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Compulsory Licensing of Climate Engineering Patents: How Embracing Technology- and Research-Sharing Strategies Brings Us One Step Closer to Solving Climate Change

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COMPULSORY LICENSING OF CLIMATE ENGINEERING PATENTS: HOW EMBRACING TECHNOLOGY- AND RESEARCHING-SHARING STRATEGIES BRINGS US ONE STEP CLOSER TO SOLVING CLIMATE CHANGE

Buzz Hardin*

I. INTRODUCTION

The impact of climate change spans the globe and includes increasingly severe and dangerous climate events, including coastal flooding, extreme heat and wildfires, reduced crop yield, and decreased food security.[1] In the United States, if the proper steps toward mitigating or reversing the effects of climate change are not taken, it is very likely that the United States will experience substantial damage to its economy, the health of its citizens, and the environment.[2] In response to the challenges presented by climate change, the number of inventions in the field of climate engineering, or "geoengineering," has skyrocketed over the past several years, and the number of patent applications and grants for technologies in that field has similarly increased dramatically.[3]

Because of the vital importance of mitigating the effects of climate change, and by extension, the importance of guaranteeing access to the types of technologies that, when properly developed,

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1. CORE WRITING TEAM, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2014: SYNTHESIS REPORT 6-11, 13-16 (Rajendra K. Pachauri & Leo Meyer eds., 2015) [hereinafter IPCC REPORT 2014].

2. *Id*. at 6-8, 13-16.

3. Anthony E. Chavez, *Exclusive Rights to Saving the Planet: The Patenting of Geoengineering Inventions*, 13 NW. J. TECH. & INTELL. PROP. 1, 2 (2015).

may help to achieve such mitigation, it is necessary for these patented technologies to be easily accessed, assessed, and improved-upon by the entities and corporations that would use them to combat climate change.[4] Thus, to help guarantee that these technologies are not repressed or lost to nonuse, the United States should implement a limited compulsory licensing policy governing climate engineering patents in the fields of solar radiation management (SRM) and carbon-dioxide removal (CDR).

II. BACKGROUND

Society's need for large-scale intervention in the progress of global climate change has never been greater, and legislative action, both nationally in the United States and through international efforts, has been unable to create a governing environmental framework that ensures the preservation of human life in the not-so-distant future.[5] In the hopes of enacting large-scale change, many inventors and private companies have researched and developed so-called "climate engineering" technologies, aimed at mitigating or, in some cases, reversing the effects of climate change in potentially dramatic and sweeping ways.[6] The number of patents in the realm of climate engineering has skyrocketed in recent years, resulting in the development of many technologies that may prove instrumental in combating climate change in the long term.[7] Compulsory licensing presents one method by which these technologies may be efficiently researched, disseminated throughout the climate engineering industry, and improved upon.

4. Simone A. Rose, *On Purple Pills, Stem Cells, and Other Market Failures: A Case for a Limited Compulsory Licensing Scheme for Patent Property*, 48 HOW. L.J. 579, 582-84, 625, 627 (2005).

5. Jay Michaelson, *Geoengineering and Climate Management: From Marginality to Inevitability*, 46 TULSA L. REV. 221, 229, 232-33, 241-42 (2010).

6. Chavez, *supra* note 3, at 5-6.

7. *Id*. at 2, 5-7, 9-10.

A. The Realities of Climate Change and the Necessity of Climate Engineering Solutions

The daunting specter of climate change looms large around the world. According to the most recent report by the Intergovernmental Panel on Climate Change,[8] the future risks and impacts caused by the changing climate span the globe and include: (1) increased damage from river and coastal flooding; (2) increased damage from extreme heat events and wildfires; (3) reduced crop productivity and livelihood and food security; (4) the increased spread of vector-borne diseases; and (5) a host of other potentially devastating consequences.[9]

Additionally, at this point, many of these consequences are nearly inevitable and, potentially irreversible, even if we were to entirely cease the emission of greenhouse gases (GHGs).[10] In the United States specifically, if the proper steps toward mitigating or reversing the effects of climate change are not taken, it is very likely that the United States will experience substantial damage to its economy, the health of its citizens, and the environment, with "losses in some sectors . . . estimated to grow to hundreds of billions of dollars by the end of the century."[11]

The resultant damage of global warming to public health and safety can hardly be understated. If unmitigated, projected deaths due to heat stroke, cardiovascular disease, respiratory disease, cerebrovascular disease, and kidney disorders are all likely to increase if warming is allowed to continue in the United States at its current pace.[12] Additionally, likely health risks arising from an expected increase in the rate of "extreme events"[13] such as droughts, wildfires, and flooding as a result of extreme precipitation include but are not limited to preterm birth and low

