Patents and clean energy technologies in Africa

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Cover
Installation of solar panels
to supply energy for
irrigation system pumps

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FOREWORD

Measures to address climate change under the aegis of the United Nations Framework Convention on Climate Change have identified the development and transfer of technologies as one of the key pillars in both mitigating the causes of climate change and adapting to its effects. Several policy challenges to technology transfer have emerged over the years, a crucial one being patent rights.

The Division of Environmental Law and Conventions (DELC) of the United Nations Environment Programme (UNEP) is charged with the development and facilitation of international environmental law, governance and policy. In this way, DELC assists the international community in the progressive development of environmental law and supports governments in the development and implementation of legal and policy measures that address emerging environmental challenges.

In this perspective, the role of patent rights in connection with climate change is obscured by a lack of accurate and relevant information, and the difficulty of accessing and interpreting the data available. Repeated exchanges with negotiators engaged in the climate change mitigation process, as well as with policy makers within governments and the private sector, identified this as a crucial issue where UNEP and partners such as the European Patent Office (EPO) could add value to the existing global repository of information relating to patent rights for renewable energy technologies. UNEP therefore undertook a basic analysis and mapping of potential sources of renewable energy around Africa, which led us to determine the types of technology on which the study could focus.

The prevailing consensus was that technologies relating to solar energy, hydro-electric power, geothermal, ocean energy, biomass and biofuels and wind energy are of primary importance in addressing issues of clean energy technologies (CETs), their innovation and transfer, and related patent rights.

Comparative advantages and its strategy of building upon existing initiatives led UNEP to pursue an established partnership with the EPO, which contributes to technological innovation and plays a leading role in developing an effective global patent system. The EPO's patent information tools, such as the global patent database Espacenet and the machine translation service Patent Translate, as well as the refined Cooperative Patent Classification (CPC) allow free of charge access to all relevant technical information on the internet. Moreover, these tools have been complemented by a specialised classification scheme, Y02, dedicated to retrieving patents related to clean technologies. In combination with the EPO's statistical database for analysing and visualising patent data ,PATSTAT, the Y02 scheme enables statistical information on patenting trends to be generated for climate change related fields.

Previous studies undertaken jointly by UNEP, the EPO and the International Centre for Trade and Sustainable Development (ICTSD) proved an apt model for the basic structure of this study. For selected patent data delivered by the new EPO information platform for mitigation and adaptation technologies, the Organization for Economic Co-operation and Development (OECD) joined the project and again built a statistical analysis methodology similar to that used for the previous UNEP-EPO-ICTSD study (http://www.epo.org/clean-energy).

The analysis was aimed at identifying the relevant patented technologies covering alternative energy generation potential and climate-change mitigation solutions in Africa. It also examined patent filing and cross-filing trends, including co-invention and co-ownership of patent rights, as indicators of innovation in Africa, as well as technology transfer both between African states and from overseas.

A survey of the status of the patent system in all African states has also been completed, including the current developments expected due to implementation of the WTO TRIPS agreement, and their relative position within the global patent system. This has allowed conclusions to be drawn on how the global and African patent systems can best be used to support innovation and transfer of clean energy technology in Africa.

The present report therefore gives insights into the legal and technological side of CETs and into patent landscapes with respect to Africa. We hope that effective dissemination and utilisation of this innovative study will contribute positively to the uptake of technology diffusion across the continent and to the leverage of the African and global patent systems to support it. It is also intended that the report act as a catalyst to successfully addressing the three broad objectives that sit within the energy paradigm, namely climate change mitigation and adaptation, energy security and poverty alleviation.

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EXECUTIVE SUMMARY

Africa has a huge untapped potential for generating clean energy, including enough hydroelectric power from its seven major river systems to serve the whole of the continent's needs, as well as enormous potential for solar energy, wind energy, geothermal energy etc. Although major hurdles exist also in the distribution of energy there is potential for Africa to leapfrog existing fossil fuel energy sources and exploit clean energy from the outset to meet its developing needs.

At the original UN Conference on Environment and Development (UNCED, or the "Earth Summit") in Rio de Janeiro, June 1992, intellectual property and patenting in particular was highlighted by some participants as a significant factor limiting the transfer of new clean technologies to developing countries, and identified as a barrier to these countries meeting new emission limits for CO2 and other Greenhouse Gases. The issue was also raised in the Rio +20 United Nations Conference on Sustainable Development in June 2012.

The present study aims at providing facts and evidence to evaluate the actual situation concerning patenting of Clean Energy Technology (CET) in Africa. It builds on an earlier study in this field carried out jointly by the EPO, UNEP and the ICTSD using methodologies and tools developed[1].

The actual patenting landscape of CET is analysed 1980 – 2009 in Africa and its sub-regions. The landscape is divided by technology area, and includes solar heat and PV, hydroelectric, wind and biofuels and other sources. Both Climate Change Mitigation Technology and Climate Change Adaptation Technology (CCMT/CCAT) are analysed. The origins of the patent applications are analysed, as well as the levels of co-patenting with and between African states.

The "Patent Information" system, available worldwide via the internet and using dedicated tools such as the EPO's free Espacenet database, has with the EPO's specially developed Y02 classification scheme tagged and indexed some 1,5 million documents relevant to most climate change related technologies by end 2012. The Y02 scheme is fully incorporated within the Cooperative Patent Classification (CPC). Together with the EPO's "PATSTAT" patent data statistical tool, patent information data relating to CETs and tagged with the Y02 scheme may be analysed and used to inform policy makers.

The results show that less than 1% of all patent applications relating to CET have been filed in Africa.

The results also show however that there is a relatively high level of inventive activity in Africa in the field of mitigation technologies. This activity is mostly focused on energy storage/hydrogen/fuel cell technologies (37%) and renewable energy (25%), in particular solar PV and solar thermal, followed by nuclear energy (20%) and biomass/waste/combustion/CCS technologies (17%), especially biofuels. While the global growth rate on overall inventive activity is 5%, in Africa the growth rate overall is 9% and is a staggering 59% for mitigation technologies. However, the overall African share of inventive activity in CCMT is still low at 0,24%, and 84% of this is in South Africa.

In the field of adaptation technologies, the African share in worldwide inventive activity is very low (0,26%), but the level of patent protection sought in African countries is increasing rapidly at an average of 17% p.a. over this period.

CCMT in particular is developed through international research collaboration; 23% for African CCMT, compared to 12% worldwide. While there is little intra-African co-invention, Africa's most frequent partners are US, UK, Belgium, Germany, Sweden, France and Canada. Overall, inventive activity and patenting is dominated by South Africa, which appears to play a leading role in in co-invention, and in technology transfer of CCMT to Africa.

Although many relevant clean energy technologies already exist, they are not yet widely available in Africa for a range of reasons, including high costs. The development of the Technology Mechanism by the United Nations Framework Convention on Climate Change (UNFCCC) has focused attention on technology transfer as the key to approaching CETs in the climate change debate.

Various countries have also developed science and technology (S&T) or science, technology and innovation (STI) policies, as well as national programmes or white papers, which all place considerable emphasis on the transfer and diffusion of technology and explicitly include the energy sector.

Patents have an important role to play in technology transfer. As the previous report on patenting and climate change mitigation technology from EPO, UNEP and ICTSD showed, the main factors impeding technology transfer are access to the real know-how from the source companies (including access to trade secrets), access to suitably skilled staff, scientific infrastructure, and favourable market conditions. The patent system can therefore support technology transfer as without patents to protect their products and processes, the source companies may be reluctant to engage in technology transfer and associated investments.

1 "Patents and Clean Energy: Bridging the gap between evidence and policy", EPO/UNEP/ICTSD 2010.

All African states except Somalia now have a patent system, and all states except for Somalia and Eritrea comply or will eventually be obliged to comply to the requirements of the TRIPS agreement as members of the WTO.

This report helps to understand how the global and African patent systems can best be used and further developed to support and facilitate the technology transfer of CETs in Africa.

To foster innovation and growth, one of the big challenges for all patent offices across the world, including African states, is to establish or maintain a high quality patent system to discourage low quality patents, ensuring that exclusive rights for CET are only granted for valid technical inventions. As an example, only approximately 50% of patent applications lead to a grant at the EPO, and the scope of protection of those granted is mostly reduced during the examination process.

High quality patents offering maximum legal security, and protecting the interests of both inventors and the public, are the cornerstone of a properly functioning patent system. They provide the optimum balance between private and public interests, disseminating technical information widely, while limiting granted exclusive rights to valid inventions.

The patent system makes a wealth of technical information readily available worldwide, free of charge via the internet. With less than 1% of patent applications relating to clean energy technology filed in Africa, patent rights are unlikely to be a major consideration in any decision to exploit CETs in the region. Longer term, all countries should investigate the possibilities around the development of a high quality patent system and facilitate effective cross-patenting to encourage both co-invention activities as well as technology transfer of more recent CET developments. The relationship between the patent system and successful technology transfer to regions such as Africa also needs to be further researched to inform and guide future policies towards development of clean energy technology for future African needs and purposes.

REPORT SUMMARY

Introduction

Although Africa has invested in conventional power sources for decades, the situation remains problematic and is characterised by challenges such as unreliable power supply, low access levels, low capacity utilisation and availability, and high transmission and distribution losses. To tackle the current challenges of climate change and to meet the United Nation's Millennium Development Goals (MDGs), the United Nations Development Programme (UNDP) and the World Health Organization (WHO) estimate that two billion people require access to modern energy services by 2015. Since approximately 800 million of these people live in sub-Saharan Africa, they are among the most vulnerable to the effects of climate change despite having contributed the least to global warming.

As Africa's energy currently comes from fossil fuels (oil and coal) and traditional biomass, which have relatively high emissions and other negative consequences, including health problems, it has become a pressing matter to develop the continent's ability to exploit its clean energy potential as its energy demands grow. Research shows that Africa has vast clean energy resources and that these are largely unexploited. However, the ability of African countries to exploit their clean energy potential and join the globally developing clean energy markets will significantly depend on their ability to access and deploy the relevant technologies.

Although many relevant clean energy technologies (CET) already existor are in development, they are not yet widely available in Africa for a range of reasons, including high costs. The development of the Technology Mechanism by the United Nations Framework Convention on Climate Change (UNFCCC) has focused attention on technology transfer as the key to wider use of CETs in the climate change debate. The discussions about the ownership and transfer of know-how in exploiting clean energy have heightened the interest in – and the misconceptions and controversy surrounding – the patent system. Technical innovation and hence the associated legal rights are key factors in the efforts to find adaptation and mitigation strategies for dealing with climate change.

The impact of the patent system is much the same in the CET field as in any other, encouraging innovation, dissemination of key technological knowledge, investments in both R&D and exploitation of inventions, as well as supporting wider implemen-tation of technology through licensing and technology transfer. However, over the last few years, a variety of reports have shown that we do not fully understand the relationship between patent rights and how the development and diffusion of CETs influences mitigation and adaptation strategies, and that we therefore have insufficient evidence to take responsibility for important policy decisions relating to patent rights, technology and climate change.

Following a methodical step-by-step approach, the present report empirically analyses the role of patents to date in the potential development and transfer of CET and relevant adaptation technologies in Africa. By mapping the continent's clean energy potential and analysing the policies and legal framework for patent protection in Africa, as well as patenting patterns, the report helps to understand how the patent system supports technology transfer, and also how that system could be optimised to facilitate the development and transfer of CET in Africa.

Mapping Africa's clean energy potential

It is widely acknowledged that Africa is home to vast, unexploited and readily available renewable energy resources with the potential to contribute to the continent's energy security. In particular, there is significant potential for wind, solar, hydro, geothermal and biomass energy generation. However, since the energy resources are not evenly distributed across the continent, generalisations are misleading.

Africa experiences some of the most intense solar radiation in the world and, therefore, the continent has vast potential for solar energy, especially in the Sahara and Kalahari deserts. This suggests that all of Africa, including the island states, could benefit considerably from photovoltaic (PV) technologies, which have already been widely promoted in recent years.

The potential for wind energy varies considerably. While many landlocked sub-Saharan African countries feature only low wind speeds, South Africa, north Africa and the east coast have significant wind energy potential. Many countries have already started to harness this energy. Even countries with less suitable wind conditions have introduced wind-powered applications such as water pumping for potable water and irrigation.

In addition, research estimates potential for 9000 megawatts (MW) of geothermal energy in Africa, particularly in the Great Rift Valley. However, of all countries with such potential, only Kenya and Ethiopia currently make notable use of geothermal energy (just over 200 MW). By far the most common form of renewable energy used in Africa is hydro energy, which is electricity generated through turbines turned by falling water. The Southern African Power Pool (SAPP) estimates that large hydro projects (more than 10 MW) utilising hydro energy at the seven major river systems (Congo, Limpopo, Niger, Nile, Orange, Senegal and Zambezi) could feasibly produce a combined hydro capacity sufficient to produce enough power for the whole continent at current consumption rates, plus additional energy for export. However, with a current exploitation rate of 4.3%, this energy source remains largely untapped.

Africa also has significant potential for generating energy from biomass. The most successful forms of biomass are sugar cane bagasse from agriculture, pulp and paper residues from forestry, and manure from livestock. While in 2011 bagasse already accounted for about 94% of the 860 MW of installed bioenergy generation on the continent, research shows that more than 16 sub-Saharan African countries could meet a significant part of their current electricity needs from bagasse-based cogeneration.

Finally, there is also considerable potential for ethanol production and for biogas from animal waste. Regarding the regional distribution of clean energy resources, Africa's energy map can be divided into four broad regions based on current consumption, access patterns and the potential for clean energy generation from different sources: north Africa, continental sub-Saharan Africa, South Africa and the island states.

Though all regions predominantly rely on oil, each energy potential map is different due to distinct geographical, economic and social factors which need to be understood. The north Africa region, consisting of Algeria, Egypt, Libya, Morocco and Tunisia, currently relies primarily on oil and gas to meet its energy needs. While universal access has almost been attained, the region has also made significant investments in unexploited clean energy generation in recent years, particularly in solar and wind power. In sub-Saharan Africa (excluding South Africa and the islands), comprising 41 countries, a group of seven countries constitutes one of the world's major exporters of oil. However, traditional biomass accounts for 80% of the total domestic energy supply. While clean energy potential for all forms is vast, only a very small proportion of the region's rural population has access to modern energy services.

South Africa's current energy sources are dominated by hard coal, which is the source of slightly more than half of the primary energy supply. Currently, the level of access stands at about 70%, but the situation in rural areas is significantly worse, even though extensive distribution infrastructure is already in place. Since 2003 South Africa has taken steps to mainstream renewable energies and use its significant clean energy sources including wind, solar, hydro and biomass.

The island states, comprising Cape Verde, Comoros, Equatorial Guinea, Madagascar, Mauritius, the Seychelles and Sao Tome & Principe, face unique energy problems due to their isolation. Overall, up to 80% of the energy in these countries comes from imported oil products, though they have significant potential to exploit a number of clean energy sources, particularly wind, solar and biomass.

Policies and legal frameworks for patent protection in Africa

Technological advances, coupled with the growth in international trade of knowledge-based goods and services, have progressively raised the awareness of patent related issues in discussions about trade regulation and global challenges such as climate change. Each member of the World Trade Organization (WTO) is required to implement the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), which mandates the provision of a minimum level of IP protection. In the climate change discussion, patent protection has become a topic of continued debate over access to technology and knowledge in general between industrialised countries on the one hand and developing countries and least-developed countries (LDCs) on the other.

African countries have increased their efforts to elaborate and implement strategic IP policies at the national and institutional level in the last few years. Factors such as the greater availability of funding and technical support for the development of such strategies and policies from organisations like the World Intellectual Property Organization (WIPO), and the co-operation with the EPO, have advanced this trend and made African countries focus more on the strategic importance of IP in the knowledge economy. Overall, the different patent policies and strategies focus on technology transfer and emphasise the importance of a patent policy that supports innovation, including the transfer of critical technologies such as CET.

This is a particularly important issue in the area of climate change considering the significant public investments in CET development and deployment. Various countries have also developed science and technology (S&T) or science, technology and innovation (STI) policies, as well as national programmes or white papers, which all place considerable emphasis on the transfer and diffusion of technology and explicitly include the energy sector. Many of these policies also acknowledge the role of and the need to address patent-related issues in the context of technology transfer.

To comply with the TRIPS agreement and other international, regional and bilateral agreements and stakeholder demands, the African countries have often to update and otherwise reform their IP and patent laws, their related legal frameworks and their institutions.

On climate change, the impact and role of patent laws has been the subject of much debate. Attitudes towards patent protection in these areas are diverging between industrialised countries on the one hand and developing and least-developed countries (LDCs) on the other. The latter group (the South) has gone so far as to call for CETs to be excluded from patenting (TWN, 2009). African countries, which are politically part of this group, have generally been supportive of such views. They were repeated at the "Rio +20" talks in 2012.

Most African countries are members of the WTO and therefore obliged to mandate a minimum level of patent protection for inventions. To date, no countries exclude CET from patenting. Meanwhile, another 11 countries are in the process of acceding to the WTO and will be required to comply with the TRIPS agreement as a condition.

In summary it can be said that CET patents can be applied for and are granted in the majority of the African countries. The situation remains unclear only in Eritrea, Libya, the Seychelles and Somalia.

Rooted in the legal obligation in the patent system to publish patent applications, the patent information system makes technical information readily available throughout the world via the internet. With dedicated tools such as the EPO's free Espacenet database and with the EPO's specially developed Y02 classification scheme (including the additional Y02B-Buildings and Y02T-Transport sections end of 2012) the technical information from some 1,5 million documents relevant to most climate change related technologies have been made freely available. The Y02 scheme is fully incorporated within the Cooperative Patent Classification (CPC). The information function of patents, therefore, constitutes a vital mechanism for dissemination of CET, also supporting further research and development in the area.

As the patent system in these countries develop, it is important to ensure that a quality-oriented patent system involving state of the art searches on technology and substantive examination of the invention on its compliance with the patent law is introduced, as opposed to mere patent registration systems. For instance, only approximately 50 % of patent applications filed with the EPO are granted, and the majority those granted have their scope of protection reduced during the substantive examination process. This not only produces greater certainty about the technical and legal merit of inventions but also minimises the risk of unwanted legal stumbling blocks to innovation.

Ensuring the validity of granted rights is all the more important as patents are increasingly filed across a larger number of countries using different filing routes, such as the Paris Convention or the Patent Co-operation Treaty (PCT), and treated by different IPOs in parallel. Accordingly, patents originating from abroad may also be subsequently filed in African states. Improved information products and services such as the Common Citation Document (CCD)[1] promote the convergence of search results, and increase their relevance for judging the merit and validity of inventions. In the case of PCT filings, initial patentability search and examination results from a recognised expert IP office acting as International Searching Authority also helps discourage the simple "registration" of low quality patents in countries that have not yet been able to establish significant examination resources.

High quality patents offer better support for the transfer of CET and other sustainable technologies across the continent on the basis of licenses. Participation in the EPO's validation scheme for patents could help a local national environment benefit from the strong quality of the EPO examination for those applications originating from abroad. In doing so, the national office is in the best position to dedicate all its resources to a full support for the national innovation while foreign direct investment is encouraged by the sound examination of the foreign applications by the EPO.

In certain exceptional cases, including a national emergency, but also where a specific patent owner has not been willing to grant authorisation on reasonable commercial terms and conditions within a reasonable length of time, some legal options are allowable under TRIPS (Art. 31). A review of the relevant patent legislation also reveals that most African countries have incorporated basic flexibilities such as compulsory licensing, government use and ex-officio licences and research exemptions into their patent laws. These countries also have regimes for voluntary licensing, including prohibitions on certain anti-competitive licensing practices. Of course, the specific application and scope of these flexibilities vary across the countries.

1 The Common Citation Document – www.trilateral.net/ccd

CET patenting patterns in Africa – a statistical analysis

In order to have a correct understanding of the policies and the legal framework, the actual patenting landscape and the role of patents in the transfer of CETs have to be disentangled from ideology, theory and speculation.

