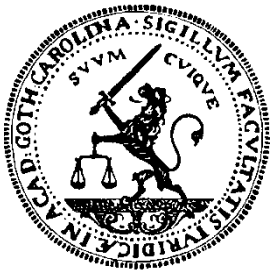

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Green Technology and Patents: in the European Context

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Contents

Summary

Green technologies are essential to the development of sustainable economy and environmental protection. Stimulating innovation in green technologies requires environmental policies, regulations, public awareness, and more importantly intellectual property protection such as patents. This thesis explores the significance of patents in the green innovation process, and how patents affect the firms' incentives and strategies. In addition, the possibility to establish a European accelerated examination on green patent applications is discussed. Few empirical experience from non-EU countries are referred to support the analysis. At the end, three conclusions are drawn: First, fast-gained patents are likely to generate more advantages than disadvantages for European innovators. Second, compared to larger companies, SMEs benefit more from the fast-tracking programs. Third, in order to speed up the pace of green transformation for innovators, accelerating green patent application is the most effective option among all others, such as slow-down patent procedure on polluting technologies.

Keywords: Green Technologies; Patents; CCMTs; Accelerated Patent Examination; European Innovators

Abbreviations

EU	European Union
CCMTs	Climate Change Mitigation Technologies
R&D	Research and Development
UNEP	The United Nations Environment Program
EPO	European Patent Office
OECD	The Organization for Economic Co-operation and Development
CETs	Clean Energy Technologies
EPC	The European Patent Convention
ECCP	European Climate Change Program
EU ETS	The European Union Greenhouse Gas Emission Trading Scheme
NICs	Newly Industrialized Countries
ICTSD	International Centre for Trade and Sustainable Development
UNCED	The United Nations Conference on Environment and Development

1. Introduction

1.1 Background

Since the 1950s, climate change has become a great interest to the world at large, scientific as well as political discussions. The term ‘climate change’ encompasses not only rising average temperatures but also extreme weather events, shifting wildlife populations and habitats, and a range of other impacts.[1] Although climate has been changing since the beginning of creation, but what is alarming is the speed of changes in recent years.[2] In the last two centuries, global temperature has witnessed a rise of 1.01 °C compared with year of 1880. Warming oceans and shrinking ice sheets are other two strong evidence indicating this accelerating global warming. So far, effect of those series of climate change were predicted to have caused rising sea level and irregular intense heat waves. Scientific evidence have further shown that this is driven largely by increased carbon dioxide and other human-made emissions into the atmosphere.[3] In Europe, a link between human activities and abnormal summer heat has also been found: key hotspots emerge particularly along coastlines and in floodplains in Southern and Western Europe, which are often highly populated and economically pivotal.[4]

In order to eliminate these environmental footprints caused by human activities, environmental ideas emerged and started growing in a wider range of recognition in the last century. These ideas, with the goal of mitigating the climate change, especially carbon dioxide emission, have been applied in various environmental policies in the areas of green politics, technologies, and social movements. These climate-friendly policies commonly consist of three pillars, namely subsidizing (or issuing tax credits for) the activity, regulating the activity (mandating its performance or controlling the price of inputs), and internalizing the externality by granting intellectual property rights that allow some appropriation of the social benefits.[5] Encouraged by these environmental policies, inventions of climate change mitigation have seen a steady growth, which is much faster than that of non-green inventions.

In 2014, the European Union (the EU)committed to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990 levels. This goal can only be met through the development and deployment of green

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[1] Christina Nunez, ‘What is Global Warming, Explained: the Planet is Heating up—and Fast’ (National Geographic, 22 Jan 2019) <https://www.nationalgeographic.com/environment/global-warming/global-warming-overview/> accessed 12 April 2020

[2] Phebe Owusu and Samuel Asumadu-Sarkodie, ‘A Review of Renewable Energy Sources, Sustainability Issues and Climate Change Mitigation’ (2016) Cogent Engineering <https://doi.org/10.1080/23311916.2016.1167990> accessed 11 May 2020

[3] NASA, ‘Facts about the Climate Change Climate Change: How do we Know?’ <https://climate.nasa.gov/evidence/> accessed 11 May 2020

[4] Giovanni Forzieri and others, ‘Multi-hazard Assessment in Europe Under Climate Change’ (2016) 137 Climatic Change 105, 119

[5] Bronwyn Hughes Hall and Christian Helmers, ‘Innovation and Diffusion of Clean/Green Technology: Can Patent Commons Help?’ (2013) 66 J Environ Econ Manage 33, 51

climate change mitigation technologies (CCMTs).[6] This is because these green innovations drive down the cost of pollution abatement, which results in welfare gains. The same environmental quality may be achieved with fewer factor inputs devoted to abatement. In this aspect, environmental quality is improved for the same amount of factor inputs.[7]

In order to measure this green technical revolution, patent information, generated by patent offices through their daily operations, is increasingly used by both policy makers and companies to monitor the technical developments and patenting activities of rivals and other undertakings.[8] In addition to this 'indicating' function, a series of studies have found that patents are significant to innovators, in particular SMEs, in appropriating the benefits from their innovations. The main reason for this is to prevent free riders from imitating the same technologies at a very low cost. In business negotiation, merger and acquisitions, patents can also be seen as the valuable assets. On the other hand, the disadvantages of patents, however, express the concern that patents may hinder the green transfer. This leads to the discussion whether patents play a positive role in the green technical evolution.

In terms of the oppositions, individuals hold that patents nowadays are often used as the weapons to block new entrants and disrupt the market though they confer legal exclusivity. This is particular the case when it comes to the green trade in the North-South cooperation. Robert Ondhowe, legal officer at the United Nations Environment Program (UNEP), held that the role played by patents was shown to be a hindrance in the non-developed nations. According to an empirical study performed jointly by the European Patent Office (EPO) and UNEP in climate change mitigation technologies, less than 1% of all patent applications relating to clean energy technologies worldwide have been filed in Africa, and figure in Latin America accounts for less than 3%.[9] This may reflect two points:

(1) Patents are barely used in the countries with less intense domestic competition: generally, the economic growth materially determines whether it is worthwhile to obtain a patent. If the competition is fierce, innovators are more motivated to obtain a patent as it secures the market position and prevents a rise of new rivals. In this aspect, patents are used more as a pure business strategy, which may distort the normal competition.

(2) Patents do not serve the goal of green knowledge diffusion and transfer: these recipient countries, mostly developing countries, lack absorptive capacities, which mainly include skilled technical

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[6] UNEP and EPO, 'Climate Change Mitigation Technologies in Europe—Evidence from Patent and Economic Data' <www.epo.org/climate-europ> accessed 12 May 2020

[7] OECD, *Environmental Policy, Technological Innovation and Patents, OECD Studies on Environmental Innovation* (OECD Publishing 2008)

[8] Sadao Nagaoka, Kazuyuki Motohashi and Akira Goto, 'Patent Statistics as an Innovation Indicator' (2010) 2 Handbook of the Economics of Innovation 1083, 1127

[9] UNEP, EPO and ICTSD, 'Patents and Clean Energy: Bridging the Gap Between Evidence and Policy: Final Report' (2010) <https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/Patents_%20and_clean_energy%20-%20bridging_the_gap_between_evidence_and_policy_UNEP.pdf> accessed 15 March 2020

personnel, information on available technologies, and high transaction costs,[10] to adopt and further develop the technologies.[11] The short of these capacities already presents a formidable barrier for a national technology to rise. If patents are invoked, it will be more difficult for local innovators to develop competitive substitutes as the market will be legally divided by existing large entities and foreign investors. In addition, the high charge of patent application is also a factor impeding the green innovation, as large undertakings could file for a patent over a same technology first. All of these factors imply a negative influence of patents.

In response to these concerns, supporters of patents argue that the low accounts of green patents out of all patents protected in the regions of Africa and Latin America, nevertheless indicate that patents cannot be a significant hindrance to technical development because the most innovators did not choose patents. In addition to that, evidence have been found in these areas that only a limited number of patents impose restrictions on their use locally though their technical knowledge can be accessed freely by the public.[12] That is to say, patents are not likely to be the obstacles for local innovation. However, whether or not patents facilitate the technology transfer is also not clear from this study.

In order to figure out what the role of patent in the green innovation and transfer, the EPO has established a dedicated tagging scheme for climate change mitigation technologies (Y02/Y04S scheme), which covers vast areas of buildings, production, energy, waste treatment and transport. This scheme helps search the information about green tech in patents. Together with the EPO's Espacenet and World-wide Patent Statistical Database (PATSTAT) services, a bosom in green technology inventions has been witnessed in the past two decades. With the number of nearly 6000 'High-value'(patent family contains over 3 patents) CCMTs inventions at the end of 2011, twice the figure of the USA, Europe has become the first leading force in the green technologies.[13] The increasing green patents in Europe illustrate the necessity of patent system in the exchange of disclosure and protection. In the case of R&D investment, the EPO president António Campinos held that

> "*Patent information is also instrumental as it allows inventors to build upon, and improve, existing technology. It gives researchers the tools they need to develop new solutions to mitigate and accommodate climate change. And it allows businesses to take effective, well-reasoned business decisions.*" [14]

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[10] Bert Metz and others, *Methodological and Technological Issues in Technology Transfer: A Special Report of the Intergovernmental Panel on Climate Change* (CUP 2000)

[11] Keller Wolfgang, 'Absorptive capacity: On the Creation and Acquisition of Technology in Development' (1996) 49 Journal of Development Economics 199, 227

[12] UNEP and EPO (n 6) 15

[13] Ivan Haščič and others, 'Climate Policy and Technological Innovation and Transfer: An Overview of Trends and Recent Empirical Results' (2010) 30 OECD Publishing <https://doi.org/10.1787/5km33bnggcd0-en>accessed 12 May 2020

[14] António Campinos, 'The EPO supporting innovation in Europe' (Green Technologies and Renewable Energies—Innovating and Patenting, Oslo, November 2018) <https://www.epo.org/service-support/updates/2019/20190412a.html> accessed 4 April 2020

This positive opinion, as well as the opposition presented earlier, is reasonable in their own, but which one is closer to the fact? The core of this analysis is to see if the actual effects of patents match the goal of green innovation and diffusion. Defined in Article 2 in Paris Agreement 2015, in the context of sustainable development and efforts to eradicate poverty, technology transfer and innovation diffusion must be promoted to reach the goals, summarized as 'green climate mitigation':

> *(a) Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;*
> *(b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and*
> *(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.*[15]

With this reference, the analysis is to examine the role of patents in reducing the influences of climate change, increasing the sustainability ability and generating benefits from climate-resilient development. More specifically, it is whether patents could generate large incentive for innovators to turn green and what the unique advantages patents bring in the technical innovation.

1.2 Research questions

This thesis focuses on the role of patents in the green technology innovation. In the context of climate change mitigation, the purpose of the thesis is to offer a constructive view to the current European Patent System regarding its possible changes. Those changes may include the introduction of an accelerated examination on green patent applications and a possible slow-down patent procedure for polluting technologies. Whether these changes could facilitate such green innovation will also be the focus of this study. In order to achieve these purposes, the following research questions are addressed:

1. **What is the role of patents in the green technology innovation and transfer?**
2. **Whether a European accelerated examination can be introduced to speed up green patent applications? Can a decelerated examination be established on polluting patent applications?**

[15] Paris Agreement under the United Nations Framework Convention on Climate Change (adopted 12 December 2015, entered into force 4 November 2016) (Paris Agreement) art 2

1.3 Methodology and material

The thesis employs the method of extraction and combination in the analysis of different elements and concepts of green technology, which stem from the previous studies and reports from the EPO, the Organization for Economic Co-operation and Development (OECD) and other Patent Offices in other jurisdictions. In the argumentation, statistics from different Patent Offices are extracted and reframed. In addition, the thesis conducts the legal comparisons between different jurisdictions in terms of their accelerated programs on green related patents. These comparisons include legal-dogmatic analysis of the existing legal texts, combination and extraction of statistics on program participation and the effects to applicants.

The most significant sources in the investigation are reports of the conference 'Green Technologies and Renewable Energies - Innovating and Patenting' (Oslo 2018), reports 'Patents and Clean energy: Bridging the Gap' and studies in CCMTs conducted jointly by UNEP and EPO. Instructions and studies given and conducted by the OECD and other national Patent Offices are used as the supporting sources. Some examples originating from the Y02/Y04S scheme and legislations such as Paris Convention 2015, European Patent Convention (EPC) and national law from both EU Member States and non-EU countries/regions are of equal importance.

1.4 Outline

The thesis will be divided into four chapters:

(1) In the first chapter, different concepts of 'green technology' will be discussed, followed by the introduction of Y02/Y04S scheme, which is also known as the classification for green technologies. The importance of green technologies for European innovators is also stressed.

(2) The second chapter starts from the concept of green patent. The main attention will be paid to the role of patents in the green technology innovation and transfer: what are the incentives and drawbacks patents bring to the innovators and industries. According to the statistics and reports from the EPO, green patents are presumed to support the green revolution.

(3) The third chapter examines whether a fast-tracking procedure can be introduced in the current European patent system(European Patent Convention (EPC)). Relevant hypothetical cases and legislations from other jurisdictions will be added to support the analysis. In addition, the possibility of a slow-down patent examination on 'polluting technologies' is also to be discussed.

(4) In the final chapter, a conclusion to the two research questions will be given.

2. Green Technology

2.1 What is green technology

The concept of Green Technology originates from the environmental movement in the early 1970s. Since then, much attention was directed to the control of damaging effects of industrial pollution and mitigation of global climate change.[16] During this period, 'sustainable development,' 'ecological sustainability,' 'sustained use of the biosphere' and 'climate change mitigation' also became popular words used in the environmental policy and research field.[17] However, there is no world-widely recognized definition of green technology as countries and regions only extract and compare the elements which best suit their own circumstances. Thus, to establish a concept that suits the EU, three questions need to be answered priorly: what is the concept of 'green,' what are the substitutive concepts of it and relevant elements of a 'green technology.'

(1) First, the term 'green' is merely a comparatively directed concept. It is always in continuous alteration along with our further understanding of the effects of humans and technology on our natural environment. In the *Oxford English Dictionary,* the concept of 'green' is defined as 'relating to the protection of the environment.' In this aspect, the application of 'green' involves the use of natural products and energy in a way that does not harm the environment. [18]

(2) Second, there are numerous similar terms with 'green,' for example, 'clean,' 'sustainable,' 'climate change mitigation' and so on. 'Clean' has the meaning of 'free from harmful or unpleasant substances.'[19] It is capable of constituting a complete substitute for 'green' in the scope of technical development and environmental protection. In comparison, 'sustainable' stresses a long-term development. Most of the time, the delimitation between 'green' and 'sustainable' is trivial and both terms are regarded as overlapping and substitutes for each other. Similarly, the term 'climate change mitigation' and 'green' also have a wide range of overlap. The UNEP defines 'climate change mitigation' as 'efforts to reduce or prevent emission of greenhouse gases.'[20] However, mitigation does not necessarily mean mitigation in a green or sustainable way. Some technologies may at the same time impose a risk of harming the ecology, i.e., nuclear technology. Thus, 'climate change mitigation' and 'green' are only substitutes when mitigation is in compliance with the goal of sustainability or environmental maintenance. In analogy, other terms can also constitute the substitutes of 'green' in the scope without causing damage to the environment. All these terms used in the later analysis are assumed to be discussed in their overlapping scopes within the term 'green.'

