

# A Modified SWOT Analysis of Successful Green Patent Development in China

WU Jinqian<sup>[a],\*</sup>; REN Chong<sup>[a]</sup>

<sup>[a]</sup>School of Public Affairs, University of Science and Technology of China, Hefei, China.

\*Corresponding author.

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## Abstract

China has witnessed a significant development of clean technology in recent years since the UN climate change conference in 2009. The green patent, as a way of addressing environmental issue, has been deemed to be one first attempt. However, compare to most developed countries, there are many obstacles and barriers for it to improve and develop successfully in China. By conducting a modified SWOT analysis, this research aims to help catch up the status quo of the green patent based on the particular context of the renewable energy sector in China. Data supporting the analysis is derive from multiple ways including governmental reports, green patent related laws, literature reviews, and patent analyses. The study opens a window through which both government and academic fields are involved can perceive the internal and external conditions of the green patent in China. The five critical strategies, which are presented based on SWOTs identified, could be used for China to shape its future green patent improvement at the strategic level.

**Key words:** Green patent; Modified SWOT analysis; Policy recommendations

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## INTRODUCTION

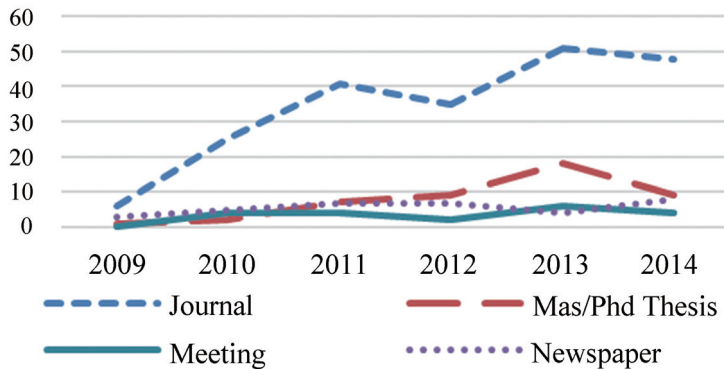
Nowadays, climate change problems have become a crucial issue result from

the vast majority of human activities and the poor awareness of environmental protection. While pursuing and maintaining a high speed of economic development, green technology has been playing an essential role in China's innovation, which can be stimulated by patent somehow. Particularly in 2013, about one third of the world's total 2.6 million patent applications were submitted by China, followed by the US and Japan (World Intellectual Property Organization, 2014). The later year in the R&D investment, around 89.5 billion dollars was used for clean energy technology development according to Bloomberg energy finance. Undoubtedly, such development speed leads to serious air pollution generated throughout the country to some extent. To deal with it, the Political Bureau of the CPC (Central Committee of China) went through the regulation Opinions on accelerating the promotion of ecological civilization on March 24<sup>th</sup>, 2015. It is the first time ever to add green to the four modernizations (modernization of agriculture, industry, national security and science & technology), which moves forward the development of China's social modernization construction altogether. The green patent is originally known as a method for addressing the global warming problem, and now has gradually become the core competitiveness of one country. Therefore, it is of great significance to develop the green patent in China.

In the academic field, China's intellectual property research started from 1980 (see Table 1). During the last decade, the green patent has attracted a lot of attention, thus resulting in a number of outcomes published in various academic journals, Master/PHD thesis, conference papers and newspapers (see Figure 1). The trend of the green patent research was growing year after year, and these outcomes indicate a rising concern of the green patent from establishment to application and diffusion, which is demonstrated by the academic community. Specifically, existing literature covers a wide range of topics, such as the construction of green patent system, fast-track program, compulsory licensing, green patent international transfer and so on. However, there is limited research to assist in quantitative studying green patent on a large scale. Generally, traditional SWOT method lacks quantitative analysis, while a modified SWOT approach is employed to achieve such purpose, which goes deeper than the conventional one by adhibiting a data analysis through a strategic perspective. This analysis is based on patent data stem from SOOPAT database combined with literature reviews in China and abroad.

**Table1**  
**Literature of IP/GP**

	Results
Key words	1 <sup>st</sup> appear/Year
IP	1980
Green patent	2008



**Figure 1**  
**Trend of GP Research**

Note. Resource: CNKI database ([www.CNKI.com.cn](http://www.CNKI.com.cn))

The rest of this article will firstly discuss some conceptions and definitions in the green patent field. Then introduce the research methodology adopted. Thirdly is a modified SWOT analysis of green patent in China. Furthermore, propose a framework incorporating six critical strategies that can be applied to help address the barriers related to green patent development. Finally, some conclusions are drawn according to the implications.

## 1. WHAT IS GREEN PATENT? HOW DOES IT PROPOSED?

### 1.1 Green Patent

The term “green technology” was coined out not long after the concept “sustainable development” was first articulated by the UN Brundtland Commission in our Common Future in 1987 (Buttar, 2011), and such technology has been patented for protection as an incentive way. While in China, the idea: “green technology innovation will be both the change and opportunity for the 21<sup>st</sup> century enterprise development” was proposed in the late twentieth century (Lü, Wang, & Xu, 1994). The green patent was first put forward precisely by Qiongdi Chen in 2009, however, there is no official definition about it until now. Varies definitions (Hsu, 2007; Chen, 2009; Lane, 2012; Liu, 2013) focus on different aspects, but what is certainly sure is that green patent is a dynamic patenting system concern with environmental sound technologies/low carbon technologies. For example, “a green patent, according to several IP Offices around the world, is defined as a patent that address issues such as energy efficiency, alternative fuels, agricultural efficiency, wind, solar, tidal/wave and nuclear energy, energy storage, waste disposal and recycling; among many others” (Grajales, Soto, & Switzer, 2012). Moreover, several patent offices in the world also gave the definitions.

## 1.2 Green Patent Strategy

The modernization of green demonstrated above is to green our production mode in the context of economy, generally speaking, is to choose environmental friendly technology to manufacture and promote green innovation in China (the State Council Information Office, 2015). This change of thinking mode will definitely leads to a revolution of greening our patenting system. What's more, it will make the green patent one of our most popular hot pots of patent research in recent years. China's green patenting system construction could generally consists of three aspects: how to define; how to establish an implementation system; how to transfer internationally.

Chen and Hu (2009) discussed how patent system could contribute to our environment protection, and then on the basis of the existing law ecology, set forth a hypothesis of building "the green patent system"; Liu and Chen (2012) argued it from the perspective of legal regulation, which stated that we could reference the experience of legal regulation abroad, and we could enhance it from four points consisting of improving the level of legislative protection, perfecting law enforcement and protection mechanism, implementing compulsory licensing reasonably and fastening the accelerating examination process; based on which Chu and Xu (2012) went further by introducing "the obligation to pay the environmental tax by the rights holder in the patent law", so that "we can dramatic promote green technology diffusion and licensing and improve both social and eco environment as well"; Xiao (2009) stated "What kind of standard, examination process and organization we have to establish", and first of all these patents "can't obey Bali forum or TRIPs agreements", furthermore "can't ignore the concern about ethics and morality".