Drawn from the EPO's public PATSTAT database, the data collected is for Africa as a whole or, in some cases, disaggregated at a regional level. In addition to the existing inventory of climate change mitigation technologies, a new set of adaptation technologies which could help the continent cope with climate change has been identified.

Overall for the 1980 – 2009 period, 580 154 mitigation and 47 108 adaptation patent applications supply data on the country of the inventor(s), the country of the applicant (patentee) and the granting authority. In addition, applications can be used to analyse the patenting activity of African inventors abroad, or of foreign inventors in Africa.

The main finding of this report is that only approximately 1% of identified CET-related patent applications have been filed in Africa, the majority thereof in South Africa, itself an identified "emerging economy". Accordingly, there has been very little patenting activity in CET in the remaining African states, and patent rights are unlikely to be a major consideration in any decision to exploit CETs in these states.

While Africa's overall inventive activity is low, there is a relatively high level of inventive activity in the field of mitigation technology. This activity is mostly focused on energy storage/hydrogen/fuel cell technologies (37%) and renewable energy (25%), in particular solar PV and solar thermal, followed by nuclear energy (20%) and biomass/waste/combustion/CCS technologies (17%), in particular biofuels. CET development in the field of efficient electricity generation/transmission/ distribution only plays a marginal role in Africa. In the global context, it is notable that inventive activities in the field of biofuels, nuclear, marine & tidal and energy from waste carry more relative weight in Africa than they do worldwide.

Assessing Africa's CET developments by measuring the relative technological advantage (RTA) in the various technologies, it was found that, despite the generally low inventive activity, the efforts made are disproportionately directed towards mitigation technologies. While the global growth rate of inventive activity in the field of mitigation technologies was 5%, total inventive activity in Africa increased at a slightly faster rate of 9%, and this figure rose to an extraordinary 59% when looking at mitigation technology in isolation.

In the 1980 – 2009 period Africa's inventive activity only accounts for about 0.3% of the global activity in mitigation technologies, and most of it took place in South Africa (84%). While South Africa has been able to diversify into other inventive fields, the inventive activity in other major African inventor countries such as Egypt, Algeria, Morocco and Kenya focuses on renewable energies. Overall, inventive activity and patenting is dominated by South Africa, which appears to plays a leading role in in co-invention, and in technology transfer of CCMT to Africa. Since 2003 South Africa has taken steps to mainstream renewable energies and use its significant clean energy sources including wind, solar, hydro and biomass, reducing its dependency on hard coal.

Overall, less than 1% of all mitigation technology patents are applied for in Africa. Only 10% of African inventors apply for patent protection in Africa, the majority tending to seek protection in four other regions: the United States (27%), the EPO (24%), Germany (13%) and Canada (10%). This appears to support the belief that Africa's IP system requires further development to better support climate change related activities.

The data shows that Africa has a relatively high proportion of patent applications for biofuels (0.14% compared to 0.04% worldwide). While other mitigation technologies like nuclear, CCS, marine & tidal and combustion are patented relatively frequently, patents for energy storage/hydrogen/fuel cells and solar PV are less often sought in Africa in relative terms than they are worldwide. In addition, the results show that overall mitigation technology is protected more often in Africa than elsewhere (1.7% in comparison to 1.2% worldwide).

The majority of inventions in CCMT have been developed in OECD countries and, while the US and France were the most important countries of origin in the 1980s, Germany took pole position in the last decade. African countries have increased their share from less than 1% to over 8% in the same period.

In the field of adaptation technologies, inventive activity in Africa focuses on water desalination (45%), energy supply in remote locations (25%), solar water treatment (14%), rainwater collection (7%) and solar/wind-powered water pumping (7%). Surprisingly, technologies that would be highly relevant for addressing several of Africa's most pressing environmental needs, like solar cooking, efficient lighting for remote locations and solar/wind-powered water pumping, are rare. The African share in worldwide inventive activity is very low (0.26%), and a higher share of African inventors of adaptation technology seek protection in Africa itself (81%), compared to only 1% who seek it worldwide. In contrast to the general trend of decreasing patent applications for mitigation technologies, the number of adaptation technologies for which patent protection was sought in Africa between 1980 and 2009 has increased by 17% per year on average.

Climate change mitigation technology, in particular, is developed through international research collaboration. The results show that 23 % of all African mitigation technology has been invented through co-invention. While 12 % of mitigation technologies and only 9 % of all inventions worldwide have been developed through co-invention, Africa has a particularly high rate. Africa's co-invention rate is higher than the rate worldwide in all cases except inventions in solar thermal, nuclear energy and waste-to-energy. While there is almost no intra-Africa co-invention, the US, the UK, Belgium, Germany, Sweden, France and Canada are Africa's most frequent partners in co-invention projects. When it comes to adaptation technologies there is hardly any international research collaboration (co-invention) and only very little co-invention activity, mostly in desalination, and primarily with South Africa.

Understanding and leveraging the global patent system to promote access to CETs in Africa

The fact that only 1% of CET patent applications have also been filed in Africa prove that claims made at the original 1992 and subsequent 2012 Rio Conferences, that patent rights provide a barrier to use of CETs, are very largely unfounded for Africa. As the energy requirements of Africa and its 1 billion people develop, patent rights are unlikely to be a major consideration in any decision to exploit CETs

The report confirms that Africa has extensive clean energy resources, yet these are not evenly distributed across the continent. It emphasises that full exploitation of these resources would provide the continent not only with enough energy to meet all local and regional needs, but also additional energy for transcontinental export. However, current exploitation levels indicate a very low usage of the potential, and in the area of hydro of only 4 %.

In recent years, African countries have invested in their capacity to exploit their resources and placed greater focus on their legal and strategic frameworks in the areas of patents and technology transfer in order to promote this trend. As a result, African countries are well integrated into the international patent system.

Since individuals and companies can seek patent protection for inventions in virtually all African countries, national and international stakeholders active in CETs place an emphasis on patent rights in their own business strategies. Despite these efforts and positive conditions, the overall counts for mitigation and adaptation technologies patent applications are still relatively low in Africa, though the rate of growth is high compared to the rest of the world. Overall inventive activity increased more quickly in Africa than worldwide, with impressive 59 % average growth in mitigation technologies between 1980 and 2009. As a result of a relative technological advantage, Africa's inventive activity is disproportionately directed towards climate mitigation technologies, and to a lesser extent adaptation technologies.

While inventions in mitigation focus on biofuels, carbon capture and storage, solar thermal and waste-to-energy, the adaptation technologies are mostly concerned with desalination, offgrid water supply and remote energy supply. Overall, inventive activity and patenting is dominated by South Africa. Regarding foreign countries' activities, the EU, especially Germany, and the US are the most active patent applicants in Africa. These countries are also the most active in international collaboration. Additionally, co-invention plays an important role in Africa's inventive activities.

Several recommendations result from these findings. In the context of the Technology Mechanism, this study and its patent landscaping on key CETs has shown that the vast majority of CETs are not patented and can be freely exploited. International policies may be developed for promotion of CET in Africa without having to consider significant issues relating to patent rights. On the contrary, the patent system has made its extensive technical documentation available freely throughout the world via the internet.

Patents still have an important role to play in technology transfer. As the previous report on patenting and climate change mitigation technology from EPO, UNEP and ICTSD showed, the main factors impeding technology transfer are access to the real know-how from the source companies (including access to trade secrets), access to suitably skilled staff, scientific infrastructure, and favourable market conditions. Moreover, the patent system provides a legal framework to support technology transfer through licensing agreements, and without patents to protect their products and processes, the source companies may be reluctant to engage in technology transfer and associated investments.

As interest in Africa and demand within Africa grows, it is foreseeable that a growing proportion of CET-related applications will be filed in African states into the future, especially if international policies support such technology transfer on a larger scale. It will then be important to ensure the granting of only high quality patents in Africa, ensuring that exclusive rights in CET and similar technologies are only granted for valid inventions, and the undeserving ones refused.

To foster innovation and growth, the big challenges for all patent offices across the world, including African states, are to establish or maintain a high quality patent system and to discourage low quality patent applications. Different actions could be taken to improve the quality of patent systems on a global basis. In general measures to improve patent quality and the overall quality of patent system concern both the pre-grant and post-grant stages (EPO, 2012).

Increasing international co-operation between African patent offices and the EPO, including sharing of best practices, could be an important aspect to help coordinate different national and regional patent systems. The European patent system also provides the possibility of extension or validation of its patents to non-Member States, therefore presenting the possibility of extending the validity of its examined patents beyond Europe on request by the patent holder. Different actions could be taken depending on the specific needs of each African country.

Regarding IP policies and legal reforms to facilitate and emphasise CET development and diffusion, it is important to understand and further develop IP policies and to define strategic approaches for technology transfer on a global basis. While all countries have or will soon have IP policies and strategies, their development towards a sustainable patent system must be accelerated in order to create an enabling environment for patent protection of CETs and to broaden access to these technologies. The relationship between the patent system and successful technology transfer to regions such as Africa also needs to be further researched to inform and guide future policies towards development and transfer of clean energy technology for future African needs.

1 INTRODUCTION

A child enjoying light from a portable led lamp using solar energy (near Kumi in Uganda)

1. INTRODUCTION

The energy situation in Africa remains dire despite decades of investment in conventional energy. The energy sector is still largely characterised by unreliable power supply, low access levels, low capacity utilisation and availability factors and high transmission and distribution losses, among other challenges (Karekezi & Kithyoma, 2003). Expanding energy access in the region is therefore a key factor that will not only determine the speed and trajectory of the region's development but also how it deals with the urgent challenge of climate change. In this regard, it is obvious that without improvements in energy access, especially in sub-Saharan Africa, the chances of meeting the Millennium Development Goals (MDGs) are slim. For example, the United Nations Development Programme (UNDP) and the World Health Organization (WHO) estimate that two billion people require access to modern energy services by 2015 to accelerate achievement of the MDGs. Many of these people live in sub-Saharan Africa.

The need for harnessing the continent's clean energy potential has come under particularly sharp focus in the last decade, spurred by increasing importance placed on climate change mitigation and adaptation. This is because although Africa contributes the least to global warming, it is one of the regions most vulnerable to the effects of climate change. Currently, Africa's energy predominantly comes from fossil fuels (oil and coal) and traditional biomass (wood and charcoal), which, apart from global warming effects, have other negative consequences, e.g. on health. For example, in sub-Saharan Africa, more than 50 % of all deaths from pneumonia in children under the age of 5 years and chronic lung disease and lung cancer in adults over 30 years can be attributed to solid fuel use (UNDP & WHO, 2009). Research and nascent projects in different countries have confirmed that Africa has substantial potential in a range of clean energy sources and that this potential is largely unexploited (Karekezi & Kithyoma, 2003; AfDB, 2008; Piebalgs, 2010). Globally, however, there has been considerable success in the development of clean energy markets (OECD and IEA, 2011). Integrating Africa into these markets will be a key policy issue going forward.

The ability of African countries to exploit their clean energy potential will significantly depend on their ability to access and deploy the relevant technologies. While many relevant clean energy technologies (CETs) already exist or are in development, these are not yet widely available in Africa for a range of reasons including high costs. It is in this context that the question of technology transfer of CETs has been an important issue in the climate change discussions. At the United Nations Framework Convention on Climate Change (UNFCCC) this has led to the establishment of the Technology Mechanism. Indeed, technology transfer has been a key objective of the UNFCCC since its inception (ICTSD, 2011). For Africa, the issue of access to CETs is critical because recent global progress and cost reductions in renewable power generation technologies can help the continent leapfrog the development path taken by developed countries and move directly to a renewable-based system (IRENA, 2011).

The importance of technology transfer in the context of climate change and, in particular, access to clean energy has inevitably led to growing interest regarding the role of patent rights. This is because technological innovation – and hence the role of patents as an incentive for the development and commercialisation of technology – is central (like access to technology and financing) to efforts to mitigate and adapt to climate change. Opinions on whether patent rights support or impede the development and diffusion of CETs are a subject of continued debate.

The truth is complex because, among other reasons:

- our evidence base regarding the relationship between patent rights and the development and diffusion of CETs remains limited, and could potentially differ for developed regions, developing regions, and emerging economies; and
- in a world that has changed so much, many remain trapped in a static view of the needs and concerns of the North versus the South.

Whatever one's opinion, the relationship between patent rights and technology transfer on a global level has become a major strategic and political topic that needs to be addressed on the basis of a far more sophisticated evidence base.

Over the last few years, and particularly in 2009, different organisations and stakeholders have released a range of reports and studies touching on the issue of IP and climate change. While these reports vary in their scope, issue coverage and analytical depth, they all show that we still do not have sufficient evidence to make irreversible policy decisions on patent laws, clean energy technology and its transfer and innovation. In summary, they arrive at a number of conclusions, some contradictory, including the following:

- further studies will be needed to enhance our understanding of the relationship between IP and technologies relevant to addressing climate change (WTO & UNEP, 2009);
- business as usual is not an option on the question of IP and technology transfer (Lee et al, 2009);
- "IPR protection is not the main barrier preventing the transfer of environmental technologies to developing countries" (Copenhagen Economics A/S & The IPR Company ApS, 2009);
- an IP and climate change agreement that moves beyond the current IP framework is needed (UNDESA, 2009).

In general, these studies and reports did not rely on any serious empirical research or data on IP rights, licensing and technology transfer. This is why the United Nations Environment Programme (UNEP), the European Patent Office (EPO) and the International Centre for Trade and Sustainable Development (ICTSD) 2010 report on “Patents and Clean Energy: Bridging the Gap between Evidence and Policy” offers a new direction in addressing the issues at stake in the patent rights and CETs transfer debate. This empirical study, which consisted of technology-mapping, patent landscaping and a survey of licensing practices, concluded that the main factors impeding technology transfer are access to the real know-how, skilled staff, scientific infrastructure, and favourable market conditions. but that more information is needed to guide future action on the demand side of the debate (technology recipient countries’ side).

This report is a response to the challenge of generating empirical evidence on the demand side, with a particular focus on Africa. A methodical step-by-step approach is used to arrive at the final conclusions on the role of the patent system to support the transfer of CETs and relevant adaptation technologies. The report makes recommendations about how Africa can engage in discussion and implementation of the Technology Mechanism on this question; how African countries can consider leverage of their patent laws and policies to provide an enabling environment and opportunities for technology transfer; and how management of patents in industry and public institutions can be improved to address any patent-related issues in CET transactions.

The report starts, in Part 2, by mapping Africa’s clean energy potential. In this part we look at the various clean energy resources in Africa and their sub-regional distribution based on a desktop review of literature. Two main questions are addressed. First, what is Africa’s clean energy potential and in which of the continent's countries and regions are these resources located/available? Second, what efforts have been made to exploit this clean energy potential and what has been the role of CETs? In Part 3, the report then turns to the policy and legal framework for patent protection in Africa. The key question addressed here is the following: what are the relevant patent policies and laws in different African countries and what policy options do they offer for technology transfer and diffusion? Against the background of Africa’s clean energy potential (Part 2) and the policy and legal framework for patent protection and the possible legal options for supporting access to CETs (Part 3), the report's Part 4 provides a statistical analysis of the situation on the ground with respect to patenting patterns. This analysis is based on patent landscaping data and statistical analysis generated by the EPO in collaboration with the OECD on the patenting of existing relevant CETs and adaptation technologies worldwide. Here we ask the following question: what are the patenting patterns (both in Africa and in other parts of the world) in different CETs and adaptation technologies of relevance to Africa?

The analysis of patenting patterns sets the stage for extracting findings and making recommendations on how the patent system can be leveraged to facilitate the transfer of CETs in Africa. These findings and recommendations are provided in Part 5. The recommendations are tailored to respond to the following questions: what further work needs to be done to better understand the interface between patents and transfer of CETs in Africa? How can African countries best engage in the discussions on the Technology Mechanism as regards the question of patent rights, and what should their priorities be? What patent policies and legal developments could be considered to ensure that African countries’ IP systems best facilitate both the development and the transfer of CETs? How can industry and public institutions improve their patent management practices and policies to expand their opportunities for the transfer of CETs?

A solar powered cooker
in front of a school
(Bobo-Dioulasso in Burkina Faso)

2
MAPPING AFRICA'S CLEAN ENERGY POTENTIAL

It is widely acknowledged that Africa is home to vast, unexploited and readily available renewable energy resources which have the potential to contribute to the continent's energy security. In particular, there is significant potential for wind, solar, hydro, geothermal and biomass energy (Karekezi & Kithyoma, 2003; AfDB, 2008; Nair, 2009; and IRENA, 2011). However, these clean energy resources are not evenly distributed across the continent. As a result, generalisations regarding the clean energy potential in Africa may at times be misleading. It is therefore important to have a deeper understanding of both the commonalities and differences in the potential for various types of clean energy resources in different countries, and of the regional dimensions to the availability of these resources.

2.1 An overview of Africa's clean energy potential and levels of exploitation

Africa, it has been argued, is rich in renewable energy resources that could power the continent's development (Nair, 2009). The potential, from wind and solar through to geothermal, is well documented. What follows is an overview of the clean energy potential in the continent based on existing literature and studies.

2.1.1 Wind energy

In general, low wind speeds prevail in many sub-Saharan African countries, especially land-locked ones (Karekezi & Kithyoma, 2003). South Africa and north Africa, however, have significant wind energy potential. Indeed, South Africa's Cape region is reputed to have the highest potential; wind speeds of up to 9.7 m/s have been recorded (Diab, 1986). The east coast of Africa also has some potential. Djibouti, for example, has significant annual average wind speeds. The island states, including Mauritius, Cape Verde and Madagascar, also have significant wind energy potential. Figure 01 shows that the best winds in Africa are found to the north of the continent and to its extreme east, west and south.

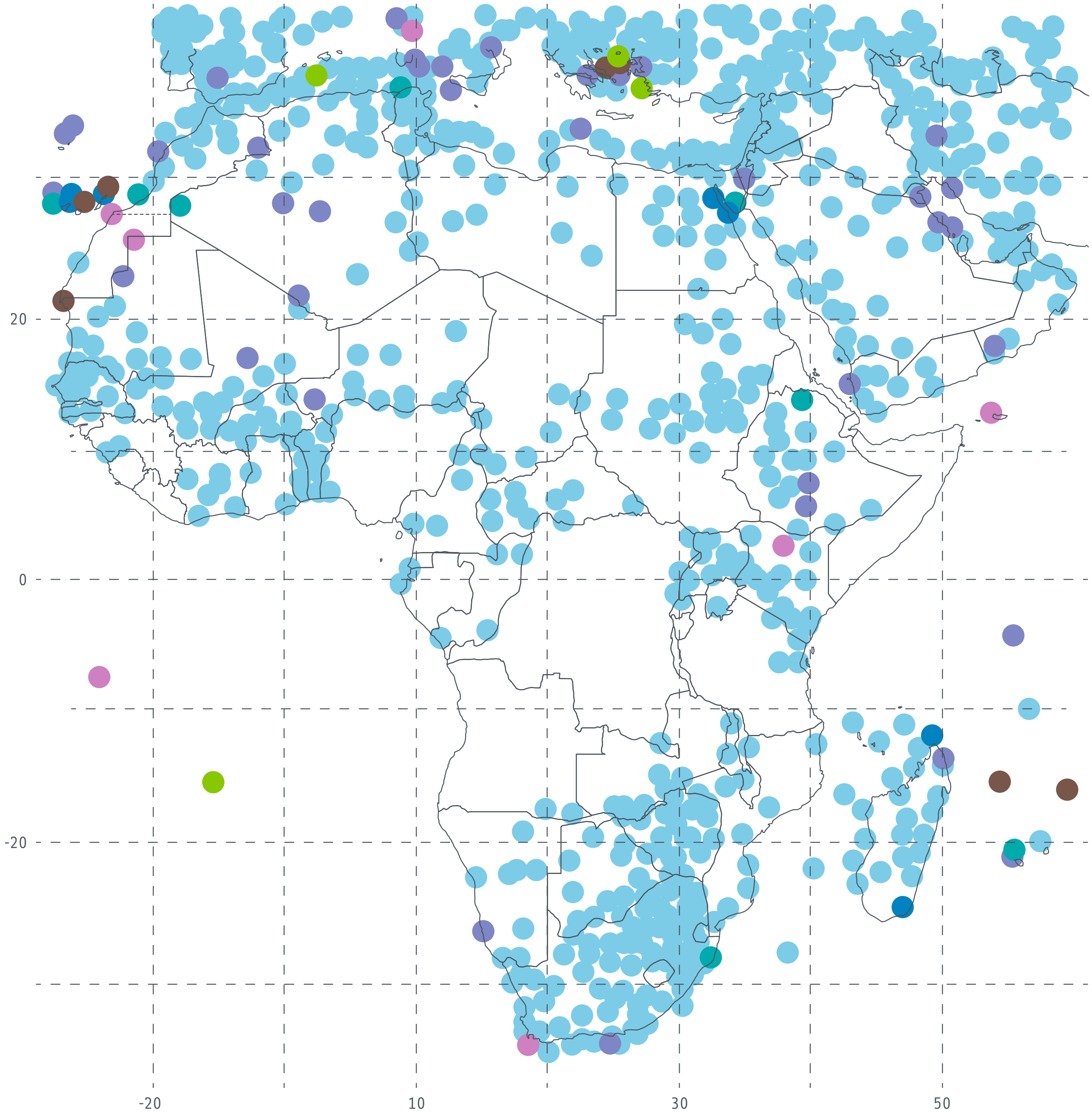
Based on the wind map, 15 African countries can be identified as having the best wind resources in Africa. These are:

- north Africa (Algeria, Egypt, Morocco and Tunisia);
- South Africa;
- sub-Saharan Africa (Chad, Djibouti, Eritrea, Lesotho, Mauritania and Somalia); and
- island states (Cape Verde, Madagascar, Mauritius and the Seychelles).