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8. IPCC REPORT 2014, *supra* note 1, at 13-14.
9. *Id*. at 14.
10. *Id*. at 16.
11. 2 U.S. GLOB. CHANGE RSCH. PROGRAM, FOURTH NATIONAL CLIMATE ASSESSMENT: IMPACTS, RISKS, AND ADAPTATION IN THE UNITED STATES 1347 (2018) [hereinafter USGCRP ASSESSMENT 2018].
12. U.S. GLOB. CHANGE RSCH. PROGRAM, THE IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN THE UNITED STATES: A SCIENTIFIC ASSESSMENT 51 (David Glick et al. eds., 2016) [hereinafter USGCRP ASSESSMENT 2016].
13. *Id*. at 100.

birth weight of newborns, carbon monoxide poisoning related to power outages, reduced water quality and quantity, exacerbations of asthma, and a range of impacts on mental health.[14]

1. Traditional Means of GHG Reduction and Climate Change Mitigation Have So Far Proven Inadequate to Prevent Disaster

While this Article will not discuss international governance of climate change or climate change technologies in detail, it is important to understand that the limitations of international institutions and agreements have created a regulatory environment that, while addressing many of the concerns arising from climate change, does not go so far as to actually prevent the disastrous effects of climate change.[15] To quote one disenchanted author, "[n]ot only has [a meaningful abatement in global GHG emissions] not occurred, but even the fitful starts toward such a policy have not even been attempted. Kyoto, Geneva, Copenhagen—at some point the international community will run out of cities in which to fail to address climate change."[16] The Paris Agreement[17] under the United Nations Framework Convention on Climate Change, for example, "indicates that the main priority is to hold the increase in the global average temperature to well below 2 °C above pre-industrial levels."[18]

While the Paris Agreement was lauded by some at its conception,[19] it has since become clear that its provisions will not

14. *Id.* at 102.

15. For a brief history of the shortcomings of international coalitions to meaningfully reduce or plan to reduce GHG emissions, see Cinnamon P. Carlarne, *Rethinking a Failing Framework: Adaptation and Institutional Rebirth for the Global Climate Change Regime*, 25 GEO. INT'L ENVTL. L. REV. 1, 49 (2012) ("In the context of global climate change, acceptance means acknowledging that a centralized, consensus based, legally-binding response to climate change cannot suffice. Acceptance means looking beyond the treaty to find new governance strategies to address a massive problem that defies traditional solutions.").

16. Michaelson, *supra* note 5, at 256.

17. Paris Agreement to the United Nations Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No. 16-1104 [hereinafter Paris Agreement].

18. Jaime Nieto et al., *Less Than 2 °C? An Economic-Environmental Evaluation of the Paris Agreement*, 146 ECOLOGICAL ECON. 69, 69 (2018) (emphasis omitted).

19. *See* Fiona Harvey, *Paris Climate Change Agreement: The World's Greatest Diplomatic Success*, THE GUARDIAN (Dec. 14, 2015), https://perma.cc/JDB5-F32M; Coral

be sufficient to reach the 2 °C goal.[20] Rather, due in large part to increases in GHG emissions in China and India, it is more likely that the global average temperature will continue to rise to between 3 and 4 °C by 2050.[21] Under such conditions there would be "severe and widespread impacts on unique and threatened systems, substantial species extinction, large risks to global and regional food security, consequential constraints on common human activities, increased likelihood of triggering tipping points (critical thresholds) and limited potential for adaptation in some cases . . . ."[22]

To the extent that specific rules in international regulation of climate engineering technologies have been implemented, only the parties to the 1996 London Protocol (itself a corollary of the previously held London Dumping Convention) and the Convention on Biological Diversity (CBD) have directly addressed geoengineering.[23] Even in these cases, regulatory regimes have focused almost exclusively on ocean iron fertilization, a type of climate engineering which involves the adding of iron (in the form of a dissolved iron sulfate) to ocean waters in order to facilitate the growth of phytoplankton, which in turn draw carbon dioxide out of the atmosphere and into the ocean, slowing the effects of global warming.[24]

The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the Convention) is an international agreement intended to control marine pollution by dumping, as well as to encourage regional agreements pertaining to the same.[25] Currently, there are eighty-seven Parties to the Convention, including the United States, in which the

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Davenport, *Nations Approve Landmark Climate Accord in Paris*, N.Y. TIMES (Dec. 12, 2015), https://perma.cc/889D-4C8P.

20. Elizabeth Burleson, *Climate-Energy Sinks and Sources: Paris Agreement and Dynamic Federalism*, 28 FORDHAM ENVTL. L. REV. 1, 3 (2016).