As depicted above, existing strategic planning of the green patent researches mostly target on improving domestic system. However, both domestic level and international transfer should be considered in the context of China in order to make the green patent development successfully. For instance, Hu (2014) discussed the construction of the global green patent prosecution highway on top of global development level.

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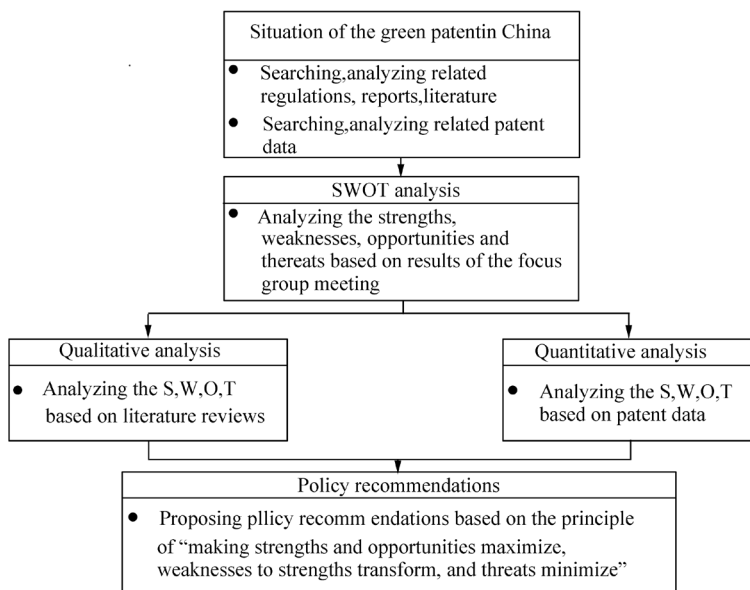
## 2. RESEARCH METHODOLOGY

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The key technique used for strategically planning green patent is a SWOT analysis approach originated from the business management discipline, which was first put up by a professor of management in the University of San Francisco in the 1980s. The SWOT methodology is a strategic analysis tool that combines the study of the strengths and weaknesses of an organization, territory, or sector with the study of opportunities and threats in its environment. The goal is to help define a development strategy (Jackson & Dutton, 1988). Such method has been widely applied to a broad array of disciplines. For example, Furkan (2011) conducted a status and perspective analysis of the photovoltaic technology field in Turkey.

Recently, a SWOT analysis on China shale gas industry was carried out by Zhao, Kang and Lan (2013). In the discipline of patent, an analysis of formulating strategic planning for promoting information technology industry in China was performed. Which adopted a research method of integrating authorized ratio, R&D capability, patent technical-value, technology opportunity and advantage with patent mapping analysis into SWOT analysis and presented a set of concrete strategy for the development of information technology in Beijing (Huang et al., 2012). It is obviously demonstrated by those studies that the SWOT analysis approach is a better tool for environmental technology problems. Besides, at present the analysis of green technology, especially the strategic researches on patent aspect lack of quantitative analysis and comprehensive approach, thus a modified SWOT analysis is adopted in the present study to strategically analyze the green patent in China.

The methodology consists of four parts (see Figure 2). First, the latest status quo of the green patent in China is introduced by referring the information collected from two resources: One is a thorough search and examination of related patent office reports, green patent related regulations and studies; the other is through quantitatively analyzing the collected patent data. Second, using the clean energy industry as an example to dissect the green patent development by diagnosing the strengths, weaknesses, opportunities and threats. Third, two detailed SWOT analyses are performed, a qualitative analysis based on literature review, a quantitative analysis based on patent data. At last, on top of the modified SWOT identified, recommendations for improving the green patent situation in China are presented in line with the principle of making the strengths and opportunities maximize, weaknesses to strengths transform, and threats minimize.



**Figure 2**  
**Research Methodology**

### 3. SWOT ANALYSIS OF GREEN PATENT IN CHINA

#### 3.1 Situation of Green Patent in China

As the largest emerging economy and one of the fast growing economies on the planet, China exists not only huge energy demand but also tremendous reduction requirement of CO<sub>2</sub> emission, which leads to great challenges in coping with climate change, environmental improvement and economic development. In this context, China continues to increase the R&D investment to spur green technology innovation actively, which directly results in increasing number of green patent application year over year.

Typically, a mature green patent system is the foundation of green development. However, along with the rapid growth of applications, what is extremely inappropriate is the imperfect of system construction in China, which leads to barriers when it comes to patent diffusion and makes it not seem like the right path to solve environmental problems. Hence, there is a high value of discussing where to go through the comprehensive SWOT analysis below.

#### 3.2 Qualitative SWOT Analysis of Green Patent in China

SWOT analysis of the green patent helps further the understanding about the external and internal conditions. The internal conditions are related to the strengths and weaknesses while the external conditions refer to the opportunities and threats (see Table 2).

**Table 2**  
**Results of SWOT Analysis on Green Patent in China**

Internal conditions	External conditions
Strengths	Opportunities
S1:Strong awareness of the government about promoting green patent S2:Rapidly growing capability of green technology innovation S3:More R&D investment from government	O1:Successful global advanced experience O2:International cooperation of green technology development O3:International climate related fund
Weaknesses	Threats
W1:Lack of cooperation of policy instrument W2:Lack of green patent law and regulation W3:Weak support platform for green technology innovation	T1:Poor international environment for international transfer T2:Obstacles from developed countries T3:Double barriers and investigation threats in international green trade

#### 3.2.1 Strengths

##### 3.2.1.1 S1: Strong Awareness of the Government About Promoting Green Patent

The green patent cannot live without government supports, which have already been shown from practical experience. Nowadays, as the climate change issue is becoming more and more serious, coupled with the world trend, Chinese government fastens its step in terms of supporting for green technology

development, and makes a series of incentive regulations, which are gradually implemented within the innovative national strategy. For example, according to the “12<sup>th</sup> Five-Year Plan for National Economic and Social Development (2011-2015)”, China has to reduce the energy consumption per unit of GDP by 16%, and reduce the CO<sub>2</sub> emission per unit of GDP by 17%. Part of the regulations are as follows:

**Table 3**  
**Green Patent Related Regulations in China**

Year	Regulations	Contents regarding green patent
2010	China’s National Program to Address Climate Change	Put up with strategies to address climate change issues
2011	Outline of the 12 <sup>th</sup> Five Year Plan for National Economic and Social Development	Clearly point out the idea of establishing green, clean and sustainable development.
2012	Administrative Measures for Priority Review of Invention Patent Applications	No.9 of the world’s green technology fast-track program
2014	National Plan Response to Climate Change(2014-2020)	The first national plan for climate change
2015	Opinions on Accelerating the Promotion of Ecological Civilization	The first time to put up with adding the green to the construction of “four constructions” in China

