THE USE OF TECHNOLOGY TRANSFERS TO PROMOTE DOMESTIC INNOVATION OF CLIMATE CHANGE TECHNOLOGIES IN CHINA

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This Comment analyzes how technology transfer of climate change technologies to China has taken place and whether such transfers have promoted indigenous innovation. Interestingly, China is the leading recipient of climate change transfers and the leading producer climate change technologies, however, a closer examination in solar industry would show that China has failed further develop the technologies it has received through technology transfers. This Comment suggests policies to encourage indigenous innovation of climate change technologies in China.

INTRODUCTION

In a matter of just ten years, China has evolved from being an insignificant player in climate change technologies space to a leader in the field.[1] Surprisingly, China's rise as a leader in climate change technologies is not due to its own genius but rather to that of developed nations. Although China is the recognized leader of climate change technologies, currently, the United States holds the largest number of patents for climate change technologies, including wind, solar photovoltaic, concentrated solar power, biomass-to-electricity, and carbon capture and storage.[2]

China's apparent lead in climate change technology space has been attributed to its "comparative advantage in the manufacturing of climate change technologies over companies in the United States and [ability] to produce these technologies at much lower costs."[3] Thus, Chinese companies may manufacture a high volume of products at a low cost without having proper ownership[4] of these technologies.[5] Even if Chinese

1. Tom Holland, *World Leader in Climate Change Tech, World Beater in Greenhouse Gas*, SOUTH CHINA MORNING POST, July 20, 2012, *available at* http://www.scmp.com/article/1007298/world-leader-green-tech-world-beater-greenhouse-gas (stating that "we are constantly being told how China leads the world in green technologies").

2. Rishi R. Gupta, Note, *Compulsory Licensing in TRIPS: Chinese and Indian Comparative Advantage in the Manufacture and Exportation of Green Technologies*, 12 AM. U. L. REV. 21, 21 (2012).

3. *Id.* at 21.

4. For instance, intellectual property rights.

5. Thomas Hout, *China's Renewable-Energy Clout,* FORBES, July 30, 2010, *available at* http://www.forbes.com/2010/07/30/china-solar-wind-industry-

companies make advancements on patented technologies, patents owned by Chinese companies are relatively weak compared to those of developed nations.[6]

Furthermore, even China's explosive growth in patenting activity is misleading,[7] as Chinese officials are determined to increase the number of patents granted within China.[8] However, the sheer number of patents issued in a particular country is not necessarily an accurate indicator of innovation.[9] Scholars have noted that such "[q]uantitative achievements should not come at the cost of carefully considering important qualitative parameters, such as the importance of certain patents and the factors that shape the chances of successful implementation of a standard."[10]

The purpose of this comment is to examine the role of technology transfers in China's development of climate change technologies and determine whether such transfers are successful enough to promote sustainability in Chinese climate change industries. This Comment will show that although China has received significant technology transfers and implemented several policies to encourage use and production of renewable energies, these measures have failed to adequately diffuse technologies into the local economy. China needs to reevaluate its strategies to incentivize domestic innovations.

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markets-equities-clean-technology-companies.html___(noting that Chinese Companies are driving down prices using "their low-cost, large-scale factories").

6. *See* Liu Songbai, *China's Solar PV Industry Accelerating Quality Transformations,* CHINA ECON. NET (Aug. 20, 2010), http://en.ce.cn/Insight/201008/20/t20100820_21741172.shtml (noting that China is relatively weak in the technical field of solar photovoltaic materials).

7. *See* Mark Liang, Note, *Chinese Patent Quality: Running the Numbers and Possible Remedies*, 11 J. MARSHALL REV. INTELL. PROP. L. 478, 492 (2012) ("The headline number of total Chinese filings–now over a million—is as staggering as it is misleading.").

8. *See* ST. INTELL. PROP. OFF. OF THE P.R.C., OUTLINE OF THE NATIONAL INTELLECTUAL PROPERTY STRATEGY, 1-2 (2008), *available at* http://english.sipo.gov.cn/laws/developing/200906/t20090616_465239.html (last visited Mar. 27, 2014) [hereinafter OUTLINE OF THE NAT'L INTELL. PROP. STRATEGY] ("By 2020, China will become a country with a comparatively high level in terms of the creation, utilization, protection and administration of IPRs. The legal environment for IPRs is much better, market entities are much better at the creation, utilization, protection and administration of IPRs . . . .").

9. Emma Barraclough, *EPO Stresses Quality over Quantity*, 179 MANAGING INTELL. PROP. 12 (2008) ("The purpose of patents is to support the generation of economic benefits for society. However, large patent numbers are not necessarily indicative of growing R&D activity. What we therefore need is not more patents, but [sic] better patents. The EPO aims to make sure that the patents it grants are relevant. The lower number of patents published in 2007 reflects this priority and is a step in the right direction.").

10. Dieter Ernst, *Indigenous Innovation and Globalization: The Challenge for China's Standardization Strategy*, U.C. INST. ON GLOBAL CONFLICT & COOP. 61 (2011).

Part I of this paper will define technology transfer, its role in combating climate change technologies, its drawbacks, and its current status in China. Part II will address the state of climate change in China and the measures the Chinese government is taking to promote the use of renewable energy. Part III will examine China's solar industry to demonstrate this industry's development and flaws. Lastly, Part IV of this Comment will propose initiatives that Chinese officials can take to promote the successful diffusion and subsequent improvement of transferred technologies.

I. TECHNOLOGY TRANSFERS AND ITS VIEWS IN CHINA

A. Technology Transfer Defined

Technology transfer is the process by which human knowledge flows from one person or entity to another.[11] This flow of knowledge may include, but is not limited to, the transfer of individual technologies and systems, such as "know-how, procedures, goods and services, equipment and organizational and managerial procedures."[12] Technologies can be transferred between governments, financial institutions, research and educational institutions, and public and private entities.