Low wind speeds in the tropical areas limit the potential for using wind energy for electricity generation to countries with a coastline. There are, however, some exceptions to the coastline rule: Chad, for example, although landlocked, has good wind potential in some parts of the country. And even in countries with low wind speeds opportunities exist for wind energy applications such as water pumping for potable water and irrigation.

While many countries in the continent lag behind in introducing wind for power generation, recent years have seen hopeful signs that things are changing. A number of countries, including Egypt, Morocco, Kenya and South Africa, have started to harness their wind resources (IRENA, 2011). For example, in 2008 South Africa's first wind farm, in the town of Darling, was completed, and it is expected to generate about 12.9 Gwh a year (Nair, 2009). In north Africa, there are already large-scale wind energy projects to exploit this potential. Egypt is the most advanced country in harnessing wind energy, with over 15 megawatt of installed electrical capacity.

01 Wind energy potential in Africa



Wind classes at 80 m

Average 80 m wind speed in 2000 (LS methodology)

- 1 (V < 5.9 m/s)
- 2 (5.9 ≤ V < 6.9 m/s)
- 3 (6.9 ≤ V < 7.5 m/s)
- 4 (7.5 ≤ V < 8.1 m/s)
- 5 (8.1 ≤ V < 8.6 m/s)
- 6 (8.6 ≤ V < 9.4 m/s)
- 7 (V ≥ 9.4 m/s)

2.1.2
Solar energy

Africa experiences some of the most intense solar radiation in the world, and therefore has vast potential for solar energy. The Sahara desert to the north and the Kalahari desert to the south have particularly high potential. This suggests that all of Africa, including the island states, can benefit significantly from photovoltaic (PV) technologies (Nair, 2009). Indeed, PV use has been promoted widely over the years, with almost every African country having had a major PV project (Karekezi & Kithyoma, 2003). The potential for solar thermal technologies (which use the sun's energy directly for heating, cooking, etc.) is also vast.

Beyond north Africa, where a range of large-scale solar energy projects are underway, encouraging results with PV systems have also been recorded in countries such as Ghana, Kenya, Namibia, South Africa and Zimbabwe. An important driving force behind wide use of PV technology in Africa has been a substantial fall in PV systems' production costs. An increase in donor funding for rural solar electrification has also been an important contributory factor. In north Africa, projects such as those pioneered by the DESERTEC Foundation have partly been driven by the potential for energy trading with Europe, using high voltage direct current (HVDC) technology to transport the energy across the Mediterranean. It is estimated that initiatives such as DESERTEC could result in 100 GW of renewable capacity producing 400 TWh of electricity for export to Europe by 2050 (IRENA, 2011).

Overall, however, there is still a long way to go in harnessing the continent's solar energy potential. Currently, approximately 90% of the PV market is accounted for by residential rooftop systems (IRENA, 2011). There are as yet no utility-scale PV plants in Africa. Use of concentrated solar power (CSP) remains very low, accounting for less than 5% of solar power generation (IRENA, 2011).

2.1.3
Geothermal

There is significant geothermal potential in Africa, particularly the Great Rift Valley. It is estimated that the continent has the potential to generate up to 9 000 MW of energy from geothermal sources (Karekezi & Kithyoma, 2003). Kenya and Ethiopia are, however, the only two countries that currently make notable use of this kind of energy (Nair, 2009). Kenya, in particular, has been able to exploit it significantly through the Olkaria projects, where exploration started as early as 1956 (Karekezi & Kithyoma, 2003). In addition to Olkaria, there are also plans to develop the Menengai and Bogoria-Silali geothermal fields. The Kenya Electricity Generation Company Limited (KenGen) estimates that by 2050 it will have added as much as 5 000 MW of capacity from geothermal (IRENA, 2011). Today, total installed capacity in Kenya and Ethiopia is just over 200 MW.

A number of other countries also have geothermal potential. These include Eritrea, Mozambique, Tanzania, Uganda and Zambia. Others still – including Algeria, Egypt and Tunisia – have limited potential and current small-scale use, such as direct heat (Nair, 2009).

A number of initiatives have been launched which could see the rapid expansion of geothermal capacity not just in Kenya and Ethiopia but also in other countries. For example, KfW, the German Development Bank, has launched the Geothermal East Africa Initiative (GEAI) to provide a mitigation fund for geothermal developments, while UNEP and the World Bank are also working to encourage geothermal development through the African Rift Geothermal Development Programme (ARGeo) (IRENA, 2011). In addition to Kenya and Ethiopia, ARGeo will also target Eritrea, Tanzania and Uganda.

2.1.4 Hydro

Hydro energy, which involves using water to turn turbines and generate electricity, is by far the most common form of renewable energy used on the African continent. Even so, it remains largely unexploited despite the fact that the region possesses huge watercourses such as the seven major river systems of Congo, Limpopo, Niger, Nile, Orange, Senegal and Zambezi. According to the Southern Africa Power Pool (SAPP), Africa has a combined feasible hydro capacity sufficient to provide enough power for the whole continent, plus additional energy for export; yet only 4.3% of this is being exploited.

Currently, there are significant hydro energy projects within sub-Saharan Africa, including Angola, Ethiopia, Kenya, Malawi, Mauritius, Mozambique, Namibia, South Africa, Tanzania, Uganda, Zambia and Zimbabwe. Also, many of the current estimates of hydro energy potential do not include small, mini and micro-hydro opportunities, which are also significant. Successful micro-hydro projects have already been implemented in Kenya, Rwanda, Zambia and Zimbabwe. There is also significant potential for small hydropower in a number of countries in west Africa, including Benin, Burkina Faso, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Mauritania, Niger, Nigeria and Senegal (IRENA, 2011).

In terms of large hydro there are two particular projects that will significantly increase Africa's hydro capacity (IRENA, 2011). The first is the Grand Inga project on the Congo River, which is planned to generate 39 GW from 52 turbines of 750 MW. When finished it is expected to be significantly larger than the Three Gorges Dam. The second is the Tekeze project on the Upper Nile in Ethiopia. With respect to small hydro, Africa is currently estimated to have approximately 588 small hydropower plants of less than 10 MW in operation (Platts, 2011). These projects are mainly multi-purpose, combining electricity production with other uses such as irrigation, flood control and the supply of drinking water.

2.1.5 Bioenergy

Africa also has significant potential for generating energy from biomass (Piebalgs, 2010). Indeed, biomass accounts for the bulk of most African countries' total national renewable energy supply. The most successful forms of biomass are sugarcane bagasse in agriculture, pulp and paper residues in forestry, and manure in livestock residues. In particular, cogeneration offers substantial opportunities for generating electricity and/or heat energy. Estimates show that upwards of 16 sub-Saharan African countries can meet significant parts of their current electricity needs from bagasse-based cogeneration (Karekezi & Kithyoma, 2003). In 2011, bagasse accounted for about 94% of the 860 MW of installed bioenergy power generation on the continent (IRENA, 2011).

Sugar-producing countries are already exploiting cogeneration potential. Mauritius is the most successful case, generating over 20% of its electricity from cogeneration. Other countries with significant potential include Burundi, Cameroon, Ethiopia, Gabon, Côte d'Ivoire, Kenya, Madagascar, Malawi, Senegal, South Africa, Sudan, Tanzania, Togo, Uganda and Zimbabwe. There is also notable potential for ethanol production. Indeed, ethanol programmes have been implemented in a number of countries, including Kenya, Malawi and Zimbabwe.

Further, there is significant potential for biogas from animal waste (dung) across the region (Nair, 2009). The raw material is plentiful in many rural areas, and the viability of biogas technology has been proven through field tests and pilot projects (Karekezi & Kithyoma, 2003).

2.2 Sub-regional distribution of clean energy resources

The overall Africa energy map that emerges from the overview in Part 2.1 above can be divided into four broad regions based on current consumption and access patterns and the potential for clean energy generation from different sources. These regions are north Africa, continental sub-Saharan Africa, South Africa and the island states. Though there are certain similarities between them, such as the current predominant reliance on oil, each of these regions has a different clean energy potential map due to distinct geographical, economic and social factors which need to be understood.

2.2.1 North Africa

The north Africa region, consisting of Algeria, Egypt, Libya, Morocco and Tunisia, currently relies primarily on oil and gas to meet its energy needs. Universal access has almost been attained (AfDB, 2008). In recent years, the region has also been making significant investments in clean energy generation, particularly in solar and wind power generation.

The region has vast potential in wind energy (Karekezi & Kithyoma, 2003). Indeed, large-scale wind power projects exist or are being implemented in Egypt, Morocco and Tunisia. North Africa also has vast potential in solar energy, particularly from the Sahara. The region also has some limited potential in the other clean energy sources, including geothermal and bioenergy.

2.2.2 Sub-Saharan Africa

The sub-Saharan Africa region (excluding South Africa and the islands), comprising approximately 41 countries, is one of the world's major exporters of energy resources, i.e. oil (AfDB, 2008). However, only seven specific countries are actually net exporters. Overall, traditional biomass accounts for 80% of the total domestic energy supply. Only a small proportion of the rural population has access to modern energy services. The situation is obviously better in urban areas, but even here significant parts of the population have no access to electricity at all or only an unreliable supply.

Clean energy potential is however vast. While the situation varies from country to country there is significant potential in all forms of clean energy sources (wind, solar, geothermal, hydro and bioenergy).

2.2.3 South Africa

South Africa's current energy sources are dominated by hard coal, which supplies slightly more than half the country's primary energy (AfDB, 2008). Up to 95% of electricity is reputed to come from this source. Currently, the level of access stands at about 70%, but the situation in rural areas is significantly worse. Raising the access level is, however, an achievable goal in the medium term as compared to the rest of sub-Saharan Africa, due to the significant refining capacity and extensive distribution infrastructure already in place.

Since 2003, South Africa has taken steps to mainstream renewable energies, aiming to generate 10 000 GWh from them by 2013 (AfDB, 2008). The country has significant clean energy sources, including wind (particularly in the Cape area), solar, hydro and biomass.

2.2.4 Island states

The island states, comprising Cape Verde, Comoros, Equatorial Guinea, Madagascar, Mauritius, Sao Tome and Principe and the Seychelles, face unique energy problems due to isolation (AfDB, 2008). Apart from Madagascar, most of them are small island states. Overall, up to 80% of the energy mix in these countries comes from imported oil products (AfDB, 2008). Mauritius and the Seychelles have achieved universal access, while the rest of the island countries have access levels comparable to those of continental sub-Saharan countries.

Despite their unique challenges, however, the island states also have significant potential in a number of clean energy sources, especially wind, solar and biomass. There is also some potential for micro-hydro generation.

3
POLICIES AND LEGAL FRAMEWORKS FOR PATENT PROTECTION IN AFRICA

A boy drinking potable water
(North Wollo, Amhara in Ethiopia)

Technological advances coupled with the growth of international trade in knowledge-based goods and services have progressively raised awareness of patent-related issues in discussions about trade regulation and global challenges such as climate change. Today, the central pillar of the international IP system is the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), which mandates each member of the World Trade Organization (WTO) to provide a minimum level of IP protection (for copyright and related rights, trademarks, geographical indications, industrial designs, patents, trade secrets and other undisclosed information).

On climate change, patent protection has become the subject of much debate, with diverging opinions between industrialised countries on the one hand against developing and least-developed countries (LDCs) on the other. The latter group has gone so far as to call for CETs to be excluded from patenting (TWN, 2009). African countries, which are politically part of this group, have generally been supportive of such views. They were repeated at the "Rio +20" talks in 2012.

A well functioning patent system should foster innovation and growth, offering maximum legal security, and protecting the interests of both innovators and the public, as well as providing a stable framework to facilitate licensing and technology transfer.

A closer look shows that African countries have differing patent policies and laws, and that the actual situation as regards patenting in these countries or their source markets is far from uniform. Consequently, an analysis of the role of patenting of CET in particular in Africa needs to be premised, first, on a deeper understanding of patent policies and regulatory frameworks in the region.

This section analyses the current status of patent policies and regulatory frameworks in Africa, and reviews also their place within the global patent system.

3.1 Patent policies and strategies relevant to CET in Africa

In recent years, African countries have stepped up their efforts to elaborate and implement strategic patent policies at both national and institutional level. These moves have been spurred by a variety of factors, including the increased availability of funding and technical support for the development of such policies and strategies from the World Intellectual Property Organization (WIPO), the European Patent Office and other organisations, and the countries' recognition of the strategic importance of patenting in the knowledge economy.

As a result, a number of countries are adopting national patenting and innovation policies and strategies. Those that have already done so include Ethiopia, Morocco, Mozambique, Rwanda, South Africa and Zambia. Other countries, such as Algeria and Kenya, are in the process of developing their policies and strategies with the assistance of WIPO. The Rwandan IP policy, which is one of the most elaborate, aims for example to ensure that "national IP laws, institutional practices and strategies in public research institutions and industry are developed and implemented in a manner that contributes to building Rwanda's technological base and cultural industries and that advancements in science and technology benefit society." The implementation strategy for achieving this policy objective considers technology transfer as a strategic issue. Another leading example is Morocco's successful endeavours to attract technology transfer with the support of IP and patenting in particular, including being the first non-European state to sign a provisional agreement for extending the validity of European patents on its territory, thereby enabling patents granted by the European Patent Office to take legal effect in Morocco on request by the patent holder. This "Validation on Request" scheme is being considered by further African states.

IP policies have also been developed at sub-regional level, for example by the Common Market for Eastern and Southern Africa (COMESA) which has adopted a policy that addresses, among other issues, the relationship and linkages between IP and economic development, trade, cultural industries, traditional knowledge and folklore, information and communication technology (ICT), and IP audit and valuation.

Overall, all these national and regional IP/patent policies and strategies place an emphasis on technology transfer and the need to ensure that patent protection supports the transfer of critical technologies – of which CETs are certainly one category. As the COMESA policy document notes, the key issue is appropriate exploitation of IP as opposed to the absence of IP protection.

The role of the patent system

All national patenting policies and strategies need to be understood in the wider context of the international patent system and the mechanisms driving its development. While there is no single jurisdiction in charge of granting patents with a world wide effect, the largest patent players have undertaken seminal steps to align procedures and share activities to achieve greater harmonization in the system. The creation of common tools and strategies in core areas such as classification are important advances in the move towards a sustainable patent system which effectively balances the needs of innovators for legal protection of their inventions against the expectations of society in terms of transparency and knowledge dissemination. The core elements of that system are a thorough examination process establishing novelty and non-obviousness of an invention and its compliance with the patent law, and a prolific system of information on technology emanating from the obligation of IP offices to publish patent applications and grants. Rendering all patents filed accessible in free public patent databases, this mechanism creates the single most comprehensive information system on state of the art technology worldwide. The advantage of an examination-based system over mere registration systems lies in its effectiveness in distinguishing meritorious inventions from undeserving ones, granting exclusive rights only on genuine inventions that further global technical knowledge. Such a distinction by quality is particularly critical in sensitive technology areas such as CET.

The information function of patents allows the creation of powerful search tools that facilitate the retrieval of technological information in areas such as CET. For instance, the EPO's Espacenet public database makes available some 88 million published patent documents and their technical content from around the world. Free automatic patent translation tool/services (e.g. EPO's Patent Translate) facilitate a multilingual access to these sources.

The global Patent Information system is seen as key in achieving the objectives of the global patent system, namely to support innovation by:

- enabling technology developers to protect their investments,
- promote the dissemination of technical information by legally obliging inventors to publicise their inventions and
- allowing research and development activities to build upon existing inventions, and
- establishing a framework for technology transfer, both locally and globally through licensing.

More specific tools can be integrated in such data collections. The EPO's specially developed Y02 classification scheme, for instance, with the launch of the additional Y02B-Buildings and Y02T-Transport sections end of 2012 tagged and indexed some 1,5 million documents relevant to most climate change related technologies, allowing identification of patent applications and patents relating to these fields more easily. The tagging has been incorporated fully into the Cooperative Patent Classification (CPC), a joint initiative between EPO and USPTO. Technological information from patent applications is available from all major IP offices, including from the WIPO through its Patentscope.

A secondary impact of the patent information system is to gain such evidence from statistics and analysis of regional and global patenting trends, thus helping businesses and policy makers in taking decisions [clearly one of the aim of this report]. Use of tools such as the EPO's PATSTAT system, in combination with the specialised Y02 classification scheme, produces data for studies that can inform and provide evidence to support regional and global policy formulation. An initial report of this kind was jointly compiled by the EPO, UNEP and ICTSD with support from OECD and published in 2010[1]. This helped identify patenting trends and key R&D centres in CET, and traced the concrete effect of such high-level policy decisions as the Kyoto protocol. Above all the study also contained the first-ever survey on the licensing potential in CET. The findings clearly indicate a general willingness on behalf of technology owners (licensors, primarily in OECD countries) to offer CET to developing countries on favourable terms. The present report follows on from the first one, implementing one of its recommendations to examine the CET patenting activity in a selected developing area, in this case Africa. It enhances the initial report by providing further factual evidence to support the debate and policy making in this important region.

With both its protection and information function, a quality-based patent system serves as a vital support to innovation, knowledge dissemination and technology transfer in key areas such as CET. While such a system requires a certain amount of infrastructural and personnel resource to be put in place, a validation agreement with the EPO as envisaged by some African states could constitute a viable solution, allowing the local environment to benefit from the strong quality of the EPO examination for those applications originating from abroad. In doing so, the national office is in the best position to dedicate all its examination resources to those patent applications originating locally, while foreign direct investment is encouraged by the sound examination of the foreign applications by the EPO.

1 "Patents and Clean Energy: Bridging the gap between evidence and policy", EPO/UNEP/ICTSD 2010

The role of national and regional IP policies

Also important is the increasing interest and emerging legislative action with respect to patents resulting from publicly funded research. This is a particularly significant issue in the area of climate change, given the substantial public investments in CET development and deployment. For example, in 2008 South Africa enacted the Intellectual Property from Publicly Financed Research and Development Act (No. 51 of 2008). The main object of the Act is to ensure that IP emanating from publicly financed research is identified, protected, utilised and commercialised for the benefit of the people of South Africa.

The growing number of national and regional IP policies and strategies complement or are inter-linked with science and technology (S&T) or science, technology and innovation (STI) policies and strategies, which have a longer history in Africa. Building on this history and experience, in 2005 the African Union and the New Partnership for African Development (NEPAD) developed the Consolidated Science and Technology Action Plan for the region. This plan seeks to articulate Africa's common objectives and commitment to collective action to develop and use S&T for the socio-economic transformation of the continent and its integration into the world economy (AU and NEPAD, 2005). It is built on three inter-related conceptual pillars: capacity building, knowledge production and technological innovation.