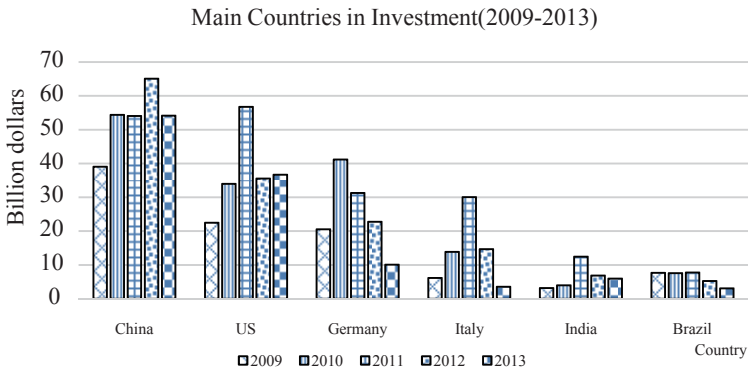
**3.2.1.2 S2: Rapidly Growing Capability of Green Technology Innovation**

With the supporting and guiding of government’s policies and regulations, China’s green technology innovation ability has grown rapidly throughout the years. For example, according to National Energy Administration of China, China’s new Photovoltaic incremented installed capacity ranked the top of the world in 2013, which reached 8.5-9 GW (Gigawatt, a unit of installed capacity). In the end of 2012, the power installed capacity increased from 7.2 GW to 11.4 GW within five years, in particular, hydropower, wind power and nuclear power ranked the world first as for construction scope. Based on such foundation and progress standing on the back, it is a great chance for China to develop green patent successfully.

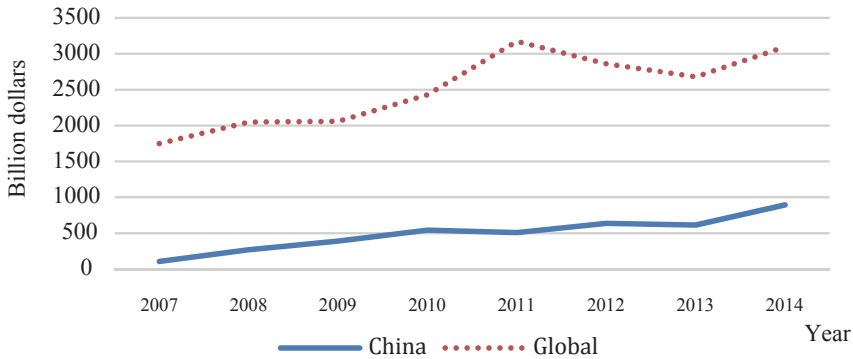
**3.2.1.3 S3: More R&D Investment From Government**

To win the dominant position in the green race, China has spared no efforts to refine its financial investments and increase the incentive policies. By investigating abundant money in the R&D of clean energy technology sector, China is becoming an investigation center around the world gradually. At the same time, there is a rapid growth in the dimension of investment promotion as well as the development of green technology around the world. For example, the world’s total clean energy finance investments have grown by 34.7%, from 17.5 billion dollars in 2007 to 26.8 billion dollars in 2013 (see Figure 4). According to the report who’s winning the clean energy race 2013 from the Pew charitable trusts, China ranked No.1 compared to main countries like US and Germany except for 2011. In 2012, China was about 1.8 times as many as US by reaching 65.1 billion dollars. What’s more, the data also showed that China still ranked 1.47 times more than US under the situation of

total investment declined in 2013 (see Figure 3). Additionally, the calendar year of clean energy investment was growing rapidly in the last eight years (2007-2014), and 2014's clean energy investment grew by almost 8.3 times than the year of 2007, which occupied 28.8% of the world's total investment (see Figure 4). Besides, China has been continuing expanding its supports for clean energy projects, as of May 6, 2014, China's registered CDM projects reached 3793, accounting for 50% of the total global CDM, which was the world's largest supplier of CDM projects (United Nations Framework Convention on Climate Change, 2011).



**Figure 3**  
**Clean energy investment in major countries (2009-2013)**  
 Note. Resource: Bloomberg energy finance.



**Figure 4**  
**Calendar Year of Investment in Clean Energy in China and World**  
 Note. Resource: Bloomberg energy finance.

### 3.2.2 Weaknesses

#### 3.2.2.1 W1: Lack of coordination of policy instrument

As previous presented, government has been playing a leading role in promoting the green patent through related regulations. While in terms of collaboration, the current regulatory system exists shortcomings, which mainly lie in: No special institution that is responsible for the development of clean energy sector in China's government, which directly leads to the majority of policies and demonstration projects coming from different ministries, so as to the central government subsidy



policies. Thus, there is no uniform coordination and integrated management of the policy instrument.

#### **3.2.2.2 W2: Lack of Green Patent Law and Regulation**

The legislation of China's patent law has been gradually in line with the international world. Centering on green, low carbon and environmental friendly target, the implementation of such policies lays the foundation of pushing the international green patent protection as well as elevating the competitiveness of the whole green industry. However, it is not enough for there still existing deficiencies, which include two aspects: One is insufficient of environmental and international protection related law regulations, the other is no such law that direct for developing the green patent to follow so far.

#### **3.2.2.3 W3: Weak Support Platform for Green Technology Innovation**

The Green technology public service platform (GTPS) is a platform aiming at promoting the competitiveness and refining related basic infrastructures at the same time. Through making the most of green resources, the GTPS ensures green technology innovation and transfer smoothly. Nevertheless, China's GTPS establishment is still in its early stage, some major problems are still waiting to be addressed: To begin with, not only the resources integrated level but also patent information sharing mechanism is needed to continue improving quality and quantity. It is also stated that the scope of the GTPS platform is too narrow, which is in urgent need to expand its cover fields. Last but not least, due to the key factor that affects the green innovation is still not clear, it is necessarily to enhance the support of R&D and information service platform.

### **3.2.3 Opportunities**

#### **3.2.3.1 O1: Successful Global Advanced Experience**

Developed countries have known the emergency of environment protection and put the green patent into practice since 2009, with the world's first fast-track program: Green Channel in the UK. After that many other countries followed their step, about ten countries have launched accelerate examination plan until now (see Table 2). As an effective way of shortening applying time and extremely reducing the examination process, it helps patent applicants get the patent and put the technology into the market as soon as possible. Meanwhile, cleantech group defined green technology as eleven different kinds, which are an apparent barrier to better the green patent application. To cope with this, the "IPC green inventory" was designed and announced by WIPO, which is an attempt to get together with the wide range of environment technologies, and convenient the data retrieval by offering the listed ESTs (WIPO, 2011). Nonetheless, chances have been offered for companies and other NGOs to build green patent technology through the sharing program, and somehow incentive the world's sustainable development. There are four main programs in the world to date: The Eco-patent commons, Green technology packages, Green X change and WIPO green program. All in all, China

has an opportunity to absorb the valuable experience in developed countries and international institutions to prosper its development.