21. Nieto et al., *supra* note 18, at 77-78, 80.

22. IPCC REPORT 2014, *supra* note 1, at 77.

23. Karen N. Scott, *International Law in the Anthropocene: Responding to the Geoengineering Challenge*, 34 MICH. J. INT'L L. 309, 311, 337, 339 (2013).

24. ERIC-MARTIAL TAKAM TAKOUGANG, IRON FERTILIZATION IN THE OCEAN AND CONSEQUENCES FOR THE GLOBAL CARBON CYCLE 7-8 (2007).

25. 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, Dec. 29, 1972, 26 U.S.T. 2403, 1046 U.N.T.S. 120 [hereinafter London Convention].

Convention's requirements are implemented in the Marine Protection, Research Protection, Research and Sanctuaries Act (MPRSA).[26] The CBD is a multilateral international treaty created with the intent of conserving biodiversity globally and encouraging the "fair and equitable sharing of the benefits arising out of the [use] of genetic resources."[27] The CBD has called upon nations to ensure that ocean fertilization does not take place without adequate scientific justification[28] and has emphasized the importance of caution in relation to ocean fertilization and geoengineering activities more generally.[29]

However, research into ocean iron fertilization represents only a fraction of the total of climate engineering research,[30] and climate engineering methods and technologies are advancing much more quickly than the slow cogs of an international regulatory regime can turn.[31] Furthermore, with the United States' future as a party to the Paris Agreement far from certain,[32] it is clear that the Paris Agreement, despite a noble effort, will be unable to rise to the challenges presented by climate change in an effective or meaningful way. Thus, the necessity of developing climate change mitigation solutions alternative to the traditional international agreement is increasingly urgent.

2. Climate Engineering as a Means of Mitigating and Reversing Climate Change

With the current state of international GHG emission regulation ineffective to stop the rapidly increasing rate of

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26. *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, INT'L MAR. ORG., https://perma.cc/W5JN-3D9Q (last visited Sept. 28, 2020); *Ocean Dumping: International Treaties*, ENVTL. PROT. AGENCY (Feb. 28, 2019), https://perma.cc/5EXB-DHWD.

27. Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 79.

28. Scott, *supra* note 23, at 332.

29. *Id.* at 332.

30. In addition to sequestration of carbon in the oceans, processes have been developed for carbon sequestration in terrestrial soil, as well as geological disposal of CO2. *See* Lisa Dilling et al., *The Role of Carbon Cycle Observations and Knowledge in Carbon Management*, 28 ANN. REV. ENV'T RES. 521, 526, 528 (2003).

31. Nieto et al., *supra* note 18, at 79-80.

32. Lisa Friedman, *Trump Administration to Begin Official Withdrawal From Paris Climate Accord*, N.Y. TIMES (Oct. 23, 2019), https://perma.cc/7VYG-5826.

emission and ecological destruction,[33] states are increasingly considering climate engineering options as alternatives to emissions reduction plans.[34] The term "climate engineering," or "geoengineering,"[35] refers to "a broad set of methods and technologies operating on a large scale that aim to deliberately alter the climate system in order to alleviate the impacts of climate change."[36] Climate engineering technologies are generally divided into two categories: (1) carbon dioxide removal (CDR), which entails removing GHGs directly from the Earth's atmosphere; and (2) solar radiation management (SRM), which involves increasing the reflectivity of the Earth's atmosphere or surface.[37]

The aim of CDR technologies is to remove GHGs from the Earth's atmosphere.[38] To this end, a number of technologies and polices have been proposed—varying widely in scope, cost, and potential environmental implications—including: (1) reforestation of deforested land to promote the absorption of carbon by foliage; (2) the sequestration of carbon as biochar or other organic materials; (3) the capture and transfer of GHGs from the atmosphere into natural "sinks" such as underground cave systems; (4) and the addition of iron sulfate to the oceans to propagate phytoplankton that consume atmospheric carbon.[39]

SRM, unlike CDR, does not endeavor to decrease the amount of GHGs in the Earth's atmosphere. Instead, its aim is to decrease the portion of solar radiation that reaches or is absorbed by the surface of the planet.[40] SRM covers a wide array of technologies and policies ranging from the mundane to the extraterrestrial, including managing the amount of the sun's radiation that is reflected back into space by changing the color

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33. Nieto et al., *supra* note 18, at 80-81.

34. Scott, *supra* note 28, at 318.

35. The terms "climate engineering" and "geoengineering" are used interchangeably throughout literature on the subject. However, "climate engineering" is potentially the more accurate of the two and will be favored throughout this Article.