When knowledge is transferred between two entities or governments of different countries, it is known as international technology transfer. Such technology transfer may occur through a variety of means, such as: (1) licensing; (2) international trade; (3) inward and outward foreign direct investment; (4) migration, travel, and foreign education of students and workers; (5) international research collaboration; (6) media and the Internet; and (7) integration of benefits into global value chains from foreign technology transferred within the supply chain.[13] The most

11. *What is Technology Transfer?*, WORLD ASS'N FOR CHRISTIAN COMMC'N, http://old.waccglobal.org/en/20062-communicating-with-angels-being-digital-being-human/585--What-is-technology-transfer.html (last visited Mar. 27, 2014) ("Technology transfer is the term used to describe the processes by which technological knowledge moves within or between organizations. International technology transfer refers to the way in which this occurs between countries.").

12. Monaque Barbut, *Transfer of Environmentally Sound Technologies: The GEF Experience*, GLOBAL ENVTL. FACILITY 14 (2008) ("[T]he IPCC defined technology transfer as 'a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders such as governments, private sector entities, financial institutions, NGOs and research/education institutions.'").

13. *See* Xiaolan Fu et. al, *The Role of Foreign Technology and Indigenous Innovation in the Emerging Economies: Technological Change and Catching-up*, 39 WORLD DEV. 1204, 1204–12 (2011) ("Technology can be diffused between firms and across regions and countries through various transmission mechanisms, including: (i) movement of goods through international trade; (ii) movement of capital through inward and outward foreign direct investment (FDI and OFDI); (iii) movement of people through migration, travel, and foreign education of students and workers; (iv) international research collaboration; (v) diffusion of disembodied knowledge through media and internet; and (vi) integration into

prominent of these transfer methods are licensing, international trade, and foreign direct investments. The rationale behind this is that, "[i]f foreign technologies are easy to diffuse and adopt, a technologically backward country can catch up rapidly through the acquisition and more rapid deployment of the most advanced technologies."[14]

B. Climate Change, Technology Transfer and the Challenges

Although climate change is a global problem, there is a paradox in its cause and effect. While developed countries have contributed the most greenhouse gases, developing countries are the ones that are most vulnerable to its consequences. Thus, it is important that developed countries collaborate with them nations that cannot afford to fund clean technology programs on their own, to transfer technologies and assist them in combating this global issue. This principle is enshrined in the United Nations Framework Convention on Climate Change (UNFCCC) preamble, which states: ". . . 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."[15]

In 2007, members of the UNFCCC met in Bali and formulated "the Bali Action Plan," in which they highlighted the urgency of combating climate change.[16] This plan noted that climate change poses a fundamental threat to sustainable development and "the critical importance of technology development and transfer and the provision of financial

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global value chains to benefit from the foreign technology transferred within the supply chain.").

14. Xiaolan Fu & Jing Zhang, *Technology Transfer, Indigenous Innovation and Leapfrogging in Climate Change Technology: the Solar-PV Industry in China and India*, 9 J. OF CHINESE ECON. & BUS. POLICY 329, 330 (2011) ("If foreign technologies are easy to diffuse and adopt, a technologically backward country can catch up rapidly through the acquisition and more rapid deployment of the most advanced technologies.").

15. United Nations Framework Convention on Climate Change, May 9, 1992, 31 I.L.M. 849, *available at* www.unfccc.int/resource/docs/convkp/conveng.pdf ("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.").

16. Susan R. Fletcher & Larry Parker, CONG. RESEARCH SERV., RL 33826, CLIMATE CHANGE: THE KYOTO PROTOCOL, BALI "ACTION PLAN," AND INTERNATIONAL ACTIONS (2008) ("In December 2007, the meeting of parties to the United Nations Framework Convention on Climate Change (UNFCCC) convened in Bali, Indonesia, and agreed on the 'Bali Action Plan' to guide negotiations over the next two years, with the goal of formulating by 2009 a treaty that would identify the next round of commitments by the nations of the world to address climate change.").

resources and investment as a means to the end of climate change mitigation and adaptation."[17]

Despite such efforts, we need to do more to curb climate change. There has been too much talk and not enough action. Many developing nations argue that technologies are not being adequately transferred to them, if at all.[18] Successful technology transfers requires substantial global cooperation and coordination because of the size, and urgency of the issue at matter.[19] Generating a successful technology transfer is a long-term process with at least three major challenges.

First, combating climate change requires transfer of a wide array of technologies to developing countries in order to assist them in reducing their growing emissions levels.[20] For an effective technology transfer, the technology portfolio must contain a broad range of technologies across various industries and geographies.[21] Furthermore, these technologies must be efficient and work toward improving existing technologies, therefore "[e]nsuring sufficient technology transfer to combat climate change is not about spreading a few key miracle technologies, but instead, about modernizing and developing entire energy industries."[22]

The second problem is that climate change technology transfer requires substantial resources and technologies worldwide, and the current levels of investments toward this end are far lower than the estimated costs of the combating climate change.[23] This means that only a fraction of the necessary infrastructure is being implemented. Thus, there is a great need for resources to deploy climate change technologies more ubiquitously: "[t]echnology transfer agreements are [likely to be of limited environmental effectiveness] unless the level of resources expended on them is large."[24] This is requires major private sector investments.[25] The

17. *Climate Change: Technology Development and Technology Transfer*, UN DEP'T. OF ECON. & SOC. AFFAIRS, 5 (2011), http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File370.pdf.

18. Van Smith, Note, *Enabling Environments or Enabling Discord: Intellectual Property Rights, Public-Private Partnerships, and the Quest for Climate Change Technology Transfer*, 42 GEO. J. INT'L L. 817, 826 (2011).

19. *Id.*

20. *Id.*

21. *Id*. at 826-27.

22. *Id*. at 827.

23. Sam Riley, *$20 trillion Call For Action on Climate Change*, (Oct. 20, 2011) http://www.top1000funds.com/news/2011/10/20/20-trillion-call-for-action-on-climate-change/ (stating that "current levels of investment in green technology are substantially lower than the $500 billion a year deemed necessary by the International Energy Agency (IEA) to hold the increase of global average temperatures below 2 degrees Celsius.").