**Table 4**  
**Ten Fast-Track Programs Around the World**

Country	Starting date	Time	Fee	Technologies Covered
UK	2009.5	9 month	No	All environmentally friendly inventions
Australia	2009.9	4-8 month	No	All environmentally friendly inventions
Korea	2009.10	1 month	200,000won	Technologies funded or accredited by the Korean government, or mentioned in relevant government environmental laws
Japan	2009.11	2 month	No	Energy-saving & CO <sub>2</sub> reduction
US	2009.12	1 year	No	Environmental quality, energy conservation, development of renewable energy resources or greenhouse gas emission reduction
Israel	2009.12	3 month	No	All environmentally friendly inventions
Canada	2011.3	2 month	No	All environmentally friendly inventions
Brazil	2012.4	Less than 2 years	No	Alternative energy, transportation, energy conservation, waste management and agriculture
China	2012.8	1 year	No	Energy saving technologies, environmental protection, new energy, new energy vehicles
Latvia	2013.4	1 hour	No	All environmentally friendly inventions

Note. Resource: own collection.

### 3.2.3.2 O2: International Cooperation of Green Technology Development

As discussed above, climate change issue has originally been a global problem, thus it has to be solved on a global scale, which needs a wide cooperation and joint action to reach the expected target. China has cooperated closely with countries like US, UK, India in environmental protection and energy saving technology fields, coupled with the low-carbon emissions, smart grid technology, renewable energy and other green technology in recent years.

Such international cooperation mainly includes two levels: political and technological. The former one refers to multilateral political negotiation. The world has gone through numerous meetings for the sake of reducing the CO<sub>2</sub> emissions and spurring green technology development and diffusion, which resulted in programs such as CDM, WIPO green program since the 1992 UNFCCC conference. The latter one is technology R&D cooperation across countries. In recent years, global warming issue has attracted wide concern, which promotes great cooperation to deal with it both in R&D sector and on a strategic scale. For example, in order to jointly develop, build and apply all kinds of wind power projects, China and US had

made an agreement of Framework agreement on strategic cooperation in the field of wind power with the total joint investment across 10 billion yuan in January of 2011 (Du, 2011). Four months later, a number of consensus were reached in the clean energy technology sector during the period of the third China-US strategic & economic dialogue conference (United Nations Department of Economic and Social Affairs, 2011).

**3.2.3.3 O3: International Climate Related Fund**

A series of agreements have been reached for green technology development and transfer under the framework of international negotiation up to now. Especially, in order to solve the high grant fee problem, the UNFCCC has built a great deal of special public funds as well as other institutions like the world bank also put forward similar public fund programs (see Table 5). For developing countries, the goal is very clear despite varies highlight points of these funds. All in all, it is such weather related funds that stimulate China’s green patent expansion.

**Table 5  
International Fund Related With Green Technology Sector**

Name of Fund	Institution	Date	Goal
Global environmental facility	World Bank/UNDP/ UNEP	1991	Continue to enhance the mitigation and adaptation of developing countries, including promoting, facilitating and financing of the appropriate environmental friendly technologies and IP rights transfer and licensing
Special climate change fund	UNFCCC COP7	2002	Supplement to the global environment facility and other multilateral or bilateral finance, includes technology transfer and other related activities
Least developed country fund	UNFCCC COP7	2002	Support the preparation and implementation of the national adaptation plan for the least developed countries.
China renewable energy project	World Bank	2005	The global environment fund and China joint investment funds offer assistance, capacity building and policy support for the transfer of technology within wind power, PV and other sectors
Clean energy financing partnership facility	Asian Development Bank	2007	Help improve energy security in developing member countries and decrease the rate of climate change.
Climate Technology fund	World Bank	2008	Provide financial support for projects and programs that are conducive to the display, use and transfer of low-carbon technologies in developing countries.
Green climate fund	UNFCCC COP17	2010	Developed countries invest 30 billion as quick start-up capital in 2010-2012, and provide 100 billion each year during 2013 to 2020 to help developing countries cope with climate change

### **3.2.4 Threats**

#### **3.2.4.1 T1: Poor International Environment for International Transfer**

Under the background of insufficient self-innovation capacity in China, it is of great significance to import green technologies from developed countries through non-market mechanism. Recently, although more and more multilateral environment agreements and soft laws were signed, there are still no compulsory constraints in the proceedings, let alone specific goals. The result is emerged as unwillingness for wealth countries to transfer core green technologies. In fact, the process of green technology transfer is very slow for not only because there exists divergent in relation to responsibility, technology, finance issues between developed and developing countries, but also the legitimate interests of China is infringed by western world through legal loopholes and restrictive clauses. Hence, such shortages bring about high patent license fee if China wants to own advanced green technology.

#### **3.2.4.2 T2: Obstacles From Developed Countries**

The green patent has double nature as a key part of solving the environment problem. For one thing, the global public interests we are confronted with are the same, and that's why negotiations is becoming much more frequent during the past decade; For another, green patent is just a kind of intellectual property, which means it's a private right that actually are mostly owned by multi-national corporations in developed countries. Consequently, there are a large number of conflicts in smoothing green technology transfer while protecting the patent simultaneously. The so-called "green race" is generally acknowledged in developed countries by hurdling the green technology international transfer to the developing world. For instance, in President Obama's 2011 State of the Union address, the president made it clear that one of his top priorities is to ensure United States global leadership in the emerging industries of clean energy and energy efficiency, going so far as to call this as our Sputnik moment (Nuehring, 2011). What it illustrated is that they wanted to win the race, and the only way to accomplish this goal is to fasten their green technology patent layout by means of strengthening competitive advantages and monopoly position, developing strict technical standards and imposing environmental taxes as well. As a consequence, China is up against great challenges for its green technology industry in the light of such strategy dominated by developed nations.