In the context of energy, the action plan places great emphasis on technology transfer, with the main projects envisaged focusing on energy research and technologies, and on research and development (R&D) in the field of bio-energy and other renewable energy sources. At the national level, various countries which have S&T or STI policies, white papers or national programmes, such as Egypt, Ghana, Kenya, Mauritius, Morocco, Nigeria, Rwanda, South Africa, Tunisia and Zambia, all place considerable emphasis on the transfer and diffusion of technology, also in the energy sector. Many of these policies also acknowledge the need to address patent-related issues in the context of transfer of technology.

3.2 Patent-related legal framework and policy options for technology diffusion and transfer

All African countries, save for Somalia, have a basic IP legal framework made up of laws on copyright and related rights, industrial designs, patents and utility models, trademarks and geographical indications or appellations of origin and trade secrets. These countries also have specific IP institutions. Since the adoption of the TRIPS Agreement most countries have made considerable effort to update, modernise or otherwise reform these laws, many of which were initially put in place many years ago. These reform processes are driven by the need to comply with the TRIPS Agreement and other international, regional or bilateral agreements and/or by national and international stakeholders who are placing greater emphasis on IP in their business strategies in the continent. As a general observation, it is therefore fair to say that Africa has embraced the international IP system, and is an integral part of it.

Implementation of the various IP laws, especially those aimed at complying with the TRIPS standards, has however raised questions regarding related patent laws' compatibility with the technology transfer and diffusion goals in these countries. In the context of transfer and diffusion of CETs, as already noted, the role and impact of patent laws have been strongly debated. That is one reason for the focus on patents and patent laws in this section of the report.

Another reason is that most CETs come under the heading of inventions, which are generally protected by patents in their countries of origin and are often also patented in other states. It is worth noting that there are currently no restrictions on patenting of inventions relating to CETs in any states around the world, African states being no exception. On the contrary, many IP Offices offer an accelerated examination of "green" patents to encourage innovation in this area.

Other kinds of IP, which are not discussed in detail here, may however also be relevant for technology transfer. Copyright and industrial designs are two cases in point. Copyright is relevant with respect to building the scientific and technological human capacity in specific fields, which requires access to scientific journals and other literature protected by copyright. Industrial designs are relevant in cases where they protect primarily the non-technical design and aesthetic appearance of designs for implementations of technology, a particularly relevant example of which could be wind turbines due to their high visual impact.

As already noted, all African countries, except Somalia, have patent legislation. Annex 1 to this report provides details on the relevant patent laws in all 53 African countries, and on these countries' membership of key regional and international patent-related treaties. The situation as regards both legislation and membership may be summarised as follows:

— 42 out of the 53 countries are members of the WTO and thus obliged to introduce minimum levels of patent protection. The other 11, namely Algeria, Comoros, Equatorial Guinea, Eritrea, Ethiopia, Liberia, Libya, Sao Tome and Principe, the Seychelles, Somalia and Sudan, are not members of the WTO and therefore have no obligations under the TRIPS Agreement. However, Algeria, Comoros, Equatorial Guinea, Ethiopia, Liberia, Libya, Sao Tome and Principe, the Seychelles and Sudan are all in the process of acceding to the WTO, which means they will be required to comply with TRIPS standards before joining. So all African countries except Eritrea and Somalia must comply with TRIPS standards, or will have to in the near future.

— Of the WTO members, 25 are classified as least-developed countries (LDCs), which means that they first have to introduce and/or enforce patent protection by at the earliest 1 July 2013, when the extended transition period for TRIPS compliance ends. This period could be extended further. Figure 02 lists the African LDCs that are WTO members.

— Save for Cape Verde, Eritrea, Ethiopia and Somalia, all African countries are party to WIPO's Paris Convention for the Protection of Industrial Property and to its Patent Cooperation Treaty (PCT). They are therefore well integrated into the international patent system, and companies and individuals around the world can file for patents under the PCT.

— 16 out of the 53 countries are signatories to the Bangui Agreement and hence members of the Africa Intellectual Property Organization (OAPI). For these countries, namely Benin, Burkina Faso, Cameroon, Central Africa Republic, Chad, Congo, Côte d'Ivoire, Equatorial Guinea, Gabon, Guinea, Guinea Bissau, Mali, Mauritania, Niger, Senegal and Togo, patents issued by OAPI are automatically considered national patents.

— Another 17 countries of the 53 are members of the African Regional Intellectual Property Organization (ARIPO). 16 of these, namely Botswana, Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mozambique, Namibia, Sierra Leone, Sudan, Swaziland, Tanzania, Uganda, Zambia and Zimbabwe, are party to ARIPO's Harare Protocol on Patents and Industrial Designs. For these countries, subject to national law, patents issued by ARIPO become national patents if no objection to their grant is raised within six months.

02 African LDCs that are WTO members

1	Angola
2	Benin
3	Burkina Faso
4	Burundi
5	Central Africa Republic
6	Chad
7	Congo, D.R
8	Djibouti
9	Gambia
10	Guinea
11	Guinea Bissau
12	Lesotho
13	Madagascar
14	Malawi
15	Mali
16	Mauritania
17	Mozambique
18	Niger
19	Rwanda
20	Senegal
21	Sierra Leone
22	Tanzania
23	Togo
24	Uganda
25	Zambia

Source: WTO

3.2.1
CETs and the patent system

With its approach not to exclude a priori any technology from legal protection the patent system is an adequate tool for promoting the diffusion of CETs in Africa. The general principle of patents, which is to provide exclusive legal protection in exchange only for the full disclosure of the invention, work as a key facilitator of the technology transfer. Thanks to patent information databases and specific tools freely available on internet, it is now possible to identify technologies, their legal status and the owners of the CET patent rights and their locations around the world. The patent system thus provides for an efficient platform for negotiations between potential licensees and patent owners: According to the findings of the first report on "Patents and clean energy: Bridging the gap between evidence and policy", these information tools might be instrumental for exploiting the still untapped licensing potential in CETs, as a majority of technology owners signaled their readiness to enter into licensing negotiations with technology recipients resident in LDC under favourable conditions.

As the patent system in these countries develop, it is important to ensure a quality patent system with a high quality of search and substantive examination, leading to patents with a high legal certainty. This ensures that exclusive rights are only granted to those applicants contributing significantly to the technological knowledge and any particular field, and more importantly, prevents the granting of unwarranted exclusive rights. The use of a high quality patent examination is therefore paramount to both successful technology transfer, but also the exploitation of technical knowledge in areas where patent protection has not been sought, or where it has expired. It provides the optimum balance between public and private interests. For instance, only approximately 50 % of patents (in 2012) applied for at the European Patent Office led to a granted patent, the remainder being either refused by the EPO, or withdrawn by the applicant after having considered the search and substantive examination results. Of the granted patents, the majority have their scope of protection reduced as a consequence of these results.

In general measures to improve patent quality and the overall quality of patent system concern both the pre-grant and post-grant stages. Pre-grant measures focus mostly on the availability of information on prior art and ways in which this information can be searched by applicants and offices alike. Post-grant measures concern legal remedies such as opposition and in-court revocation proceedings (EPO, 2012).

A patent application, usually initially filed in the country of the inventor, may also be filed in other countries around the world, either within 12 months under the "Paris Convention", or using the Patent Co-operation Treaty (PCT) governed by the World Intellectual Property Organization (WIPO) with potentially 146 PCT signatory states. Patent offices currently active as PCT International Search Authorities (ISA) include the "IP5 Offices" (EPO, JPO, KIPO, SIPO, USPTO) each with several thousand highly specialised patent examiners, as well as 12 other smaller national and regional patent offices of which two are not yet active. The EPO, with its 4 000 examiners, ensures that the quality of search and examination of PCT applications for which it is PCT ISA is equivalent to that for its own European Patent applications.

Many smaller national patent offices, receiving "second filings" from abroad via either the Paris Route or via the PCT system, have very limited substantive examiner capacity available for comprehensive search and substantive examination and may have a "registration" system, with the risk that not all exclusive rights granted are warrantable.

Different actions could be taken to help promote quality in these smaller patent offices, in this case depending on the specific needs of each African country. Increasing international co-operation between African patent offices and the larger actors in the world patent system, including WIPO and other IP Offices such as the EPO, could help in sharing of best practises.

Use of the EPO's search facility, already made available to many other IPOs, enables patent examiners in other IPOs to perform comprehensive prior art searches to support evaluation of novelty and inventive step.

The Common Citation Document (CCD) managed by the EPO allows the public and other IPOs to view and re-use the search results from contributing offices, thereby supporting all IPOs in their substantive examination of cross-filed patent applications. As this information is readily available to applicants, competitors and to the general public, it also helps support the post-grant processes ensuring high patent quality, such as opposition and court proceedings.

An advanced form of partnership exists between the EPO and other IPOs, where applicants using the European patent system (over 60% of them are non European) can request that their European applications and granted European patents are validated to a non EPO Member State. The EPO offers to these countries the possibility to benefit from the work of its 4 000 examiners without having the necessity of re-examination. This scheme allows the validation on request of European patents in a paricipating state, permitting the national offices to develop national examination capacity with the sole purpose to process the resident filings while the national economy benefits from the strong quality of the EPO examination. In doing so, the national office is in the best position to dedicate all its resources to a full support of the national innovation while foreign direct investment is encouraged by the sound examination of the foreign applications by the EPO.

3.2.2
Exceptions to rights conferred

In certain exceptional cases, including a national emergency, but also where a specific patent owner has not been willing to grant authorisation on reasonable commercial terms and conditions within a reasonable length of time, some legal options are allowable under TRIPS (Art. 31) for circumventing this refusal.

A review of the relevant patent legislation also reveals that most African countries have incorporated basic flexibilities such as compulsory licensing, government use and ex-officio licenses and research exemptions into their patent laws. These countries also have regimes for voluntary licensing, including prohibitions on certain anti-competitive licensing practices. Of course, the specific application and scope of these flexibilities vary across the countries. A brief summary of these exceptions is given in Annex 12. In practice, the number of cases where these exceptions have been used are extremely rare.

Wind energy farm
(Dhar Saadane in Morocco)

4
CET PATENTING PATTERNS IN AFRICA – A STATISTICAL ANALYSIS

Besides policies and legal frameworks, another key parameter that needs to be better understood in the discussions on IP and access to CETs is the actual patenting landscape of the relevant technologies, both in Africa and in Africa's import markets. Without such an understanding, the discussion of the role of patents in the transfer of CETs is driven by ideology, theory and speculation. Knowing the landscape is important for policymakers, businesses and communities to identify the strategies they need to deploy in order to increase the inflow of CETs to the continent. It is in this context that a specific statistical analysis of patent data related to climate change mitigation and adaptation in Africa was undertaken for this report.

This part of the report presents a detailed analysis of the role of Africa in the development of these technologies (invention), using patenting as a proxy. We also examine Africa as a technology market and the question of cross-border technology development (co-invention) in Africa. The discussion of these three issues is preceded by an explanation of the methodology used in collecting and analysing the patent data. To the extent possible, an effort is made to place the data in the broader context of overall patenting trends. It must be emphasised, however, that due to unequal data coverage in African countries care should be taken in interpreting some of the findings presented here.

The primary focus of the statistical analysis is on technologies that are relevant to helping Africa tap its huge renewable energy potential and thereby contribute to mitigating climate change. These are referred to as mitigation technologies in the analysis. This coincides with the main purpose of the report, which is to examine the role of patents in technology transfer to unlock Africa's clean energy potential. However, an effort has also been made to examine the patenting patterns in those technologies that are suitable for addressing specific adaptation needs, to provide a more comprehensive picture. These technologies, which include e.g. those for desalination, water treatment, water pumping and rainwater collection, are referred to in this report as adaptation technologies.

4.1
Methodology

The primary data source for the analysis in this part of the report is the PATSTAT database. In terms of scope, in addition to considering Africa as a whole, the analysis was conducted at a more disaggregated level where adequate data was available, including at the level of sub-regions:

- north Africa (Morocco, Algeria, Tunisia, Libya, Egypt)
- South Africa and
- sub-Saharan Africa (remaining countries, including the OAPI and ARIPO regions).

4.1.1
Patent search strategies

For mitigation technologies, relevant patent documents were identified using the recently-developed CPC classes Y02C and Y02E that cover those in selected climate change mitigation technologies related to energy supply (see Annex 2). However, given the rather limited volume of patents related to Africa, presenting the data at a highly disaggregated level would not have been very meaningful. So instead, this report presents it at a rather more aggregated level – for 14 technological fields that are both sufficiently 'thick' and meaningful for policy-makers. See Annex 3 for a description of the fields.

For adaptation technologies, the relevant documents were identified using new Z-tags, which cover the fields described in Annex 4. The data is presented for 11 technological fields, with a statistical summary in Annex 5.

4.1.2
Construction of patent statistics

The data was analysed by examining the country of the inventor(s), the country of the applicant (patentee), and the application authority. While in much of the previous work by the statistical analysts for this report a case was made for using 'claimed' (as opposed to 'singular') priorities as an indicator of inventive activity, this report does not make that distinction due to the limited volume of inventive activity in Africa. We use all priority applications (both singular and claimed priorities) to measure the number of patented inventions. We adopt the "single-priority" definition of a patent family.

In addition, applications are used to analyse the patenting activity of African inventors abroad, or of foreign inventors in Africa. In all cases, we construct counts of patent applications (i.e. registered by the patent system but not necessarily valid patents).

Overall, 580 154 patent applications tagged using the Y02 scheme (Annex 3) were identified, including 2 804 applications registered with an African patent office (Annex 6) and 657 African priorities (Annex 7; single-priority patent families with an African inventor) during the period 1980 to 2009. No patent family members of these documents in PATSTAT that would not be Y-tagged were found.

For applications tagged using the new Z scheme we identified 47 108 patent applications (Annex 5), including 389 applications registered with an African patent office (Annex 8) and 56 African priorities (Annex 9; single-priority patent families with an African inventor) during the period 1980 to 2009.

In order to place the data of applications registered with an African office in context, detailed data on patenting by African countries worldwide in both the Y02 and Z schemes are presented in Annexes 10 and 11.

03 Coverage of data from African patent offices in PATSTAT

	Authority	From	Until	No. of years covered 1980 – 2009
ZA	South Africa	1971	2010	30
EG	Egypt	1976	2011	30
AP	ARIPO	1984	2011	26
MA	Morocco	1993	2011	17
OA	OAPI	1992	2007	16
ZW	Zimbabwe	1980	1995	16
ZM	Zambia	1968	1994	15
MW	Malawi	1973	1994	15
KE	Kenya	1975	1989	10
DZ	Algeria	2002	2005	4

Source: Contents and coverage of the DOCDB bibliographic file, EPO (2011). Available at http://www.epo.org/searching/essentials/data/tables.html

4.1.3 Caveats and limitations

The results presented in this report should be interpreted in the context of PATSTAT's 'idiosyncrasies', in particular regarding unequal coverage of countries over time. Country coverage is an important piece of information in general, and particularly so with respect to Africa. In fact, there are only six patent authorities for which PATSTAT includes recent (post-2000) data, with four other authorities covered only partially (Figure 03).

This has only a limited effect on our ability to identify inventions that have sought protection overseas (at an office covered in PATSTAT) or priority documents that have sought protection first in Africa and subsequently overseas ('claimed priorities'), because we can impute inventor information from other members of the same patent family. However, it does compromise the ability to identify inventions that have sought protection solely at African authorities (singulars) or duplicate applications of foreign patents registered with African authorities. An effort has therefore been made to qualify the findings presented here by comparing the trends in mitigation and adaptation with overall trends – measured as "PATSTAT TOTAL" counts that reflect the actual coverage of PATSTAT database.

4.2
The place of Africa in CET development

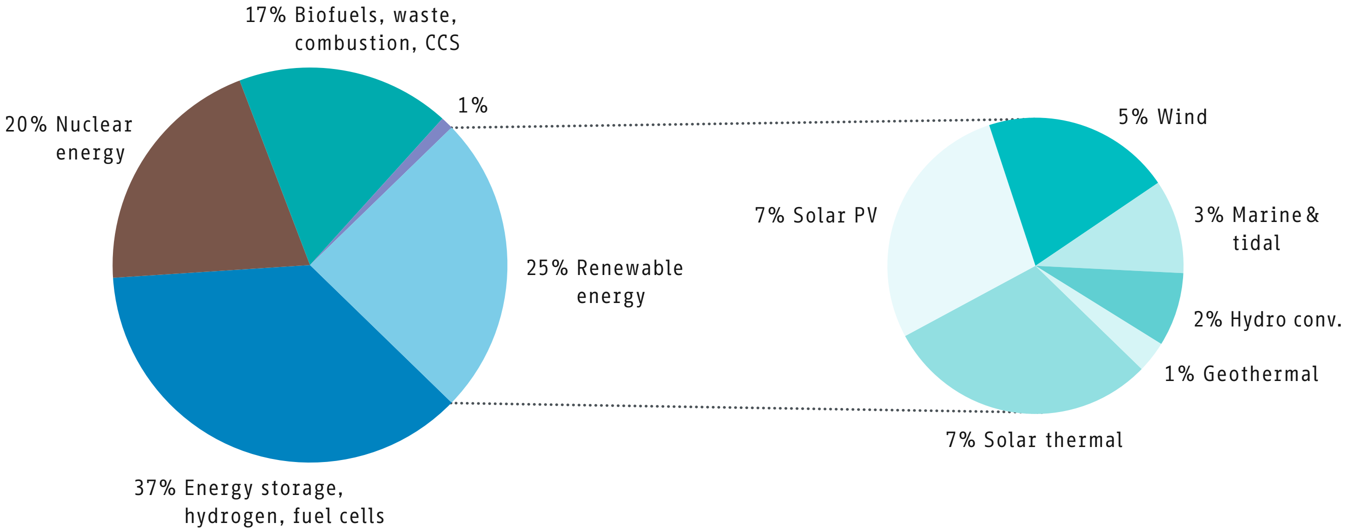
Figures 04a and 04b give the breakdown of inventive activity for mitigation technologies in Africa throughout the period 1980–2009. For presentational purposes, we aggregate the 14 technological fields into five somewhat broader major categories. The figure shows that most inventive activity occurs in energy storage/hydrogen/fuel cell technologies (37%) and renewable energy (25%), in particular solar PV and solar thermal. This is followed by nuclear energy (20%) and biomass/waste/combustion/CCS technologies (17%), especially biofuels. Invention in efficient electricity generation/transmission/distribution is of marginal importance in Africa.

To put these figures in context, while in Africa biofuels account for 6% of its Y02 inventions (and 0.19% of all its patented inventions, in any field), worldwide the corresponding ratios are 3.4% (and 0.036%). Hence, we can conclude that among all the Y02 mitigation technologies, Africa's inventive output in biofuels is relatively more important than that observable worldwide. Other Y02 mitigation technologies that are relatively frequently invented in Africa are nuclear, marine & tidal, and energy from waste. On the other hand, solar PV is Y02 technology that is developed relatively less frequently in Africa than in the rest of the world. Inventive activity in wind and combustion technologies is of about the same level as that observable worldwide.

Another way to assess Africa's inventive capacity is in terms of its relative technological advantage (RTA) in the various technologies, calculated as the share of Y02 priorities to TOTAL priorities in Africa versus worldwide, or as Africa's share of Y02 priorities worldwide compared to its share of TOTAL priorities. Hence, an RTA=1 indicates that the number of inventions in Africa, relative to its overall number of inventions, is about the same as the world average. An RTA>1 indicates that Africa invents relatively more in a given field than the world does. For example, invention in mitigation technologies (Y02) represents 3% of Africa's overall inventive activity, compared with only 1% worldwide, hence the RTA=3 (Figure 05). The ranking of the individual fields is the same as discussed above. Interestingly, all 14 mitigation fields examined have RTA>1. This means that despite Africa's generally low volume of inventive activity, it is disproportionately directed towards Y02 technologies.