36. IPCC REPORT 2014, *supra* note 1, at 89.

37. KELSI BRACMORT & RICHARD K. LATTANZIO, CONG. RES. SERV., R41371, GEOENGINEERING: GOVERNANCE AND TECHNOLOGY POLICY 1-2 (2013).

38. *Geoengineering: Parts I, II, and III: Hearing Before the H. Comm. on Sci. & Tech.*, 111th Cong. 5 (2010) [hereinafter *Geoengineering: I, II, and III*].

39. *Geoengineering: I, II, and III*, *supra* note 38 at 5-6.

40. *Id.* at 6.

of our rooftops to white or even modifying portions of the earth's natural land cover to make them more reflective.[41] Potentially more extreme options include spraying sulfates into the stratosphere to mirror the kind of radiation absorption that occurs following volcanic eruptions, injecting salt water or sulfuric acid into the troposphere to promote cloud formation, and even launching reflective satellites into the Earth's orbit.[42]

3. The State of Climate Engineering Patents in the United States Today

In the United States, funding for research into climate engineering technologies is largely a private, corporate affair. "The United States lacks a dedicated research program, with existing geoengineering research efforts occurring largely as part of broader climate and atmospheric science programs."[43] While the theater of American politics features a few outspoken proponents of climate engineering,[44] federal funding of research in the field remains minimal, with an estimated total of less than $2 million going directly to that pursuit in 2010.[45] However, in 2017, federal scientists recommended for the first time that the United States government begin funding research into the efficacy and mitigating potential of climate engineering technologies.[46] Thus, the United States seems primed to join the private sector in providing meaningful funding for such technologies.

41. *Id*.

42. *Id*.

43. *See* Albert C. Lin, *The Missing Pieces of Geoengineering Research Governance*, 100 MINN. L. REV. 2509, 2521 (2016) (citing GOV'T ACCOUNTABILITY OFFICE, GAO-10-903, CLIMATE CHANGE: A COORDINATED STRATEGY COULD FOCUS FEDERAL GEOENGINEERING RESEARCH AND INFORM GOVERNANCE EFFORTS 19 (2010)).

44. *See, e.g.*, Alexander C. Kaufman, *A Longshot 2020 Candidate Wants to Push Geoengineering into the Climate Debate*, HUFFPOST (June 26, 2019), https://perma.cc/TD6Y-3HG5 ("[Andrew] Yang's embrace of geoengineering marks what could be a political turning point for an issue long written off as too risky and fatalistic to seriously consider—too much the stuff of science fiction.").

45. Lin, *supra* note 43, at 2521.

46. *Geoengineering: I, II, and III*, *supra* note 38, at 48 (prepared statement of Alan Robock) (recommending that the United States "embark on a well-funded research program to 'consider geoengineering's potential benefits, to understand its limitations, and to avoid ill-considered deployment.'").

The Clean Air Act (CAA) is one of the few pieces of legislation which already allows the EPA some level of control over climate engineering research projects.[47] Additionally, "[t]he National Environmental Policy Act (NEPA) might, under circumstances such as public funding of research or large-scale outdoor SCE activities, require an environmental impact assessment or a programmatic environmental impact statement if the risks were thought to be significant."[48]

III. ANALYSIS

Although the United States Congress has historically shunned the notion of creating a general compulsory licensing statute and actual instances of compulsory licensing in the United States are limited, the international community provides a number of possible frameworks from which the United States may be able to borrow in crafting legislation providing specifically for the compulsory licensing of climate engineering patents.[49] Evidence of Congress's willingness over the past several decades to adopt limited, albeit significant, pieces of legislation with provisions for the compulsory licensing of patented technologies in particular industries suggests that, should such a provision be implemented for climate engineering patents, public policy considerations of

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47. 42 U.S.C. § 7403 (Research, investigation, training, and other activities). In relevant part, the Clean Air Act provides:

> (a) Research and development program for prevention and control of air pollution The Administrator shall establish a national research and development program for the prevention and control of air pollution and as part of such program shall—
>
> (1) conduct, and promote the coordination and acceleration of, research, investigations, experiments, demonstrations, surveys, and studies relating to the causes, effects (including health and welfare effects), extent, prevention, and control of air pollution[.]

42 U.S.C. § 7403.

48. Jesse L. Reynolds et al., *Solar Climate Engineering and Intellectual Property: Toward a Research Commons*, 18 MIN. J. L. SCI. & TECH. 1, 15-16 (2017).