#### **3.2.4.3 T3: Double Barriers and Investigation Threats in International Green Trade**

Traditional trade barriers seem to disappear in China with its participation into the WTO in 2001, along with developing chances in foreign trade. However, the inner immature of environment regulation is a threat to promoting the green patent in China. Latest technology is owned by developed countries, which make them reluctant to transfer green technology. What's worse, they also set forth export trade barriers in the name of patent protection, among which the most rigorous

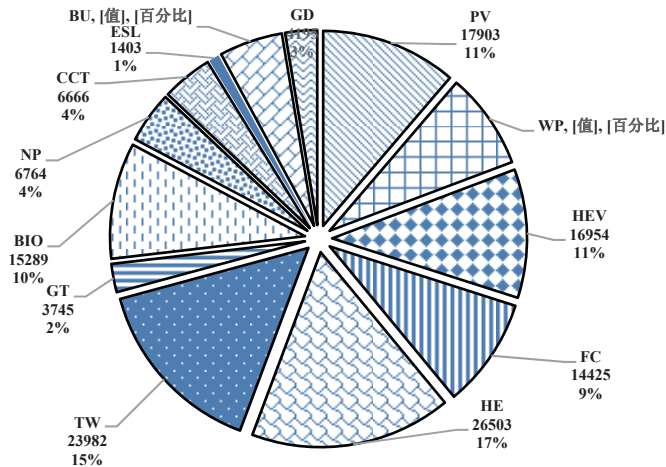
one is green trade barrier. on the one hand, the export of China’s green technology products were unreasonably restricted by using the internal shortcoming to set up strict environmental clauses; On the other hand, some surveys were frequently launched by Europe and US pointing at China’s green patent strategies.

### 3.3 Quantitative SWOT Analysis of Clean Energy Patent in China

Data resources in this part are from SOOPAT patent database and related reports, according to the Clean Energy Patent Growth Index, clean energy patent contains Solar Photovoltaic, Wind, Hybrid/Electric vehicles, Fuel Cells, Hydroelectric, Tidal/Wave, Geothermal, Biomass/Biofuels and other clean energy. WIPO also got a classification of ESTs: Biofuels, Integrated Gasification Combined Cycle, Pyrolysis or gasification of biomass and Fuel Cells etc. (WIPO, 2010). Taking the subject feature and data availability into account, this paper tracks the applying and granting of China’s clean energy patents for the following sub-components: Solar Photovoltaic (PV), Wind Power (WP), Hybrid/Electric vehicles (HEV), Fuel Cells (FC), Hydroelectric (HE), Tidal/Wave (TW), Geothermal (GT), Biomass/Biofuels (BIO), Nuclear Power (NP), Clean coal/Coal combustion/Coal conversion (CCT), Energy Saving Lighting (ESL), Biogas Utilization (BU) and Garbage Disposal (GD).

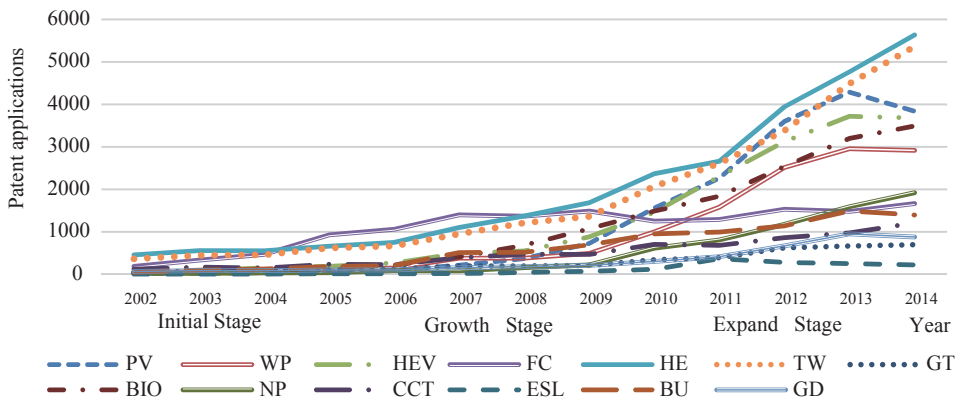
#### 3.3.1 S\*: Substantial Growth in Clean Energy Patent Applications

Fast growth has witnessed the total clean energy technology patent applications from 2002 to 2014 when China’s green industry experienced a long-term development. Typically, the total clean energy patents applications were 158066, while in 2014 were at an all time high of 32913, which is over 22 times more than the original year. In particular, HE is the most active field that occupies 17%, followed by TW, HEV, Bio and PV over 10% share respectively. Other industries show normal level with about 4.5% on average.



**Figure 5**  
**Trends of Clean Energy Technology Patent Application in China**  
 Note. Resource: own collection from SOOPAT.

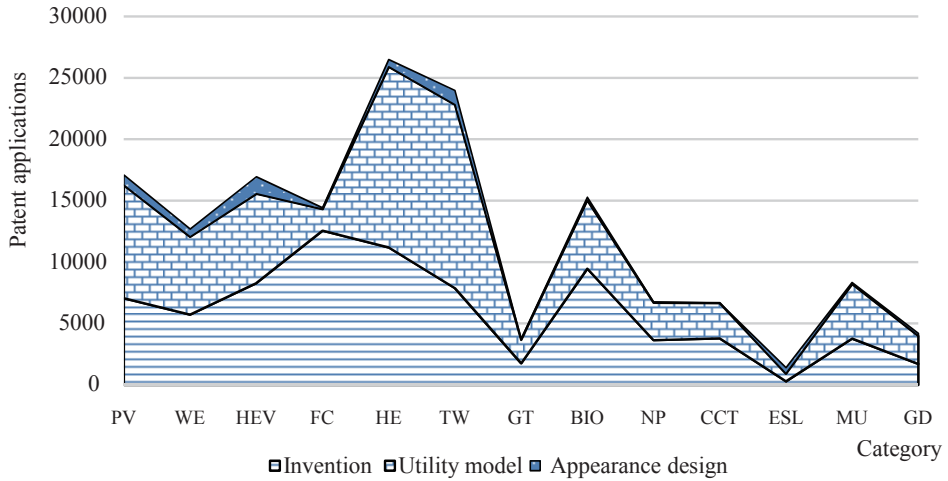
As indicated below of all branches sectors, the general trend appears to be sharp increases in China. Compared with 2013, CCT had the highest 24% growth rate in 2014, Nuclear Power the second with 20%. HE and TW technologies both had big gains with HE increasing 18% and TW one percent more. FC applications were up 12%, GT 4%, Bio 9%. ESL, PV, GD, BU, WP, HEV fell for, 11%, 10%, 7%, 6%, 1%, 1%. In the long term, the development of clean energy patents can divide into three stages: Initial stage (2002-2004), Growth stage (2004-2009) and Expansion stage (2009-2014). The first stage has a slow growth rate, since more and more concern converted to this sector, patent applications have been increasing steadily especially in FC, TW and HE fields. When times move on to the third stage, great expansion is shown across all fields. It is not only because the import of “green patent” and its construction in the research area for the first time, but also due to the promotion of innovation capacity and investment of green development, which lead to plenty of technology outcomes. It can be predicted that the trend will last in the near future with the view to the proposition of China’s green innovation strategy.



