail.do?releaseID=2056 (announcing the creation of a Deep Dimming LED Driver IC) (on file with the Washington and Lee University Journal of Energy, Climate, and the Environment).

243. *See* TRIPS Agreement, *supra* note 39, at art. 39 ("In the course of ensuring effective protection against unfair competition . . . Members shall protect undisclosed information . . . [that] has commercial value because it is secret.").

244. *See* Walter G. Park, *Property Rights in the New Economy*, *in* NEW ECONOMY HANDBOOK 841, 845 (Derek C. Jones, ed. 2003) [hereinafter NEW ECONOMY HANDBOOK] (stating that protections of trade secret are important forms of intellectual property rights).

245. *See id.*at 845–46 (explaining the conditions of trade secret protection).

246. *See Lessons from the Global Debate*, *supra* note 181, at 4–5 (comparing trade secret protection favorably to patent protection).

247. *See* NEW ECONOMY HANDBOOK, *supra* note 245, at 846 ("The trade secret protection is infinite in duration . . . . Protection is also automatic, requiring no formal registration.").

248. *See* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 817 ("[B]y relying on trade secrets, rather than seeking patent protection, it would be possible for an inventor to have permanent control over the use of the technology.").

information, or the lack thereof, prevents most developing countries from adopting many of the existing technologies.[249] China's oil and gas industry illustrates this phenomenon.[250] China has enormous reserves of shale gas, a cleaner alternative to coal, which have barely been tapped.[251] China has only recently begun producing the resource, primarily because of the lack of prior access to knowledge and technology.[252] Through collaboration with foreign investors, China is beginning to tap into this promising resource.[253] While such technology transfer is encouraging, the case of China demonstrates how rights in technological confidential information impede the diffusion and adoption of an entire clean energy source.

Furthermore, trade secret protections may be a hurdle to the feasibility of compulsory licences for green technology because rights-owners may withhold the information, which is necessary to adopt and use the technology.[254] Access to confidential information requires more than authorization to use the information; it requires the transfer of confidential information and the applications of the information.[255] As such, compulsory or "free" licensing is not a feasible solution because compulsory licensing would unreasonably require the information owner to reveal their

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249. *See Energy Innovation*, *supra* note 62, at xviii ("Technology has to be actively pushed out into emerging economies throughout the innovation process—from R&D, through demonstration and commercialization, to diffusion and deployment.").

250. *See generally* ALEXIS AIK & CHRIS GASCOYNE, FACTS GLOBAL ENERGY, UNCONVENTIONAL GAS AND IMPLICATIONS FOR THE LNG MARKET (2011), *available at* http://www.nbr.org/downloads/pdfs/eta/PES_2011_Facts_Global_Energy.pdf [hereinafter FACTS GLOBAL ENERGY] (assessing the barriers that China faces in developing natural gas).

251. *See id.* at 3, 10 (discussing the large, untapped reserves of shale gas available in China).

252. *See* Catherine T. Yang, *China Drills Into Shale Gas, Targeting Huge Reserves Amid Challenges*, NAT'L GEOGRAPHIC DAILY NEWS (Aug. 8, 2012), http://news.nationalgeographic.com/news/energy/2012/08/120808-china-shale-gas/ ("[H]ydraulic fracturing rigs [were] assembled [in June 2012] . . . to drill into one of China's first shale gas exploration sites.") (on file with the Washington and Lee University Journal of Energy, Climate, and the Environment)**.**

253. *See* FACTS GLOBAL ENERGY, *supra* note 251, at 8 ("In November 2009, PetroChina signed its first agreement for cooperative exploration and development of shale gas with Shell. . . . Other international oil companies . . . are also currently looking to invest in China's shale gas exploration and development projects.").

254. *See Energy Innovation*, *supra* note 62, at xix ("The United States should . . . be extremely cautious, though, when it comes to compulsory licensing of technologies. . . . Compulsory licensing will usually hurt U.S. firms while failing to promote meaningful technology transfer, since the owner of a technology will likely refuse to cooperate."); *Inventing Clean Technologies*, *supra* note 23, at 365 (addressing the ineffectiveness of compulsory licensure where the receiving country lacks the knowledge to properly implement and use the technology).

255. *See Energy Innovation*, *supra* note 62, at xviii ("Technology has to be actively pushed out into emerging economies throughout the innovation process—from R&D, through demonstration and commercialization, to diffusion and deployment.").

confidential information.[256] There is no legal basis for compulsory licensing of trade secrets, unlike patents.[257] Further, any terms of disclosure and enforcement of the same would likely be unreliable given that the recipient would be unable to offer any satisfactory relief, even if it wanted to, considering that (1) once the confidential information is disclosed, it would be difficult, if not impossible, to control,[258] and (2) the recipient would likely not have any resources to satisfy any claim for damages as it would have initially obtained the mandated transfer as a result of its lack of resources.[259]

B. Non-Technological IP

Non-Technological intellectual property such as trademark rights, design rights, and copyright (not including computer programs) generally do not impede the development and diffusion of green technology. The primary reason these rights may be non-impeding is apparently because they themselves are not a direct solution to climate change, nor do they embody the technology themselves. Other reasons these rights do not appear to be impeding is because their impact actually encourages the diffusion of green technology. As discussed below, increased diffusion would result in added resources to develop the technology, which would, in turn, result in further development.