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[16] Samir Billatos and Nadia A. Basaly, *Green Technology and Design for the Environment* (CRC 1997) 3

[17] Becky J. Brown and others, 'Global Sustainability: Toward Definition' (1987) 11 Environmental Management 713, 719

[18] 'Green', *Oxford English Dictionary* (2nd edn, OUP 1989)

[19] ibid (n 18) 'Clean'

[20] UN Environmental Programme, 'Mitigation: UN Environment Takes a Multifaceted Approach Towards Climate Change Mitigation in its Efforts to Help Countries Move Towards Climate-resilient and Low Emissions Strategies.' <https://www.unenvironment.org/explore-topics/climate-change/what-we-do/mitigation>accessed 12 May 2020

(3) Third, despite the broad interpretation of 'green,' its boundary is nevertheless confined with some fundamental preconditions, such as public's awareness of green, the ecological influences and realistic ecological functions. Those preconditions vary from country to country, and render great difficulties to achieve a commonly agreed definition of 'green.' However, there are ranges of contexts and scales where such definition can be developed in a specific region. In order to correctly understand the elements of 'green technology.' It is significant to consider two relevant definitions below.

In 1987, the 'Brundtland Report' (World Commission on Environment and Development) from the United Nations framed 'sustainable development' as '…development that meets the needs of the present without compromising the ability of future generations to meet their own needs.' This idea was first widely articulated and it posits that the only truly sustainable form of progress is that which simultaneously addresses the interlinked aspects of economy, environment and social well-being.[21] If we consider 'green' and 'sustainable' are substitutes, 'green' should also reflect the potential social economic impact on human society in both short and long terms.

In 1992, the term 'Environmentally Sound Technologies' was established to refer to the technologies that protect the environment, are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products and handle residual wastes in a more acceptable manner than the technologies for which they were substitutes.[22] The wordings of 'sustainable manner' and 'acceptable manner' in this concept further indicate that the boundary of 'green' should also be interpreted in a broad sense and be established on a precondition of not doing harm to existing social productivity and the living standard of human beings, but attempting to diminish any destructive consequence caused to the ecology by technology and production that may endanger survival of human kind.[23]

Therefore, a correct understanding in green technology requires a number of related knowledge in its comprehensive impacts on both social economic and ecologically environmental levels. The existence of a green technology is based on public's awareness to maintain natural sustainability that affects the sustainability of human life. Therefore, the term 'green technology' is a systems-level approach to product and process design where environmental attributes are treated as primary objectives or opportunities, rather than as simple constraints, and emphasizes the legitimacy of environmental objectives as consistent with the overall requirements of product quality and economy.[24]

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[21] Paul Johnston and others, 'Reclaiming the Definition of Sustainability' (2007) 14 Environmental Science and Pollution Research 60

[22] UNCED, 'The Rio Declaration on Environment and Development, and the Statement of Principles for the Sustainable Management of Forests '(UNCED Earth Summit Agenda 21, Rio, June 1992) <https://sustainabledevelopment.un.org/outcomedocuments/agenda21>accessed 12 May 2020

[23] Xiaoqing Heng and Chengxiao Zou, 'How Can Green Technology Be Possible' (2010) 6 Asian Social Science <https://www.researchgate.net/publication/43199065_How_Can_Green_Technology_Be_Possible> accessed 12 May 2020

[24] ibid (n 16)

2.2 The category of green technologies:

Green technologies involves numerous types of production and consumption technologies. The type depends largely on 'what the technology is for' instead of 'how green the technology is.' That is because green technologies are designed with a specific goal, which is to meet the certain need in that industry. For example, a hydrolysis system to neutralize toxic chemicals falls into the group 'pollution prevention and control.' The actual effect of this system, such as whether it results in a complete toxic decomposition, is not part of the consideration. Moreover, it is not categorized as 'waste management' or any others as it is not designed to have the corresponding function. Thus, green technologies can be split into certain groups by their goal for which it is designed. Based on the same reasoning, the 2005 Oslo Manual divides the environmental innovations into organizational, product and process innovations as these three stages are indispensable in the manufacturing line.[25] Inspired by this method, a tailored category system for green tech is given below:

(1) The first type is 'pollution prevention technology.' The term 'pollution' stands for the presence in or introduction into the environment of a substance which has harmful or poisonous effects.[26] In a board sense, a pollution covers excessive greenhouse emissions that result in adverse global climate change. Thus in terms of technical inventions that prevent pollution, they differ from 'management/ organizational innovations,' which exist *ex ante* the production starts. Although management/ organizational innovations are also necessary to pollution prevention and control, it is difficult to find these 'innovations' inherently technical or green. Based on this reason, organizational measures are excluded from being a type of green technologies. When the production process begins, the prevention of pollution is achieved by redesigning the manufacturing processes that may cause harmful by-products.

(2) The second type is 'pollution control technology,' known as 'end-of-pipe solution.' It refers to treatment of pollution that already exists. This is process-related but different compared to 'pollution prevention technology,' which is seen as directly reducing environmentally harmful impacts during the production process. By contrast, end-of-pipe technologies do not make up an essential part of the production process, but are add-on measures so as to comply with environmental requirements. Incineration plants (waste disposal), waste water treatment plants (water protection), sound absorbers (noise abatement), and exhaust-gas cleaning equipment (air quality control) are all typical examples of end-of-pipe technologies.[27]

(3) The third type is 'product enhancing technology.' This aims to improve the greenness of products so as to reduce the involvement of processes that have detrimental effect. Furthermore, by adding features that result in less waste and pollution during operating use, these technologies are leading the innovations in the industries.

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[25] OECD, Eurostat and European Union, 'Proposed Guidelines for Collecting and Interpreting Technological Innovation Data: Oslo Manual, The Measurement of Scientific and Technological Activities' (3 April 1997) <http://www.oecd.org/science/inno/2367614.pdf> accessed 6 April 2020

[26] ibid (n 18) 'Pollution'

[27] Manuel Frondel, Jens Horbach and Klaus Rennings, 'Working Paper End-of-Pipe or Cleaner Production? An Empirical Comparison of Environmental Innovation Decisions Across OECD Countries' (2004) ZEW Discussion Papers <https://www.econstor.eu/bitstream/10419/24090/1/dp0482.pdf>accessed 12 May 2020

These three types of green technologies, together with management/organizational measures, consist of a complete chain to eliminate pollutants to the environment and prevent adverse global climate changes. It reflects a vast sectors and industries green technologies could apply, for example agriculture, energy, water and waste management, building, transport and so on.

2.3 Strengths for European innovators to develop and adopt green technologies

2.3.1 Environmental policies

Green technology adoption is not a passive, one-way process. It is driven largely by the intensive legislations and policies. The environmental policies adopted by the EU has been significantly intertwined with both International and national environmental policies. Currently, the estimated body of EU environmental laws amounts to exceed 500, including decisions, directives and regulations. The aims behind are well known as to promote more and better innovation and establishing a resource-efficient and climate-resilient society and economy in sync with the natural environment.[28]

In all environmental policies, global warming is one of the major areas. It can further be divided into European Climate Change Program (ECCP), launched in June 2000, and the European Union Greenhouse Gas Emission Trading Scheme (EU ETS), which is an important contribution of the ECCP and remains the largest greenhouse gas emissions trading scheme so far in the world. In recent years, the importance of environmental policies in the green revolution has been widely recognized. For example, during the years 2009-2014, the number of legislative proposals in the sector of climate tripled to 13 compared to the figure in the previous five-year period (Burns, Eckersley& Tobin 2019). These increasing environmental laws not only force the Member States to engage more in the environment initiatives, but provide incentives for a series of firms to embrace green sustainability into their business mode(Aragon−Correa and Sharma, 2003; Lee, 2009).[29]

2.3.2 Public green awareness

The increasing public green awareness in the EU also forms an internal push. Theoretically, a high public environmental awareness should result in more green purchases, which would in turn create incentives for innovators to turn green. This part is to examine the whether there is a positive relation between these two factors. The data come from the questionnaire conducted by European Commission to the citizens in all EU countries. Two most relevant questions are raised: personal importance of environmental protection and whether they would be ready to buy environmentally friendly products even if they were more expensive than ‘normal’ products. The figure 1 shows the portions by different answers collected.

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[28] Commission, ‘Horizon 2020—the EU's New Research and Innovation Program’ (Conference Memo, Brussels, December 2013) <http://europa.eu/rapid/press-release_MEMO-13-1085_en.htm> accessed 14 April 2020

[29] Ki−Hoon Lee and Ji−Whan Kim, ‘Integrating Suppliers into Green Product Innovation Development: An Empirical Case Study in the Semiconductor Industry’ (2011) 20/8 Business Strategy and the Environment 527, 538

In terms of the first question, Europeans attach an overwhelming importance to protecting the environment. Almost everybody says that it is very or fairly important to them (96%) and they are inclined to rank the issue as very important (64%)rather than fairly important(32%). Moreover, when it comes to importance of the joint effort of environmental intention and action, 79% respondents agree it is very important, compared to 20% of fairly important. In this sense, it can be said that almost all Europeans consider the protection of the environment to be highly important.

For the second question that whether they will take actions in practice of their environmental awareness, such as paying higher for a green product, exactly three-quarters (25% totally agree and 50% tend to agree) say they would be willing to do this while nearly a fifth is not willing to change consumer habits in this respect. In this sense, environmentally friendly attitudes do not necessarily lead to environmentally friendly actions, mainly known as the green assumption. Though 75% respondents in the poll said they are ready to buy environmentally friendly products even if they are more expensive, only 17% have actually done so in the month before the survey.[30]

This inconsistency reflects that high environmental awareness may not lead to an action such as more green purchases. This is because consumers' action is more largely affected by a series of factors, in particular the price concern and whether they know the product is green or not before purchasing(green label or any other indiction). In this aspect, environmental awareness is not a determining factor but an influential factor. However, that could say if the green product sets the price at the same level with other substitute non-green products, green products will be more attractive for consumers. The high public green awareness presents a considerable market potential for companies and producers to modify existing products and develop new ones that are less harmful to the environment, provided their price are similar. [31]

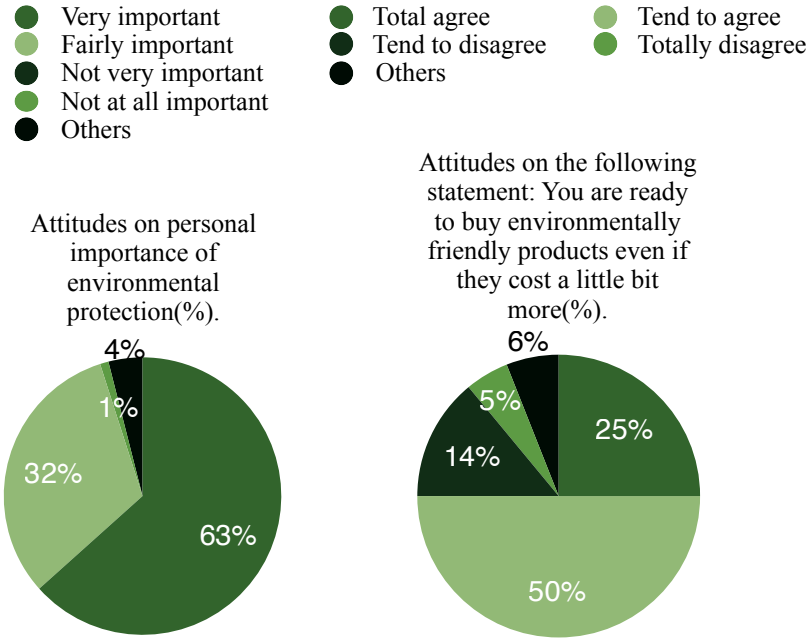

Figure 1: Intentions on green purchasing

Source: Attitudes of European citizens towards the environment, European Commission Report

[30] European Commission, *Attitudes of European Citizens Towards the Environment* (EU Publications 2017)

[31] Melody E. Schuhwerk and Roxanne Lefkoff-Hagius, 'Green or Non-Green? Does Type of Appeal Matter When Advertising a Green Product?' (1995) 24/2 Journal of Advertising 45, 54

2.3.3 Market potential for a commercial success

Commercial success is another generator of green motivations. It is closely linked to the relevant market potential and firms' performance. In the greenfield, the market potential varies due to the differences of individual countries in terms of economic development, social system, historical background and value concepts, and more importantly, capacity and infrastructure to support green production and management. Because of these differences, the green technical information flows not only from industrialized economies to the developing world, but also within developed economies. On the demand side, the need for a successful absorption of green technologies in the recipient countries, which are mostly newly industrialized countries (NICs), presents a huge external business potential for European innovators:[32]

(1) Firstly, environmental pollution and health related issues are becoming major issues in NICs. A great number of sustainable/green/clean technologies would help solve this domestic environmental pressure.

(2) Secondly, analyzed green technologies part of the economic modernization, as they are able to improve the infrastructure, e.g., in the energy, water or transportation sector, or address the growing demand for raw materials.

(3) Thirdly, moving towards environmental sustainability generates huge international markets for green trade. It is estimated that the green technologies are becoming a major market in the future, with average annual growth rates for technology demand in the fields of energy supply, energy efficiency, transport, water technologies and material efficiency in the order of 5 to 8% per year. These high growth rates will lead to an annual demand for technologies in these five fields above 2,000 billion Euro in 2020 (Roland Berger 2007; Ecorys et al. 2009). Thus, by supplying the world market a NIC is more likely to compete for the lead roles with the countries of the North.[33]

These local pull factors, along with the market demand from relatively less developed Member States, consist of the external push for European innovators to engage more and input more in the case of green R&D activities.