**Figure 6**  
**Trends of All Sectors Patents Application by Year 2002-2014**  
 Note. Resource: Own collection from SOOPAT

### 3.3.2 W\*: Low Quality of Patent Application & Grant

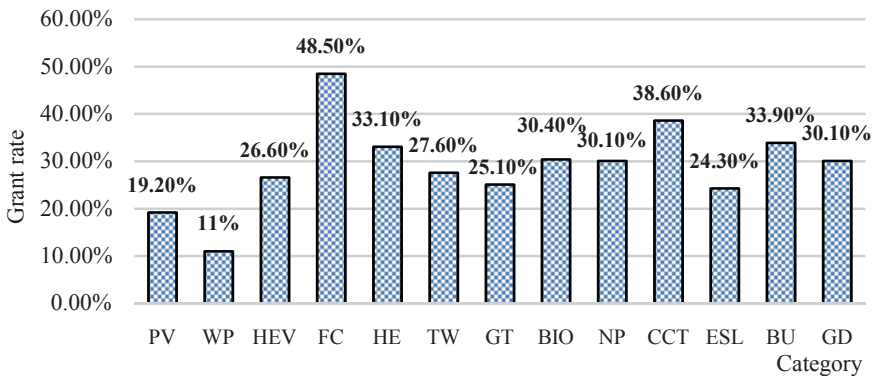
Generally, patent applications consist of three types: invention, utility model and appearance design, among which the number of invention applications is the signal of innovation capability in a country. On the contrary, the quality of applications in China is rather low in sharp contrast to the huge number in total. The graph shows the percentage of invention applications in the fields of HEV, GT, WP, BU, HE, PV, GD, TW, ESL is 48%, 46%, 45%, 45%, 42%, 41%, 40%, 32%, 20% separately, and FC gets a high proportion of 87% while Bio is 61% and CCT ranks the third by 56% of total patent applications. The average level is just 47%, which imply that there is a long way to go for China’s green patent development as to the quality of patent application.



**Figure 7**  
**Comparison of Three Kinds of Patent Distribution in China**

Note. Resource: Own collection from SOOPAT.

In addition, it is worth noting that the invention authorizations of clean energy are still very limited compare to the huge amount of applications. For example, PV’s applications are as high as 7053 while grants are as little as 1261 with the contrast ratio of 7:1, which reveals a dramatic gap between two sides. Typically, authorization rate = invention authorization / invention application number, which uncovers how many applications are granted, and the greater the rate, the higher the quality. China’s total patent authorization rate was 31.7% (1110971/3502683) by the end of 2012 (State intellectual Property Office of the P.R.C, 2012). The clean energy patent authorization rate is depicted below (see Figure 8), the average rate of which is just 29.1%, a little below the total rate. What it implies is the quality is lower than the average level in China. Particularly, regardless of the rate of PV, WP, HEV, TW, GT, ESL lower than the average, other industries are maintained an average level, and FC gets 48.5% to take over the highest.

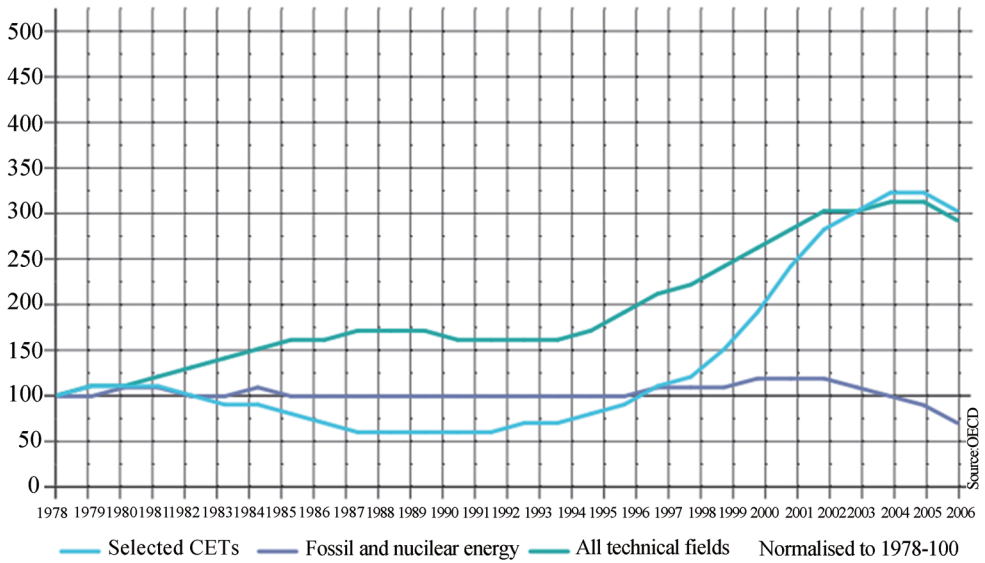


**Figure 8**  
**Clean Energy Invention Patents Authorization Rate (2002-2014)**

Note. Resource: Own collection from SOOPAT.

### 3.3.3 O\*: Strong Awareness for Clean Technology Development of the World

The following figure displays the patenting trends for selected CETs (clean energy technologies), including: PV, Solar thermal, Wind, Geothermal, Hydro/Marine, Biofuels, Carbon capture and storage, Integrated with gasification combined cycle. Technology development and rapid diffusion are thought to be crucial for tackling the climate change challenge. Although there is divergent among patent system and climate change issue, patent is vital for green technology transfer (United Nations Environment Programme et al, 2010). We can see a very noticeable trend stagnate in the 80s and even decrease in the early 90s for patents of CETs in Figure 5. Needless to say, the growth rate began to accelerate since the middle 90s, and some annual growth rate was even faster than 20%.



**Figure 9**  
**Aggregated Growth Rate of CET Claimed Priorities Patenting**  
 Note. Resource: UNEP, EPO and ICTSD Report.

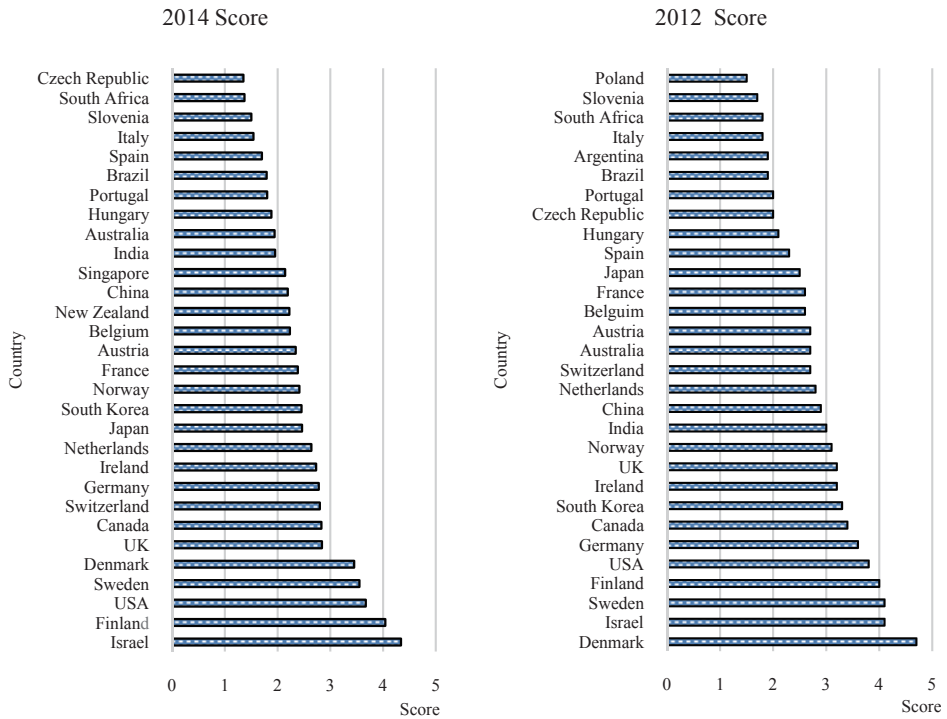
Besides, the fast growth was also confirmed by another patent grants data from the USPTO. US patents for clean energy technologies in 2014 were 3,609, which were 434 more in comparison with 2013. This gain more than tripled the previous year-to-year increase but was still far fewer than the increase of 730 between 2011 and 2012 (Clean Energy Patent Growth Index, 2014).