As will be considered below, it is arguable that rights which grant exclusivity would be an entry barrier to consumers where there is no free access. However, as will be seen, this is a matter of perspective, and if the bigger picture is examined, the benefit would outweigh any hurdle caused by the exclusive right.

1. Trademark Rights

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256. *See* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 24 ("[L]icenses . . . are simply agreements between the right holder and third parties to determine how, when, where, and for how much the third party can exploit the IP of the owner."); HOLYOAK AND TORREMANS, *supra* note 92, at 106 (stating that compulsory licenses will be granted only in limited circumstances, where the interests of society are deemed to take priority over the rights of the owner).

257. *See* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 945 ("[P]atent law does contain provisions for compulsory licenses.").

258. *See* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 844 ("[O]nce information is disclosed, it is, generally, uncontrollable.").

259. *See* INTELLECTUAL PROPERTY LAW, *supra* note 236, at 1048 ("Specific problems have arisen in relation to financial remedies for breach of confidence as a result of the confusion as to the juridical nature of the obligation.").

Trademark rights confer exclusive rights to an owner with regards to names or signs capable of distinguishing the goods or services of one undertaking from those of other undertakings.[260] Trademark rights also provide incentives to mark owners to develop their business, goodwill, and brand-name, as well as attract consumers to adopt their technology and provide confidence and guidance to the products they are purchasing.[261] Insofar as green technology is concerned, trademark rights enable manufacturers of solar panels, such as SunPower Corporation, and manufacturers of wind turbines, such as Vestas Wind Systems A/S to distinguish themselves and to develop brand-names.

While the *direct* impact of trademark rights seems limited insofar as the development and adoption of green technology is concerned, particularly when compared to patent rights and copyright, there are important indirect impacts that occur. First, successful use of a trademark may translate to added sales and resulting revenue, which may, in turn, be applied to develop new and improved green technologies.[262] Second, the use of trademarks is intrinsically linked with marketing.[263] It is well recognized that marketing is a phase that is necessary for the diffusion of innovations.[264] Accordingly, the successful marketing and market power of a brand have the potential to result in the diffusion of technology, subject to the goods attached to the marks and their ability to attract consumers and

260. *See* Trade Marks Act, 1994, c. 26, § 9 (Eng.) ("The proprietor of a registered trade mark has exclusive rights in the trade mark . . . in the United Kingdom."); TRIPS Agreement, *supra* note 39, at art. 15–16 (defining "trademark" and the rights a trademark confers on its owner).

261. *See* NEW ECONOMY HANDBOOK, *supra* note 245, at 845 (discussing the benefits and incentives that trademark rights create for trademark owners and consumers).

262. *See* William M. Landes & Richard A. Posner, *Trade Mark Law: An Economic Perspective*, 30 J. L. & ECON. 265, 270 (1987) [hereinafter *Trade Mark Law*] (explaining that after a reputation for a trademark exists, sales will increase due to purchasers who buy the product multiple times and purchasers who tell others about the product).

263. *See* Eric Lane, *Consumer Protection in the Eco-Mark Era*, 9 J. MARSHALL REV. INTELL. PROP. L. 742, 743 (2010) (stating that trademark law enables consumers to trust that the trademarked product is authentic and has the qualities, features, design, or other characteristics desired by the consumer).

264. *See Agricultural Innovation*, *supra* note 73, at 5 (discussing the stages by which innovation is diffused and stating that adoption of innovations can only occur after the marketing phase).

popularize the technology.[265] Further, diffusion has the potential to increase resources invested, which results in further development.[266]

One of the more effective uses of trademark rights in promoting the development and adoption of green technology is the certification mark. A certification mark indicates that the goods or services in connection with which it is used are certified by the proprietor of the mark regarding its origin, material, mode of manufacture of goods or performance of services, quality, accuracy or other characteristics.[267] An example of a certification mark, which successfully and positively impacts the development and adoption of green technology, is the "Energy Star" mark that signifies the Energy Star program, a joint initiative of the U.S. Environmental Protection Agency and the U.S. Department of Energy.[268] The mark is placed on products that meet certain energy efficiency standards[269] and use of the mark is governed by strict guidelines.[270] This program is an effective force in the increased use of innovative green technologies such as efficient fluorescent lighting, power management systems for office equipment, and low standby energy use.[271] According to its website, the Energy Star program provided energy-cost savings of approximately $18 billion to

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265. *See Trade Mark Law*, *supra* note 263, at 270 ("Once the reputation is created, the firm will obtain greater profits because repeat purchases and word-of-mouth references will generate higher sales.").