24. Heleen de Coninck et al., *International Technology-Oriented Agreements to Address Climate Change,* RESOURCES FOR THE FUTURE, abstract (2007).

"private sector should be used for efficiency reasons; coordination of such a large amount of resources is not feasible without private markets."[26]

Finally, a third major problem with climate change technology transfer is the urgency of the issue and the rate at which the problem must be addressed.[27] Combating climate change successfully requires global coordination and cooperation among countries, which in turn requires vast amounts of investments. While global investment in clean energy has more than tripled between 2005 and 2009, the rate is "nowhere near what is required to quickly scale up energy investment to levels approaching trillions of dollars of annual global energy investment."[28] We need to strongly encourage Developed nations must be encouraged to facilitate transfers of clean technologies to developing nations and then push for developing nations to adopt and improve such technologies and then improve on them because the in order to both combat climate change and facilitate sustainable development.

Thus, while addressing climate change is not an easy task, it can be tackled through global coordination. As the example of China will show,[29] international technology transfers and other global efforts have brought in substantial levels of climate change technologies to China within a short period of time such that China is now considered a leader in climate change technologies. However, the issue with China lies with inadequately diffusing these technologies to promote sustainable development in which they sustainably improve on these technologies to develop indigenous markets and industries.

II. CHINA AND ITS STATE OF CLIMATE CHANGE

China is the largest developing country in the world, and energy production and consumption is key to continued growth.[30] Recent studies indicate China's carbon emissions have surpassed the United States',[31]

25. *See* Muthukumara Mani, *Incentive Mechanisms and Climate-Friendly Technologies*, CLIMATE AND TRADE POLICIES IN A POST-2012 WORLD 35, 35-36 (2008) ("The magnitude of the resources needed to finance access to, and implementation of, environmentally sound technologies and processes is such that the bulk must be provided through private sources with the public sector playing a catalytic and facilitating role.").

26. Smith, *supra* note 18, at 828.

27. *Id.*

28. *Id.*

29. See *infra*, Section III (discussing climate change in China and the Chinese government's response).

30. Liming Gong, Qiang Wu & Wanbin Bi, *Low Carbon Economy and New Energy Applications in China*, 171 ADVANCES IN INTELLIGENT AND SOFT COMPUTING 471, 471(2012) (analyzing the low carbon economy in China and its implication in future new energy application).

31. Jan C. Minx et al., *A "Carbonizing Dragon": China's Fast Growing CO2 Emissions Revisited,* 45 ENVTL. SCI. & TECH. 9144, 9145 (2011) (discussing the

sparking concerns within China and abroad, because China's carbon emissions are projected to continue growing. Energy has been a challenging issue to China's national economic and social development for a long time.

Interestingly, when Kyoto Protocol on global warming was drafted, China was given an exemption from any requirement to control emissions.[32] At the time, Chinese officials claimed the Chinese Government had more urgent matters to attend to, and global leaders, believing China was too poor at the time to implement significant control anyways, did not consider pressuring China into committing to the Kyoto Protocol.[33] As it continued to develop and become an important player in global trade, that thinking has changed, especially now that China is the largest emitters carbon dioxide. Yet, Chinese officials continue to claim China cannot address climate change at this time, and China remains exempt from the Kyoto Protocol.

However, in the past decade, concerns regarding climate change, dependence on fossil fuels, and pollution has prompted the Chinese government radically change how the country uses and produces its energy. China is already taking several crucial steps: it is cutting emissions by becoming more energy efficient and it is encouraging development of climate change technologies. Although China still relies heavily on fossil fuels, climate change technologies are sprouting up rapidly in many forms: solar, wind, hydropower and nuclear. The country is utilizing these constructions as a form of developmental aid to certain regions and nurturing new industries, especially since growth in theses has been stagnant compared to that of Coastal regions.

China's clean technology manufacturing industry has been growing rapidly and is projected to continue growing.[34] As result of China's role in global manufacturing and foreign direct investment, China is the global leader in climate change technologies. In fact, in 2006, China became the world's third-largest producer of solar panels[35] and its production has only risen since.[36] Furthermore, it is already the largest producer of solar water

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connection between increase of CO2 emissions and capital investment in China between 2002 and 2007).

32. John Feldon, *The Black Hole in the Kyoto Protocol: Was the Exclusion of Black Carbon Regulation a "Fatal Flaw?*, 7 SUSTAINABLE DEV. L & POL'Y 2, 60 (2007).

33. Gong, *supra* note 30, at 473 (discussing the importance of coal production to China's energy structure).

34. *Id*. at 474.

35. Margret J. Kim and Robert E. Jones, *China: Climate Change Superpower and the Clean Technology Revolution*, 22 NAT. RESOURCES & ENV'T 13 (2008) (discussing carbon dioxide emissions in proportion to economic factors and the need to address China's climate change policy).

36. Keith Bradsher, *Glut of Solar Panels Poses a New Threat to China,* N.Y. TIMES, Oct. 4, 2012, *available at* http://www.nytimes.com/2012/10/05/business/global/glut-of-solar-panels-is-a-

heaters in the world, accounting for approximately 60 percent of the world's total installed capacity.[37] Moreover, wind turbine production is also expected to rise, as the Chinese government has now demanded that 70 percent of wind turbine equipment purchased for wind farm projects be made with local components.[38]

China's progress has made it a leader in climate change technologies, however; foreign companies own most of the technology patents. While China now accounts for more than fifty percent of the world's investment in clean technologies, it only owns five percent of the patents in that area.[39] Its strengths are in investment and manufacturing, not innovation.[40] As the next section will show, China has taken initiatives to address this concern and is attempting to promote climate change technology innovation.[41] However, other existing concerns, such as lack of administration and strong intellectual property protections, still prevent China from promoting indigenous industries.

III. EXAMINATION OF THE SOLAR INDUSTRY

To understand the problems in China better, we can examine the Chinese solar industry. The solar industry has received much publicity due to its remarkable growth within the last decade.