49. *See, e.g.*, Naval Satarawala Chopra & Dinoo Muthappa, *The Curious Case of Compulsory Licensing in India*, COMPETITION L. INT'L, Aug. 2012, at 34, 35.

public health, public safety, and general welfare would be cornerstones of that legislation.[50]

A. Compulsory Licensing of Climate Engineering Patents

Despite its relative infancy, the number of patents (both patent applications and patents granted) in the field of climate engineering has skyrocketed in recent years.[51] One "author directed a review of USPTO records to determine trends in applications for and granting of patents involving climate-engineering technologies[,]" including both SRM and CDR technologies.[52] The findings of the study were as follows:

> [B]efore 2008, the combined number of patent applications and patents granted for geoengineering technologies did not exceed twenty in a single year. However, the total exceeded forty in 2009, and eventually increased to more than one hundred in 2013. Moreover, the rate at which the USPTO has granted these patents has similarly increased. For instance, the USPTO never granted more than ten such patents annually before 2010. Four years later, the annual number of geoengineering patents granted increased nearly tenfold. In sum, both the number of patents granted and applications filed illustrate startling growth over the past four years.[53]

Of these patent applications and grants, CDR methods constituted more than 90%, with "particle-dispersion" and "solar-ray-reflection" technologies constituting only 4% and 2% of all climate geoengineering patents, respectively.[54] Along with the rise in number of climate engineering patents, a number of authors have raised serious concerns that the patenting of climate engineering technologies could result in an industry where development of the technologies that could be used to save the

50. *See* Susan Vastano Vaughan, *Compulsory Licensing of Pharmaceuticals Under TRIPS: What Standard of Compensation?*, 25 HASTINGS INT'L & COMP. L. REV. 87, 88-89 (2001).

51. Chavez, *supra* note 3, at 5-6.

52. *Id*. at 9.

53. *Id*. at 10.

54. *Id*. at 10-11.

planet is actually hindered, and access to those technologies limited.[55] The "[p]atenting of geoengineering technologies could have serious negative impacts by creating a culture of secrecy that could delay much-needed developments."[56]

Climate engineering initiatives undertaken by private companies create the potential for these technologies to be deployed without a thorough assessment of the ecological risk involved.[57] Because of the potentially rapid and widespread ecological effects of some climate engineering technologies, possession of these technologies by a small number of private individuals or corporations is certainly troubling.[58] Furthermore, just as allowing a small number of individuals to have access to powerful climate engineering technologies creates an environment where the potential detrimental effects of climate engineering are amplified or unrestricted, such an environment also prevents the public at large from enjoying climate engineering's potential benefits.[59] One author has noted that "[f]oreseeably, potential trade in geoengineering-related goods and services would be highly sensitive, given that the public-goods character of climate change mitigation and adaptation efforts could potentially be hampered by considerations around the protection of private interests."[60]

Namely, these considerations include private organizations restricting use of their climate engineering technologies by other individuals or organizations with the purpose of maximizing the profitability of those technologies. However, exclusive use in cases like these could potentially come at the cost of meaningful development of those technologies.[61] This possibility is particularly troubling in the field of climate engineering. With

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55. *See, e.g.*, Daniela Lai, *Deployment of Geoengineering by the Private and Public Sector: Can the Risks of Geoengineering Ever Be Effectively Regulated?*, 37 LOY. L.A. INT'L & COMP. L. REV. 341, 342 (2016); Rafael Leal-Arcas & Andrew Filis-Yelaghotis, *Geoengineering a Future for Humankind: Some Technical and Ethical Considerations*, 2012 CCLR 128, 130 (2012); Chavez, *supra* note 3, at 9.

56. Lai, *supra* note 55, at 361.

57. *See id*.

58. *Id*.

59. *See* Leal-Arcas & Filis-Yelaghotis, *supra* note 55, at 141.

60. *Id*. at 144.

61. *See* Chavez, *supra* note 3, at 13-14.

the state of international deliberations on the subject of reductions in GHG emissions unable to provide binding, meaningful progress so as to adequately mitigate or reverse the effects of climate change, it is increasingly necessary to supplement any such international agreements with well-researched technologies.

Under the patents system, patent holders are provided twenty years of completely exclusive use of their designs, at the end of which they are required to disclose their inventions, thus "facilitat[ing] the development of successive inventions, thereby fostering technological advancement."[62] However, climate engineering technologies are distinguishable from the everyday inventions due to their incredible value, not just economically to those firms able to secure adequate funding to research them, but also as a potential solution to the wide range of health and public safety risks associated with unmitigated climate change.[63] Thus, there is a compelling public policy interest in ensuring that these technologies can be distributed throughout the industry quickly and efficiently.

"Compulsory licensing" refers generally "to the grant of permission for an enterprise seeking to use another's intellectual property to do so without the consent of its proprietor."[64] Historical instances of compulsory licenses in the United States are limited and, while a number of general compulsory licensing laws have been proposed in Congress,[65] the United States, unlike many of its trading partners,[66] does not include a general provision on compulsory licensing in its patent codes.[67]

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62. *Id.* at 9.