### 4.3.4 T\*: Gap between China and International Development

An innovation index map has been drawn according to the global cleantech innovation index (GCII). As a matter of fact, China’s clean technology patents ranked 13 in 2012 and 19 in 2014, which actually shrunk 6 degrees (see Figure 10). From 2012 report “China and India did not top the index in 2011, but they



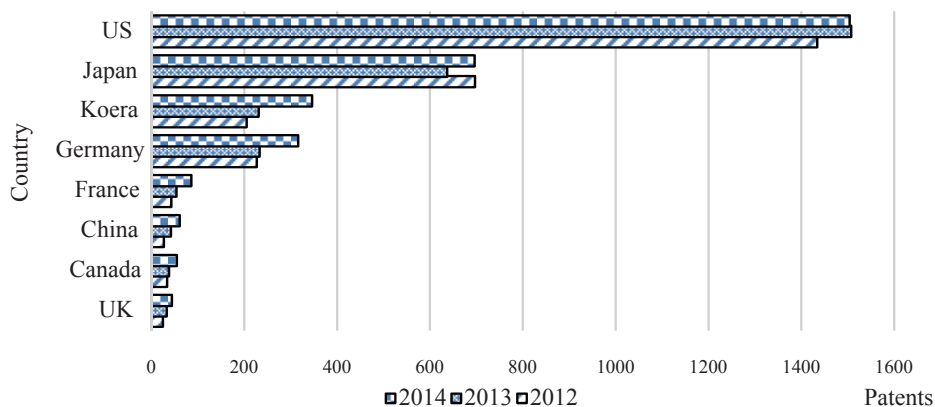
stand out as having a strong potential to rise through the ranks in the coming years. They are already strong centers for the production of cleantech products and have increasingly supportive governments, large sums of private money ready to be invested, and massive domestic markets” (GCII, 2012). After that changed to the saying from 2014 report “China took 19th place this year, due to its high availability of expansion capital and high sales generation from manufacturing of solar cells and other cleantech products” (GCII, 2014). Interestingly, these critics are somehow reflecting China’s innovation capacity slowdown a little. Conversely, Japan gained the highest promotion at 7 degrees ranked from 19 to 12, so was Switzerland from 15 to 8. US was up to No.3, and UK No.6. Particularly, Canada and Portugal were the same as 2012. On the whole, China’s index was always in the middle seat of the line, which proved a great need to develop the green patent in the future, since it’s defined as an important incentive of cleantech innovation by most scholars.



**Figure 10**  
**Global Cleantech Innovation Index (2012, 2014)**  
 Note. Resource: Own collection from GCII.

What is worse, another data collected from The Clean Energy Growth Index (CEGI) shows that the US and Japan continue to dominate in the number of granted patents from 2012 to 2014. As indicated below, the number of China’s granted patents jumped from 28 to 61, which was up 31 during last three years. Nevertheless, China only ranked No.8 in 2014 after three years of development,

which shows the shortage of China’s international competitiveness of green patent to date.

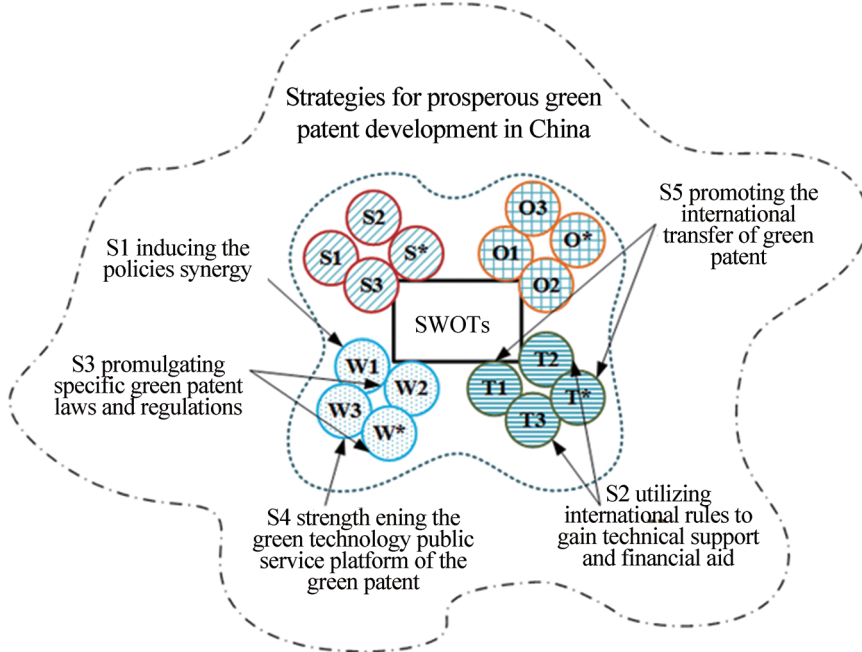


**Figure 11**  
**Clean Energy Patent for Top Countries (2012-2014)**  
 Note. Resource: Own collection from CEGI.

#### 4. STRATEGIES FOR PROMOTING GREEN PATENT IN CHINA

Based on the comprehensive SWOTs (quantitative & qualitative) identified above, this article proposed critical strategies for green patent development accordingly exhibited in figure 11. The basic principle of designing green patent strategies is “making strengths and opportunities maximize, weaknesses to strengths transform, and threats minimize”.

Five critical strategies have been drawn in Figure 11 apparently for addressing green patent development problems in China in the view of strategic planning. Namely, S1-inducing the policies synergy, S2-utilizing international rules to gain technical support and financial aid, S3-promulgating specific green patent laws and regulations, S4-strengthening the green technology public service platform of green patent, S5-promoting the international transfer of the green patent. Particularly, S1 is to address W1; S3 is mainly to deal with W2 and W\*; S2 is used to minimize the influence of T2 and T3; S4 is represented to address W3; S5 is mainly used to minimize the influence of T1 and T\*. The specific strategies proposed are discussed in the following section.