A. Solar Industries in China

China's global share of the solar photovoltaic (PV) industry has increased from being a bare one percent in 2001 to more than fifty percent in 2009.[42] Today, China is a global leader in solar PV production.[43] While

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new-test-for-china.html?pagewanted=all&_r=0 (discussing the rapid growth in China's solar panel and wind turbine manufacturing and looming economic disaster created by China's overproduction).

37. Kim, *supra* note 35, at 13 (discussing the impact of even small adaptation of solar, wind, biofuel, and other renewable technology in reducing carbon emissions).

38. *Id*. (discussing the growing wind turbine manufacturing industry in China).

39. Ginger Szala, *China's Lack of Technology Innovation Hurts Growth*, TREASURY & RISK (May 22, 2012), http://www.treasuryandrisk.com/2012/05/22/chinas-lack-of-technology-innovation-hurts-growth (explaining why, while China's GDP will most likely surpass United States' GDP in the next 10 to 12 years, it is still about 20 years behind the United States technologically).

40. *Id.* (discussing how China only owns a very small percentage of the world's patents).

41. See *infra* Section IV (referring to Chinese companies that focus on innovation).

42. Bram Buijs, *China and the Future of New Energy Technologies*, TRENDS IN GLOBAL COMPETITION AND INNOVATION 39 (2011) (reviewing China's Solar PV industry).

43. *China Continues to be the Largest Producer of Solar PV Modules in the World*, ELECTRONICS.CA RESEARCH NETWORK (Sept. 13, 2013), http://www.electronics.ca/presscenter/articles/2099/1/China-Continues-to-be-the-

this is remarkable, much of the products are being exported—around 95% of China's PV products have been exported to other countries—rather than being used internally .[44] Again, this is an example of how China maintains it power as a manufacturer rather than an innovator in the field. In fact, foreign players are driving much of the innovation within the solar industry. With a 98% export share in the past few years, "foreign markets rather than the national [market] have been the key driver for Chinese companies."[45]

The majority of domestic players focus on the manufacturing aspects rather than innovation. Chinese companies have concentrated on achieving an unrivalled level of price-competitiveness and the ability to quickly increase production rather than focus on innovation.[46] Furthermore, these players employ various cost-cutting measures while using standard manufacturing processes.[47] For instance, some Chinese firms buy the best automation equipment only to replace it with cheap manual labor, which decreases their overall costs and up-front costs.[48] Additionally, most of these players focus on producing the least costly technologies such as producing modules using crystalline wafer-based silicon cells[49] because these modules require less overhead and electricity costs, and they sell them at thirty percent lower price than US-manufactured modules.[50]

However, some of the more powerful Chinese domestic players, such as Yingli Climate change Energy, Trina Solar, and Suntech, do focus on innovation.[51] These companies have established relations with foreign companies and institutes to help them develop their product lines. The Chinese market leader, Suntech Power, not only has set up a strong patent portfolio and research and development program, but it is also engaging in licensing agreements with international players, such as Akeena, whom it is working with to sell state of the art solar panel technologies across the

Largest-Producer-of-Solar-PV-Modules-in-the-World/Page1.html (stating that "in 2012, 66% of the [solar] modules produced globally were from China.").

44. *Technology Roundup: Solar Photovoltaic Energy*, INT'L ENERGY AGENCY 16 (2010), https://www.iea.org/publications/freepublications/publication/pv_roadmap.pdf (China is the number one exporter of PV cells in the world.).

45. Rasmus Lema & Adrian Lema, 2 INNOVATION & DEV. 1, 11(2012) (discussing the fast growing Chinese solar photovoltaic industry).

46. Buijs, *supra* note 42, at 40 (discussing the reasons behind the success of Chinese companies in the global photovoltaic industry).

47. *Id*.

48. *Id*.

49. *Id.* at 40-41.

50. *See* Larry Alberts et al., *Sunrise in the East: China's Advance in Solar PV—and the Competitive Implications for the Industry*, BOSTON CONSULTING GROUP (Dec. 2013), https://www.bcg.com/documents/file68429.pdf.

51. *See* Buijs, *supra* note 42, at 40-41 (stating that it is developing high-efficiency solar cells).

world.[52] Moreover, it is working closely with research institutes domestically (Sun Yatsen University and Shanghai University of Technology) and internationally (University of New South Wales, Australia).[53] Other Chinese companies are following similar patterns. For instance, Yingli has set up collaborative efforts with the Energy Research Center of the Netherlands to develop new highly efficient solar cells, and they were able to successfully introduce these products into the market.[54] Additionally, Trina Solar utilized China's Ministry of Science and Technology's funding program to develop a new state-of-the-art research center, which establishes collaborative efforts between government institutions, private players and university and research institutions.[55]

China's goal to increase domestic solar PV installations to 20 GW by 2020 will also aid its domestic market in solar technology to continue to grow.[56] In 2009, Chinese officials implemented the "Golden Sun" policy program to boost the domestic market by providing additional subsidies in the order of 50-70% of total solar PV investment.[57] Hopefully, this will attract more companies and players to the market, leading to more competition, and increase the need for stronger research and development programs. Ultimately, the emphasis should be on increasing innovation through well-funded research and development programs rather than in finding ways to reduce manufacturing costs. "In-house R&D, cooperative R&D with local research institutions and domestic R&D by foreign companies are in the mix of the knowledge and technology creation which makes China among the world leaders of solar PV technology."[58]

B. Lessons from the Chinese Solar Industry

China has clearly taken several steps in the right direction to promote use of climate change technologies. Through various policies, whether protecting local players or promoting use of renewable energies and various subsidies, China has developed a diverse portfolio of climate change technologies.[59] Some domestic players are taking actions to

52. *See* Lema, *supra* note 45, at 11; *Akena Solar Licenses New Solar Panel Technology to Suntech,* SUNTECH-POWER.COM (Jan. 2, 2008), http://ir.suntech-power.com/phoenix.zhtml?c=192654&p=irol-newsArticle&ID=1090391&highlight=.