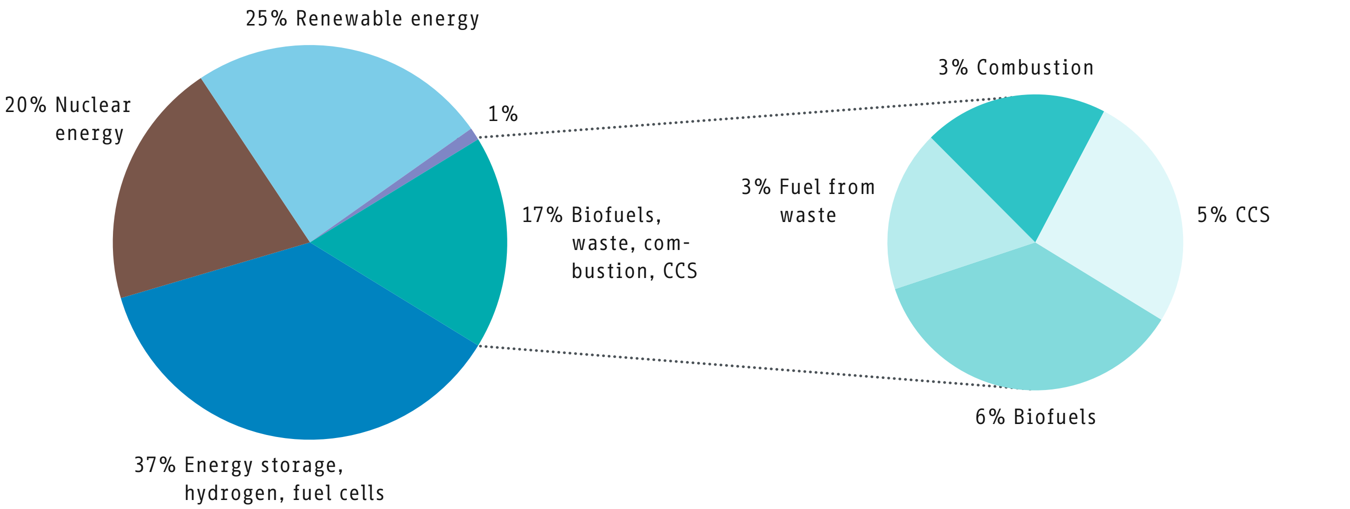
In terms of average growth rates between 1980 and 2009, while worldwide the number of inventions (priorities) in all technologies (TOTAL) increased by 4% on average, it grew by 5% in Y02 fields. In Africa, not only did inventive activity overall (TOTAL) increase faster (9%), but Y02 activity grew by an extraordinary 59% on average. Over time, inventive activity in Africa shows some rather surprising patterns which prompt two observations. First, development of nuclear energy technologies is startling, in terms of both the relative volume of invention and of its timing – with a spike of activity in the early 2000s. This is in stark contrast to global trends, which show a decreasing pattern over time. Second, another difference relative to the rest of the world is a strong performance in energy storage/hydrogen/fuel cell technologies in Africa between the mid-1980s and mid-1990s. Lastly, inventions in renewable energy and in biomass/waste/combustion/CCS technologies have grown sharply in Africa in the last decade, trends that are similar to those observed globally (Figure 05).

04a* Counts of patents for each field 1980–2009 (Africa only)



* The non-labelled 1% is for technologies related to efficient electricity generation, transmission and distribution.

04b* Counts of patents for each field 1980–2009 (Africa only)



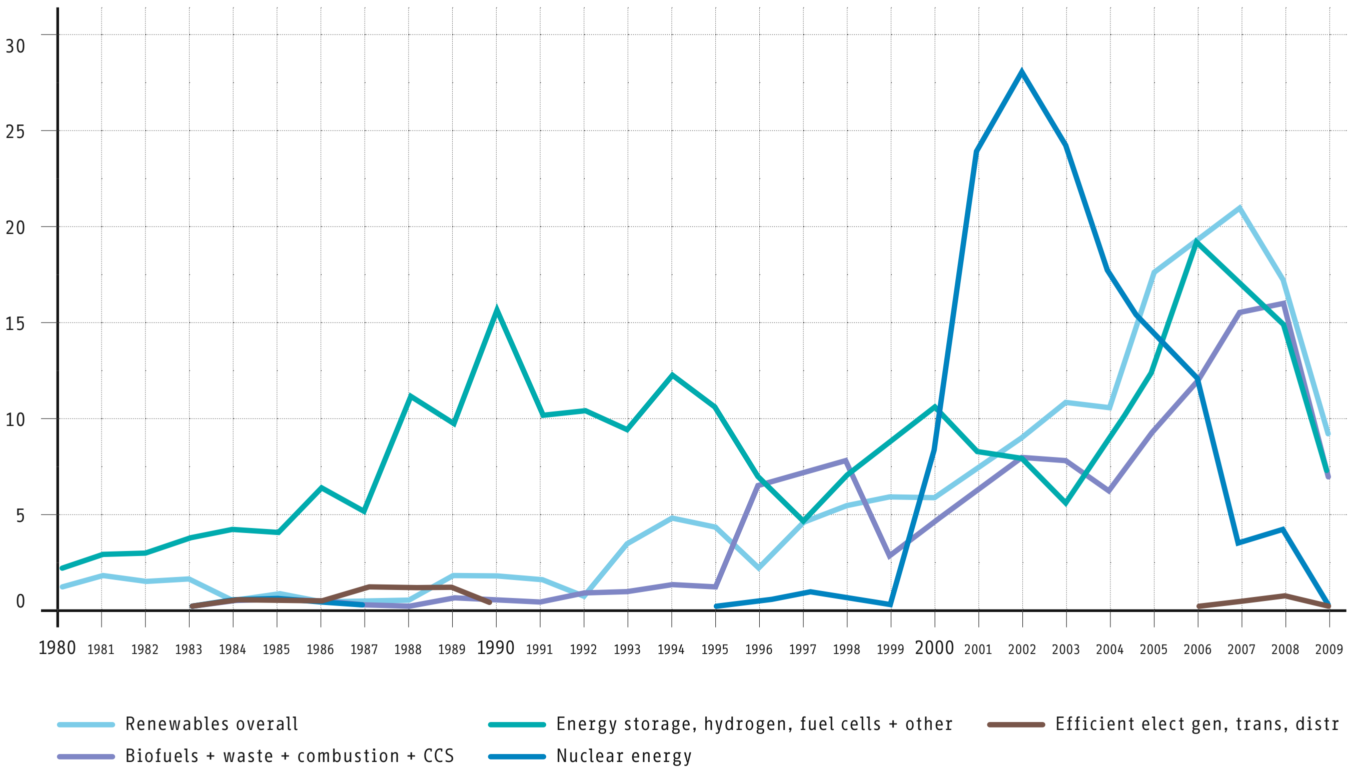
* The non-labelled 1% is for technologies related to efficient electricity generation, transmission and distribution.

Overall, the volume of inventive activity in Africa represents only a fraction of the global effort – 0.3% on average during 1980–2009 for all Y02 technologies. Unsurprisingly, however, given the heterogeneity of the African continent, some technologies and countries stand out. In particular, South Africa accounts for the lion's share of Africa's inventions. It is also the only African country active in nuclear energy technology development, though one other country (Egypt) has one nuclear plant.

Apart from nuclear energy, Africa has a relatively strong position in all Y02 fields (relative to Africa's position in other technologies) – most notably in biofuels, marine & tidal, and energy from waste.

South Africa alone is responsible for the large majority (84%) of Africa's inventions in mitigation (Y02) technologies. Other inventor countries include Egypt, Algeria, Morocco and Kenya (Figure 06). Its volume of inventions allows South Africa to achieve a fairly diversified "invention portfolio", with significant activity in energy storage/hydrogen/fuel cells, alongside nuclear energy and renewables. This is in contrast to other major African inventor countries that have a less diversified portfolio and are active primarily in renewables. Overall, South Africa ranks first amongst African countries in 12 out of the 14 fields studied, the exception being geothermal energy (Burundi) and "other Y02" technologies (Morocco) (Figure 07).

05 Counts of patents for each field 1980–2009 (Africa only)



06 Major African inventor countries 1980–2009 (by field)

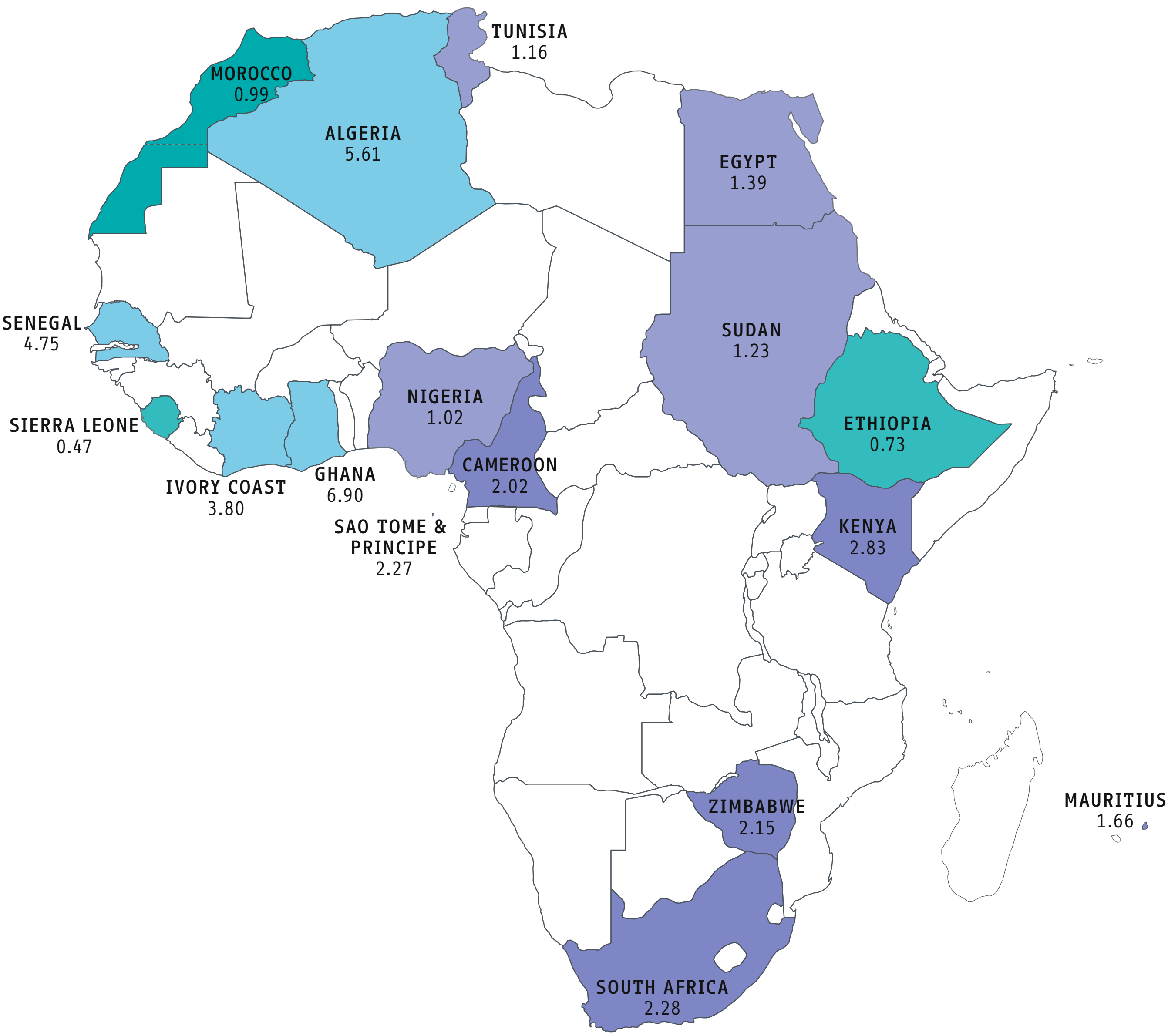
Field	Inventor country
Renewables overall	South Africa (63%), Egypt (8%)
Wind	South Africa (53%), Burundi (14%), Ghana (14%), Morocco (7%)
Solar PV	South Africa (72%), Algeria (14%)
Solar thermal	South Africa (46%), Algeria (13%), Burundi (10%), Morocco (6.5%), Senegal (6.5%)
Geothermal	Burundi (71%), Côte d'Ivoire (14%), Libya (14%)
Marine & tidal	South Africa (67%), Egypt (19%), Mauritius (9.5%)
Hydro conv.	South Africa (61%), Egypt (18%), Morocco (12%), Cameroon (6%)
Biofuels	South Africa (74%), Kenya (12%)
Energy from waste	South Africa (62%), Kenya (24%), Mali (9.5%)
Combustion	South Africa (99%)
CCS	South Africa (87%), Algeria (6.5%)
Nuclear energy	South Africa (99%)
Efficient electricity gen, trans, distr.	South Africa (80%), Morocco (20%)
Energy storage, hydrogen, fuel cells	South Africa (89%)
Other Y02	Morocco (100%)
All Y02	South Africa (77%)

07 Major African inventor countries 1980–2009 (Y02 mitigation technologies, number of priorities)

	Count	%	Invention portfolio
South Africa	553.3	84.2%	Energy storage, hydrogen, fuel cells (40%), nuclear (25%), renewables (19%)
Egypt	18.5	2.8%	Renewables (70%, esp. marine & tidal, hydro conv., solar), energy storage, hydrogen, fuel cells (21%)
Algeria	12.2	1.9%	Renewables (66%, esp. solar thermal & PV), energy storage,hydrogen, fuel cells (18%), CCS (16%)
Morocco	11.7	1.8%	Renewables (54%, esp. solar, wind, hydro conv.), energy storage, hydrogen, fuel cells (50%)
Kenya	7.7	1.2%	Biofuels + energy from waste (65%), energy storage, hydrogen, fuel cells (28%)
Ghana	6.3	1.0%	Renewables (96%, esp. wind, marine & tidal)
Burundi	6.0	0.9%	Renewables (100%, esp. wind, solar thermal, geothermal)
Mali	4.5	0.7%	
Senegal	4.0	0.6%	
Zimbabwe	4.0	0.6%	
Tunisia	3.8	0.6%	
Rest of Africa	25.5	3.9%	
Africa total	657	100%	

To put these figures in context, South Africa's patented inventions (single-priority patent families) account for about 0.33% of the worldwide stock of inventions in mitigation technologies, more than twice as much as for all technology fields taken together (0.15%) The corresponding figures for Africa as a whole are 0.39% and 0.18%. This means that African inventors have an RTA in mitigation technologies because they are more likely to develop them than 'average' technologies. Countries such as Ghana, Algeria and Senegal have the highest RTA in mitigation technologies. These figures are also shown in Figure 08. The map shows countries with a minimum of 50 patent priorities in total (PATSTAT_TOTAL).

08 Relative technological advantage of Africa (mitigation technologies – Y02)



Interestingly, only a small percentage of African inventions (10%) seek protection in Africa. In fact, African innovators more often seek protection in the United States (27%), the EPO (14%), Germany (13%) and Canada (10%). On the other hand, 6% of inventions seek protection in China and only 3% in Japan and Korea (Figure 09). It is also interesting to compare these figures with those for Y02 priorities worldwide. For example, 14% of African Y02 inventions seek protection at the EPO, whereas 22% of worldwide Y02 inventions do so. However, it should be borne in mind that a lot of African office data is missing.

These patterns vary somewhat across different technological fields, but the US and the EPO remain the most frequent jurisdictions where patent protection for African inventions is sought. Other interesting facts: 9% of African priorities in wind energy and 11% in solar thermal seek protection in South Africa, 11% in solar thermal at OAPI, 11% in biofuels in Canada, 13% and 10% in CCS in the UK and Norway respectively, 24% and 13% in energy storage/hydrogen/fuel cells in Germany and Canada respectively, and 12% in nuclear energy in both China and Canada.

09 Markets where protection for African inventions is sought 1980–2009 (selected mitigation technologies – Y02-tags)

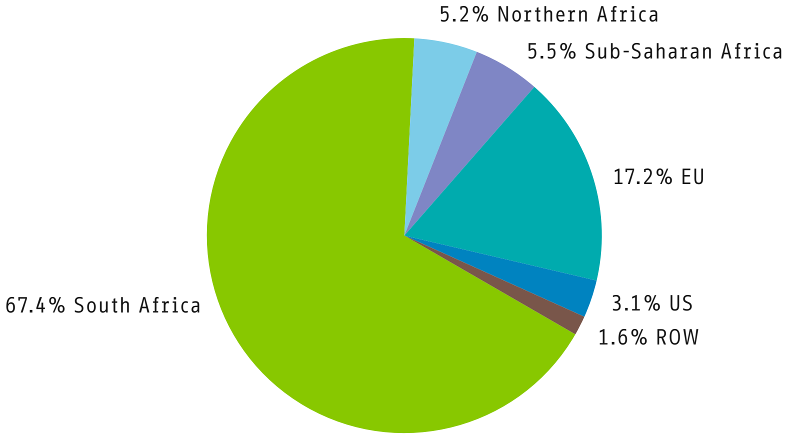
Application authority (patent office)	African priorities	World priorities
United States	27%	41%
International Bureau of WIPO	15%	1%
European Patent Office (EPO)	14%	22%
Germany	13%	19%
Canada	10%	8%
China	6%	10%
South Africa	**5%**	**1%**
Austria	5%	3%
Korea	3%	6%
United Kingdom	3%	3%
Japan	3%	33%
Australia	2.3%	7%
African Intellectual Property Organisation (OAPI)	**2.3%**	**0.1%**
Spain	1.9%	2.7%
Mexico	1.8%	1.1%
Egypt	**1.3%**	**0.05%**
Denmark	0.9%	1.3%
Norway	0.9%	1.0%
Morocco	**0.8%**	**0.1%**
Russia	0.7%	1.0%
Chinese Taipei	0.6%	1.3%
France	0.6%	4%
Eurasian Patent Organization (EAPO)	0.5%	0.2%
African Regional Industrial Property Organization (ARIPO)	**0.5%**	**0.01%**
Algeria	**0.3%**	**0.01%**
Rest of world (ROW)	3%	10%
AFRICA OVERALL (all patent offices)	**10%**	**1.2%**

The values add up to more than 100% because an invention may seek protection in more than one jurisdiction, or through alternative routes (e.g. regional or international route).

Not surprisingly, South Africa is the most important 'applicant country'. As many as 78% of African mitigation inventions (patent families with priority in Africa) have been patented by applicants residing in Africa, including the countries of north Africa (especially Algeria and Egypt) and sub-Saharan Africa (especially Burundi) (Figure 10a). This share has increased to 87% in the last decade (Figure 10b). Historically, countries of the European Union (especially Luxembourg) have accounted for much of the remainder, but their share has decreased recently (with Belgium as the major applicant).

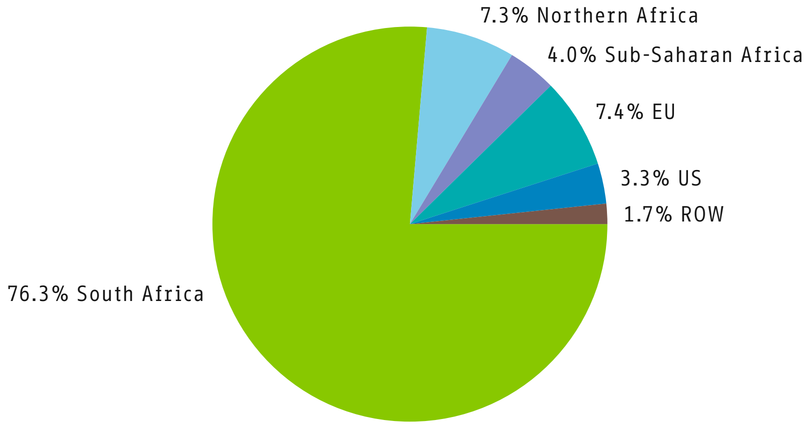
Conversely, when it comes to African ownership of foreign (i.e. non-African) inventions, the major applicant country is South Africa, followed by Sao Tome and Principe and Algeria (Figure 11).