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[32] World Intellectual Property Organization, 'World Intellectual Property Report 2011: The Changing Face of Innovation' (Report, Geneva, 2011)<www.wipo.int/freepublications/en/intproperty/944/wipo_pub_944_2011.pdf > accessed 05 March 2020

[33] Rainer Walz, 'Competences for Green Development and Leapfrogging in Newly Industrializing Countries' (2010) 7/2 Int Econ Econ Policy 245, 265 <https://doi.org/10.1007/s10368-010-0164-x> accessed 1 April 2020

3. Green patents

3.1 Patents as the indicators of green innovation

Patent data are increasingly used to measure the green innovation activities these years. Although numerous ways have been designed to help provide decision-making information for policy makers, these measures all have drawbacks.[34] For instance, research and development (R&D)data is unsatisfactory, as it measures an input to innovation, rather than an output. Data on scientific personnel possesses a similar drawback. In recent years, a new biblio-metric data has been used, however, it can render a great difficulty to develop efficient search strategies, and the link between publication and value is likely to be imperfect at best.[35] Thus, to obtain the data from the 'output' of innovation process, patent system has been used as it provides a wealth of information on both the nature of the invention and the applicant. More importantly, patent data can be disaggregated into specific technological areas. It also provides information about not only the countries where these new technologies are developed but also where they are used.[36] In terms of the wind-related patents for instance, high patent growth rates have resulted in a very significant increase in the rate of deployment of these technologies. Figure 2 illustrates a positive correlation between patenting growth and the rate of deployment for wind energy technologies. In this case the time lag between the growth of patents and the market growth seems to be 5–10 years. A steep increase in patenting predates the take-off of deployment by a few years, also indicating that growth in patent activities can be an indicator for market prospects.[37]

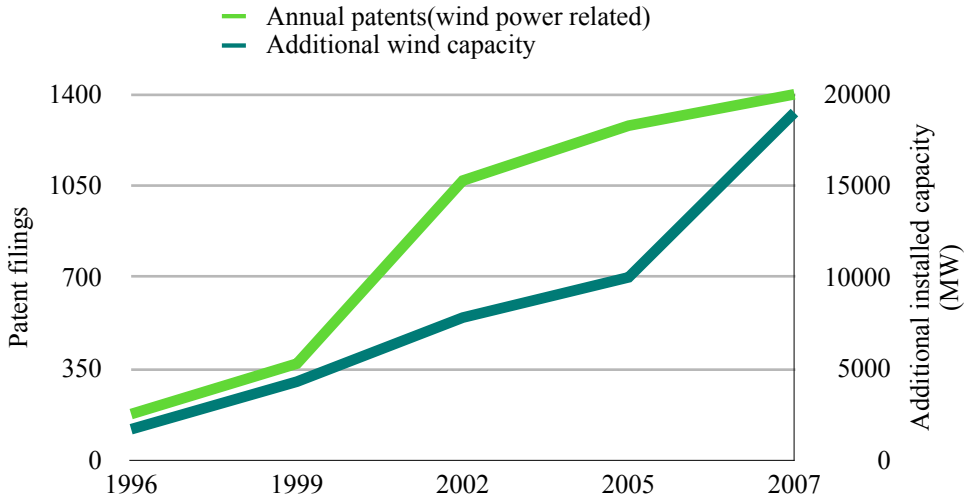

Figure 2: Patent filings and deployment of wind energy technology

Source: Lee, et al., 2009

[34] OECD, 'Main Science and Technology Indicators R&D Highlights' (28 Feb, 2020) <https://www.oecd.org/sti/msti.htm> accessed 12 May 2020

[35] ibid (n 13)

[36] Antoine Dechezleprêtre and others, 'Invention and Transfer of Climate Change–Mitigation Technologies: A Global Analysis' (2011) 5 Review of Environmental Economics and Policy 109, 130

[37] Mirei Isaka, 'Intellectual Property Rights: the Role of Patents in Renewable Energy Technology Innovation, International Renewable Energy Agency' (2013) International Renewable Energy <https://www.irena.org/documentdownloads/publications/intellectual_property_rights.pdf> accessed 8 April 2020

Furthermore, patent system contains a rich pool of classifications of all kins of technologies, which allows very specific 'environmental' technologies to be identified —for example, a distinction can be drawn between air pollution control devices designed to reduce NO_X emissions and devices designed to control SO_2 emissions. In addition, each patent application can be classified in multiple classes (unlike commodity or sectoral classifications), which allows for refined searches when inventions are horizontal in nature (e.g., fuel cells for mobile uses). And finally, keyword searches can be used to refine the searches.[38] All these unique characteristics make patent data best suitable for identifying and measuring specially green innovations.

3.2 The general benefits: patents and trade secrets

In addition to the 'indicating' function, patents also safeguard firm's innovations. The nature of patent right vests individuals and organizations with an exclusive monopoly on their inventions for a limited term of up to 20 years. If a European patent has been granted, the same protection as would be conferred by a national patent granted in the Member State concerned will be given.[39] The patent rights include but not limit to where the subject matter of a patent is a product, to prevent third parties not having the owner's consent from the acts of: making, using, offering for sale, selling, or importing for these purposes that product.[40] In this way, a patent enables the proprietor to prevent its competitors from free riding over the same technologies without affecting the next-stage innovations where the published technical information may be used. In this sense, patents facilitate an efficient allocation of resources, that is, more resources will be distributed to innovations instead of commercial competition.

However, some innovators may seek trade secrets over patents to protect their technical knowledge. In general, the law governing the patent and trade secret serves two very different purposes in the society: patent law mainly serves to promote the sharing of information, while the trade secret aims to protect an individual or an undertaking from theft and promote secrecy. The main differences between these two protection mechanisms include term of protection, cost, requirement of disclosure and scope of right, as listed below:

(1) Patent confers its proprietor an exclusive right to prevent others from making, selling, using or importing the same invention or technology. In contrast, the trade secrets only prohibits misappropriation.

(2) While patent is granted the technical knowledge will be made available to public but this is not the case in trade secrets. The information still remains out of public reach and protected under secrecy.

(3) In the granite procedure, patent applicants are required to file a formal application before the substantive examination in the Patent Office. No such formalities are asked to obtain trade secrets.

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[38] Ivan Haščič and Mauro Migotto, 'Measuring Environmental Innovation Using Patent Data, (2015) 89 OECD Environment Working Papers <https://dx.doi.org/10.1787/5js009kf48xw-en> accessed 16 March 2020

[39] Convention on the Grant of European Patents (European Patent Convention, as revised) (EPC) art 64

[40] Agreement on Trade-related Aspect of Intellectual Property Rights (15 April 1994) (TRIPS Agreement) art. 28

(4) *The duration for the granting of EU patents is approximately 4-5 years which is way more than trade secret, as they take the time as long as it takes to establish and maintain the internal procedure only.*

(5) *The term of protection of patent is 20 years at maximum, whilst the term in case of trade secrets is permanent.*

(6) *The cost and expenditure in patent application is more in comparison to trade secrets, which requires only the fees raised in internal procedures). The real cost could vary from country to country.*[41]

Although patents and trade secrets provide similar protection, they are not in substitution relation. A study conducted through the survey sent to the main industrial sectors in the EU 24 (EU 24, excluding Spain, France and Denmark) has provided some preferences by companies between patents and trade secrets. In the years 2010-2012, as figure 3 illustrates, 52.3% of firms used trade secrets to protect their innovations, and 31.7% of firms chose patents. The preference also differs among companies with different sizes. To be more specific, trade secrets were used by 69.1% and patents by 52.8% of the larger companies, compared to 51.2% and 30.4%, respectively, among SMEs.[42]

Figure 3 The firm's preference between trade secrets and patents

Source: EUIPO

The data indicate that without considering other intellectual property mechanisms, a combination of patent and trade secret protection remains more popular than a mere single protection of those, regardless of the company size. This 'combined' strategy is commonly adopted when technological uncertainty is high and when their innovation has a higher degree of novelty and requires significant financial investment. If a company, especially SME, aims to achieve their business expansion in a short term, patents are more powerful and effective, as single trade secrecy could not effectively prevent competitors from developing same technologies and patenting the same technologies.

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[41] Pratibha Ahirwar, 'India: What To Choose Between Trade Secrets And Patents' (21 February 2019) <https://www.mondaq.com/india/trade-secrets/783558/what-to-choose-between-trade-secrets-and-patents> accessed 16 April 2020

[42] EUIPO, 'Protecting Innovation Through Trade Secrets and Patents: Determinants for European Union Firms' (14 July 2017) <https://euipo.europa.eu/tunnel-web/secure/webdav/guest/document_library/observatory/documents/reports/Trade%20Secrets%20Report_en.pdf> accessed 16 April 2020

3.3 The significance of patent protection for European green innovators

3.3.1 Furthering foreign market penetration and stabilization:

According to the OECD, Europe is the number one driving force in the world's green innovations and has developed 28% of the world's environmentally related innovations, see figure 4. This lead makes the EU a global green technology provider. In the course of CCMTs related inventions trade for example, Europe runs a great surplus to the non-EU world.[43] In order to protect the technologies in the exporting countries and regions, patents become an undeniable option for European innovators.

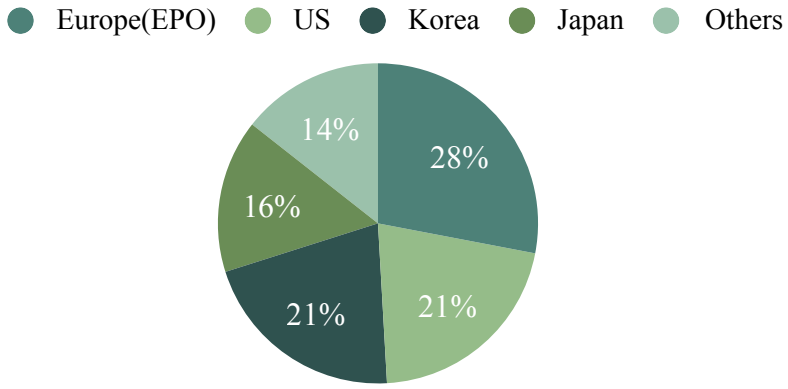

Figure 4 The distribution of green innovations

Source: OECD

3.3.2 Safeguarding the early expansion:

Having inventions patented is the key in early product development, especially for European SMEs and start-ups. Today, most R&D in the environmental technology industry have been conducted within companies to date. The sectors of green innovations are vast. For instance, in the UK, as figure 5 shows, 29.5% green patents are filed in the area of energy saving, 19.2% in transport, 8% in water and recycling, 7% in solar and 6% in wind.[44]

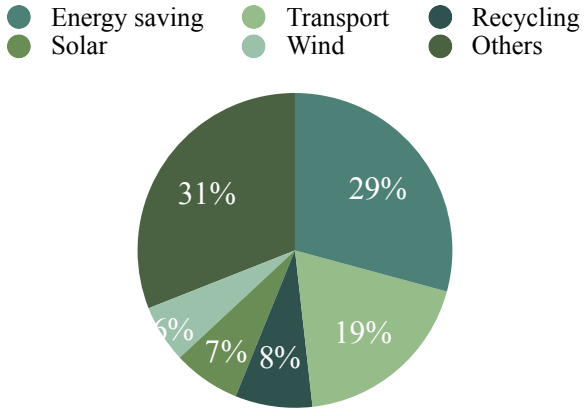

Figure 5 The green patents distribution in the UK

Source: UKIPO

[43] OECD, 'Technology diffusion' (2015) <https://www.oecd.org/env/indicators-modelling-outlooks/green-patents.htm> accessed 18 March 2020

[44] ibid (n 31)

Among these sectors, a single invention normally consists of several technologies. More importantly, the segments of a new green technology may not always be mature and thus may need further improvement before being put on the market. In the process of product enhancing, the complexity of the technical problems may thus rise. De Marchi (2012) argues that the development of new and green products calls for competences that are far from the traditional industrial knowledge base. In this aspect, environmental technologies, compared to non-green technologies, encompass a broader range of objectives and knowledge inputs, which are related to production efficiency, and product quality (Florida, 1996; Oltra and Saint Jean, 2005).[45] This high complexity of green technologies is demonstrated by the multi-purpose and systemic nature of environmental innovations (Ghisetti et al., 2015). In order to fulfill these objectives, even for a single technical invention, enormous and continuous investments in all relevant technologies and areas are required.

This high demand of investments further leads to a tradeoff for producers, that is, due to the limited resources and time, to either concentrate more closely on their core competencies or purchase non-core expertise in order to have a full development of all their technologies in possession. For example, it is likely that small, specialized makers of wind energy plants will not be able to conduct all R&D in-house when they have to tackle complex production processes and master just-in-time manufacturing. It simply will be too expensive to keep a team of specialists on the payroll, especially given the vast potential scope of environmental technologies.[46] In order to solve this dilemma, contractual cooperations between smaller entities as the first-stage innovators and larger entities as the further developers become a popular business mode in the course of green R&D. More importantly, a comprehensive IP strategy has to be created, such as building a patent portfolio as a platform for further applications for advanced materials. This is particularly significant since the value of the company is mostly attributed to its IP during the early years.[47] For example, single green innovators with new-to-market innovations, can achieve higher sales in the short run merely by choosing patents but not secrecy as protection strategy.[48] In this aspect, early stage patent management largely furthers the business growth. Two case studies are presented below to specifically show the significance of establishing an early patent portfolio:

(1) Skeleton is an Estonian based company that develops, manufactures and sells ultra capacitor energy storage cells, modules and systems. The use of curved graphene, a nano-material, allows the ultra capacitors to achieve high power and energy density. Having put into effect an IP strategy as soon as Skeleton was established, Skeleton ensured that the patenting of inventions in the initial stages of R&D has been streamlined with the early product development. This strategy has led to three benefits: better IP capture; a better idea of the value of the invention, which is of huge importance in the early stage,

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[45] Nicolò Barbieriad, Alberto Marzucchibd and UgoRizzo, 'Knowledge Sources and Impacts on Subsequent Inventions: Do Green Technologies Differ from Non-Green Ones?' (2020) 49/2 Research Policy <https://doi.org/10.1016/j.respol.2019.103901> accessed 5 April 2020

[46] Roland Berger, *Green Growth, Green Profit: How Green Transformation Boosts Business* (Springer, 2016) 226

[47] EPO, *SME Case Studies* (EPO 2017) 57

[48] Dirk Crass and others, 'Protecting Innovation Through Patents and Trade Secrets: Evidence for Firms with a Single Innovation' (2019) 26/1 International Journal of the Economics of Business 117, 156

where investment is crucial, and the ability to assess whether the company will be able to use the invention without being dependent on others (fat mass and obesity associated gene (FTO) investigation).[49] Therefore, by patenting these early stage technologies, a SME is establishing a strong patent portfolio for future competition. Madiberk, the Co-Founder of Skeleton, pointed out,

> '*Larger markets lead to more IP litigation as a general rule. Skeleton's emerging and growing business will attract a lot of competition and IP litigation will come in the future, so it is very important to be prepared now– and we are*.'[50]

From this perspective, patents strengthen not the incentives to engage into further innovation, but the firm's performance.

(2) Orcan Energy is a renewable energy company that offers standard components for heat power generators that recycle waste heat by turning it into electricity, using the Organic Rankine Cycle (ORC), a process similar to that used in steam engines. On the market, Orcan's standard components could easily be reverse-engineered by competitors, so patents are essential if the company is to prevent its assets being copied, whereas a single trade secret protection is not enough. Therefore Orcan has established a patent portfolio involving 23 patent families (with the number of patents over 100), making sure that it protects the relevant innovative aspects of the components that make up the control system. Among the patents, although 8 of them stem from research carried out by its external partners, Orcan avoids joint ownership while cooperating with other companies. The advantage of having a strong and independent patent portfolio is also illustrated that when the company was spun off, it was important for the company to get access to these patents as quickly as possible. Patent protection is thus critical when it comes to venture capital funding for early stage technology companies, who need to actually own the patents rather than just license them. There are two reasons for this. Firstly, the company must be able to minimize the complexity by being able to control and manage patent issues related to their key assets direct, so as to reduce the potential risk of delaying decision-making or missing deadlines. These aspects were especially important for Orcan's investors. Secondly, through patents, backers can create a return for their investment even if the young technology company fails in the first instance and a turnaround is required. This would not be possible if the patents were simply licensed. [51] Because of these successful patent strategies, in 2010, Orcan achieved a transitional agreement with its business partner, under which the company was able to acquire the patents in return for a fair remuneration.

3.4 The classification for green patents

To provide a maximum geographical coverage of patent data for innovators and policymakers, the EPO has developed Espacenet service, offering free access to the world's largest repository of patents and patent applications. The search process of Espacenet, however, depends on an independent patent classification, which divides the technologies into different groups based on the areas they are applied in.

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[49] ibid (n 47) 51

[50] ibid (n 47) 52

[51] ibid (n 47) 45

In 2013, the Cooperative Patent Classification (CPC) was adopted by the EPO with an extension of 250, 000 patent codes, over three times that of the former International Patent Classification (IPC). However, two types of common errors are still observed in practice. In the vast fields of technology, a certain green technology may be classified and searched independently in several technical areas. Overlooking one of the potential areas will lead to incomplete results. In addition, the injudicious use would also lead to inclusion of patent documents which are not related to green technology.[52] Those two errors especially occur in the search of CCMTs patents.