53. Lema, *supra* note 45, at 6.

54. Buijs *supra* note 42, at 41; *Yingli Green Energy, ECN and Amtech Join Efforts to Develop N-type MWT High Efficiency PV Cell and Module*, SOLARBUZZ (Sept. 7, 2011), http://www.solarbuzz.com/industry-news/yingli-green-energy-ecn-and-amtech-join-efforts-develop-n-type-mwt-high-efficiency-pv-.

55. *Id.*

56. Lema, *supra* note 45, at 11.

57. *Id*. at 6.

58. *Id*. at 12.

59. *See generally*, *id. See also*, Buijs *supra* note 42.

innovate the technologies they have in order to compete globally. However, China's current efforts are not sufficient.

China has demonstrated the ability to manufacture and acquire technology transfers through a wide array of methods, but as examinations of China's leading climate change industries show, foreign players contribute much of the effort. China certainly has the power and ability to advance these technologies, but continued reliance on technologies transfer and manufacturing abilities raise an important question: Is China's climate change technology industry self-sustaining? As of now, the answer is no. The next section will address policies that China can implement to transition from being a technology transfer dependent country to a sustainable economy.

IV. ABSORPTIVE CAPABILITIES MOVING FORWARD

If China is to continue developing, it is vital that it addresses its means of sustainable development. While China's planned economy has helped it grow sustainably, it now needs to reconsider its transition plans. China should rely less on its manufacturing capabilities since it is already a strong player in that area, and rely more on promoting indigenous markets through fair means.

Even with the increased global demand in clean technologies, China is manufacturing at a rate far greater than demand.[60] This creates an excess supply that results in an unjust price war.[61] This war then creates financial problems not only for domestic and foreign manufacturers, but also state-owned banks that financed the domestic manufactures with approximately $18 billion in low-rate loans.[62] Chinese companies partly blame their difficulties on Western nations who are imposing anti-dumping and anti-subsidy tariffs on clean technologies manufactured in China.[63] However, this blame is misplaced because the problem stems from the amount and methods of Chinese production.

There is a large need for China to promote technological innovations derived from its current technology portfolio or technologies that are transferred to them. As this section will illustrate, there are several strategies the Chinese government can take to promote indigenous innovations from technology transfers.

60. Bradsher, *supra* note 36.

61. *Id. See infra* section IV (discussing how Chinese manufacturers are cutting costs and making their products much cheaper than those of foreign player.).

62. Bradsher, *supra* note 36 ("The result is a looming financial disaster, not only for manufacturers but for state-owned banks that financed factories with approximately $18 billion in low-rate loans and for municipal and provincial governments that provided loan guarantees and sold manufacturers valuable land at deeply discounted prices.").

63. *Id.*

A. Intellectual Property Rights

Intellectual Property Rights (IPR) provide incentives for people to enter into a market. IPR provides inventors with certain exclusive rights, such as the right sell or use the technologies. It also creates competition because multiple players will compete with one another to create the best product. The section below, discusses two options for Chinese officials. The first and more preferred option deals with strengthening patent laws. The second option discusses the use of utility models.

1. Option 1: Strengthening Patent Rights

China has repeatedly been criticized in its lack of intellectual property enforcement. While China has IPR laws on paper, there is simply inadequate administration.[64] This issue is worrisome for many foreign players who wish to enter the Chinese market but cannot because of potential infringement. While China is making progress toward strengthening its IPR protection, the pace is slow and it continues to be severely criticized.[65]

The lack of IPR is problematic in transfers of climate change technologies because stronger IPR would help facilitate technology transfers.[66] By providing government-sponsored monopolies over technologies to their inventors for a limited period of time, IPR in the form of patents could provide an incentive to market players.[67]

"In the context of patent rights, the relevant form of IPR when discussing [clean technologies], the government-sponsored monopoly distorts the market for the patented invention for the life of the patent but yields two corresponding benefits that outweigh that cost: first, the patent must be disclosed publicly, so that others can benefit from the advance in technology that is patented, and second, others are incentivized to create new technologies to gain access to the government monopoly and generate rents."[68]

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64. Victoria Maroulis, *China's Evolving IP Regime and Avenues of Enforcement*, 2013 WL 4192387, at 1 (2013) ("The reasons routinely cited for China's poor enforcement include its reliance on administrative instead of criminal measures to combat intellectual property rights infringements, corruption, and local protectionism at the provincial levels, limited resources and training available to enforcement officials, lack of public education regarding both the economic and social impact of counterfeiting and piracy, and the protection of valuable research and development.").

65. *Id.* (discussing China's slowly developing IPR protection and the international response).

66. Bronwyn H. Hall & Christian Helmers, *The Role of Patent Protection in (Clean/Climate Change) Technology Transfer*, 26 SANTA CLARA COMPUTER & HIGH TECH. L.J. 487, 487 (2010) (discussing the advantages of strong enforceable IPRs).

67. Smith, *supra* note 18, at 817 (2011).

68. *Id.*

Ultimately, encouraging public disclosure of invention and providing adequate protection of the technology can benefit the inventor, competitors, and society.

As a member of the World Trade Organization (WTO) and signees TRIPS Agreement, China is required to provide IPRs.[69] The TRIPS agreement states that member nations must patent owner terms of at least twenty years and does not allow member nations to discriminate based on most-favored-nation treatment and national treatment.[70] Interestingly, China has already implemented laws to meet several of the standards set forth in the TRIPS agreement.[71] However, there is a lack of adequate administration and enforcement of these laws, which make the laws ineffective.[72] The judiciary also fails to provide adequate protection when a patent is infringed.[73]

In order to remain competitive both locally and internationally, China must address the problems with its IPR laws. The innovation theory provides that multiple stakeholders are necessary in "geographically dispersed innovation networks that extend the boundaries of industries and nations."[74] Furthermore, innovation requires "complex systems that are characterized by the heterogeneity of agents with different functions, different endowments, different learning capabilities and different perspectives, and most importantly, different locations in the multidimensional spaces of geography, knowledge, technology, and reputation."[75] More resources need to be allocated to protect the rights of patent holders. Once this is achieved, new players will be incentivized to enter the market, as the cost of entry will be lower. Market forces would promote competition and research and development, such that new or existing players would look to existing technologies and find methods of

69. Konstantina Athanasakou, *China IPR Enforcement: Hard as Steel or Soft as Tofu? Bringing the Question to the WTO Under TRIPS*, 39 GEO. J. INT'L L. 217, 217 (2007).