10a Foreign ownership of African inventions 1980 – 2009



Based on a total of 599 inventions during 1980 – 2009 for which the country of both the inventor and the applicant is known.

10b Foreign ownership of African inventions 2000 – 2009

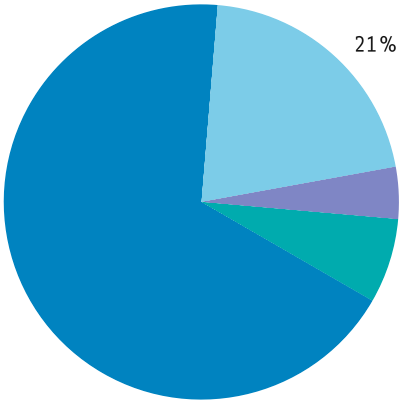


Based on a total of 392 inventions during 2000 – 2009 for which the country of both the inventor and the applicant is known.

In the 'adaptation' technologies (Z inventions) analysed, inventive activity in Africa mostly targets water desalination (45%), followed by energy supply in remote locations (25%), solar water treatment (14%), rainwater collection (7%) and solar/wind-powered water pumping (7%). Surprisingly, there are no African inventions in solar cooking. Figure 12 gives the breakdown of inventive activity in Africa during 1980–2009 for adaptation technologies.

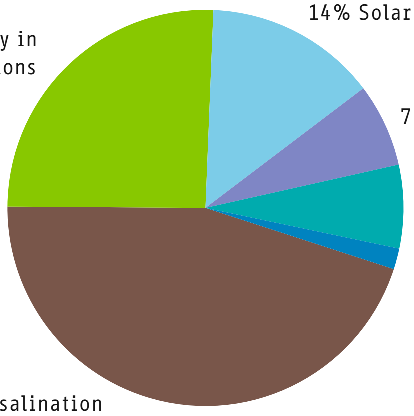
Overall, the share of African inventors in worldwide efforts to develop adaptation technologies has been very low (0.26%). South Africa is the most important inventor country but much less dominant than in mitigation technologies. Other major inventor countries are Morocco and Egypt. Interestingly, a very high proportion of African adaptation inventions seek protection in Africa itself (81%) – a much greater share than for mitigation technologies. As much as 47% of African adaptation-related inventions seek protection in South Africa alone, compared to only 1% which seek protection worldwide. African inventors are also more likely to use WIPO's Patent Cooperation Treaty (PCT) route to protect their inventions.

11 African ownership of foreign (non-African) inventions 1980 – 2009



Based on a total of 118 inventions during 1980 – 2009 for which the country of both the inventor and the applicant is known.

12 Inventive activity: adaption technologies, only priorities, African inventor 1980 – 2009



4.3 Africa as a market for CETs

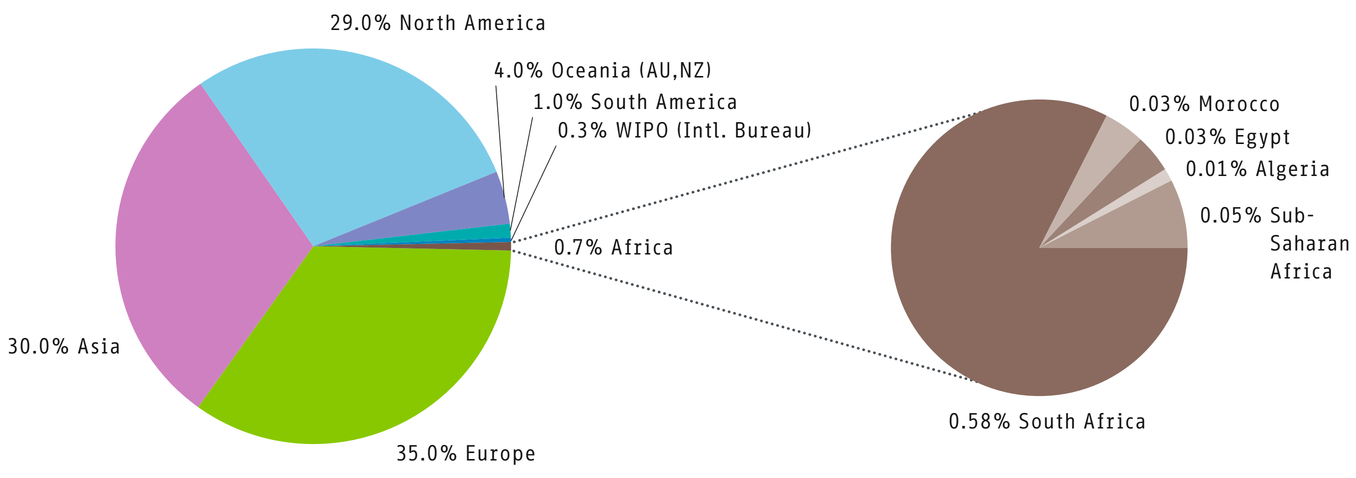
Figure 13 below shows inventive activity worldwide in selected mitigation technologies. This section examines to what extent innovators seek protection for these inventions in Africa. Overall, less than 1% of Y02 patenting activity worldwide targets African countries, with South Africa the dominant market. Other major markets include Morocco and Egypt. However, while the available data indicate a very low propensity to patent inventions in Africa, this conclusion must be qualified in the light of PATSTAT's coverage. Nevertheless, while the percentage of the world's patent applications in mitigation technologies (Y02) registered at one of Africa's patent offices is low (0.7%), it is higher than the propensity to patent in Africa for all technology, which is less than 0.5%.

During the last 30 years, there have been considerable variations in Y02 patenting activity in Africa, starting from a high of 166 patent applications in 1982 and falling to a low of 45 only ten years later in 1992. Since then patenting has increased again. Interestingly, these variations seem to have little to do with specific technological fields, but appear to be a general phenomenon.

In fact, a closer look at the data indicates that the large variations are due to changes in duplication patterns – i.e. duplicate applications in Africa for inventions originally protected elsewhere. In contrast, priority patenting in Africa has remained fairly stable over time, and has even increased since the year 2000 (Figure 15). The ratio of duplicates to priorities has been particularly high in Africa (but similar to that in South America). Almost all priorities are singulars, with protection sought at only one office.

The results show that in Africa about 0.14% of all patents are in biofuels, compared with only 0.04% worldwide. Other Y02 mitigation technologies that are relatively frequently patented in Africa are nuclear, CCS, marine & tidal, and combustion. On the other hand, energy storage/hydrogen/fuel cells and solar PV are protected relatively less frequently in Africa than in the rest of the world. Overall, the propensity to protect mitigation technologies (Y02) is greater in Africa than worldwide (1.7% compared with 1.2% of overall patenting).

13 Patenting activity across different continents 1980 – 2009 (selected mitigation technologies – Y02, by application authority)



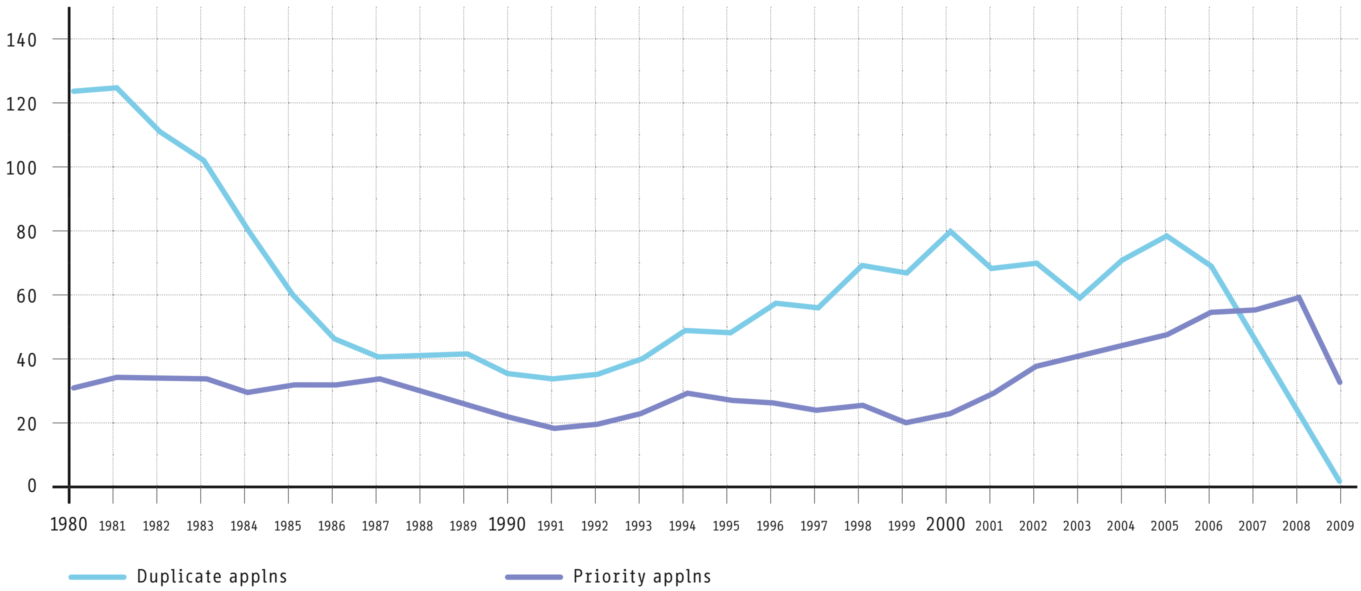
During the period 1980–2009, the number of Y02 patents registered with African patent offices was constant, while patenting overall went down by 2.2%. Despite the general pattern, there are differences across fields, with patenting in wind, CCS and biofuels increasing and that in energy storage/hydrogen/fuel cells, nuclear and solar thermal energy decreasing.

One key question that arises when looking at the data is whether particular countries are more attractive for patent protection of Y02 technologies than others. To answer this question, we examine the propensity to patent at different African authorities. We first calculate the shares of the world's inventions that seek protection in Africa, for Y02 technologies and overall (**Figure 14**). These figures suggest that an average inventor is almost twice as likely to patent mitigation technology in South Africa than 'average' technology.

14 The share of the world's inventions that seek protection in Africa 1980–2009
(number of applications registered at African patent offices divided by number of priorities worldwide)

Application authority (patent office)	Y02 priorities	TOTAL priorities
South Africa	1.00%	0.53%
African Intellectual Property Organization (OAPI)	0.07%	0.03%
Morocco	0.06%	0.03%
Egypt	0.05%	0.03%
Algeria	0.01%	0.01%
African Regional Industrial Property Organization (ARIPO)	0.01%	0.02%
Zimbabwe	0.01%	0.01%

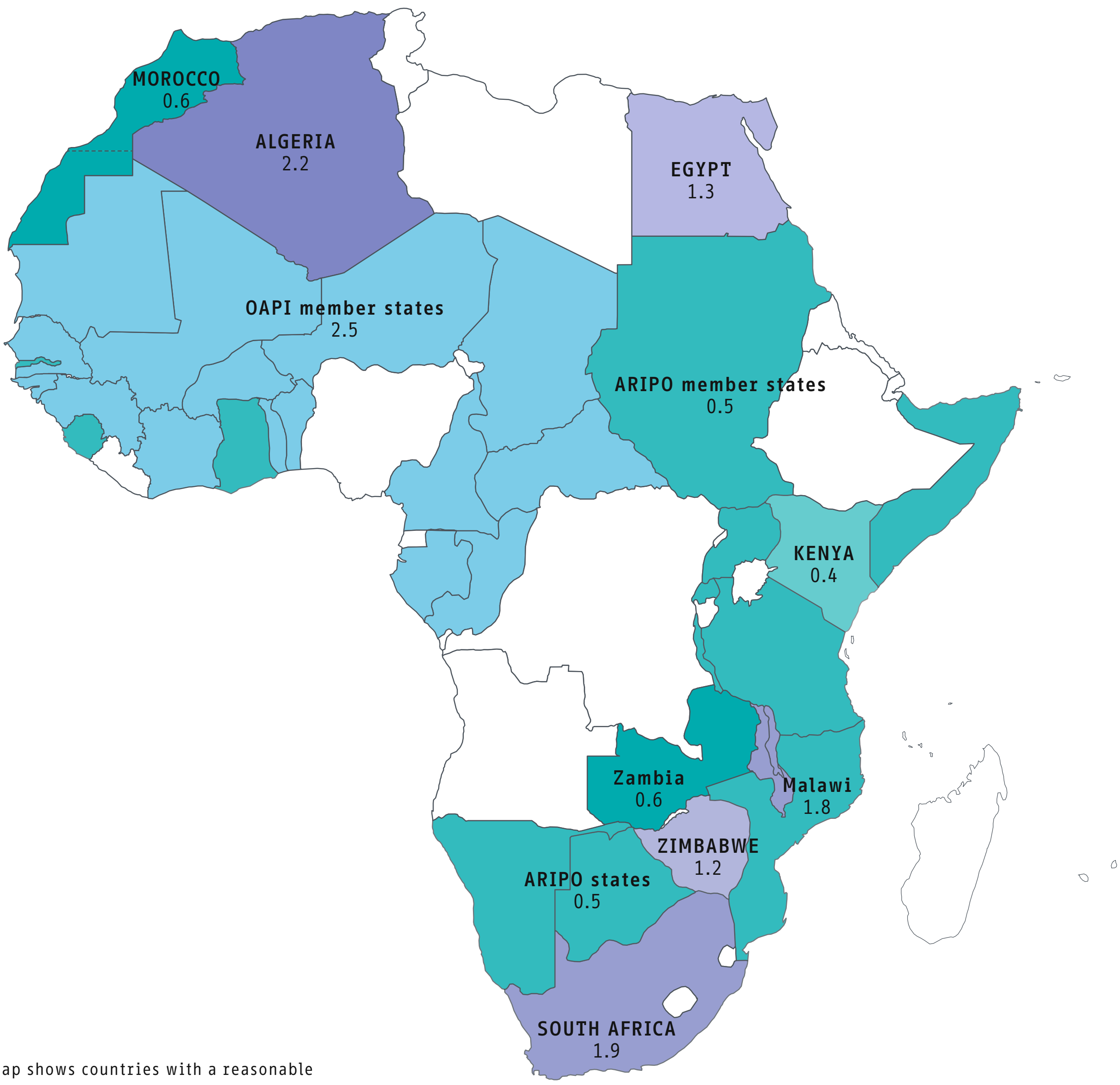
15 Priority vs duplicate filings in Africa 1980–2009



Next, we take the ratio of these shares and interpret them as “propensities to patent”. A propensity equal to one indicates that a Y02 invention is as likely to be patented in the country as is an ‘average’ invention (Figure 16).

To get some idea whether this matches the size of different African markets for the relevant technologies, we extracted data from the UN Comtrade database on commodity imports. Unfortunately there are few commodity classifications that can be mapped directly on environmental/climate-related technologies. Figure 17 gives the import shares of wind-power generating equipment for different African economies over the period 1990–2009. Egypt dominates, followed by Morocco and Sudan. The main differences compared with patent protection data are the high share of Sudan and the low share of South Africa. However, as already noted, South Africa is itself a significant inventor of wind-power technologies.

16 Relative propensity to protect mitigation technologies in Africa

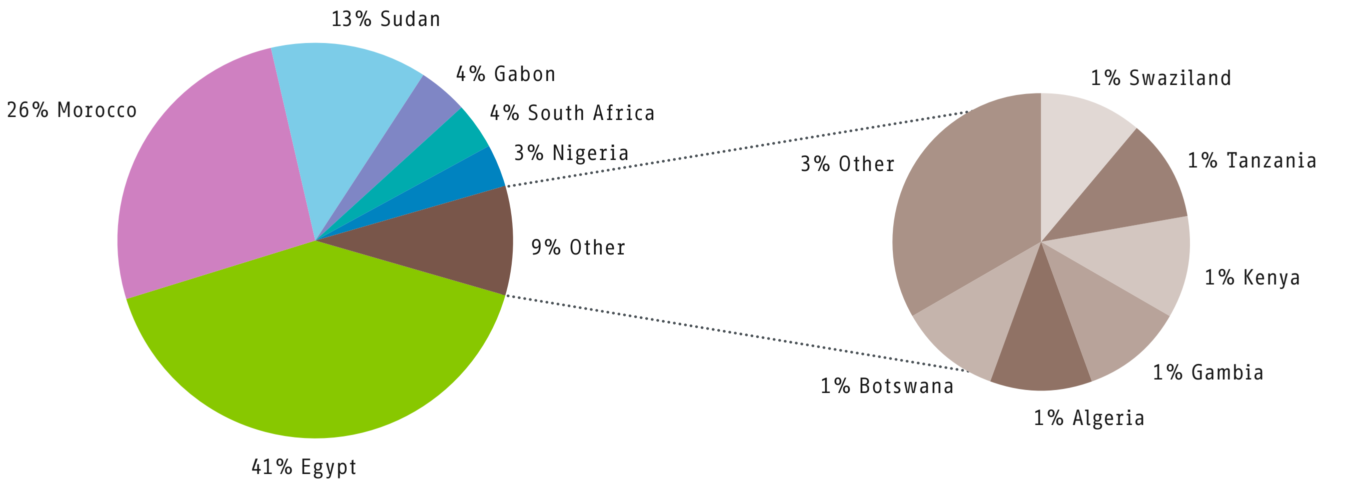


The map shows countries with a reasonable coverage in PATSTAT.

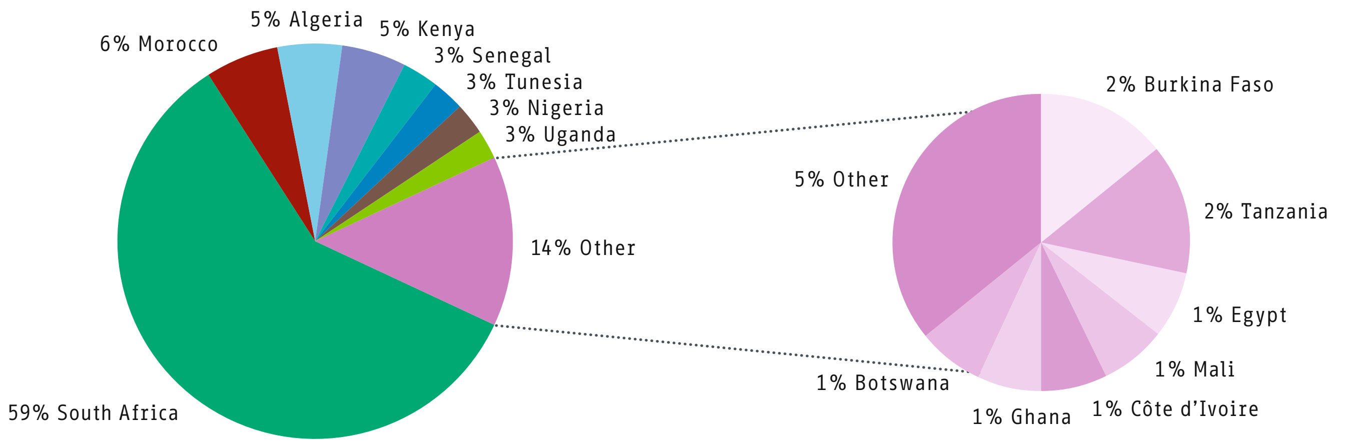
Figure 18 plots the patents registered in Africa against imports of wind-power technologies for countries for which both patent and trade data are available. Since very recently, the HS classification now includes a separate code for solar PV equipment. The data suggests that the major importers of solar PV equipment are South Africa, Morocco, Algeria and Kenya. As above, we then plot these data against the corresponding patent registrations for countries where both data sources are available. The linear (Pearson) correlation is positive and surprisingly high (0.98).

Finally, in imports of nuclear power equipment South Africa dominates (80%), followed by Nigeria (13%) and Morocco (6%).

17 Import shares of wind-power technologies in Africa 1990–2009



18 Import shares of solar PV technologies to Africa 1990–2009



Another key question is the 'origin' of inventions protected in Africa. Overwhelmingly, Y02 inventions have been invented in OECD countries, and this has changed little over time. However, in the 1980s over half of all inventions patented in Africa originated in only two countries (United States and France), and their share has fallen significantly over the last decade as Germany has become the most important 'origin' (Figure 19). At the same time, the share of African countries has increased from less than 1% to over 8%.