At the same time, a bosom in 'high-value'(number of patent family is over 3) CCMTs patent applications have shown in recent years. From 1995 to 2010, the world number of patents filed related to CCMTs rose fivefold. Europe has been leading the trend.[53] These growing innovations have become the driven force in the green revolution. In response to this new challenge, the EPO has developed a dedicated classification scheme Y02/Y04S in order to increase the transparency and accessibility of patent information related to CCMTs. This scheme consists of 7 tags, mainly covering the green areas of building, greenhouse gases, energy production, transport, waste management and system, see figure 6 (Revised 2018). It provides a unique perspective in monitoring green technical innovation and transfer in the areas of clean energy, such as solar, wind, hydropower and biomass. For other green technologies not fit in the Y02/Y04S scheme, the Cooperative Patent Classification (CPC), as a general principle, will apply.

Y02/Y04S Scheme (2018)	
Class	**Title and description**
Y02	Technologies or applications for mitigation or adaption against climate change
Y02A	Adaption to climate change
Y02B	Buildings
Y02C	Capture and storage of greenhouse gases
Y02D	ICT aiming at the reduction of own energy use
Y02E	Production, distribution and transport of energy
Y02P	Industry and agriculture
Y02T	Transportation
Y02W	Waste and wastewater
Y04S	Systems integrating technologies related to e.g., power network operation, communication or information technologies, i.e. smart grids

Figure 6 Y02/Y04S scheme [54]

Source: EPO

[52] Victor Veefkind and others, 'A New EPO Classification Scheme for Climate Change Mitigation Technologies' (2012) 34/2 World Patent Information 106, 111

[53] ibid (n 6) 9

[54] EPO, 'Y02/Y04S Scheme' (2018) <http://www.epo.org/newsissues/issues/classification/classification.html> accessed 20 February 2020

3.5 Patentability on green inventions

3.5.1 The general requirements

The conditions for patent protection are defined in Articles 54-57 in the EPC. These basic requirements uniformly apply to all types of patent applications:

(1) Novelty: article 54 EPC provides that:

> *(1) An invention shall be considered to be new if it does not form part of the state of the art.*
> *(2) The state of the art shall be held to comprise everything made available to the public by means of a written or oral description, by use, or in any other way, before the date of filing of the European patent application.* [55]

This criterion applies strictly. The criterion of the invention having been 'publicly available' does not mean that the public must actually have been aware of the disclosure, or that the invention was made known to a large audience. For example, an oral presentation before a selected audience which was not subject to a secrecy agreement will be considered as novelty-destructive.[56] In addition, novelty may be interpreted to mean that small derivative improvements will infringe a prior patent in order to serve the social goal of protecting profits. This is because a full disclosure of technical information confers a positive externality on a firm's competitors, which firms might want to avoid. In the greenfield, this 'strong novelty' interpretation balances the competition between close substitutes. It could encourage high-value (normally with patent family of over than three patents) patent research and more importantly, accelerate the elimination of lagging firms and technologies, as they may drop out of the race and are unlikely to catch up.[57]

(2) Inventive step: article 56 EPC states:

> *An invention shall be considered as involving an inventive step if, having regard to the state of the art, it is not obvious to a person skilled in the art. If the state of the art also includes documents within the meaning of Article 54, paragraph 3, these documents shall not be considered in deciding whether there has been an inventive step.* [58]

In the Examination Guidelines of the EPO(2019 edition), the detailed interpretation of 'obviousness' has been given, it shall be understood in the way that the same or similar technical expectation could be achieved by merely following plainly or logically from the priorly published technical information without necessarily involving a person skilled in the art.[59] This 'obviousness' purposes to exclude free riding misconducts and low-quality patents. For example, farmers able to invent 'digestion tanks' which can transfer the biodegradable waste into gas or electricity may not be eligible to file for a patent for

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[55] EPC art 54

[56] Technical Board of Appeal, T 877/90, Hooper Trading/T-GELL GROWTH FACTOR [1993] EPOR 6

[57] Suzanne Scotchmer and Jerry Green, 'Novelty and Disclosure in Patent Law' (1990) 21/1 Journal of Economics 131, 146

[58] EPC art 56

[59] EPO, 'Guidelines for Examination on Patents Part G - Chapter VII.4' (Guidelines for Examination, 2018) <https://www.epo.org/law-practice/legal-texts/html/guidelines/e/g_vii_4.htm> accessed 30 March 2020

their inventions, provided the previous existing technical information already explained in a clear and precise way, by following which any person could be able to obtain the same technical effect.

At the same time, an invention could also be seen as obvious to a person skilled in the art. This requirement stresses the significance of a person skilled in the art in the assessment of the inventive step, that is, an invention will be denied registration if a person who is presumed to possess knowledge and ability in the relevant areas, pursuant to their understanding of the art at the date, is able to achieve the same technical expectation through experimentations or routine work.[60] In the greenfield, designers, science experts and engineers can all be regarded as the persons skilled in the art, whilst sales managers and manufacturers who usually do not possess the required knowledge or access to technical files are excluded from that recognition. Therefore, for green inventions, the assessment of inventive step at the EPO is usually consists of three steps:

(1) Identification of the closest field of prior art and comparison between the field and the invention claimed: this could be conducted using comprehensive patent search strategies, including CPC and Y02/04S scheme. For instance, a waste-to-energy device *X* could be classified in 'B09B Disposal of Solid Waste' under the CPC. Below B09B, more than 50 subclasses are provided, and the references (in the sense of paragraph 39 of the Guide to the IPC) remain non-exhausted. By referring to these subclasses, the closest and relevant fields to device *X* can be found, i.e., A23J 1/16 Obtaining Proteins from Waste Water of Starch Manufacturing Plants of like Wastes, and B03B 7/00 Combinations of Wet Processes or Apparatus with other Processes or Apparatus, e.g., for dressing ores or garbage.[61]

(2) Definition of a technical problem purported to be solved: as discussed under 2.3, green inventions are designed primarily for three goals: pollution prevention, pollution control and product enhancing. These three main aims help define which specific technical problem of which the technology is invented to solve. For instance, an electric car belongs to the main type of 'Enhancing Product.' The technical problem presented is to reduce emissions of hydrocarbons, carbon monoxide, NO_X and carbon dioxide, which are detrimental to the environment.

(3) After the assessment of whether on those two basis, the green technology cannot be seen as obvious to person skilled in the art, in the sense that under consideration of the closest prior art in its entirety, the skilled person would have arrived at a solution which lies within the claims and achieves the same effects which are ascribed to the invention.[62]

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[60] Guidelines for Examination, Part G - Chapter VII.3

[61] USPTO, 'Classification Resources: CPC Cooperative Patent Classification B09B Disposal of sold Waste' (20 May 2020) <https://www.uspto.gov/web/patents/classification/cpc/html/cpc-B09B.html> accessed 20 May 2020

[62] Annette Kur and Thomas Dreier, *European Intellectual Property Law: Text, Cases & Materials* (Edward Elgar Publishing 2013) 113

(3) Industrial application: article 57 EPC provides:

An invention shall be considered as susceptible of industrial application if it can be made or used in any kind of industry, including agriculture.[63]

The assessment depends on individual cases, it requires a green technology to own a potential for industrial application regardless whether it has been used. However, a mere speculation of potential uses is not considered as qualifying the 'a potential for industrial application.' This aspect is of particular relevance for green biotechnological inventions, as it prohibits the claiming of the isolated biological material as such, without disclosing its functions. The requirement of industrial application has furnished the reason inter alia for excluding therapeutic and diagnostic methods from patentability, as such uses are not considered to be of an industrial character. Otherwise, the term 'industrial' is understood in a very broad sense which includes all possible fields of modern technology and only exempts uses and purposes that are strictly private.[64] An example of green biotechnology application is given below:

> Green genetic engineering is one of the areas of green biotechnologies. Luminescent genes, created by gene manipulation, could be used not only for medical diagnostic methods, but also in perspective could go far in the application on the luminescent trees, which might one day make street lighting superfluous. During the festivals, it could be applied for tree decorations and save electricity.[65]

3.5.2 Exceptions to patentability:

Pursuant to Article. 53 EPC, European patents shall not be granted in respect of:

(a) inventions the commercial exploitation of which would be contrary to "ordre public" or morality; such exploitation shall not be deemed to be so contrary merely because it is prohibited by law or regulation in some or all of the Contracting States;

(b) plant or animal varieties or essentially biological processes for the production of plants or animals; this provision shall not apply to microbiological processes or the products thereof;

(c) *methods for treatment of the human or animal body by surgery or therapy and diagnostic methods practiced on the human or animal body; this provision shall not apply to products, in particular substances or compositions, for use in any of these methods.*[66]

For green innovators, the ineligibility rule regarding 'plant variety or its production process' is a more relevant ground than others, especially in the sustainable biotechnology sector that includes agricultural processes and products (seed).

In general, a biotechnology is considered to fall under the umbrella of sustainable agriculture so long as it, over a long term:

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[63] EPC art 57

[64] EPC art 62

[65] German Patent and Trade Mark Office, 'Biotechnology and Patents' (8 May 2020) <https://www.dpma.de/english/patents/patent_protection/protection_requirements/biotechnology_and_patents/index.html>accessed 19 April 2020

[66] EPC art 53

(1) Enhances environmental quality and the resource base on which agriculture relies

(2) Meets the basic human food and fiber needs

(3) Is economically viable

(4) Improves living quality for farmers and society as whole.[67]

The typical example of this type of biotechnology is insect-resistant maize and marker-assisted breeding.[68] However, under Article 53(b) EPC, a new type of insect-resistant maize (cryIA) is likely to be rejected on the ground that it consists of a new plant variety. This is particular the case when it comes to the bio-agricultural technologies. It amounts to a question—what is the exact scope of this article, since a plant variety can be easily created or edited through cross-selection or gene manipulating methods. In the absence of the state law, the EPO has answered this question definitively in the case of plant innovations.[69] In Novartis, the Enlarged Board of the EPO ruled that:

> *According to Article 53(b) EPC, a patent is "in respect of plant varieties" and shall not be granted if the claimed subject-matter is directed to plant varieties. In the absence of the identification of a specific plan variety in a product claim, the subject-matter of the claimed invention is not directed to a plant variety or varieties within the meaning of Article 53(b) EPC.*[70]

This interpretation distinguishes plant parts, plant species and plant variety, as figure 7 illustrates. The rule of logic is that under the 'plant variety' ineligibility rule, only claims drawn expressly to a 'plant variety' will manifestly fall within the rule and thus be rejected. This interpretation is problematic, because the rule can be so easily circumvented— simply by forwuatig claims to seeds or plant parts, for example— that is may be rendered meaningless.[71] However, such loosen explanation could benefit green biotechnology innovators, especially when it comes to gene manipulating agricultural technologies, as the outcome of their case is largely determined by individual patent claims.

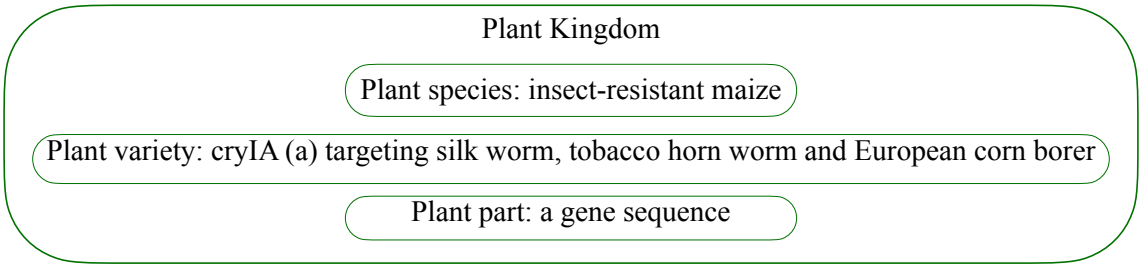

Figure 7 The relationship between plant species, plant variety and plant part

Source: Author

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[67] Neil D. Hamilton, *Agriculture Without Farmers? Is Industrialization Restructuring American Food Production and Threatening the Future of SustainableAgriculture?*(Agricultural Law Center, Drake University Law School 1994) 613, 645

[68] Raman Singh and Kuldeep Singh, 'Biological Patent and Patentability' (2018) 5/1 Integrated Journal of Social Sciences 35, 40

[69] Mark D. Janis, 'Sustainable Agriculture, Patent Rights, and Plant Innovation' (2001) 9/1 Indiana Journal of Global Legal Studies 91, 117 <www.jstor.org/stable/20643821> accessed 18 April 2020

[70] G 01/98, Novartis II/Transgenic Plant, [2000]E.P.O.R. 303, 319

[71] ibid (n 69)

4. European accelerated examination on green patents

4.1 Overview

Across the world, a number of national Intellectual Property Offices have put in place measures to accelerate the patent applications related to green technologies. The first program was established by the United Kingdom Intellectual Property Office (UKIPO) in 2009. Australia, Israel, Japan, the Republic of Korea (ROK) and the US followed the trend in the same year.[72] Since then, more countries, i.e., China and Brazil, adopted similar programs. These programs have the same goal to expedite the review of green technologies. Through these programs, a great amount of time, varying from few months to few years, could be saved. In order to participate in this program, a green technology has to qualify both eligibility and process requirements, which respectively determine what green technology can participate and what are the non-subject-matter limitations. These two requirements also consist of the main differences between these national programs and help the users pre-examine their technologies before the participation. Director of the United States Patent and Trademark Office (USPTO) David Kappos summed up his view of this accelerated program: '…by advancing a commitment to building a more sustainable energy future the agency is able to spur additional innovation and promote green collar jobs that provide our world with alternatives to harmful energy practices.'[73] From business perspective, the reduced pendency allows applicants to start marketing and licensing their patent soon as the patent is granted. In this sense, it creates an early competitive advantage for companies, in particular startups and SMEs, as they can use patents to attract venture capital investment, develop additional products and services, and even create new jobs.[74]

However, not every applicant is looking for a time-reduction. For some companies, getting an early patent may not be in their interest as the relevant market is not mature. For others, they are happy to proceed to grant at a slower pace because it enables them to develop and plan the commercialization and marketing of their invention. It gives them time to determine whether their invention is commercially viable before committing to a greater financial outlay.[75] More importantly, a long examination period provides applicants with the possibility to withdraw and amend the list of claims. It also prevents an early exposure of their business trend and ongoing R&D research to competitors. Based on these traits, normal examination is preferred by most applicants. This is also explained by the popularity of PCT system, that is, once the applications are published, applicants are given up to one year to decide what to do with their applications before entering into national or regional phase. They are able to base their decision on the search information

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[72] Antoine Dechezleprêtre, 'Fast-tracking Green Patent Applications' (WIPO Magazine, June 2013) <https://www.wipo.int/wipo_magazine/en/2013/03/article_0002.html> accessed 14 April 2020

[73] USPTO, 'Issues 500th Patent Through Successful Green Technology Pilot Program' (5 October 2011) <https://www.uspto.gov/about-us/news-updates/uspto-issues-500th-patent-through-successful-green-technology-pilot-program> accessed 13 March 2020

[74] Henry R. Nothhaft and David Kline, 'The Biggest Job Creator You Never Heard Of: The Patent Office' (Harvard Business Review, 6 May 2010) <http://blogs.hbr.org/cs/2010/05/the-biggest-job-creator-youne.html>accessed 13 May 2020

[75] UKIPO, 'Patents Fast Grant Guidance' (12 August 2016) <https://www.gov.uk/government/publications/patents-fast-grant/patents-fast-grant-guidance> accessed 21 April 2020

and reports around the applications. In other words, accelerated mechanism could deprive applicants of a large freedom to adjust their applications according to business considerations.[76] Therefore, in some countries the usage of the programs remains unexpectedly low: the numbers of requests, calculated by August 2012, were 776 in the UK, 220 in Japan and 604 in Korea, whilst the figures of all patent applications filed in these three regions were respectively 51528, 490271 and 203835.[77]

However, it is not adequate to find such fast-tracking program unsuccessful merely based on the low usage in some countries. In the evaluation, several factors need to be considered at the same time:

(1) How many patents have been filed through the various fast-tracking schemes?