70. Agreement on Trade-Related Aspects of Intellectual Property Rights, art. 33, 1869 U.N.T.S. 299, Apr. 15, 1994.

71. Peter K. Yu, *TRIPS Enforcement and Developing Countries*, 26 AM. U. INT'L L. REV. 727, 728 (2011) (stating that "Article 4 of it Copyright Law and Article 27 of its Regulations on Customs Protection of Intellectual Property Rights" meet the standard of the TRIPS agreement).

72. Hall, *supra* note 62, at 487.

73. *See Intellectual Property Rights – Protecting Your Intellectual Property Rights (IPR) in China*, EMBASSY OF THE UNITED STATES IN BEIJING, CHINA, http://beijing.usembassy-china.org.cn/protecting_ipr.html (last visited Mar. 27, 2014) (explaining that China provides "IP remedies through commercial enforcement" but "despite these criminal provisions, most IP cases [continue] to be handled through the administrative system.).

74. Dieter Ernst, *Indigenous Innovation and Globalization: The Challenge for China's Standardization Strategy*, EAST-WEST CENTER 17 (2012).

75. *Id.* at 41.

improving them. Having inadequate IPRs discourages players as the cost of entry exceeds the actual benefits.

In order to promote domestic innovation, Chinese officials need to address IPR enforcement and administration within its state.[76] Stronger IPRs will encourage competition, and drive players to create better products at a better quality. The market forces these players to compete with each other and ultimately make the best product possible. This will lead to better quality patents, which is what China needs today.

2. Option 2: Strengthening Utility Models

If China does not want to strengthen its patent laws and enforcement, it could still achieve similar goals by promoting utility models.[77] Although the term "utility model" varies in meaning depending on geographic location, it generally refers to a "second tier patent system, offering cheap, no-examination protection regime for technical inventions which would not usually fulfill the strict patentability criteria."[78] The Utility Model is closely tied to the patent system and it provides rights to innovations or discoveries that fall short of the inventive step and/or novelty bars under the traditional patent system.[79] This second-tier system encourages minor adaptations and inventions by local firms.

Utility models are especially useful in promoting innovation during initial steps of development.[80] There are several benefits of the utility model. These benefits include:

[E]nabling artisans [and inventors] to secure protection for types of innovation that do not meet the stricter novelty and inventive step requirements of patent law; making it possible to increase the role of traditional innovators and artisans in economic development; acting as a catalyst to enhanced levels of innovation; is the fact that they are cheaper to acquire than patents; [and] that they may become a source of data on innovative activity and experience in technological management.[81]

While the utility model assists second-tier innovations made by smaller local companies in entering costly markets, it also assists counterfeiters because they can claim protection for their modified version of goods even

76. *Report on Patent Enforcement in China*, U.S. PATENT & TRADEMARK OFFICE, http://www.uspto.gov/ip/global/China_Report_on_Patent_Enforcement_%28Full Rprt%29FINAL.pdf (last visited Mar. 27, 2014) (suggesting that Chinese officials should address enforcement issues in the areas of evidence collection, remedies, and court orders).

77. Uma Suthersanen, *Utility Models and Innovation in Developing Countries*, INT'L CENTRE FOR TRADE AND SUSTAINABLE DEV. xii (2006) ("'[U]tility model' is a generic term which refers to subject-matter that hinges precariously between that protectable under patent law and sui generis design law.").

78. *Id*.

79. *Id.* at x.

80. *Id.* at. vii.

81. *Id.*

when the infringed upon product is protected by foreign patents.[82] This use by counterfeiters is counterproductive to the goals of utility models and hurts true inventors, who are foreigners. This imposes an additional cost that of policing existing patents and court costs upon true inventors and discourages some players from entering the market.

Additionally, lack of substantive examination in utility models is a major problem. Without examination, it is difficult to guarantee the quality or level of inventiveness involved in a utility model.[83] If the purpose of the utility model is to protect improvements on existing technologies, then quality measures must be implemented to determine whether such innovation should be protected under the second-tier patent systems. Without doing so, local companies may make only slight or unsubstantial changes to the existing technology and still obtain protection; which is not optimal.

China has already implemented a utility model system.[84] In China, a utility model is generally granted except for "scientific discoveries, rules and methods for diagnosis or the treatment of diseases, animal and plant varieties, substances obtained by nuclear transformation, and chemical formulas."[85] There is no examination required, and grants under the utility system typically only take six months to year.[86] Utility model patents "are merely reviewed by SIPO for compliance with procedural formalities."[87] It also costs sixty percent less than patenting.[88] Therefore, in industries where technology is rapidly changing, utility models are the better option because they are cheaper and faster to obtain. However, utility models are given weaker protection than patents and are generally granted for a lessor term.[89] But since climate change technology is not rapid technology, shorter termed protection may not be ideal.

Lastly, and most importantly, it is unclear whether China needs second-tier patent systems. As a developing nation, China has already received substantial technology transfer[90] and has the manufacturing

82. *Id.* at vii.

83. Hans-Peter Brack, *Utility Models and Their Comparison with Patents and Implications for the US Intellectual Property Law System*, B.C. INTELL. PROP. & TECH. FORUM, viii (2009), http://bciptf.org/wp-content/uploads/2011/07/13-iptf-Brack.pdf.

84. *See* Suthersanen, *supra* note 73, at 20.

85. *Id*.

86. *Id.* Standard patents generally take two to four years to issue in this system.