While applicant data are very often missing, the available evidence suggests that overwhelmingly the owners of inventions seeking protection in Africa are European, followed by US nationals (Figure 20).

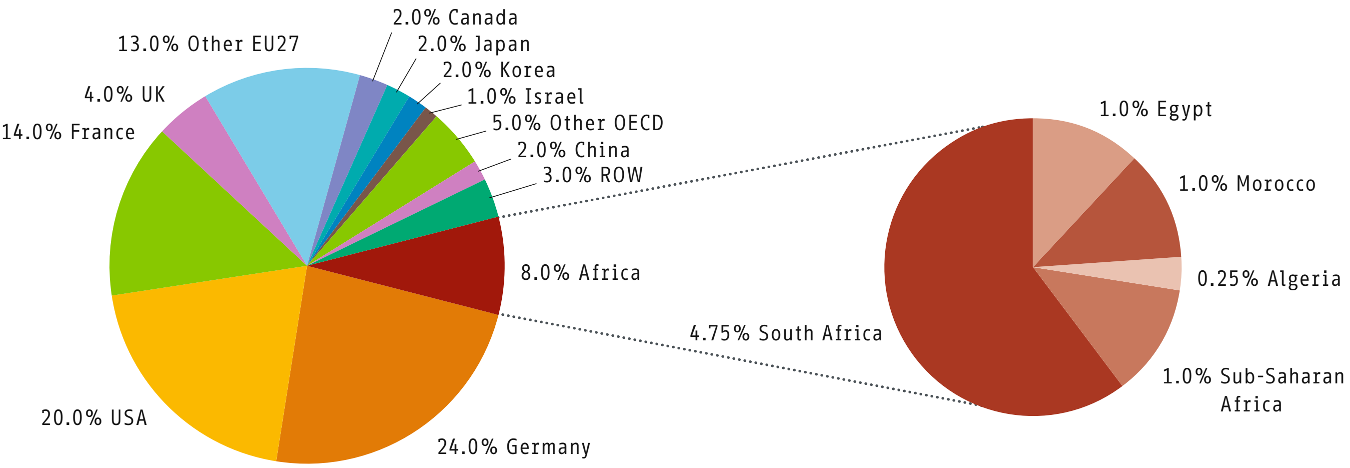
The picture that emerges of Africa as a market for adaptation technologies is also an interesting one. Globally, while for mitigation technologies the principal market for patent protection is Europe, the most important market for adaptation technologies is Asia. The share of Africa is low in both cases, with only about 1% of world's patents for adaptation technologies registered with African patent offices. Again, South Africa is the country where such patent protection is sought most often, although to a lesser degree than for mitigation technologies. Conversely, the share of sub-Saharan countries is greater (Figure 22).

Among the adaptation technologies examined, water desalination is by far the primary technology protected in Africa. However, several other adaptation technologies tend to be protected relatively more often in Africa than elsewhere in the world, including those related to resilience of the electricity supply grid in the face of extreme weather events, solar water treatment, severe weather prediction and rainwater collection. It is rather surprising that there have been very few patents in fields that would seem highly relevant for addressing some of the Africa's most pressing environmental needs, such as solar cooking, efficient lighting for remote locations, and solar/wind-powered water pumping.

Indeed, when we control for the overall volume of patents in a given field and their propensity to be patented widely, we conclude that many adaptation technologies tend to be protected relatively more often in Africa than elsewhere in the world. This is true especially for grid resilience and desalination, and to a lesser extent for solar water treatment and severe weather prediction. Conversely, solar cooking and efficient lighting for remote locations are relatively less frequently protected in Africa than elsewhere. Again, this is rather surprising.

During the period 1980 – 2009, the number of adaptation-related patents registered with African patent offices increased every year by as much as 17% on average, while patenting in general actually decreased (Figure 21).

19 Patenting in Africa by inventor country 2000 – 2009 (patent applications registered at African patent offices, by country of the inventor)



The figure shows data for 2000 - 2009. Few African inventions were patented in Africa prior to this period.

20 Invention & ownership of inventions protected in Africa 1980 – 2009 (inventor and applicant country for filings at African patent offices)

	Applicant countries													
Inventor countries	Un-known	FR	DE	US	ZA	UK	AU	CH	ES	NL	CA	EG	AT	Total*
Unknown	836	13	3	14	2	10	8	1		6				902
United States	524			47							0.5			571
France	362	82		0.5				2						447
Germany	276		57		0.3			3				0.3	1	341
United Kingdom	54			0.5		7				0.5				62
Canada	38	1			0.5						7			46
South Africa	3		0.3		31	0.5					0.5			35
Italy	28	1												33
Japan	26	1												29
Sweden	27													28
Spain	17					1			9					27
Netherlands	22									3				25
Israel	20		1											25
Switzerland	20							4						24
Belgium	18					1								23
Austria	15		1										6	22
Australia	4						8							13
China	12			0.3										13
Norway	8													12
Korea	11		0.5											12
India	11													11
Brazil	7													9
Finland	8													9
Denmark	8													8
Egypt	0		0.3									7		8
Morocco	2	1												7
Grand total*	2390	99	64	63	34	20	16	10	9	9	8	8	7	2804

AT = Austria
AU = Australia
CA = Canada
CH = Switzerland
DE = Germany
EG = Egypt
ES = Spain
FR = France
NL = Netherlands
UK = United Kingdom
US = United States
ZA = South Africa

* The totals are greater than the sum of individual amounts, as countries with very small counts are not shown in the table.

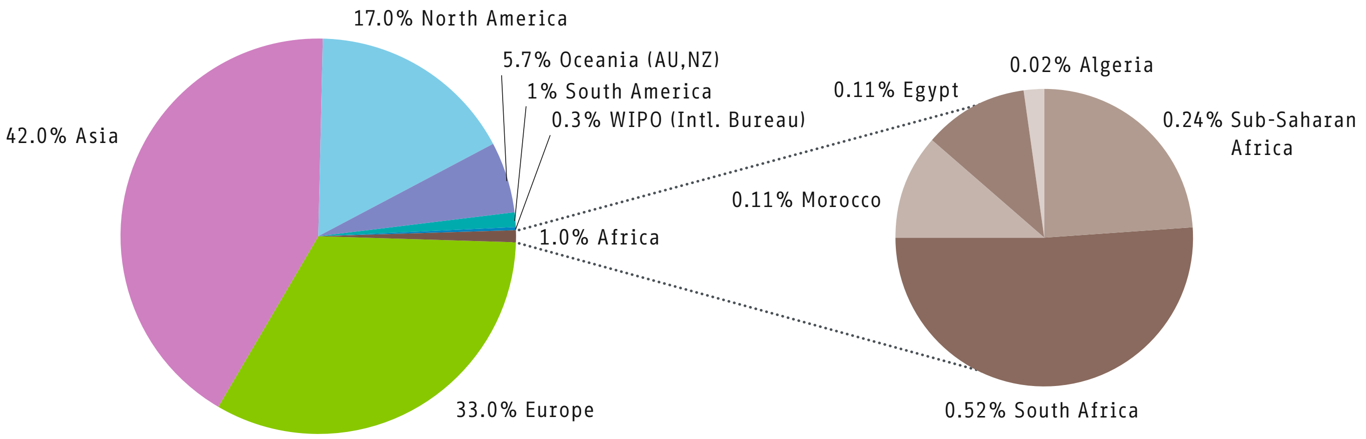
21 Average annual growth rate in patenting activity 1980–2009

	African offices	World
Adaptation technologies (Z-tags)	17%	5%
All technologies (PATSTAT_TOTAL)	-2%	3%

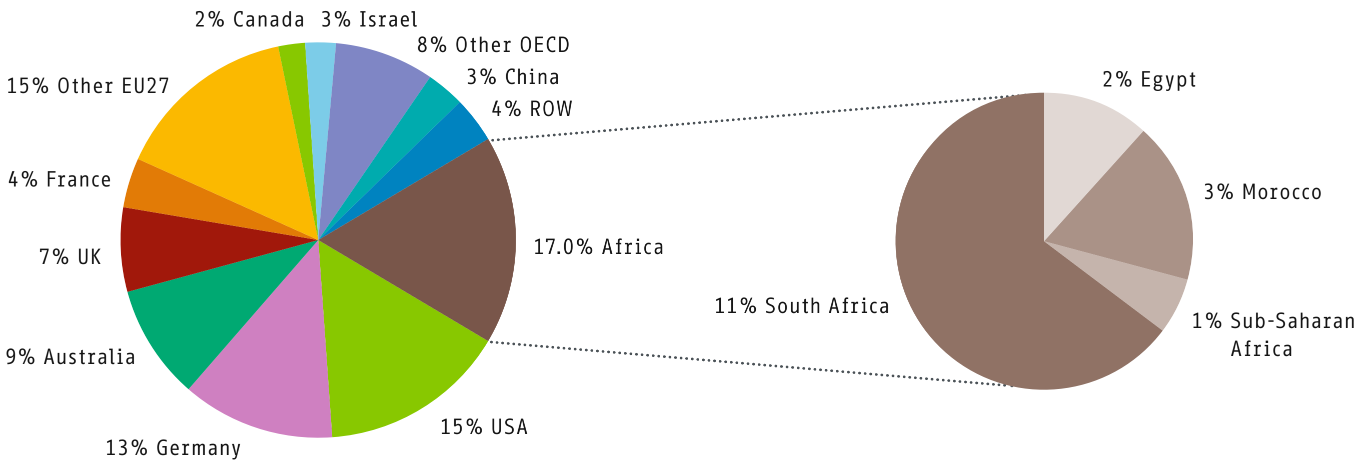
The adaptation technologies patented in Africa originate predominantly in OECD countries (76%), with USA and Germany the major inventors, followed by Australia (9% – an unusually high share). Conversely, the shares of Japan and Korea are extremely low. The proportion of Africa's own inventions is as much as 17% – a much higher share than for mitigation (Figure 23).

Interestingly, adaptation technologies are much more likely to be protected in northern and sub-Saharan Africa than in South Africa. For example, an adaptation technology is seven times more likely to be protected at ARIPO and OAPI than an 'average' technology.

22 Patenting activity across different continents 1980–2009 (selected adaptation technologies – Z, by application authority)



23 Whose inventions are being protected in Africa



The figure shows data for 2000-2009. Few African adaptation inventions were patented in Africa prior to this period.

4.4 Africa's participation in international collaborations for CET development

International research collaboration is of particular relevance in the field of climate change mitigation. In this respect, patent data can be used to develop indicators of co-invention, i.e. the number of priorities that involve inventors from more than one country (OECD 2012). Overall, 23% of African inventions in mitigation technologies involve co-invention. This contrasts with 12% of Y02 inventions co-invented worldwide, and 9% of inventions overall (in all fields) co-invented worldwide. Hence, Y02 technologies have a generally higher rate of co-invention, but this is particularly the case in Africa.

Among mitigation technologies, biofuels and efficient combustion tend to involve the most co-invention, with nuclear energy and energy from waste involving the least (Figure 24). As a point of comparison it is interesting to note that in every Y02 field the rate of co-invention worldwide is lower than in Africa, with the exception of solar thermal, nuclear energy, and waste-to-energy.

Interestingly South Africa, while ranking as the major inventor in Africa, is less likely to co-invent with others when developing mitigation technologies. Countries that are most likely to co-invent include Tunisia, Morocco, Egypt, Kenya and Mali – all of whom have co-invention rates of at least 50% (Figure 25).

The most frequent partner countries include the US, UK, Belgium, Germany and Sweden (for whom South Africa is the primary co-inventor partner in Africa) as well as France and Canada (for whom other African countries are equally important co-invention partners) (Figure 27). Finally, there is very little evidence of intra-African co-invention, with a single documented case (Kenya-Egypt), suggesting that every African country is an "island".

In adaptation technologies there is very little co-invention activity, mostly in desalination (Figure 26) and primarily with South Africa (Figure 28).

In effect, there is hardly any international research collaboration (co-invention) in adaptation technologies – a significant contrast to mitigation technologies.

24 Co-invention in Africa 1980–2009 (Y02 mitigation technologies)

	Co-invention rate in Africa	Co-invention rate worldwide
Biofuels	47%	20%
Efficient combustion	42%	15%
Wind	37%	12%
Hydro conventional	35%	9%
Energy storage, hydrogen, fuel cells	29%	12%
CCS	25%	19%
Renewable energy (overall)	20%	11%
Solar PV	15%	14%
Marine & tidal	9%	6%
Solar thermal	5%	8%
Nuclear energy	**1%**	**6%**
Energy from waste	0%	11%
Y02 (overall)	23%	12%

25 Top African co-inventors 1980–2009 (Y02 mitigation technologies)

	Co-invention rate
Tunisia	67%
Morocco	61%
Egypt	56%
Kenya	55%
Mali	50%
Algeria	21%
South Africa	16%
Ghana	14%
Africa (all countries)	23%

26 Co-invention in Africa 1980–2009 (adaptation technologies, Z-tags)

	Co-invention rate in Africa	Co-invention rate worldwide
Desalination	31%	10%
Solar water treatment	30%	8%
Remote energy supply	0%	6%
Other Z-tags	0%	7%
Adaptation techs (Z-tags) overall	21%	7%

27 Bilateral co-invention co-operation between African countries and the world 1980–2009 (selected mitigation technologies Y02)

	US	UK	BE	DE	FR	SE	CA	ES	CN	JP	IL	CH	NL	KR	ROW	Total
South Africa	11	34	18	11	1	12	3	2	2		5	1	3		3	106
Egypt	9		5	1	1		2								1	19
Morocco	2		1	2	4			3	2						2	16
Kenya	4													2	2	8
Nigeria	3	1		1			1		1	1						8
Algeria	3	1			1											5
Gabon		1					4									5
Tunisia				1	3							1				5
Chad										4						4
Cameroon								1				1			1	3
Ghana	1								1						1	3
Libya	3															3
Mali					3											3
Mauritius	1	1													1	3
Other Africa	2		1	1				2	1			1		1	4	13
Total	39	38	25	17	13	12	10	8	7	5	5	4	3	3	15	204

BE = Belgium
CA = Canada
CH = Switzerland
CN = China
DE = Germany
ES = Spain
FR = France
IL = Israel
JP = Japan
KR = Korea
NL = Netherlands
SE = Sweden
UK = United Kingdom
US = United States

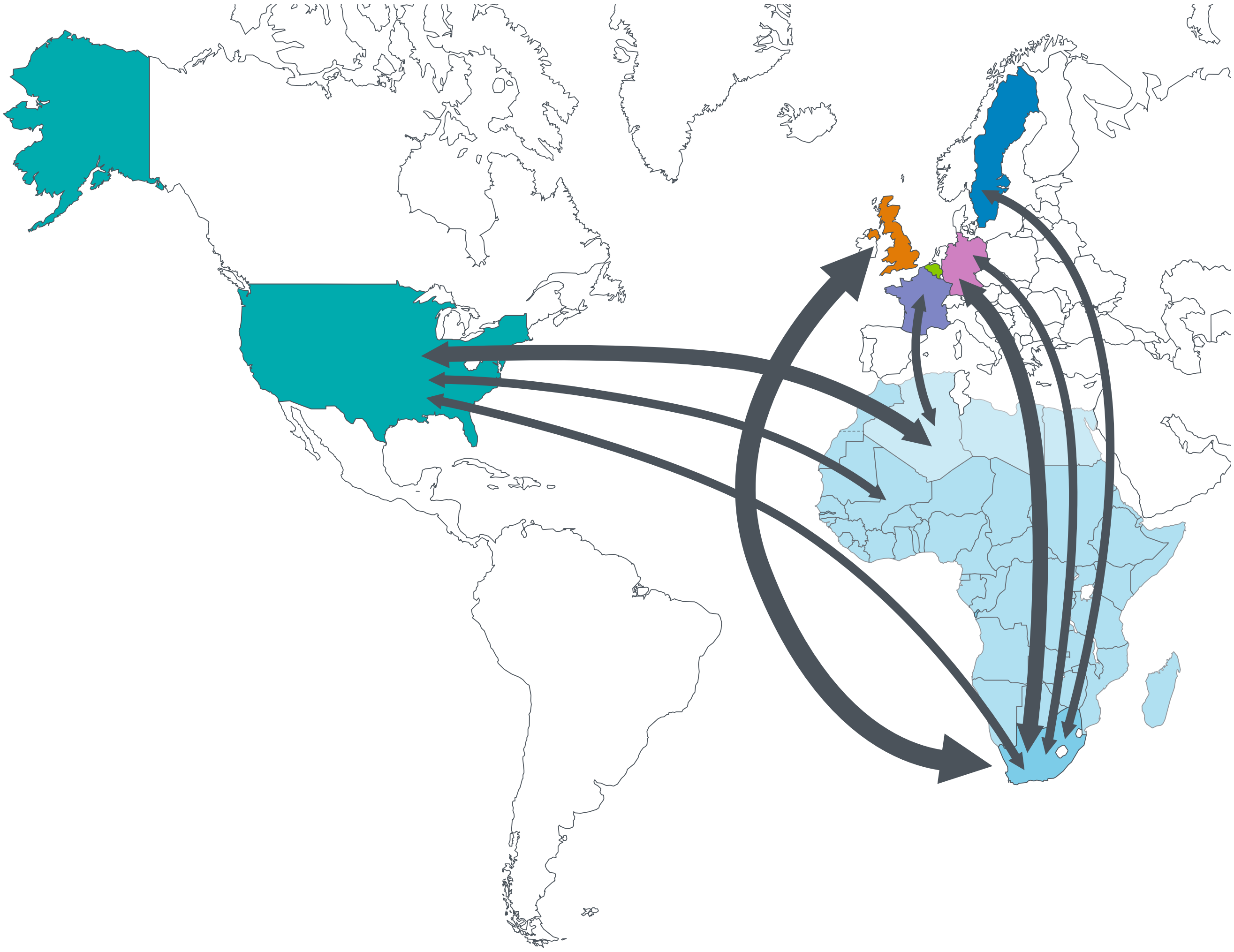
28 Bilateral co-invention between African countries and the rest of the world 1980–2009 (adaptation technologies, Z-tags)

	VG (Brit.)	SG	US	JP	SA	BE	DE	CH	Total
South Africa	3	2	2						7
Sudan				2	2				4
Morocco						1			1
Niger							1		1
Cameroon								1	1
Total	3	2	2	2	2	1	1	1	14

BE = Belgium
CH = Switzerland
DE = Germany
JP = Japan
SA = Saudi Arabia
SG = Singapore
US = United States
VG = Virgin Islands (British)

The most important co-invention relationships are illustrated in Figure 29.