(2) What type of technologies are most relevant?

(3) What type of companies is most likely to make use of the fast-tracking examination?

(4) Do the programs encourage the diffusion of green technological knowledge?[78]

In the EU, no other country except the UK has set up a similar system in the past 11 years. As the significance of green technologies becomes more widely recognized, it is necessary to evaluate the possibility to establish a similar European accelerated program. The assessment consists of two parts: part one examines the 'need' of European applicants to speed up their patent procedure, and the advantages that come with the time-reduction. The second part explores the plausible modes of European fast-tracking channel, which are discussed by answering the questions list above and referring to the empirical experience from different jurisdictions in the light of the requirements, usage rate, and characteristics of these programs. It gives us an overview of the pros and cons.[79]

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[76] WIPO, 'PCT – The International Patent System' <https://www.wipo.int/pct/en/> accessed 18 March 2020

[77] ibid (n 31)

[78] Antoine Dechezleprêtre, 'Fast-tracking Green Patent Applications An Empirical Analysis' (ICTSD Global Platform on Climate Change, Trade and Sustainable Energy, 2013) <https://www.ictsd.org/sites/default/files/downloads/2013/02/fast-tracking-green-patent-applications-an-empirical-analysis.pdf>accessed 15 April 2020

[79] Eric L. Lane, 'Building the Global Green Patent Highway: A Proposal for International Harmonization of Green Technology Fast Track Programs' (2012) 27/3 Berkeley Technology Law Journal

4.2 Need

4.2.1 The need to reduce patent backlogs:

The increasing complexity of green technology and volume of prior art that needs to be examined is making the role of patent examiners more difficult. If the average period of patent pendency remains constant, the patent backlog will continue to grow as patent applications grow and the system becomes even more backlogged.[80] Few drawbacks are reviewed: First, backlogs reduce the effectiveness of the patent system by creating costs for the applicant. Costs arise because any uncertainty about vanity complicates planning and formulating business strategy, investment decisions and access to funding. Second, backlogs impact on patent quality. Uncertainty over the scope of patent quality deters shareholders from investing and lenders from granting loans as a pending patent has less value than a granted patent. If the backlog stretches the patent office's resources and patent quality decreases, more applications are encouraged to 'try their luck' by making low quality patent applications, which will harm green innovation process. This also predictably means patent litigation will increase.[81]

Therefore, it is always in the best interest for the EPO to reduce the pending patent cases and ensure greater transparency and higher legal certainty for their applicants. The statics from the EPO, see figure 8, illustrate the recent backlogs, which The EPO estimates that it will take over couple of years to clear. In 2016, 4300 patent examiners at the EPO delivered nearly 396, 000 searches, examinations and oppositions, an increase of a further 8.5% on the previous year. In addition, almost 96, 000 patents are granted, up by 40% on 2015. In comparison, the number of patent applications filed in 2015 is 160, 004, and the figure stabilizes in 2016. In this aspect, the workload for examiners and backlogs steadily grew despite a considerable growth in examination production.[82] In other words, the need to reduce the backlogs is urgent. Accelerating the normal procedure could thus generate double benefits not only to solve the backlogs issue but also to speed up the green transformation.

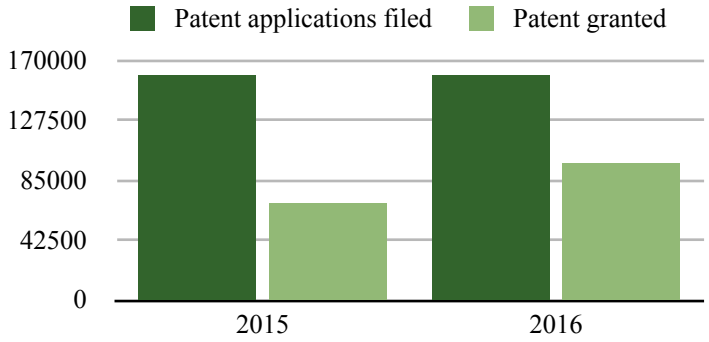

Figure 8 Patent backlogs in 2015 and 2016

Source: EPO

[80] Ruth Soetendorp, 'Intellectual Property, Finance and Corporate Governance' (2019) 53/1 The Law Teacher 126, 129 <https://doi.org/10.1080/03069400.2018.1537610> accessed 14 May 2020

[81] Janice Denoncourt, *Intellectual Property, Finance and Corporate Governance* (Routledge, 2018)

[82] EPO, 'Annual Report 2016: Boosting Performance and Quality' (EPO, 2016) <https://www.epo.org/about-us/annual-reports-statistics/annual-report/2016/highlights/boosting-performance-and-quality.html> accessed 21 April 2020

4.2.2 The internal push: environmental policies

In terms of world's total natural resources, Europe merely occupies a small fraction. By the end of 2018, see figure 9, the European share of world's proved reserves account 14.8% in primary energy, 14.3% in oil, 2.0% in natural gas, 12.8% in coal, 34.7% in nuclear energy, 15.3% in hydroelectricity, 30.7% in renewable energy, 15.3% in electricity, 12.5% in carbon, 0% in key minerals (lithium, natural graphite, rare earth metals).[83]

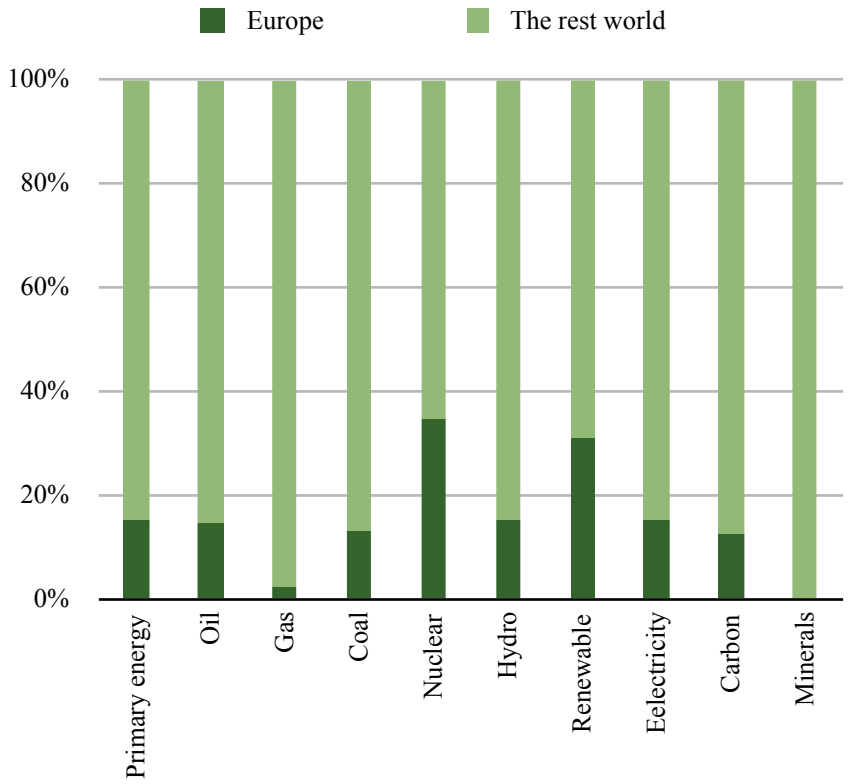

Figure 9: Energy distribution, Europe, 2018

Source: BP Statistical Review of World Energy 2019| 68th edition

On the other hand, Europe relies heavily on natural resources to fuel its economic development. Although past and current production and resource consumption patterns have underpinned substantial growth in wealth across Europe, they also result in a high energy dependency from abroad.[84] In 2017, see figure 10, Europe witnessed the highest need (gross inland consumption and international maritime bunkers) for oil and petroleum products, 626.5 *Mtoe*, of which 86.7% were imported. For natural gas the need was 398.4 *Mtoe*, 74.3% of it covered by imports. The figure for solid fuels, although experienced a decline of internal production over the last two decades, was still 43.9% imported. In general, the long trend since 1990, when

[83] Bob Dudley, 'BP Statistical Review of World Energy' (BP, 14 February 2019) <https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2019-full-report.pdf>accessed 22 April 2020

[84] European Environmental Agency, 'The European Environment State and Outlook 2010 Synthesis' (22 November 2010) <https://www.eea.europa.eu/soer/synthesis/synthesis> accessed 21 March 2020

import energy dependency was 44%, shows an increase import dependency, which further increased to 55.1% after years of stabilization in the end of 2017.[85]

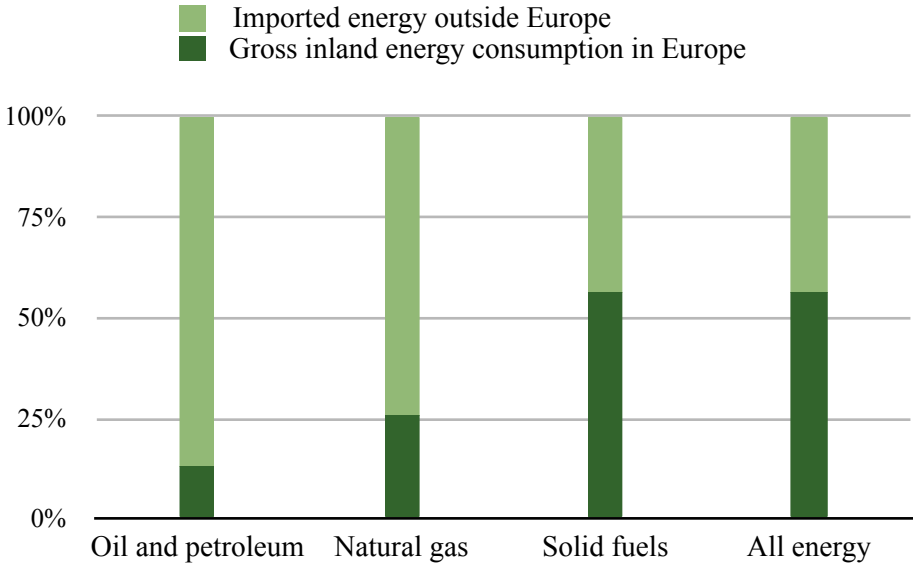

Figure 10: Energy dependency of Europe

Source: Eurostat

The asymmetry between the increasing energy demand and the high dependency of imported resources amounts to concerns about the sustainability of these patterns, particularly regarding the implications related to resource use and over-use.[86] In 2018, as part of the 'Clean energy for all Europeans package,' the new amending Directive on Energy Efficiency (2018/2002) was agreed to update the policy framework to 2030 and beyond. The key element of the amended directive is a headline energy efficiency target for 2030 of at least 32.5%.[87] This indicates green technology patents are always the targets of being propped up focally in Europe. In parallel, on the topic of climate change, the EU formulated and implemented climate policies and strategies, taking a leading role in international negotiations on climate. It is committed to ensuring the successful implementation of the Paris Agreement and implementing the EU's Emissions Trading System (EU ETS), which covers around 45% of the EU's greenhouse gas emissions. In this regard, EU countries have agreed to meet various targets in the years to come.[88] All these policies and regulatory efforts present a great increasing need for green investors to arise and for current investors to turn green. As to force a green change of current energy patterns, more green technologies are always needed no matter in the long term or

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[85] Eurostat Statistics Explained, 'Energy Statistics—An Overview' (June 2019) <https://ec.europa.eu/eurostat/statistics-explained/index.php/Energy_statistics_-_an_overview#Final_energy_consumption> accessed 28 March 2020

[86] ibid (n 70)

[87] Council Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency [2018] OJ L 328/210

[88] EUR-Lex, 'Environment and Climate Change' <https://eur-lex.europa.eu/summary/chapter/environment.html?root_default=SUM_1_CODED%3D20,SUM_2_CODED%3D2001&locale=en> accessed 27 March 2020

short time. In this sense, accelerated programs open a window that allows a rapid increase in green patents in a short time. Once the technical files are published, more information and knowledge will be provided and used in the R&D activities and green policies makings.

4.2.3 The external push: green trade

The external market for European green patents exchange: the EU green trade balance with non-EU countries varies among different green technologies. During the whole period analyzed, from 2000 to 2015, the EU experienced positive trade balances (energy technologies)in the following sectors: clean coal and gas, heating and wind. This positive trend was also witnessed in other technologies, such as insulation, hydropower, nuclear and solar thermal, see figure 11.[89] Therefore it is necessary and significant to involve a patent family size of more than one to safeguard technologies in exporting countries or regions. At the end of 2011, 55.3% European CCMTs inventions have sought patents protection in other regions outside the EU, mainly in the US, China and Japan.[90] Participating in accelerated examinations allows an European invention to penetrate the foreign markets and obtain legal protection as soon as possible.

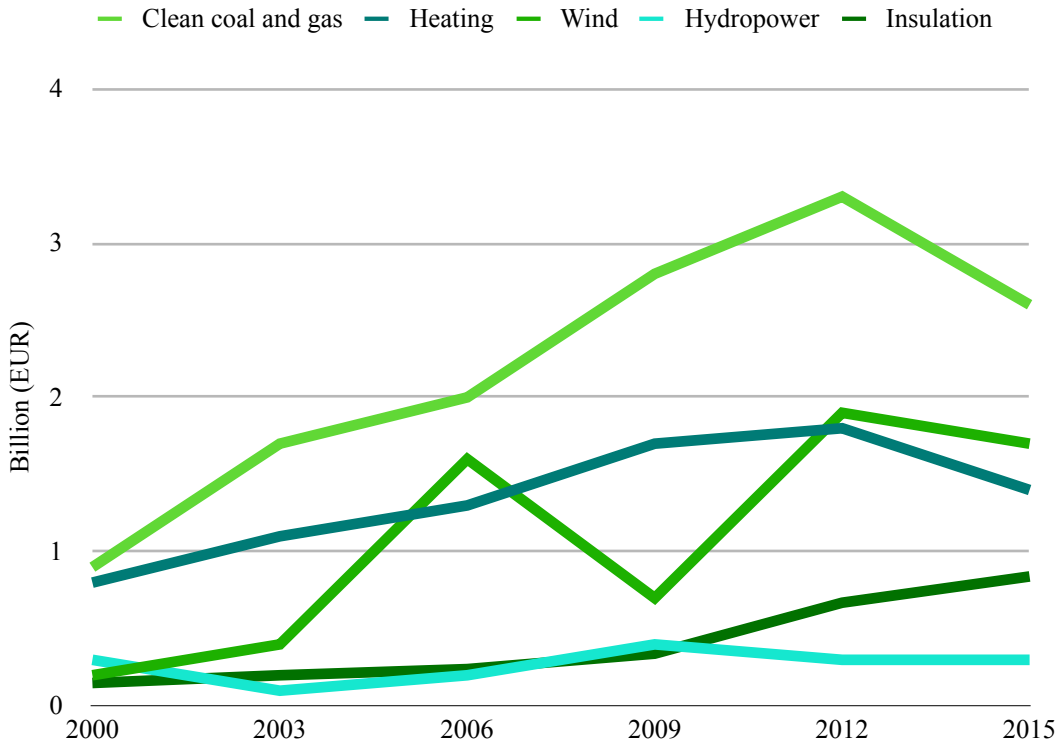

Figure 11 EU-28 energy technologies trade with non-EU countries/regions

Source: European Commission

[89] Francesco Pasimeni, 'EU Energy Technology Trade: Import and Export' (EU Commission JRC Science for Policy Report, 2017) <https://setis.ec.europa.eu/publications/relevant-reports/eu-energy-technology-trade-import-and-export> accessed 22 March 2020