87. Brian J. Safran, *A Critical Look at Western Perceptions of China's Intellectual Property System*, 3 U. PUERTO RICO BUS. L.J. 135, 152 (2012).

88. *See* Suthersanen, *supra* note 73, at 20 (stating that "[a] utility model is also more attractive as it costs around 40 percent of the invention patent where technologies are rapidly changing").

89. *Id*.

90. *See, e.g.*, United Nations Environmental. Progamme, CDM PIPELINE, http://cdmpipeline.org/cdm-projects-region.htm (last visited Mar. 27, 2014)

capabilities required to implement the new technologies.[91] Furthermore, China is not short "of well-trained scientists, engineers, mathematicians, or other technical experts."[92] It is unclear whether China should even use utility models because the effectiveness of a utility model is strongest during initial stages of development where local companies are learning the know-hows of the technologies. Considering the size of the educated Chinese population, the substantial patent technology within China, and China's existing manufacturing capabilities, it is clear that China should not make use of the utility model to facilitate domestic innovation because reliance on it could lead to weak intellectual property rights. Instead, Option 1 would better allocate resources. China's needs would be better served if it developed better quality patents. It needs to drive market players to compete with one another and make drastic improvements to existing technologies. Allowing local companies to make slight changes to foreign patents is not an effective strategy for a sustainable development. A stronger patent system will draw more players and drive innovation.

B. Removing Local Bias

While the benefits of promoting domestic innovation—nourishing local companies to develop infant industries without having to compete with more experienced competitors—usually make sense, it does not within the Chinese climate change technology space. Simply put, China's climate change technology industry is already booming; it is no longer an infant industry. Within the space of climate change technologies, China's strategy needs to change because there are already significant numbers of local players in the market. In fact, since many of leading companies in this field are from China,[93] China needs to push for these companies and others to innovate. Introduction of more players into the Chinese market, especially foreign players that invest in research and development, will drive Chinese companies to compete on a global scale.

Furthermore, there is a misunderstandings China's need for indigenous innovation. In reality, Chinese citizens are very good learners and they can

(indicating that China is one of the largest recipients of CDM green technology transfers); *see also* Stephen Seres, ANALYSIS OF TECHNOLOGY TRANSFER IN CDM PROJECTS 8 (Dec. 2008), http://sa.indiaenvironmentportal.org.in/files/TTrep08.pdf ("Four countries–Brazil, China, India and South Korea–dominate the totals, accounting for 72% of the [CDM] projects and almost 80% of the annual emission reductions.").

91. Karel Eloot, Alan Huang & Martin Lehnich, *A New Era for Manufacturing in China*, MCKINSEY & COMPANY (June 2013), http://www.mckinsey.com/insights/manufacturing/a_new_era_for_manufacturing_in_china (describing China's leading manufacturing power).

92. *U.S. Commercial Technology Transfers to the People's Republic of China*, FAS.ORG (Jan. 1999), http://www.fas.org/nuke/guide/china/doctrine/dmrr_chinatech.htm.

93. *See* Buijs, *supra* note 42, at 40 (discussing how some solar, wind, and hydropower companies are global leaders in their field.).

learn things quickly, but they are not necessarily creative and innovative. There is a strong reliance on manufacturing rather than innovation.[94] Although this is used to justify Chinese officials' implementation of domestic protection policies,[95] Chinese officials should focus their attention on policies promoting innovation rather than providing unnecessary local protection. Chinese companies are simply not innovating; they are merely duplicating or cheaply manufacturing even though there is potential to do much more—and that is a problem.[96] Allowing foreign companies to enter into the China market and compete for Chinese citizen's sale could be the push that drives Chinese companies to innovate.

As previously discussed, innovation theory shows that innovation depends on interactions of a variety of diverse stakeholders throughout geographic networks.[97] Scholars also argue that companies are more likely to invest in productivity-enhancing advancements when market competition forces drive them to do so.[98] Boumill notes:

World trade and global innovation flourish because the pool of ideas off which to build becomes greater and more diverse, and because the brainpower and perspective available to solve critical problems increase dramatically. This same policy reasoning underpins the TRIPS agreement itself.[99]

Thus, as previously stated, China's domestic innovation policies seem counterintuitive.[100] Instead, Chinese officials should focus more on enforcing IPR, creating greater incentives to innovate and--as the next section will show--make better investments.

C. Other Suggestions

In addition to the policies stated above, Chinese officials can continue to promote indigenous innovation by reconsidering existing investment

94. S. James Boumil III, *China's Indigenous Innovation Policies Under the TRIPS and GPA Agreements and Alternatives for Promoting Economic Growth*, 12 CHI. J. INT'L L. 755, 758 (2012) ("Although China has enjoyed significant industrial development in the last several decades, it continues to be confined largely to a manufacturing role.").

95. *Id.* at 759 (stating that "in recent years key government officials have expressed heightened fear that dependence on foreign innovations compromises China's economic and security interests").

96. *Id.* ("Known for decades as 'the world's factory,' China has capitalized upon its abundance of low-cost labor to manufacture the staples of daily life at prices that significantly undercut those produced by its Western competitors.").

97. Ernst, *supra* note 10, at 41 (detailing what innovation requires).

98. Boumil, *supra* note 91, at 777 (stating "firms seem to invest in productivity-enhancing innovation only if competition forces them to do so").

99. *Id.*

100. *See* Boumil, *supra* note 91, at 756 (discussing alternative strategies to domestic innovation policies).

strategies and providing incentives for Chinese scholars to remaining within China.

1. Smarter Investments

Although China has attracted more new investment in renewable energy, it is not being invested efficiently. In 2010 alone, China received one-third of the world's investments in renewable technologies.[101] First, there are still major corruption issues among officials in China. Second, even if corruption is not a factor, the money is not used when it is made available. The Chinese government has extended over $35 billion in credit to solar-energy companies since 2010,[102] and China Development Bank Corporation has offered $29 billion in credit to five Chinese PV panel manufacturers.[103] As of November 2011, the Chinese had only used $866 million, which is less than three percent of available funds.[104] Billions of dollars remain available and unused by Chinese companies. This money could be used to fund research and development programs.