**Figure 11**  
**Strategies for Successful Green Patent Development**

#### 4.1 S1 Inducing the Policies Synergy

The synergism of multiple policies is regarded as a way of promoting the green patent to a new level since green technology widely covers many industries. As discussed above, policy coordination should be considered for further development, which means government will integrate with the intellectual property policy, industrial policy, fiscal policy, tax policy, cultural policy and other policies into a strong linkage system, and promote the policies to achieve the goal of maximizing the policy effect. To ensure the development of the green patent in China, following aspects must be highlighted currently: First, promote intellectual property policy coordination with other scientific policies effectively, in addition, strengthen cooperation of finance policy and tax policy. Lastly, enhance the synergism of culture, people and education policies of green patent.

#### 4.2 S2 Utilizing International Rules to Gain Technical Support and Financial Aid

As presented above in O2, which shows a great opportunity of international cooperation. S3 is to take the advantage of O2 and solve the barriers in T1 and T\*. In particular, utilize the regulations that pertain to green technology transfer and financial support effectively to gain some external support. Such as the UNFCCC (article 4.5) called for developed countries to help implement technology transfer in developing countries in 1992:

The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention. In this process, the developed country Parties shall support the development and enhancement of endogenous capacities and technologies of developing country Parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies;

the article 4.7 also stated that:

The extent to which developing country Parties will effectively implement their commitments under the Convention will depend on the effective implementation by developed country Parties of their commitments under the Convention related to financial resources and transfer of technology and will take fully into account that economic and social development and poverty eradication are the first and overriding priorities of the developing country Parties. (UNFCCC, 1992)

The Kyoto protocol repeated them in 1997. According to the World Bank, China renewable energy program also provided meaningful assistance especially in technology aid, capability construction and policy support. To boosting the driving force for green technology development, China should be adept at exploiting the above international rules in technology transfer and financial aid programs.

### **4.3 S3 Promulgating Specific Green Patent Laws and Regulations**

The detailed green patent related law is a blank in China from the discussion in W2, and regulations are incomplete as well. In this case, in order to make the legal system play a vital role in the development of green technology, China should take the initiative to promote construction of the green patent strategy through ecological adjustment of laws and regulations. Three aspects are contained: augment the patent law for environmental protection principles, establish a high efficiency patent system to protect the interest of green patentees, implement the compulsory licensing system reasonably, which is widely used in pharmaceutical and public health fields. Currently, considering the incomplete of green patent status quo, a high-performance system that specific for China is proposed. To reach this goal, numerous efforts from the cooperation of multiple institutions need to be done as follows:

- The first is to figure out what green technology includes. As described in section 2, there is still no uniform definition about green technology so far, so it's urgent to make it clear for future development;
- The second endeavor refers to patent application acceleration examination system; Since China has launched its first program in 2012, some refinements still required, such as formulate rigorous examination procedures to improve the quality of application as well as international

competitiveness, set up the classification of green technology to specify what sorts of technologies is qualified for green patent application;

- The last attempt is to ensure the green patent dissemination coupled with some incentive and oversight mechanisms, which mainly includes: reduce the costs of green patent applications and maintenance, continue to supervise the patents afterwards based on the specific content of each patent application in case to take preventive measures in time.

#### **4.4 S4 Strengthening the Green Technology Public Service Platform of the Green Patent**

In the light of the increasing severe international environment, every country around the world is shed light on strengthening the green science and technology innovation as a key choice, while providing powerful public service in the meantime. GTPS really is a strong foundation as for green development, which is also the key part of improving green patent as well. Particularly, the following steps should be maintained: at first, establish the R&D platform, which is the crucial role of green technology industrialization. Secondly, set up the green patent database, which is of great value for patent examiners and applicants. At last, to develop the green patent sharing mechanism, which is built by enterprises, government, industry institutions, research center together like the famous eco-patent commons and green technology package programs.

#### **4.5 S5 Promoting the International Transfer of the Green Patent**

Through the literature review in recent years, a clear trend of green patent development is international transfer. Different from green technology transfer, which is also a tough part needed to discuss, the green patent international transfer puts emphasis on non-market mechanism more than technology sector. Thus, S5 can be seen as the final step of promoting green patent development for not only because a large part of the core technologies are still controlled by developed countries, but also climate change issue can only be solved under the international cooperation framework. What's more, it can shorten the gap between China and foreign countries in the green patent field as well. As displayed before, weak willingness, finance and safe issues are the main factors that affect the green patent international transfer between countries. Thus, the measures are as follows: one is to make the best of a series of climate funds (see Table 5) properly, which is the best method that allows developing countries to gain the benefits of green technology. Besides, neither China has sufficient green patent laws, nor the world. Hence, strengthen the effects of international laws and regulations by subdividing close regulations and making the soft items tough. Most important, strong partnership across countries should be advocated to finally solve the climate change problem for the sake of human group interest.

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## CONCLUSION

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By executing a modified SWOT analysis, the internal and external conditions of the green patent in China were clearly displayed. The results of qualitative analysis recommend that while developing the green patent, China should rely on its strengths including strong awareness of the government about promoting green patent, rapidly growing capability of green technology innovation and more R&D investment from government. Besides, China also unfolds some weaknesses that mainly involve lack of cooperation of policy instrument, lack of green patent law regulation, and weak support platform for green technology innovation. These weaknesses would hamper future development for the green patent in a large scale. The analyses also present opportunities that China can use, such as successful global advanced experience, international cooperation of green technology development and international weather related fund, which form a solid understructure for promoting the green patent in China. Whereas, threats to prosperous green patent cannot be ignored, which mainly embody poor international environment for international transfer, obstacles from developed countries, and double barriers and investigation threats in international green trade.

Furthermore, the quantitative analysis also uncovers similar results. As to internal conditions, strengths encompass substantial growth in clean energy patent applications as well as weaknesses include low quality of patent application & grant. As for external conditions, the findings show big opportunities of strong awareness for clean technology development of the world, and gap between China and international development provided as threats in the end.

Built on the modified SWOTs, five critical strategies were proposed for ameliorating the green patent situation in China, which includes: S1-inducing the policies synergy, S2-utilizing international rules to gain technical support and financial aid, S3-promulgating specific green patent laws and regulations, S4-strengthening the green technology public service platform of the green patent, S5 promoting the international transfer of the green patent. It is critical to the modified SWOTs that contribute to the successful green patent development in China, which could also be useful for other industries that mean to enhance green development. When the strategies carried out by policy makers properly, it is quite possible for China to fulfill its green patent development successfully.

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