[90] ibid (n 69)

4.3 Advantages

4.3.1 The 'speeding value' of fast-gained patents:

(1) Providing early protection: inventors have strong incentives to file a first ('priority') application as soon as possible because, until then, they have nothing but secrecy to protect themselves from imitators. In this context, information leakage concerning the invention would be doubly damageable: it would enable competitors to use the invention legally and could prevent the invention from being ever patented (since, through the leakage, it has become prior art). In addition, even if the secret is well kept, there is a risk under the first-to-file rule that the patent could be granted to another inventor who had filed a prior application. In order to alleviate these risks, a fast-gained patent is introduced, as it freezes relevant prior art at the date of application and guarantees that the patent, once granted, can be used to oppose any infringer.[91]

(2) Speeding up the trade and market penetration: in practice, a successful penetration into a foreign market may not be as easy as anticipated, it requires a investor to possess local experience, capabilities, assist specificity, resources, networks and other conditions.[92] It is therefore necessary to establish a business cooperation with local partners as they provide not only valuable experience, but access to networks and key resources. This cooperation could be achieved by acquisitions, mergers, franchising or just a strategic agreement. In terms of these four modes, although the acquisition/merger provides greenfield investors with existing operations in the market, which speeds up their penetration, contractual modes, such as franchising or patent licensing, are suggested to be a more feasible option than mergers and acquisitions because it is sometimes difficult to come across local firms that are ready to sell their operations.[93] It also illustrates the importance of patents as the main subject in contractual negotiations. On the other hand, novel technologies emerge everyday, which implies the high volatility of the greenfield market and high cost of delaying entry. For European applicants, years of pending under a normal patent examination will cause an uncertainty for their business negotiation as potential partners could enter into final agreements with others provided they have already obtained patents. Thereby a fast-tracking patent will tremendously accelerate their market entry and win investors massive time for further market adjustments. In the same line, fast-gained patents are expected to benefit the green trade within the EU in the same aspects.

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[91] Antoine Dechezleprêtre, Yann Ménière and Myra Mohnen, 'International Patent Families: From Application Strategies to Statistical Indicators' (2017) 111 Scientometrics 793, 828

[92] Zhi Shen, Francisco Puig and Justin Paul, 'Foreign Market Entry Mode Research: A Review and Research Agenda' (2017) 31/5 The International Trade Journal <http://dx.doi.org/10.1080/08853908.2017.1361368> accessed 23 March 2020

[93] ibid (n 91)

4.3.2 The 'accelerating value' to green R&D:

(1) Patents are also considered as an intermediate step between R&D (upstream) and innovation (the invention is used downstream in economic processes). Patents can be obtained at different stages of the R&D process, notably in the case of incremental or cumulative inventions. In this sense, patents can be seen not only as an output of R&D but also as an input to innovation and thus as both inputs and outputs in the invention process.[94] That is to say the fast-gained patents can save the time to build such connection between R&D output and innovation input, and thus facilitate both activities.

(2) Early patents may provide more knowledge references for sequence R&D activity in a short term. Normally, patent documents contain not only a detailed description of the patented innovation but also references to previous patents, i.e., patent citations. These citations between European patents are seen as a measure of knowledge flows as they are mostly added by the examiner, and thus an indirect indication of knowledge actually used by the inventor. From an economic point of view, a reference to a previous patent indicates that the knowledge in the latter patent was in some way useful for developing the new knowledge described in the citing patent.[95] When it comes to clean inventions, the patent citations are more important. On average, clean patented inventions received 43% more citations (between 23% and 160%, depending on the technologies) than polluting and non-green inventions.[96] In this aspect, green R&D requires more relevant knowledge released. Once the fast-gained patent is granted, more patents data could be cited and used in a short term. As a result, a positive impact is generated on the next-step technical development. This is thought to spur more innovations later in the entire industry.

4.3.3 Answers to the disadvantages of time-reduction

(1) Rapping time for market adjustments vs avoiding futile patents: in the case of complex green technologies, applicants might burn through more than half the length of a patent term in their patent applications as there are shortages of particular types of expertise or oddities with respect in the particular area. Given the pace of advancement and obsolescence in these certain industries, much or all of the truly useful life of a patent could be spent waiting for a grant.[97] Furthermore, it is meaningless to adjust patent claims under a long-pendency procedure, if the technology may already be obsolete or at a

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[94] OECD, *Patent Statistics Manual* (OECD Publishing 2009)

[95] Paola Criscuolo, Rajneesh Narula and Bart Verspagen, 'Role of Home and Host Country Innovation Systems in R&D Internationalization: A Patent Citation Analysis' (2005) 14/5 Economics of Innovation and New Technology <http://10.1080/10438590420003152 85> accessed 21 April 2020

[96] Antoine Dechezleprêtre, Ralf Martin and Myra Mohnen, 'Knowledge Spillovers from Clean and Dirty Technologies: A Patent Citation Analysis, Grantham Research Institute on Climate Change and the Environment' (Working Paper No. 135, 2013) <http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2013/10/WP135-Knowledge-spillovers-from-clean-and-dirty-technologies.pdf> accessed 23 April 2020

[97] Mark Schultz and Kevin Madigan, 'The Long Wait for Innovation: The Global Patent Pendency Problem' (The Center for the Protection of Intellectual Property (CPIP), 24 October 2016) <https://sls.gmu.edu/cpip/wp-content/uploads/sites/31/2016/10/Schultz-Madigan-The-Long-Wait-for-Innovation-The-Global-Patent-Pendency-Problem.pdf> accessed 8 April 2020

minimum surpassed on the market. In this aspect, an early patent is more adaptable to fast-moving technologies, i.e., green technologies. An analysis on green vehicles on EU market is conducted below:

Green vehicles refer to the road motor vehicles with 'new' technologies, seen as 'green'. Technologies as fuel cell electric vehicles (FCEV) or hydrogen driven vehicles, hybrid electric vehicles (HEV) or full electric vehicles (EV) with or without plug-in devices, vehicles powered by gas, bio-fuels or dedicated new Internal Combustion Engines (ICE) with a strong reduction on environmentally impact.[98] The EU is among the world's biggest producers of those motor vehicles and the sector represents the largest private investor in research and development. It accounts for 4% of European GDP. Global sales of passenger cars in 2017 hit 77.7 million vehicles and these numbers are expected to grow. [99]

The innovation of green vehicles scatters in the areas of electrification, battery developments, new vehicle architectures, weight reduction, rolling resistance and so on. A breakthrough in any of these aspects will easily grant an advantage for producers ahead of others. If we take a look at Green Car of the Year, an annual award given by Green Car Journal, between the years 2011 to 2017, each year's award went to different types of green vehicles, i.e., Chevrolet Bolt EV, an electric car, for the year 2017[100], and Ford Fusion 2nd gen line-up, a motor vehicle powered by gasoline, hybrid and plug-in variants, for the year 2014.[101] From this perspective, any technical breakthrough in a certain aspect leads to a quick rise of a new green vehicle. Moreover, it is quite rare to see only one type of green vehicle always stay in popularity due to the high vitality of the market. Taking this into consideration, a long patent pendency may cost valuable time before a new technology is ready to hit the market. As the needs change and evolve all the time, a technology which was regarded state-of-art at the date of patent filing may no longer be well recognized the time when the patent is granted.

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[98] European Road Transport Research Advisory Council (ERTRAC), 'European Roadmap Infrastructure for Green Vehicles' (October 2012) <https://ertrac.org/uploads/documentsearch/id6/infrastructure-for-green-vehicles_final-october-2012_65.pdf> accessed 20 April 2020

[99] Commission, 'Horizon 2020 (Work Programme 2016- 2017): Transport, Green Vehicles State of Art and Beyond' C (2017) 2468

[100] Sebastian Blanco, 'Chevy Bolt wins 2017 Green Car of the Year' (Autoblog, 17 November 2016) <https://www.autoblog.com/2016/11/17/chevy-bolt-wins-2017-green-car-of-the-year/> accessed 20 April 2020

[101] Sebastian Blanco, 'Ford Fusion wins 2013 Green Car Of The Year' (Autoblog, 29 November 2012) <https://www.autoblog.com/2012/11/29/ford-fusion-wins-2013-green-car-of-the-year/> accessed 20 April 2020

Green Car of the Year, Green Car Journal		
Vehicle	Year	Type of vehicle/fuel
Chevrolet Bolt EV	2017	Electric car
Chevrolet Volt (second generation)	2016	Plug-in hybrid
BMW i3	2015	Electric car
Honda Accord ninth generation line-up	2014	Gasoline hybrid and plug-in variants
Ford Fusion 2nd gen line-up	2013	Gasoline, EcoBoost, hybrid and plug-in variants
Honda Civic GX	2012	Natural gas
Chevrloet Volt	2011	Plug-in hybrid

Figure 12 Green Car of the Year

Source: Green Car Journal

Last but not least, long patent pendency is not friendly to SMEs. The reason is that multinational companies and other large businesses may have the resources to sustain momentum over such long waiting periods, but individuals and small and medium enterprises lack the resources and time to wait. Long waiting time for patents almost certainly hurts local entrepreneurs the most.[102] In this sense, fast-tracking procedure is more preferred by smaller entities.

(2) The 'early exposure' concern: accelerating patents amount to concerns for some investors that fast-tracking programs may lead to an early exposure of their technical research and strategic direction to competitors. In most cases, however, "early exposure" does not necessarily lead to the rise of a new competitor or enhancement of current competitors. According to PATVAL survey (2005), most European inventions (the survey targets the investors in Germany, Spain, France, Italy, Netherlands and the UK) were not developed further most commonly for three reasons, shown in figure 13, namely estimated costs were expected to go beyond the resources (94.84% European investors agreed), further improvements could have resulted in another invention (97.69% agreed) and further improvements seemed beyond existing technological opportunities (90.66% agreed).[103] The lack of complementary downstream assets also prevents an invention from further development. Due to these factors, it is less likely for a new competitor to enter into the relevant market. On the other hand, average man-month that the most research needs to develop the whole group of intertwined patents is more than 12 months, and only 5.15% research can achieve such effect in less than one year.[104] That is to say, even for existing competitors having intertwined patents or technologies, it is less likely that this "early patent exposure" will enhance their competitiveness in a short term.

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[102] ibid (n 99)

[103] Commission, 'The Value of European Patents Evidence From a Survey of European Inventors' (Final Report of the PATVAL EU Project: Contract HPV2-CT-2001-00013, January 2005)

[104] ibid (n 79)

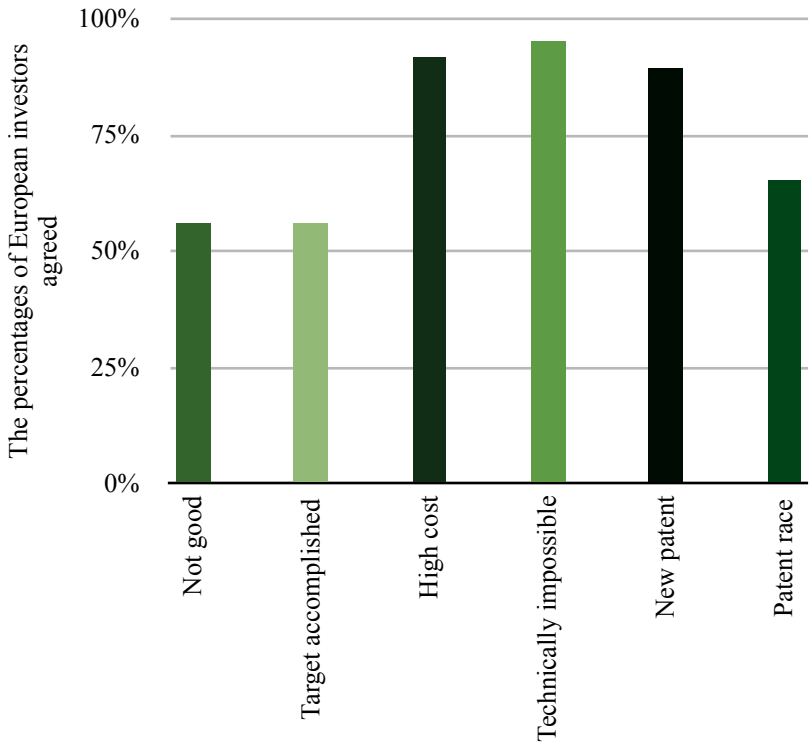

Figure 13 Reasons why an invention was not developed further

Source: PATVAL survey (2005)

At the same time, the 'early exposure' concern to some extent explains the low usage (less than 2%)of accelerated procedures in Korea, Japan and Australia. However, it is difficult to find this concern materially determine the program usage. In countries such as the UK, the usage of accelerated program is relatively much higher. In the US, the upper limit 'first 3000' green patents were met in less than two years.[105] This indicates that the usage could vary from country to country, and this concern may not be as relevant and important as it is thought to be. Furthermore, even within a country, for example China, participation of accelerated program differs among regions due to the discrepancy of regional green innovation levels. A search presents a considerable regional difference in green innovation efficiency in China. The levels in north-east and western regions are below the national average. Two main reasons are provided: the lack of geographical advantages and insufficient market demand for the development of the green technology.[106] These reasons jointly also explain the low usage of fast-track programs in different regions and countries, that is, lack of urgent and adequate market need. Therefore, whether a European accelerated program is worth establishing depends on whether there is a great market demand for European green patents and the whether fast-gained patents can secure their market performance.

[105] USPTO, Pilot a Program for Green Technologies Including Greenhouse Gas Reduction Federal Register. 64666 (Dec. 8, 2009/Notices)

[106] Junliang Du, Yong Liu and Weixue Diao, 'Assessing Regional Differences in Green Innovation Efficiency of Industrial Enterprises in China' (2019) 16/6 International Journal of Environmental Research and Public Health 940

4.4 Plausible modes of European accelerated channel

4.4.1 Experience from the UK

UK IPO

The fast track for patent applications was first introduced on 12 May 2009. It initially provided a green channel that allows applicants to request accelerated processing of their patent application if the invention has an environmental benefit. On 28 May 2010, the scope of this fast track program was extended to patent applications that enter into the UK national phase after receiving a positive International Preliminary Report on Patentability under the Patent Cooperation Treaty (PCT) procedure.

For green patent applicants, they must indicate:

(1) How their application is environmentally friendly;

(2) Which actions they seek for time-reduction: search, examination and/or publication.[107]

The accelerated examination is activated only when requested by applicants, and shares the same mechanism with normal procedure. As a general rule, applicants will make a reasonable assertion that their invention (contained one or more technologies) has some environment benefits. If, for example, the invention is a solar panel or a wind turbine then a simple statement is likely to be enough. The UKIPO will not conduct any detailed investigation into these assertions, but will refuse requests if they are clearly unfounded, for example if the application relates to a perpetual motion machine.[108] Under this fast track program, green patents on average are granted within 11 months, compared with 2 or 3 years under the normal procedure.