2. Foreign Acquisitions

As previously stated, a popular method by which many Chinese companies have begun to acquire quality patents is through acquisition of foreign technologies.[105] Chinese outward foreign direct investment has grown rapidly over the past decade. From 1978 to 2002, Chinese companies accumulated $30 billion in foreign direct investment.[106] That number rose to $57.2 billion by 2005, and then to $73.3 billion by 2006.[107]

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101. Angus McCorone et al., *Global Trends in Renewable Energy Investment 2011*, UNITED NATIONS ENV'T PROGRAMME & BLOOMBERG ENERGY FIN. 18 (2011), *available at* http://www.unep.org/pdf/BNEF_global_trends_in_renewable_energy_investment_2011_report.pdf (arguing that investment incentives and other government policies deserve much of the credit for technological progress in renewable energy).

102. Ben Sills, *China Buries Obama's 'Sputnik' Goal for Clean-Energy Use*, BLOOMBERG (Apr. 4, 2011), http://www.bloomberg.com/news/2011-04-03/china-buries-obama-sputnik-aim-for-clean-power-as-kissinger-advises-bank.html (detailing the exact monetary amounts the Chinese invested in clean-energy companies).

103. Sally Bakewell, *Chinese Renewable Energy Companies Slow to Tap $47 Billion Credit*, BLOOMBERG (Nov. 16, 2011), http:// www.bloomberg.com/news/2011-11-16/chinese-renewable-companies-slow-to-tap-47-billion-credit-line.html (detailing Chinese lenders of solar and wind-energy companies).

104. Daniel K. Tracey, *The Missing Lending Link: Why A Federal Loan Guarantee Program Is Critical to the Continued Growth of the Solar Power Industry*, 16 N.C. BANKING INST. 349, 353 (2012).

105. See *supra* Section IV.

106. Hauichuan Rui and George Yip, *Foreign Acquisitions by Chinese Firms: A Strategic Intent Perspective*, 43 J. WORLD BUS. 213, 213 (2008).

107. *Id.*

This has led Chinese companies to acquire foreign companies. For example in 2000, foreign acquisitions were only $344 million, but in 2005, it was $6.5 billion, 53% of the total outward FDI for that year.[108] Through such means, Chinese companies are getting valuable technologies that they can sell and further develop.

Much will depend on what Chinese companies decide to do with the patents they acquire: further develop the technology or simply manufacture the technology as cheaply as possible. To promote and maintain sustainable growth, Chinese companies will have to place an importance on research and development, at least much as or if not more than manufacturing cheaper product. Development of products they acquire is key, an ideal that must be promoted.

3. Invest in Smart Innovations

Moreover, China needs to focus on getting quality patents, which is a goal that it has neglected up until now. Instead, Chinese officials have been trying to increase number patent application which in China. The State Intellectual Property Office of China is determined to increase the number of patents granted and standards issued.[109] However, this strategy is ill equipped to cope with the new challenges for standards and innovation policy that result from the rise in complexity through globalization. The focus on "quantitative achievements should not come at the cost of [quality]" and the careful consideration of "important qualitative parameters, such as the importance of certain patents."[110] In other words, having thousands of weak patents does not help China sustain industrial growth. Instead, quality patents with continued development will help China develop.

4. Retaining Chinese Scholars

Another key aspect that Chinese officials must address is its retention of Chinese scholars, as it currently suffers a large "brain drain." A 2007 study shows that only thirty percent of the Chinese students who study overseas return to China upon graduation.[111] This appears to be changing after the government implemented several policies and programs that provide generous incentives for top-level researchers and scholars to return

108. *Id.*

109. *See* OUTLINE OF THE NAT'L INTELL. PROP. STRATEGY, *supra* note 8.

110. *See* Ernst, *supra* note 10, at 52.

111. *See* Jonathan Watts, *China Fears Brain Drain as Its Overseas Students Stay Put,* THE GUARDIAN, June 2, 2007, *available at* http://www.theguardian.com/world/2007/jun/02/internationaleducationnews.highereducation.

home,[112] and recent trends show that more Chinese scholars are returning home.[113] However, a significant number of students still remain overseas due to many complex social factors, such as, lower standard of living, social program and educational opportunities, and the country's "only one child" policy.[114] China must continue to address these issues so that more of their scholars return and help their own industries rather than those of foreign nations. In short, China simply cannot be an innovative center if it cannot retain its scholars.

Implementing some of these suggestions should help China make further strides in the right direction. This will require effort from both Chinese government officials and those in the private sector. The technology is there, the resources are there, the only thing that is missing is the desire and motivation to innovate.

CONCLUSION

While China has made a remarkable leap forward in the climate change technology space, much work remains, especially in promoting indigenous innovation. If China wishes to transition from a developing country to a developed one, it will need to rely less on technology transfers and instead create more incentives for promoting existing companies to innovate.

Undoubtedly, the technology and capability to manufacture climate change technologies exists within China, but the mechanisms are outdated and must be developed. Chinese officials need to encourage innovation to encourage Chinese companies to move away from their current tendency to value lower manufacturing cost over research and development. Additionally, officials must encourage companies to invest in research and development, build partnerships with public institutions and file quality patents. These are just a few of the essential aspects that are necessary for China's sustainable development. With China's remarkable growth in the past thirty years, China can achieve sustainability, but for now, it is a long ways away.

112. Will Oremus, *China's Brain Drain*, NEWSWEEK, Aug. 30, 2010, *available at* http://www.newsweek.com/2010/08/30/china-s-brain-drain.html (last visited Mar. 27, 2014).

113. Sheng Ruowei, *818,400 Overseas Students Return to China*, PEOPLE'S DAILY ONLINE, Mar. 16, 2012, http://english.peopledaily.com.cn/90882/7760545.html.

114. Jonathan Chow, *China's Brain Drain,* SHANGHAIIST, (July 28, 2009), http://shanghaiist.com/2009/07/28/dang_brain_drain.php.