63. *See generally* Leal-Arcas & Filis-Yelaghotis, *supra* note 55, at 141.

64. JOHN R. THOMAS, CONG. RES. SERV., R43266, COMPULSORY LICENSING OF PATENTED INVENTIONS 1 (2014).

65. *See* Kristopher Lancial, *Compulsory Patent Licensing: The Next Step in Adapting Patents to the Technological Age*, 18 INTELL. PROP. L. BULL. 59, 64 (2013); A. Jason Mirabito, *Compulsory Patent Licensing for the United States: A Current Proposal*, 57 J. PAT. OFF. SOC'Y 404, 431-32 (1975).

66. THOMAS, *supra* note 64, at 9.

67. *Id.* at 6.

B. International Law on Compulsory Licensing

Although it lacks a universal compulsory licensing provision, the United States is party to the Agreement on Trade-Related Aspects of Intellectual Property Rights (the TRIPs Agreement),[68] an international agreement that went into effect in 1995 and "significantly affected the manner in which the international community utilizes compulsory patents."[69] In relevant part, the TRIPs Agreement provides "for other use of the subject matter of a patent without the authorization of the right holder, including use by the government or third parties authorized by the government[.]"[70] Additionally, nations which are party to the TRIPs Agreement are authorized to institute measures that "prevent the abuses which might result from the exercise of the exclusive rights conferred by [a] patent,"[71] and Article 30 of the TRIPs Agreement allows for "limited exceptions to . . . exclusive rights"[72] when "necessary to protect public health and nutrition, and to promote the public interest in sectors of vital importance"[73] and to prevent "abuse of intellectual property rights."[74]

The lack of an overarching compulsory licensing provision in United States patent law reflects a general hesitancy in the United States to issue such licensing.[75] The United States generally does not utilize compulsory licensing as an instrument against private corporations for the sake of competition, reserving it as a punitive measure against corporations that are found to have violated antitrust law.[76]

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68. Agreement on Trade-Related Aspects of Intellectual Property Rights, Sept. 1994, 33 I.L.M. 1197.

69. Lancial, *supra* note 65, at 63.

70. Agreement on Trade-Related Aspects of Intellectual Property Rights, *supra* note 68.

71. Paris Convention for the Protect. of Indus. Prop., Mar. 20, 1883, 21 U.S.T. 1583.

72. Agreement on Trade-Related Aspects of Intellectual Property Rights, *supra* note 68.

73. *Id*.

74. *Id*.

75. *See* Sara M. Ford, *Compulsory Licensing Provisions Under the TRIPs Agreement: Balancing Pills and Patents,* 15 AM. U. INT'L L. REV. 941, 953 (2000).

76. Kurt M. Saunders, *Patent Nonuse and the Role of Public Interest as a Deterrent to Technology Suppression*, 15 HARV. J. L. & TECH 389, 392 n.13 (2002).

The sets of legislation on compulsory licensing in other nations, however, provide a much more vibrant landscape to explore, particularly in some developing nations.[77] Consistent with both the TRIPs Agreement and the Paris Agreement, the vast majority of nations belonging to the World Trade Organization (WTO) have adopted compulsory licensing provisions.[78] In India, for example:

> At any time after the expiration of three years from the date a patent is granted, any interested person may make an application to the Registrar of the Patent Office seeking the grant of a compulsory license to work the patented invention . . . . In determining whether or not to grant such a license, the Registrar takes into account:
>
> (1) the nature of the invention, the time which has elapsed since the granting of the patent, and the measures already taken by the patentee or any licensee to make full use of the invention;
>
> (2) the ability of the applicant to work the invention to the public advantage; and
>
> (3) the capacity of the applicant to undertake the risk in providing capital and working the invention, if the application is granted.[79]

Such compulsory licenses are typically applied to patents registered in industries closely tied to public health and safety.[80] For example, the first compulsory license granted by the Indian Patents Office was granted in 2012 for the manufacture of a particular pharmaceutical.[81]

The rationale behind compulsory licensing for the sake of public health and safety is clear—if a patented product or process is necessary to address a critical public health concern, it is in the public's best interest that the product or process be made available to companies that would build on and distribute it, thus addressing the public health concern.[82] In such cases, the inventor's interest

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77. *See, e.g.*, Chopra & Muthappa, *supra* note 49, at 35.

78. Saunders, *supra* note 76, at 438.

79. 6 DAVID M. EPSTEIN, ECKSTROM'S LICENSING IN FOR.EIGN & DOMESTIC. OPERATIONS § 39:28 (2020).