4.4.2 Experience from non-EU countries

Type A: Without detailed eligible green categories

China's IPO

Following the UKIPO, China adopted the 'Patent Prioritized Examination Regulation 2012,' the Article 3(1) of which establishes a general principle that the prior review will apply to the patent applications pertaining to technologies in energy saving, environmental protection, new generation information, biology, hi-tech equipment manufacturing, new energy, new material and new energy vehicles. Significant applications in other technical fields are also eligible.[109] At the same time, Article 3(2), as a specific provision for green technologies, further states, 'The prioritized assessment applies to the low carbon technologies, resource conserving technologies and any significant invention complying with the goal of green development'.[110] In this sense, the scope of prioritized examination is wide. It allows China to grant fast-gained patents in technical and also non-technical industries that are considered crucial to the economic or social development.

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[107] GOV.UK, 'Patents: Accelerated Processing: The Intellectual Property Office Offers Different Methods of Accelerating the Processing of Your Patent Application' (Guidance, 18 December 2019) <https://www.gov.uk/guidance/patents-accelerated-processing> accessed 15 April 2020

[108] ibid (n 107)

[109] 19/06/2012 Regulation on Prioritized Examination on Patent Applications(No. 65 Order) at National Intellectual Property Administration of PRC (PRC Patent Prioritized Examination Regulation 2012), art 3(1)

[110] PRC Patent Prioritized Examination Regulation 2012, art 3(2)

Once the patent application is accepted, it will be examined immediately and the result is expected to come out within one year after the filing date.[111]

In 2017, this regulation was amended. Article 3(2) and the wording 'green' were removed. In comparison, Article 3(1) was slightly extended and remained as the miscellaneous provision.[112] One of the reasons is that old Article 3(2) is a mere emphasis of 'energy saving and environmental protection.' Therefore, the elimination of this provision will not affect the general eligibility criteria. This change, therefore, cannot be interpreted as neither broadening nor narrowing the range of eligible technologies as the literal meaning of Art. 3(1) has not changed, that is, a technology is qualified for the accelerated examination procedure so long it is in compliance with the aim of energy saving or environmental protection.

Similar to the UK, China's IPO has not interpreted the concept of environmental protection, implying there are no more barriers for green technologies to participate. The burden proof of greenness falls on applicants. On the other hand, although the broad applicability of the prioritized examination is thought to spur an increase of patent filings from various industries, it also amounts to a great difficulty to calculate the program usage by a specific technology or sector. It is thus somehow controversial to find a concrete link between the increasing usage of prioritized examination and a bosom of technologies that are environmentally friendly.

Japan

Earlier than most countries, Japan had launched three expedited patent examinations for a wide range of technical or non-technical inventions in 1986. Each examination demands a certain level of requirements and comes with different time reduction. These examinations include accelerated examination, preferential examination and super accelerated examination. Applicants are capable to select the examination that suits them the best.

Inspired by the UK green channel, green-related applications were introduced as one of the four eligible types of inventions in 2009. Further interpretation of 'green related' is given,— 'energy-saving effects and contributes to carbon dioxide emission reduction.'[113] Applicants are responsible for the compliance description of 'green related' and a series of non-subject matter conditions. These conditions include, for example, with the petition, a prior art search and an explanation comparing the claimed invention with the prior art are needed. However, if a search report and its opinion from a search authority are submitted, the prior art search and the explanation can be omitted. Additionally, the request for Super Accelerated Examination must be filed before receiving the first office action on the merits. [114]

Compared to the regular examination system, examination results under super accelerated system come out more quickly. The average pendency under the super accelerated system is about 2.3 months (in 2017),

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[111] 27/06/2017 Regulation on Prioritized Examination on Patent Applications(No. 76 Order) at National Intellectual Property Administration of PRC (PRC Patent Prioritized Examination Regulation 2017), art 10

[112] PRC Patent Prioritized Examination Regulation 2017, art 3(1)

[113] Han-Mei Tso, 'Introduction to Prioritized and Expedited Patent Examination Procedures (Part Two) Chapter of Japan' (Tokyo, 01 May 2019) <https://oshaliang.com/newsletter/introduction-to-prioritized-and-expedited-patent-examination-procedures-part-two-chapter-of-japan/>accessed 15 March 2020

[114] ibid (n 112)

which is much shorter than under the regular system (2-3 years).[115] However, most applicants chose to stay out of this super-speed mechanism. By contrast, accelerated examination remained the most popular way. In the year of 2009, the number of applications using accelerated examination reached nearly 10, 000 and this figure doubled at 20, 029 in 2017.[116]

USA

The United States Patent and Trademark Office (USPTO) also launched the Green Technology Pilot Program in 2009. Under this scheme, an applicant was able to have an application advanced out of turn (accorded special status) for examination, for applications pertaining to green technologies including greenhouse gas reduction (applications pertaining to environmental quality, energy conservation, development of renewable energy resources or greenhouse gas emission reduction). [117]

Initially the program was restricted in several ways. First the window of opportunity was nominally one year. Under the Federal Register. 64666 (Dec. 8, 2009/Notices), USPTO has made it clear that only the first 3, 000 petitions will be accepted to make special in previously filed new applications, provided that the petitions meet the requirements set forth in this notice.[118] The second is that only applications filed before the program launched date and not examined were eligible. That is to say, new applications would not be accepted into the program.[119] The third limitation is that the subject-matter of the applications was stringent and required a specific technology classification and sub-classification so as to be deemed as "eligible green technology."[120] Because of this, the vast majority of green tech petitions were denied on the ground for lacking an eligible classification. To counteract this dilemma, the USPTO eliminated the 'classification requirements' and announced another one-year extension until 31 December 2011.[121] With the subject matter eligibility change and the door open to new applications, the petition process became much smoother. Applicants could be more confident that their technologies were eligible and their applications would be accepted into the

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[115] JPO, 'Outline of Accelerated Examination and Accelerated Appeal Examination' (4 July 2018) <https://www.jpo.go.jp/e/system/patent/shinsa/jp-soki/> accessed 15 March 2020

[116] ibid (n 114) Records of Use (Accelerated Examination)

[117] USPTO, 'Green Technology Pilot Program - CLOSED' (17 May, 2011) <https://www.uspto.gov/patent/initiatives/green-technology-pilot-program-closed> accessed 13 March 2020

[118] ibid (n 105)

[119] ibid (n 105) 64667 (*Requirements:* A petition to make special under the Green Technology Pilot Program may be granted in an application if the eligibility requirements set forth in section II or III and the following conditions are satisfied: (1)… The application must be previously filed before the publication date of this notice…(6) The petition to make special must be filed at least one day prior to the date that a first office action… appears in the Patent Application Information (PAIR) system.')

[120] ibid (n 105) 64667 ('(2) The application must be classified in one of the U.S. classifications listed in section VI of this notice at the time of examination.')

[121] USPTO, Elimination of Classification Requirement in the Green Technology Pilot Program, Vol. 75, No. 98 Federal Register. 28554 (May 21, 2010/Notices) (The USPTO has determined that the classification requirement… was causing the denial of petitions for applications that are drawn to green technologies)

program as long as they broadly related to environmental quality, energy conservation, development of renewable-energy resources, or greenhouse gas emissions reduction.[122]

After a series of extensions, this program was eventually ended on 27 February 2012.[123] During the years 2009-2012, 3, 533 green patents had been granted through this Pilot Program, whilst 2, 017 applications were dismissed or denied. [124]

Type B: With detailed eligible green categories

South Korea

With the aim to further green technologies R&D under the national strategy of low-carbon green growth, the Korean Intellectual Property Office (KIPO) also announced its accelerated examinations, to start which applicants can request a prior arts search to an authenticated agency, and submit the results of the search to the KIPO. Using the super-speed examination system, the period can be slashed to less than one month, compared with 18 months under ordinary examination, making it the fastest examination period in the world.[125] In order to participate in the accelerated examination, applications have to fall within any of the following technical categories:

(1) noise and vibration prevention facilities or methods and sound proofing or dust proofing
(2) water quality contamination prevention facilities or methods
(3) air pollution prevention facilities or methods
(4) waste disposal facilities or methods
(5) facilities or methods of livestock excretions management, purification and disposal
(6) recycling facilities or methods
(7) sewage disposal facilities or methods[126]

Or subcategories that have received a green certificate or financial support from the Korean government:

(a) new renewable energy technology
(b) carbon reduction energy technology
(c) high powered water handling technology
(d) LED application technology

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[122] Eric L.Lane, *Legal Aspects of Green Patents* (LexisNexis 2013)

[123] ibid (n 116) ('The Office is **no longer accepting** Petitions to Make Special Under the Green Technology Pilot Program or requests for reconsideration based solely on a defective original petition. The program will meet its limit based on petitions that were previously filed and are awaiting decision.')

[124] USPTO, 'Green Petition Report Summary' (7 May 2012) <https://www.uspto.gov/sites/default/files/patents/init_events/green_report_summary20120426.pdf> accessed 13 March 2020

[125] KPO, 'Thanks to Super-speed Examination, Green Technology Acquires Patent in a Month' (10 March 2013) <http://www.kipo.gp.kr/kpo/user.tdf> accessed 14 March 2020

[126] Eric L. Lane, 'Green Patent Blog: Speed Bumps Emerge on KIPO Green Tech Fast Track' (LexisNexis, 25 October 2011) <https://www.lexisnexis.com/legalnewsroom/intellectual-property/b/patent-law-blog/posts/green-patent-blog-speed-bumps-emerge-on-kipo-green-tech-fast-track> accessed 14 March 2020

(e) green transportation system related technology

(f) green city related technology

(g) technology that economizes and efficiently uses energy and resources to minimize greenhouse gas and contaminated substances

(h) any technology belonging to one of (a) to (g) that fuses with another technology[127]

In the same line as the US's elimination of green categories, the 'subcategories clause' adopted by the KIPO has the same effect to remove the barriers for green technologies. In the years 2009-2012, a green growth has been witnessed in the sub-themes of 'reduce carbon emissions,' 'decrease energy dependence on oil and enhance energy self-sufficiency,' and 'creation of new growth engines.'[128]

Brazil

Fast-tracking green patents run by Brazilian Patent and Trademark Office (BPTO) reduce the pendency of patent applications to about two or three years, whilst the current average is of not less than 10 to 12 years. BPTO also gave a list of green patents that are eligible to this Green Patent Expedited Grant. To participate, the application must refer one of the following green technology categories listed below, which are in the same basis provided by the World Intellectual Property Office's International Patent Classification Green Inventory: [129]

(1) Alternative energy production: Bio-fuels, fuel cells, harnessing energy from manmade waste, hydro energy, wind energy, solar energy, geothermal energy, other production or use of heat, not derived from combustion and using waste heat;

(2) Transportation: Vehicles in general, vehicles other rail vehicles, rail vehicles and marine vessel propulsion;

(3) Energy conservation: Storage of electrical energy, power supply circuitry, low energy lighting, thermal building insulation and recovering mechanical energy;

(4) Waste management: Waste disposal, treatment of waste, reuse of waste materials and pollution control;

(5) Agriculture/Forestry: Forestry techniques, alternative irrigation techniques, pesticide alternatives and soil improvement;

(6) Administrative, regulatory or design aspects: Commuting (e.g. HOV, teleworking), carbon/emission trading and static structure design;

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[127] ibid (n 125)

[128] United Nations Industrial Development Organization, 'Global Green Growth: Clean Energy Industrial Investments and Expanding Job Opportunities: Experiences of Brazil, Germany, Indonesia, the Republic of Korea and South Africa' (2015) <www.http://constructionreviewonline.com> accessed 17 March 2020

[129] Claudio Szabas, 'Understanding the Brazilian Green Patent Fast-track' (30 July 2019) <https://blog.dennemeyer.com/understanding-the-brazilian-green-patent-fast-track> accessed 16 March 2020

(7) *Nuclear power generation: Nuclear engineering.*[130]

This Green Expedited Grant provides a solution to beat the backlog of unexamined patent applications. It motivates applicants and investors to go green.[131] Because of a remarkable success, "Green Patents" priority examination program became a permanent service at the BPTO in 2016.[132]

4.4.3 The expectation and modes

Objectively, the usage of accelerated program cannot reach 100% and it is never designed so. When UK first introduced the green channel, it had made clear the accelerated examination will only start once requested by the applicants. In other words, the green channel is not obligatory and only aims to provide an 'accelerated path' for applicants who are in such need. Therefore, a green channel shall be deemed effective and successful so long as it complies with this goal.

On the other hand, the low usage of accelerated programs in other countries does not indicate a similar result in another, as the reasons for this are attributed from a series of factors and vary from country to country. Cultural background, different eligible scopes and subject or non-subject requirements are typical factors that cause a remarkable influence on applicants' choice. In countries like Korea and Japan, there are more restrictions on the eligibility while UK, US and China imposed barely no limitations on that. The difference of the usage rate itself is also worthy being noted, in Korea and Japan, the figure is less than 1%, in comparison to an impressive 20% in the UK. Also, the figure in the US was nearly 8% but considering only first 3000 applications would be accepted it could have increased much higher if there was no upper limit. From this perspective, it is hard not to find usage rate in the UK and US not high compared to that of other countries. Based on the analysis above, a European fast-track program shall purpose to meet the 'accelerating need' by green applicants instead of chasing a high participation rate. Learnt from these countries' experience, few modes are extracted for the EU:

(1) Mode 1: A miscellaneous fast-track examination not only for green patents but also other patents deemed to be crucial to the economic or social development(China Mode): although this mode includes a wide range of patents and could generate a massive application wave, it meanwhile blurs the participation eligibility. That is to say, some patent applications in technologies at the expense of environment or social welfare ('polluting inventions and technologies') can also be accepted in the program. In this sense, the main subject of fast-track examination becomes vague and the goal of green policies and sustainable development will be harmed. Generally speaking, this mode aims to boost economy in a

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[130] United Nations Framework Convention on Climate Change (UNFCCC), 'IPC Green Inventory, Developed by the IPC Committee of Experts, Facilitates Searches for Patent Information Relating to Environmentally Sound Technologies (ESTs), as listed by the United Nations Framework Convention on Climate Change (UNFCCC)' <https://www.wipo.int/classifications/ipc/en/green_inventory/> accessed 16 March 2020

[131] 'Patent Examination in Brazil: Go Green to Beat the Backlog' (Life Science Intellectual Property Review, 13 June 2017) <https://www.lifesciencesipreview.com/contributed-article/go-green-to-%20beat-the-backlog> accessed 16 March 2020

[132] Resolution No 175/2016 (Brazilian Patent Office)

short term regardless of environmental cost. It is normally adopted in developing countries and regions as the early stage development policies. For these reasons, China Mode does not apply to Europe.

(2) Mode 2: A fast tracking examination with limited number of green patents to participate (US Mode): taking the energy section as an example, in order to meet the energy efficiency goal set in EU Directive on Energy Efficiency 2018 for the next decade 2020-2030 (over 30%), numerous amount of technologies have to be involved. However, it is impossible to anticipate a specific number of technologies needed to achieve this 'green goal.' In other words, there is no solid relationship between the quantity of green patents and a better energy efficiency performance. Therefore this is not the way for the EU/EPO.

(3) Mode 3: Several accelerated examinations exist at the same time while with only one super accelerated examination designed only for green technologies (Korea Mode/Japan Mode): this mode solves some shortcomings of China mode. Overall, any applicant can request the accelerated examination so long as they submit a prior art search report from an officially designated search organization and prove they qualify for one of the conditions set in Article 61 of Patent Act (Korea).[133] Once their applications can be deemed green, they are eligible to request a super accelerated examination. In this aspect, each applicant is free to choose the examination method whose pendency suits them the best.