266. *See Trade Mark Law*, *supra* note 263, at 270 ("[T]rademarks have a self-enforcing feature. They are valuable because they denote consistent quality, and a firm has an incentive to develop a trademark only if it is able to maintain consistent quality.").

267. Trade Marks Act, 1994, c. 26, § 50 (Eng.).

268. *See* U.S. EPA, *About ENERGY STAR*, http://www.energystar.gov/index.cfm?c=about.ab index (last visited Sept. 16, 2012) ("ENERGY STAR is a joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy.") (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

269. *See id.* ("Energy Star . . . help[s] us all save money and protect the environment through energy efficient products and practices.").

270. *See* U.S. EPA, *Using the ENERGY STAR Marks Correctly, A Brief Introduction to the Mark Guidelines*, http://www.energystar.gov/ia/partners/logos/downloads/Brief_Guidelines_to_Using_the_ENERGY_STAR_Mark_Correctly.pdf (last visited Sept. 16, 2012) ("The ENERGY STAR identity is a valuable asset, and like any asset with appreciable value, it must be properly used and protected. . . . Ensuring that the marks are properly used protects every ENERGY STAR partner's investment in the program—and consumer confidence in the ENERGY STAR brand.") (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

271. *See* U.S. Envtl. Prot. Agency, *History of ENERGY STAR*, http://www.energystar.gov/index.cfm?c=about.ab_history (last visited Sept. 16, 2012) ("Over the past decade, ENERGY STAR has been a driving force behind the more widespread use of such technological innovations as efficient fluorescent lighting, power management systems for office equipment, and low standby energy use.") (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

businesses, organizations, and consumers in the United States in 2010 alone.[272] Certification marks such as Energy Star help in the reduction of energy use by and energy costs to consumers, which, in turn, results in the reduction of greenhouse gas emissions.[273] The effectiveness of green trademarks seems to be reflected in anecdotal evidence of a growing number of such marks being registered.[274]

2. Design Rights

Design rights provide protection to independently-created industrial designs that are new or original.[275] Such rights are related to the appearance of a product, but do not include designs that are dictated by technical or functional considerations.[276] Such rights should not pose any serious hurdle to the development of green technology.[277] For example, the protected design of a wind turbine casing or of an energy-saving lightbulb may make the products appealing to customers, but this does not prevent the use of the technology.

Therefore, the protected design is certainly relevant to the marketability of a product, and, in turn, to the diffusion of the underlying technology, because the product's aesthetics may encourage adoption of the technology.[278] While it is arguable that exclusive design rights increase the

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272. *See id.* (stating that the Energy Star program saved consumers and businesses approximately $18 billion in 2010 alone).

273. *See* E. Howard Barnett, *Green With Envy: The FTC, the EPA, the States, and the Regulation of Environmental Marketing*, 1 ENVTL. LAW. 491, 493 (1995) ("[G]reen marketing achieves a larger societal purpose by harnessing market forces to improve environmental conditions.").

274. *See* Michael E. Tschupp, *Weekly Round-Up of New Green Trademarks*, SUSTAINABLE MARKS (Sept. 16, 2012), http://sustainablemarks.com/category/trademarks/ (compiling green trademarks processed by the U.S. Patent Office on a weekly basis) (on file with the Washington and Lee Journal of Energy, Climate, and the Environment).

275. *See* Registered Designs Act, 1949, c. 88, §§ 1, 1B, 7 (Eng.) (defining the protections afforded to original industrial designs); TRIPS Agreement, *supra* note 39, at art. 25–26 (establishing the scope and requirements of industrial design protections).

276. *See* Registered Designs Act, 1949, c. 88, § 1C (Eng.) ("A right in a registered design shall not subsist in features of appearance of a product which are solely dictated by the product's technical function."); Council Directive 98/71, 1998 O.J. (L 289) 28 (EC) ("'[D]esign' means the appearance of the whole or a part of a product resulting from the features of, in particular, the lines, contours, colours, shape, texture and/or materials of the product itself.").

277. *See Lessons from the Global Debate*, *supra* note 181, at 6 ("Design protection is typically afforded to new and nonfunctional ornamental characteristics of products. It is not easy to distinguish form from function in many cases.").