80. Chopra & Muthappa, *supra* note 49, at 37.

81. *Id*. at 34.

82. Vaughan, supra note 50, at 88-89.

in the patented product may be "subordinate" to that of the public.[83] However, there is not a precise or agreed-upon definition of "public interest" in the international community as it relates to compulsory licensing.

In nations where compulsory licensing is more common, public interest-based compulsory licenses are generally issued exclusively to regulate products that are considered especially valuable to the general public.[84] These licenses usually deal with inventions and technologies relating to national defense, public health, public safety, and/or general welfare.[85] In these areas, the particular interest serviced by an inventor's patented invention is more likely to be deemed superior to the inventor's interests in his or her intellectual property.[86] In the instances when the United States has imposed compulsory licenses, it has often been as a remedy for violations of antitrust laws.[87]

One author connected the differing sentiments of various nations toward compulsory licensing provisions to national identity: the United States' use of compulsory licensing as a remedy for antitrust violations "reflect[s] the value of free enterprise and competition in the United States[,]" while in the Soviet Union, on the other hand, any technology is subject to a compulsory license if it is deemed "of special importance to the State."[88] Reflecting their shared common law ancestry, Canada and the United Kingdom all share very similar laws with respect to compulsory licensing, which provide a means for mandating licensing of technologies that are not being worked, evidence of a patent-holder's "refusal to deal."[89] The United Kingdom also recognizes an important public interest in the availability of

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83. Cole M. Fauver, *Compulsory Patent Licensing in the United States: An Idea Whose Time Has Come*, 8 NW. J. INT'L L. & BUS. 666, 670 (1988).

84. *Id*.

85. *Id*.

86. *Id*.

87. *See* Lawrence Schlam, *Compulsory Royalty-Free Licensing as an Antitrust Remedy for Patent Fraud: Law, Policy and the Patent-Antitrust Interface Revisited*, 7 CORNELL J. L. & PUB. POL'Y 467, 501-02 (1998).

88. Fauver, *supra* note 83, at 670-71 (internal quotations omitted).

89. *See id*. at 672.

affordable materials to produce food, medicine, and medical equipment.[90]

Developing countries may also implement compulsory licenses on foreign investors' inventions so as to access technologies that the pre-industrialized countries could not develop otherwise.[91] However, this limits the amount of control such investors are able to exercise over a patented invention, which has the effect of potentially driving away investors. Legislatures in developing nations must, therefore, take these opposing interests into account in creating compulsory licensing legislation that both assuages the intellectual property concerns of these foreign investors and expands access to the new technologies which these investors own, and which can be critical to their industrialization and further economic development.[92]

Compulsory licensing essentially "compels a patent owner to allow certain others to practice the invention otherwise protected by a patent."[93] In such cases, the government essentially usurps the patent holder and takes over the patent holder's right to grant a license to a third party or some government agency.[94] Generally, the patent holder subsequently receives a "reasonable royalty" for the license, as if the patent holder had voluntarily licensed his or her invention.[95]

Compulsory licensing allows more widespread access to certain inventions, which furthers innovation and may compensate for situations in which a particular field has failed to disseminate important technologies, as in cases where an individual or corporation with monopoly access to a patented invention exercises that power but chooses not to practice the technology.[96] Such non-use can create an environment that stifles

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90. *Id.* at 671.

91. *Id.*

92. *Id.* For a more expansive discussion of compulsory licensing and patent systems in developing nations see generally Fauver, *supra* note 83.

93. Andrew W. Torrance, *Patents to the Rescue: Disasters and Patent Law*, 10 DEPAUL J. HEALTH CARE L. 309, 336 (2007).

94. *Id.*

95. *Id.*

96. *See* Gregory N. Mandel, *Promoting Environmental Innovation with Intellectual Property Innovation: A New Basis for Patent Rewards*, 24 TEMP. J. SCI. TECH & ENVTL. L. 51, 59 (2005).

technological advancement and impairs future researchers' attempts to continue innovation by acquiring and building on patented technologies.[97] Furthermore, compulsory licenses can be especially critical to promoting continued innovation in fields which touch on issues of public health and safety or otherwise have some significant social value.[98]

Even so, the United States has been generally hesitant to enact legislation to implement a general provision for compulsory licensing.[99] There have, however, been a limited number of instances where compulsory licensing has been used to resolve legal disputes. Such was the case in 1956, when the United States negotiated agreements with International Business Machines (IBM) and American Telegraph & Telephone (AT&T) to license their inventions.[100] The compulsory licensing of these patents is now recognized for "fostering the rapid growth of the semiconductor industry."[101]

The United States has dabbled in compulsory licensing not only on an individual basis with specific private entities, but has also enacted limited, albeit significant pieces of legislation with compulsory licensing provisions. The Clean Air Act (CAA),[102] the Atomic Energy Act (AEA),[103] and the Plant Variety Protection Act (PVPA)[104], all contain conditional provisions under which certain types of technology must be licensed for public use. In particular, the Clean Air Act provides for the

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97. *See id.* at 60.