This Mode also has its drawbacks: first, the time difference between those accelerated paths is merely few months. It is relatively difficult for producers, inter alia smaller green companies, in such short period, to form competitiveness over its substitutional non-green competitors. As a result, the goal of environmental policies may not be fully realized. Second, if the average pendency under super accelerated examination does not make a manifest difference from that under ordinary/accelerated procedure, applicants may be less motivated to file through the super accelerated mechanism. If the ordinary examination only costs 1-3 years, applicants will be more inclined to stay out of super fast-tracking path. This is explained by the low program usage in Japan: Japan provides one of the fastest patent exams in the world (2-3 years on average). In the year 2009, more than 10, 000 patents are filed though accelerated program (1 year), however, only few hundred went through super accelerated examination (few months). This suggests that green applicants may prefer a time reduction down to 1-2 years. In the UK, a less aggressive time-reduction (11 months on average) brought more participants into the green channel. It could indicate that an accelerated program with its pendency reduction closer to one year is able to appeal to more green applicants.

Before the EPO, the ordinary pendency requires normally 4-5 years. It is thus possible for the EPO to establish several parallel accelerated examinations with distinguished levels of time reduction. For instance, an accelerated examination (to be completed within 3 years)for all applications if they are considered crucial to economic and social development. A super accelerated examination only targeting green patents with the pendency drop to less than one year. In terms of the non-subject and subject requirements of the super accelerated examination, the UK/Brazil Mode, as analyzed in Mode 4, will apply.

[133] Patent Act (Korea)

(4) Mode 4: One and only accelerated examination procedure merely for green patents (Brazil Mode): European accelerated examination should make a considerable difference between green inventions and non-green inventions so as to strengthen the incentives specifically for innovators to engage more in green R&D. There are two ways to achieve this goal:

a. The first method (UK Mode) is to adopt a broad concept of 'green technologies/inventions' without providing detailed interpretation. In order to participate, applicants have to submit the assertions that their inventions are green to some extent, and no further requirements are asked. An example green shortlist could be given to provide more guidelines for applicants, i.e., the World Intellectual Property Office's International Patent Classification Green Inventory. This mode purposes to cover as many green inventions as possible and eliminate the 'formalities' barriers for applicants.

b. The second way is to have a clear range of eligible technologies (Japan Mode). The program is not designed to cover all green technologies. Only shortlisted types of technologies/inventions are eligible to participate. In Japan, the program is confined to technologies only related to 'energy-saving effects and contributing to carbon dioxide emission reduction.' In the same line, the EU could establish its own shortlist to meet its own environmental preferences. For example, technologies related to 'mitigate the greenhouse gas emission' are eligible, to meet the objective for reducing its greenhouse gas emissions progressively up to 2050. Member States can further clarify the requirements according to their national considerations, that is, giving national green interpretations or making a detailed shortlist for specific green technologies they are willing to encourage more.

In both ways, the burden proof of greenness falls on applicants. Once European applicants submit a request with robust documents to show the greenness of their inventions, they should be principally accepted without going into a detailed investigation. Any of these two ways does not make a big difference for European investors. Regarding all four modes discussed above, this mode and mode 3 maximumly match the need in European market.

4.5 Possibility of a 'decelerated' examination on 'polluting patent applications'

4.5.1 Overview

In terms of the European patent grant procedure, it is made up of two main stages and takes about three to five years from the date the application is filed. The first phase comprises a formalities examination, the preparation of the search report and the preliminary opinion on whether the claimed invention and the application meet the requirements of the EPC. The second phase involves substantive examination.[134] The major topic of this section is to examine in the context of greenhouse gas emission mitigation, whether a slow-down examination on polluting technologies will accelerate the pace for innovators to turn green without harming the technical innovations as a whole. The discussion will focus on the energy sector where the majority of the greenhouse gas emissions are generated.

The concept of 'polluting inventions' should be understood in a board sense and refer to the inventions that have the direct effect to cause environmental damage or accelerate the global climate change. For example, a new pesticide that is capable to kill more insects whilst with more residual pesticides, soil and water pollution, or an engine for heavy duty vehicles with bigger fuel combustion. A polluting invention might at the same time contain 'green,' 'non-green but not polluting' and 'polluting' technologies. All these types of technologies are precisely placed together to make an invention fully function and achieve anticipated technical or environmental effect. In a complete life cycle of a polluting invention, it could be developing into a green invention provided the technologies have evolved. These technologies, regardless inherently green or not, are eligible for patent protection so long as they qualify the patentability conditions set in the EPC.[135]

4.5.2 Negative impacts

Decelerated examination is a double sword. On the one hand, affected by the negative delay, 'polluting technology' innovators and investors could be facing a loss of business opportunities. As a result, a green transformation might be spurred. On the other hand, a massive prolongation of pendency leads to a sharp increase of workload for examiners and thus piles up the backlogs at the patent office. It is thought to lower the working efficiency and indirectly drive up the fees for applicants. Moreover, less transparency and legal uncertainty could arise. It is therefore significant to overweigh its benefits and costs, some of which are demonstrated below:

(1) Killing small new and growing business: not every business starts with reputation, goodwill, physical assets and mature clean technologies. In the short of those factors, patents are the tools to gather all essential production engagements. Compared to big companies, small business are more vulnerable in response to a patent delay. For example, a SME only having polluting technologies could lose business opportunities under the long pendency of their patents. Those opportunities include jobs creating, sales growth, innovation, investor benefits and so on. In the study of 'the Bright Side of Patents,' it found that a first-time patent grant increased the probability that a startup would receive venture capital by 53%,

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[134] EPO, 'How Long Does the Grant Procedure Take?' <https://www.epo.org/service-support/faq/procedure-law.html#faq-274> accessed 8 April 2020

[135] EPC art 52-57

and the effect was strongest for inexperienced entrepreneurs. Even more important for present purposes, the study found that delays in obtaining a startup's first patent impair its performance.[136] Every year of delay reduces the startup's employment and sales growth over the five years following its eventual approval by 21% and 28% respectively. Delays also hurt a startup's ability to innovate, reducing the number and quality of its subsequent patents. Furthermore, the startup's chances of going public are reduced by half in each sequence year of delay[137] This presents a risk that decelerated examination could harm the early stage innovations.

(2) Impossibility of a rapid green turn: in the energy sector, the EU has developed a series of high environmental standards and policies to facilitate the green technology revolution in the past decades. These efforts serve the goal to encourage investors to turn green. However, the current EU economy is still largely fueled by natural energy, including oil and petroleum. Figure 14 gives a comparison between distributions of greenhouse gas emissions by different source sectors in the EU-28 countries in 1990 and 2017. In general, the greenhouse emissions in fuel combustion and transport accounted nearly 80% of the total figure in both years.[138] It indicated that the EU energy consuming structure had not changed in the past three decades and it is still less likely to change in a short term. In this sense, a decelerated examination in its essence is not able to largely facilitate the green revolution.

As for applicants, the introduction of decelerated examination also does not necessarily lead to their rapid green transformation. If the ordinary patent examination becomes longer, applicants in particular single innovators may choose trade secrets over patents as the prior IP protection. This is more relevant when it comes to new-to-market innovations (products or processes).[139] Furthermore, some innovations are based on the knowledge of published non-green and polluting technologies. Long pendency would thus hinder the patent citations and references in new green product enhancing activities and even in companies' own green transformation. In this aspect, decelerated examination is seen as counterproductive to its goal.

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[136] Joan Farre-Mensa, Deepak Hegde and Alexander Ljungqvist, 'The Bright Side of Patents' (2016) NBER Working Paper No. w21959 National Bureau of Economic Research <https://ssrn.com/abstract=2729060> accessed 9 April 2020

[137] ibid (n 76)

[138] Eurostat Statistics Explained, 'Greenhouse Gas Emission Statistics—Emission Inventories, Statistics Explained' (June 2017) <https://ec.europa.eu/eurostat/statistics-explained/pdfscache/1180.pdf> accessed 7 April 2020

[139] Dirk Crass and others, 'Protecting Innovation Through Patents and Trade Secrets: Evidence for Firms with a Single Innovation' (2019) 26/1 International Journal of the Economics of Business 117, 156

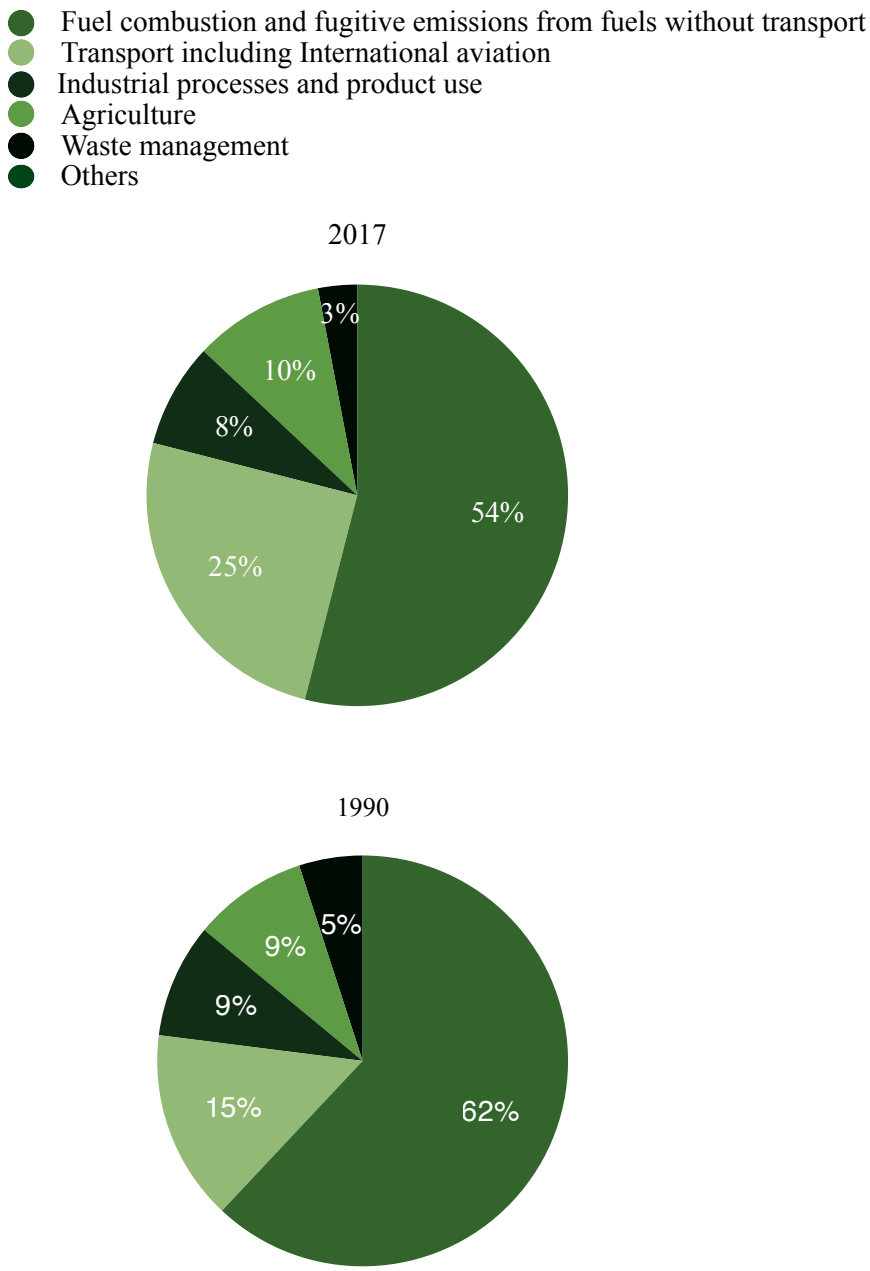

Figure 14 Greenhouse gas emission by source sectors (1990, 2017)

Source: Eurostat, European Environment Agency

(3) Sharp increase of patent backlogs: the demand for European patents continues to grow in recent years. In 2019, the EPO received over 181, 000 applications, 4% more than in 2018 and reached a new all-time high. Among all patents, the number of environmental patents were only 1908, which somehow indicated most patented technologies are non-green.[140] Bearing this in mind, it is foreseeable that a decelerated examination would cause a shape rise to patent backlogs before the patent office. As the pendency continues, the legal uncertainty in the every part of energy supply chain is also likely to

[140] EPO, 'Patent Index 2019' <https://www.epo.org/about-us/annual-reports-statistics/statistics/2019.html> accessed 10 April 2020

increase, wavering capital flow in the investment and sequence technical development. In the long run, knock-on effects from the slow-down examination are still unpredictable.

At the same time, some alternative methods potentially having the same or similar impacts are also discussed, i.e., stricter patentability. A proposal was made so as to supplement the patenting criteria by an eco-friendly condition along with the customary novelty, inventive step and industrial application prerequisites.[141] Such proposal was not supported for two reasons: first, the patent system does not have a regulatory and political function (beyond the existing limits regarding, e.g., ordre public and morality), it is the responsibility and competence of governments and/or international conventions to provide regulatory instructions or restrictions regarding the use of certain technologies. Second, patent examiners do not have the responsibility, competence and adequate time to assess scientific questions relating to the environmental effect of inventions concerned as inventions may be complex and multi-faceted. For instance, many inventions allow 'dual use,' i.e. they can be exploited both in an environmentally friendly way and in a way that might be damaging the environment. Therefore it is technically difficult to calculate the scope of these inventions to which the stricter patentability requirements would apply.

[141] E. Derclaye, 'Intellectual Property Rights and Global Warming' (2008)12 Marquette Intellectual Property Law Review 263

5. Conclusion

Green technologies are the core to battle against the accelerating climate change. The growth of technical innovations in greenfield strengthens EU's performance of achieving a more effective energy consuming structure and greenhouse gas emission mitigation. A series of efforts have been continuously made to further this green evolution, including environmental policies, regulations and intellectual property rights, which together offset the costs of environmental compliance for companies.

Among all these methods, the thesis finds a statistical interaction between patent filings and green trade: First, patent data are irreplaceable as the indicator as well as the driving force in the technical innovations and transfer. Second, patents provide incentives and advantages for European innovators, particularly smaller companies, to develop new technologies and secure their marketing position in the green technology trade, especially in the course of CCMTs export to non-EU countries.

The thesis also finds that long patent granting pendency harms patents' marketing value in early business and imposes negative impact on green R&D. In response, an accelerated green patent examination is introduced. There are two pushes for such European accelerated procedure: internal and external market needs. The internal push comes from the increasing EU environmental policies and regulations. The external push stems from the market need in Member States and non-EU countries to adopt and develop new green technologies and achieve a green economic pattern. In this green revolution, an accelerated examination could bring 'speeding up' value not only to the undertakings in the greenfield, but also to the green R&D activities as a whole. In terms of firm's performance, a fast-gained patent is also likely to accelerate firm's sequence business and secure its current market position, which is particularly important to SMEs. At last, the thesis suggests that the UK green channel is the best suitable for the EU. This mode has a wide-scope concept of green technology without detailed interpretation. It is applicants' liability to submit their 'green assertions.' For other methods such as a decelerated examination on polluting technologies, it is not plausible in the EU as it is likely to cause a sharp increase of patent backlogs and potential risks to kill small business.

Overall, a mere green accelerated program is far from enough in meeting the goals set in the international and EU environmental policies and regulations. A joint effort from different mechanisms and cooperations between companies, nations and regions is still needed.

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