278. *See* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 267 (explaining that the purpose of design protection is to support good design, which gives products a competitive edge in the marketplace).

cost of products, thereby hindering diffusion of the products' underlying technology, it is more likely that such rights encourage adoption of the underlying technology because protected designs make the products more appealing to the public. Moreover, new designs can always be made, and so long as the underlying technology is available, diffusion of the technology should not be prevented.[279]

3. Copyright

Copyright protects various types of rights in respect of various types of original works including literary, dramatic, and musical works, databases, artistic works, sound recordings, films, broadcasts, published editions, and rights in performances and designs.[280] Save for copyright in computer programs and electronic circuit diagrams, it is more likely than not that such copyright will be non-technological in nature.

Nonetheless, non-technological copyright works may be still relevant and related to green technology. For example, architectural plans and works of architecture for energy efficient buildings[281] and design drawings of energy saving lightbulbs may be protected as artistic works;[282] instruction manuals or promotional videos for hybrid passenger vehicles may be protected as literary works[283] and films,[284] respectively. These expressive types of intellectual property, like Design Rights, are more relevant to the diffusion of green technology and may indirectly impact the development of green technology.[285]

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279. *SSee* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 292 ("The exclusion from protection of designs which are solely functional probably reflects . . . [that] purely technological or technical innovation should be protected by patents.").

280. *See* CDPA, *supra* note 79, at c. 1, §§ 3–8 (Eng.) (describing the categories of original works protected by copyright in the United Kingdom); Berne Convention, *supra* note 121 (listing protected works under the Convention); TRIPS Agreement, *supra* note 39, at art. 9 (incorporating Article 2 of the Berne Convention).

281. *See* CDPA, *supra* note 79, at c. 48, § 4 (Eng.) (defining graphic works protected by the CDPA to include diagrams, maps, charts, and plans).

282. *See* CDPA, *supra* note 79, at c. 48, § 4.

283. *See* CDPA, *supra* note 79, at § 3 ("'[L]iterary work' means any work, other than a dramatic or musical work, which is written, spoken or sung.").

284. *See* CDPA, *supra* note 79, at § 5b ("'[F]ilm' means a recording on any medium from which a moving image may by any means be produced. . . . The sound track accompanying a film shall be treated as part of the film.").

285. *See* CONTEMPORARY INTELLECTUAL PROPERTY LAW, *supra* note 75, at 44 ("[Copyright] rests ultimately upon the general or public interest in having works containing ideas, information, instruction and entertainment made available, and in rewarding those . . . who perform this function in society in accordance with the public demand for their efforts.").

V. Discussion and Conclusion

There is a moral distinction to be drawn between traditional technology and green technology. As discussed in Part I, there is an urgent need for the world to make a joint effort to reduce greenhouse gas emissions and to mitigate climate change. Green technology is recognized to be the tool to effect the mitigation. The fact that climate change affects every single person in the world and affects future generations is what sets green technology and traditional technology apart, and warrants special treatment.

There is absolutely no doubt that intellectual property rights have an impact on the development and diffusion of green technology. The question, however, is whether the impact impedes or facilitates the development the diffusion of green technology, and, if so, whether the impact necessitates and warrants taking measures to improve development. As mentioned above, intellectual property has traditionally been shaped somehow by principles based on morality.[286] The Kyoto Protocol and TRIPS Agreement provide a basis to justify reasonable measures *if necessary*.[287]

The positive impact that Non-Technological IP rights have on the development and diffusion of green technology seems well established and does not appear to warrant any interference as the protections offered in this regard do not impede, and in some instances encourage, the development and diffusion of green technology.

As for Technological IP rights, the situation is not as clear. On one hand, there are clear, negative impacts that do affect the development and diffusion of green technology, particularly with regard to patents, Green Operating Software, and confidential information, all of which have the potential to affect an entire class of green technology. All types of intellectual property will become more impeding as the technology becomes refined and its variation narrows.[288] However, at the moment, Technological IP rights appear to only really affect technology that improves existing technology. On the other hand, the positive impacts of Technological IP rights are a driving force behind innovation in green technology. In fact, with the progresses being made and evident increase and readiness of firms from developed countries to transfer technology to

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286. *See generally* MORAL RIGHTS, *supra* note 120 (explaining that intellectual property rights are, and have previously been, highly influenced by notions of morality).

287. *See* Kyoto Protocol, *supra* note 1, at art. 13 ¶ 4(c) ("[Parties shall] [p]romote and facilitate the exchange of information on measures adopted by the Parties to address climate change and its effects."); TRIPS Agreement, *supra* note 39.

288. *See* HOLYOAK AND TORREMANS, *supra* note 92, at 26 (noting that the proliferation of property rights granted in an increasingly complex economy means that innovators and creators are hindered because they need to obtain "a whole raft" of licenses).

developing countries through joint ventures, the negative effects seem to be more of a passing symptom, and may be not be a major impediment to the development and diffusion of green technology. As such, measures taken now to divert from our current course would either be premature or unnecessary.