98. Rose, *supra* note 4, at 579-627.

99. *Id.*

100. Chavez, *supra* note 3, at 22 ("The agreement with AT&T required that it license at reasonable royalties all patents controlled by a subsidiary, Bell Systems. Similarly, the IBM decree required that it grant nonexclusive, nontransferable licenses for all of its patents to any applicant at reasonable royalties. Accordingly, the applicant was obligated to cross license its patents to IBM on similar terms.").

101. *Id.*

102. 42 U.S.C. § 7608 (Providing mandatory licensing of air pollution prevention inventions under Title 42, the Public Health and Welfare).

103. 42 U.S.C. § 2183 (Allowing for compulsory licenses of any patent which is determined to be "affected with the public interest" so long as its primary purpose is "the production or utilization of special nuclear material or atomic energy[.]").

104. 7 U.S.C. §§ 2321, 2404 (Enabling the Secretary of the United States Department of Agriculture to declare a compulsory license allowing the use of a patented variety of plant for two years in limited cases where such a license is necessary to maintain a sufficient food supply).

compulsory licensing of patents for pollution control devices, acknowledging even in 1970 that technologies with the potential to substantially reduce emissions are critical to public health and safety.[105] Recognizing that the aim of the Clean Air Act—"to improve air quality through the implementation of a regulatory scheme designed to stimulate private development of air-pollution-control technology"—would result in the invention of critically important technologies, Congress included a means by which individual states may acquire compulsory licenses to inventions in furtherance of attaining federally-mandated air-quality standards.[106] "If the state can satisfy a set of requirements, then the U.S. Attorney General certifies that application to a district court, which may order the patentee to license the invention upon reasonable terms."[107]

"Compulsory licensing schemes are justified on the ground that they increase public access to inventions."[108] Should the United States seek to apply compulsory licenses to particular climate engineering technologies, this is likely the theory under which those compulsory licenses would be justified. Opponents of compulsory licensing have argued that this theory is not grounded in reality; rather, that the type of patent nonuse, or suppression, that might justify a compulsory license is mere myth,[109] and that "[a]nyone who invests the time and money to develop a new invention and goes through the trouble to obtain patent protection would probably exploit the invention to realize a return on that investment."[110] There have, however, been a number of instances of such patent suppression in the United States, including in the fields of pharmaceuticals and automotive engineering.[111] Thus, it is to the advantage of American markets

105. Fauver, *supra* note 86, at 670.

106. Chavez, *supra* note 3, at 24.

107. *Id*. (citing 42 U.S.C. § 7608). "The Clean Air Act requires a party to satisfy three requirements to obtain a license. First, the patented technology is not 'reasonably available' yet 'necessary to comply with an air-quality standard; second, 'no reasonable alternative methods' exist; and third, the unavailability of such technology may cause a 'substantial lessening of competition.'" *Id*. at 24 n.204.

108. Fauver, *supra* note 83, at 671.

109. *Id*. at 674-75.

110. *Id*. at 675.

111. For a discussion of the history of patent nonuse and how such nonuse leads to patent suppression in the United States, see Saunders, *supra* note 76.

and the public to have a system in place to prevent such patent suppression in the field of climate engineering and a system that embraces the idea of compulsory licensing on climate engineering technologies could potentially do so.

IV. CONCLUSION

Mitigating the effects of climate change in the United States and throughout the world is vitally important to guarantee public health and safety in the coming decades. One avenue that society has yet to meaningfully explore on a large scale in order to achieve that mitigation is climate engineering technology. This technology, when properly developed, tested, and distributed, may unlock new insights into society's efforts to counter the effects of unmitigated climate change. Thus, it is necessary for these patented technologies to be easily accessed, assessed, and improved-upon by the entities and corporations that would use them to combat climate change.

Additionally, the limitations of international institutions and agreements in combating climate change have created a regulatory environment that does not go far enough to actually prevent the impeding disastrous effects of climate change. Thus, the United States seems primed to embrace not just meaningful climate engineering efforts, but to guarantee that the benefits of climate engineering technologies are available to the public through the limited use of compulsory licensing in the industry. The United States' previous dabbling in compulsory licensing, as well as robust compulsory licensing frameworks in other nations, provide a clear path toward implementing the doctrine effectively in the United States, and doing so could bring the United States and the world one step closer to combating the long-term effects of climate change.