29 International co-invention between African countries and the rest of the world



The map shows co-invention between South Africa and the UK, US, Belgium, Germany and Sweden, between Maghreb countries and the US, between Maghreb and France, and between countries of sub-Saharan Africa and the US.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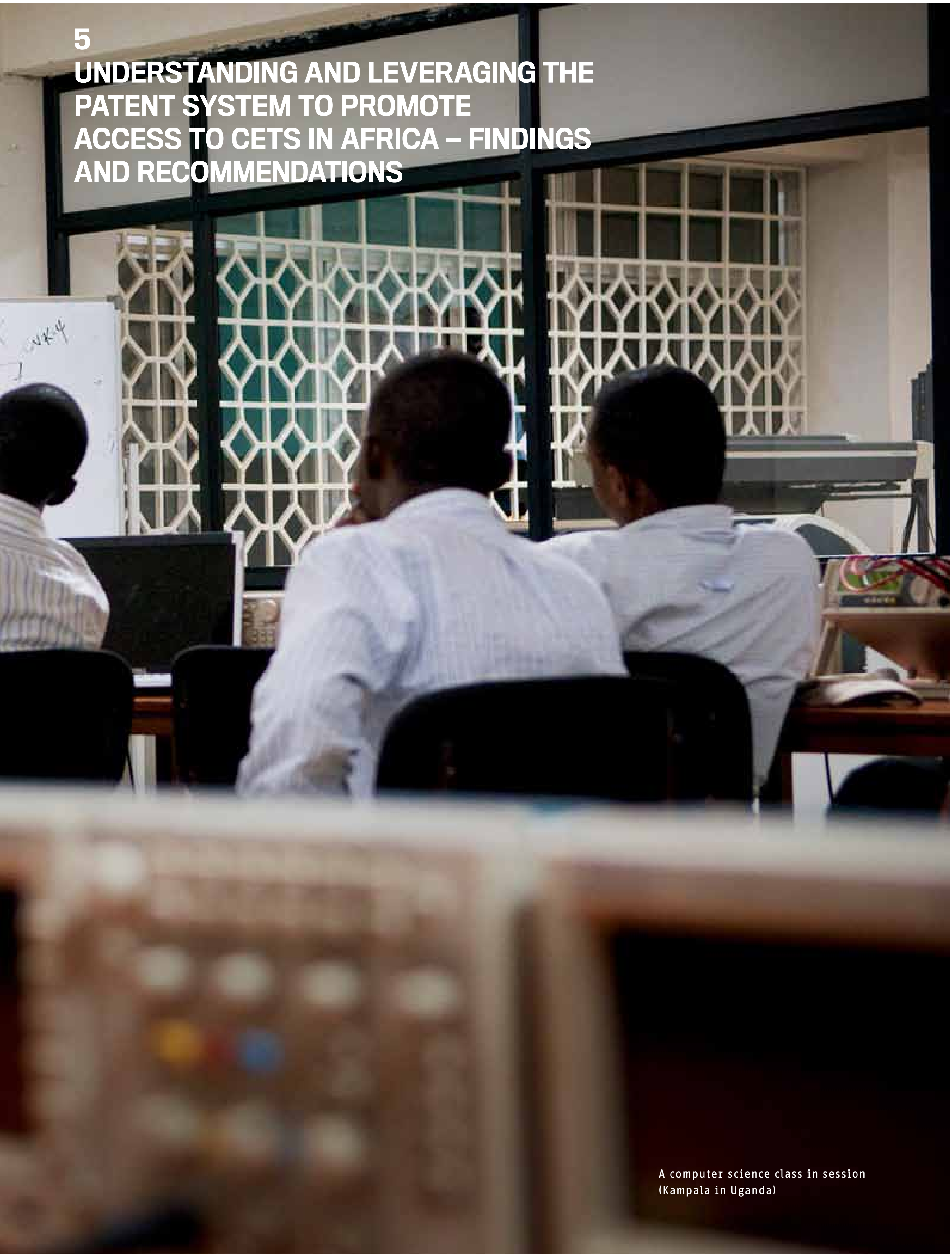
5
UNDERSTANDING AND LEVERAGING THE PATENT SYSTEM TO PROMOTE ACCESS TO CETS IN AFRICA – FINDINGS AND RECOMMENDATIONS



A computer science class in session
(Kampala in Uganda)

Any assessment of the role of IP, particularly patents, in the transfer and diffusion of CETs in Africa needs to be based on a careful study of the patent landscape of these technologies on the one hand, and a nuanced appreciation of the legal framework and policies in place on the other.

Both the statistical and legal analysis offer a clear view on the situation of CETs; while the vast majority of African countries have brought their IP systems in line with the international standards laid down in TRIPS, patenting activity both from African and Non-African inventors remains comparatively low, with less than one percent of all CET patent applications worldwide filed in Africa. However, the analysis also shows promising tendencies of growth in African patent application filings related to mitigation technologies, as regional growth rates vastly outpace the global ones. Any improvement of CETs transfer to Africa, therefore, would need to examine improvements on the patenting process in order to safeguard a better exploitation of Africa's vast untapped clean technology potential, to support inventive activity, and enhance inter- and intra-African technology exchange by taking better into account the diversity of African countries' technological needs and capabilities. It would also need to take account of the fact that, as the previous report on patents and climate change mitigation technology from EPO, UNEP and ICTSD showed, the main factors impeding technology transfer are access to the real know-how from the source companies (including access to trade secrets), access to suitably skilled staff, scientific infrastructure, and favourable market conditions.

5.1 Key findings

The research and analysis contained in this report aimed to answer four main questions, namely:

- What is Africa's clean energy potential and in which countries and regions are the relevant resources located?
- What efforts have been made to exploit the continent's clean energy potential through the use of CETs?
- What is the patent policy and legal framework in different African countries and how is it positioned within the global patent system; and what options do these frameworks offer for technology transfer and diffusion?
- What are the patenting patterns (both inside and outside Africa) in different CETs that are of relevance to Africa?

Our findings in answer to these four questions, based on the analysis in Parts 2, 3 and 4 of this report, can be summarised as follows:

With respect to clean energy potential and location, the report confirms the widely acknowledged fact that Africa has huge clean energy resources. Although not evenly distributed, most countries are significantly endowed with at least one clean energy resource, solar being the leading one. In a significant number of cases these resources, if fully exploited, can provide energy not only within the countries where they are located but also regionally and, in cases such as north Africa, transcontinentally.

When it comes to efforts to exploit the vast clean energy potential in the continent, the picture is far from rosy though things are improving. In all areas (wind, solar, geothermal, hydro and bioenergy), exploitation levels remain very low, and only about 4 % in the case of hydro for example. Nevertheless, recent years have seen important efforts to ramp up the exploitation of the continent's clean energy potential, with north African countries leading in solar and wind, Kenya in geothermal, DRC and Ethiopia in hydro, and Mauritius in bioenergy. Various countries have also set ambitious clean energy targets. For example, South Africa has set a target of 10 000 GWh by 2013.

Regarding IP policies and legal framework, we find that:

- An increasing number of African countries are putting in place specific patenting policies and strategies as part of their development framework. These policies, which seek to promote the use of patents for development, place significant importance on technology transfer.

- Most African countries are fairly well integrated into the international patent system, as their national patent laws are compliant with the TRIPS standards. They therefore provide the basic patent-related framework for support of cross-patenting of CET or other technologies.

- As a consequence, African inventors – individuals and domestic companies active in the field of CETs – re also putting greater emphasis on patents as part of their business strategies, using the international, regional and national filing systems for patent applications in Africa and elsewhere.

This report, in Part 4, has presented the most comprehensive data to this day on the invention and protection of climate change mitigation and adaptation technologies in Africa. In general we find that:

- Both the number of domestic and foreign patent applications filed in Africa are low, with less than 1 % of all applications for mitigation and even fewer for adaption technologies worldwide addressing the continent. This means that patent rights are unlikely to be a major consideration in any decision to exploit CETs in Africa;

- Despite low patent application numbers the overall inventive activity in African countries has grown markedly between 1980 and 2009 by 5 %, compared to 4 % at worldwide level. With an impressive 59 % increase, mitigation technologies grew most significantly in that period, outpacing all other fields of technology and underlining Africa's high propensity to patenting in that field: African inventors have a relative technological advantage (RTA) in mitigation technologies, and are more likely to develop them than other technologies.

- With respect to mitigation, and in comparison with specialisation in the rest of the world, inventive activity is relatively low in Africa in the solar PV sector, whereas in the sectors of biofuels, carbon capture and storage, solar thermal, and waste-to-energy it is relatively high.

- In adaptation technologies, African inventors have a particular focus on desalination, off-grid water supply and remote energy service technologies. A high proportion of African adaptation inventions seek protection in Africa itself.

- South Africa is the most dominant country of origin for African mitigation technologies applications, followed by Egypt, Algeria, Morocco and Kenya. Most of these applications are filed with the US, European countries (EPO) and Canada, and only 10 % are filed in Africa.

- Again, although absolute numbers are very low, sub-Saharan Africa seems to be a relatively frequent choice for protecting adaptation technologies, especially from OECD countries, with Germany being the most important country of origin of patent applications. It is notable, however, that since 1980, the share of African countries as origin of patent applications in other African countries has risen to 8 % from a low of 1 %. This means that in adaptation technologies, African inventors are increasingly looking for protection in other African countries, too.

- There is relatively little evidence of patenting activity from BRIC countries in Africa, despite the increasingly important role played by countries such as China in a number of African economies. Overwhelmingly, patentees seeking protection in Africa are Europeans, followed by US nationals. The role of Japan and Korea is very limited.

- The rate of co-invention for mitigation technologies is much higher in Africa (23 % of mitigation technologies) than in the rest of the world (12 %). This means that there is a significantly higher rate of international collaboration in these areas of technology compared to others. Co-invention in adaption technologies is lower.

- Regrettably, there is very little evidence of intra-African co-invention and cross-border patenting. Every country is an “island”, with links outside the continent but not within. In other words, there is limited collaboration between African countries in the development of mitigation and adaptation technologies, reflecting similar trends in intra-African trade.

- Overall, inventive activity and patenting is dominated by South Africa, a recognised "emerging economy" on the world stage, which appears to plays a leading role in in co-invention, and in technology transfer of CCMT to Africa. as indicated by cross-patenting trends.

5.2 Recommendations

A number of recommendations can be made on the basis of the findings of this report, as just summarised in Part 5.1 above. The recommendations focus on three areas: Africa's participation in the Technology Mechanism, policy and legal reforms in the area of IP, and practical strategies at industry level.

5.2.1
Africa's priorities in the climate Technology Mechanism

A Technology Mechanism, under the guidance of and accountable to the COP, was established by the 16th session of the UNFCCC-COP in Cancun in 2010. The Technology Mechanism is expected to facilitate the implementation of enhanced action on technology development and transfer in order to support action on climate change mitigation and adaptation. The Technology Mechanism consists of two components: a technology executive committee, and climate technology centres and network. It is expected to support the entire technology cycle in all sectors of the economy, from R&D to technology diffusion, including technology transfer.

One of the key issues for Africa is identifying its top priorities in the context of the Technology Mechanism. On the basis of the findings of this report, particularly in relation to patenting patterns, it is recommended that efforts in the Technology Mechanism are focused on:

- Patent landscaping on key CETs which have the most potential to supply Africa's future energy requirements, which will enable countries and companies to identify technologies and, where there are patents, to identify the origin countries and companies for follow-up action, including licensing. The systematic use of free patent information tools and databases will be instrumental to such a landscaping exercise. This work will also help African inventors in this area to identify potential collaborators.
- Technology acquisition financing, in particular where high-impact CETs are readily available, considering the rising propensity to protect mitigation technologies in Africa and the increasing importance of Africa as a desirable region for protecting adaptation technologies.
- licensing approaches for CETs, including enhancing intra-African licensing.
- Ways to further enhance international research collaboration and kick-start intra-African research collaboration on CET development.

5.2.2
Patent policy and developments to facilitate CET development and diffusion in Africa

Most African countries have patent laws and, therefore, also offer legal protection to CET inventions. There are ongoing reforms to further modernise the legal framework in order to improve access to technology and efficiency of patent protection.

In line with the call to encourage a greater influx of CET to Africa as a consequence of the increasing global dimension of patenting strategies, and to enhance a intra-African inventive activity and trade, establishment of an high-quality examination-based patent system needs to be envisaged, as such a system favours the grant of meritorious patents and puts a barrier to undeserving exclusive rights created by weak patents.

To foster innovation and growth, the big challenges for all patent offices across the world, including African states, are to maintain or establish a high quality patent system in order to discourage low quality patent applications. A well functioning patent system offers maximum legal security, protects the interests of both innovators and the public and will also provide a stable framework to facilitate licensing and technology transfer of technologies, including CET.

Different actions could be taken to improve the quality of patent systems. In general such measures concern both the pre-grant and post-grant stages of the patenting process. Pre-grant measures focus mostly on the availability of information on relevant prior art, and the ways in which such information can be accessed and searched by innovators and offices alike. Post-grant measures are invalidation procedures in the form of post-grant opposition and in-court invalidity proceedings (EPO, 2012). Different actions could be taken depending on the specific needs of each country. Increasing international co-operation between African patent offices and the EPO, especially sharing of best practices, could be an important aspect to help further the African patent system.

Establishment of a high-quality examination-based patent system may be a longer-term development, including development of highly-trained staff resources and supporting systems. While such a system requires a certain amount of infrastructural and personnel resource to be put in place, a validation agreement with the EPO as envisaged by some African states could constitute a viable solution, allowing the local environment to benefit from the strong quality of the EPO examination and its 4 000 examiners for those applications originating from abroad, while the national office is able to dedicate all its examination resources to those patent applications originating locally.

Re-use of the search and examination results from the high quality examination of other patent offices may also be envisaged. The Common Citation Document managed by the EPO, for example, allows analysis of the key documents cited by other IPOs in their examinations process, helping export these search and examination results to other IPOs and the general public.

Clear policies on patent rights and defined strategic approaches to technology transfer should be investigated for further opportunities. Though the number of countries adopting patent policies and strategies is increasing, the pace needs to be accelerated to ensure an enabling environment both for patent protection of CETs and broader access to these technologies.

It is therefore recommended that any countries that do not yet have a national IP policy/strategy should prioritise its formulation, paying special attention to technology transfer and diffusion generally and for CETs in particular. Clear policies will ensure that the IP system in these countries comes in support of clear goals and is geared to accentuate key national development priorities such as efforts to address climate change and enhance energy security.

5.2.3
Practical strategies for management of patent rights

Having the right patent policy and laws and participating robustly in the UNFCCC Technology Mechanism will only mean anything for Africa if companies and individuals are able to manage patent rights appropriately. They need to be able not only to protect their inventions but also to acquire the technologies necessary to participate in realising Africa's clean energy potential. This will require specific strategies and action at industry level. In this regard, it is recommended that African companies and other stakeholders in the CET sector invest in the development of patent management strategies to enable them to identify suitable CETs for exploitation and provide a framework for seeking protection for their inventions as well as for licensing CETs owned by others. Again, relying on a quality-oriented patent system and using up to date patent information tools will be instrumental in achieving this aim.

Geothermal hot springs
(Lake Bogoria in Kenya)

ANNEXES

Annex 1

Patent legislation in African countries

	Country	Domestic legislation	Membership of regional and multilateral patent-related treaties
1	Algeria	Ordinance No. 03 – 07 on Patents (19 Joumada El Oula 1424 corresponding to 19 July 2003)	Paris Convention/PCT
2	Angola	Industrial Property Law No. 3/92 of 28 February 1992	Paris Convention/PCT/TRIPS
3	Benin	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
4	Botswana	Industrial Property, Act, 1996, No. 14 of 1996 as amended by Act No. 19 of 1997	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
5	Burkina Faso	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
6	Burundi	Law No. 1/13 of 28 July 2009 on Industrial Property in Burundi	Paris Convention/TRIPS
7	Cameroon	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
8	Cape Verde	Industrial Property Code, Decree Law No. 4 of 20 August 2007	TRIPS
9	Central African Republic	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
10	Chad	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
11	Comoros	Law of 5 July 1844 on Patents for Inventions	Paris Convention/PCT
12	Congo	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
13	Côte d'Ivoire	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
14	Congo, Democratic Republic	Industrial Property Law No. 82 – 0001 7 January 1982	Paris Convention/TRIPS
15	Djibouti	Law No. 50/AN/09/6th on Protection of Industrial Property, adopted on 21 June 2009	Paris Convention/TRIPS
16	Egypt	Law on the Protection of Intellectual Property Rights, No. 82 of 2002	Paris Convention/PCT/TRIPS
17	Equatorial Guinea	N/A	Bangui Agreement/Paris Convention/PCT
18	Eritrea	No information available	None
19	Ethiopia	Proclamation No. 123 of 1995 on Inventions, Minor Inventions and Industrial Designs	None
20	Gabon	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
21	Gambia	No information available	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
22	Ghana	Patent Law of 30 December 1992	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
23	Guinea	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
24	Guinea-Bissau	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
25	Kenya	Industrial Property Act, 2001	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
26	Lesotho	The Industrial Property Order (IPO) OF 1989, as amended in 1997	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
27	Liberia	Industrial Property Act, 2003	ARIPO's Harare Protocol/Paris Convention/PCT
28	Libya	No information available	Paris Convention/PCT
29	Madagascar	July 1989 ordinance No. 89-019 setting up a regime for the protection of industrial property (Title I) (Articles 3 to 54) (O] of August 1989)	Paris Convention/PCT/TRIPS

Patent legislation in African countries

	Country	Domestic legislation	Membership of regional and multilateral patent-related treaties
30	Malawi	Patents Act, 1992	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
31	Mali	Law on the Protection of Industrial Property of 9 March 1987	Bangui Agreement/Paris Convention/PCT/ TRIPS
32	Mauritania	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
33	Mauritius	The Patents, Industrial Designs and Trade-mark Act, No. 25 of 2002	Paris Convention/TRIPS
34	Morocco	Law No. 17-97 on the Protection of Industrial Property (promulgated by Dahir No. 1-00-91 of 9 Kaada 1420 of 15 February 2000) as amended in 2006	Paris Convention/PCT/TRIPS
35	Mozambique	Industrial Property Code: Decree No. 4 of 12 April 2006	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
36	Namibia	No information available	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
37	Niger	N/A	Bangui Agreement/Paris Convention/PCT/ TRIPS
38	Nigeria	Patent and Design Act, Chapter 344 Laws of Nigeria (1990)	Paris Convention/PCT/TRIPS
39	Rwanda	Intellectual Property Code, Law No. 31 of 26 October 2009	Paris Convention/TRIPS
40	Sao Tome and Principe	Industrial Property Law, No. 4 of 31 December 2001	Paris Convention/PCT/TRIPS
41	Senegal	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
42	Seychelles	No information available	Paris Convention/PCT
43	Sierra Leone	Patents Act No. 21, Chapter 247, of 1924, 10 of 1932, 31 of 1932, 9 of 1957, as amended by the Laws (Adaptation) Act No. 29 of 1972	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
44	Somalia	No information available	None
45	South Africa	Patents Act 1978 as amended 1997, 2002, 2005, Intellectual Property Rights from Publicly Financed Research and Development Act, No. 51 of 2008	Paris Convention/PCT/TRIPS
46	Sudan	Patent Act 1971	ARIPO's Harare Protocol/ Paris Convention/PCT
47	Swaziland	Patents, Utility Models and Industrial Designs Act, No. 6 of 1997	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
48	Tanzania	Tanzania Patent Act 1987 as amended by Acts Nos. 13 and 18 of 1991 Zanzibar	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
49	Togo	N/A	Bangui Agreement/Paris Convention/PCT/TRIPS
50	Tunisia	Patent Law No. 84 of 24 August 2000	Paris Convention/PCT/TRIPS
51	Uganda	The Patents Act 1993 as amended by the Pat-ents (Amendment) Act of 2002	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
52	Zambia	The Patent Act, Chapter 400 Laws of Zambia, as amended in 1980 and 1987	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS
53	Zimbabwe	Patents Act, Chapter 26:03 of 2002	ARIPO's Harare Protocol/ Paris Convention/ PCT/TRIPS

Source: WIPO Lex and authors' research.

Annex 2

Patent search strategy for selected mitigation technologies[1]

Field	Description	ECLA Y-tag
Wind	**Wind energy** All subclasses, including: – Wind turbines with rotation axis in wind direction; including: Blades or rotors; Components or gearbox; Control of turbines; Generator or configuration; Nacelles; Offshore towers; Onshore towers – Wind turbines with rotation axis perpendicular to the wind direction – Power conversion electric or electronic aspects; including: for grid-connected applications; concerning power management inside the plant, e.g. battery charging/discharging, economical operation, hybridisation with other energy sources	Y02E10:7
Solar PV	**Solar photovoltaic (PV) energy** All subclasses, including: – PV systems with concentrators – Material technologies, including: $CuInSe_2$ material PV cells; Dye sensitized solar cells; Solar cells from Group II-VI materials; Solar cells from Group III-V materials; Microcrystalline silicon PV cells; Polycrystalline silicon PV cells; Amorphous silicon PV – Power conversion electric or electronic aspects, including: for grid-connected applications; concerning power management inside the plant , e.g. battery charging/discharging, economical operation, hybridisation with other energy sources – Power conversion electric or electronic aspects; Maximum power point tracking (MPPT)	Y02E10:5
Solar thermal	**Solar thermal energy** All subclasses, including: – Tower concentrators; Dish collectors; Fresnel lenses; Heat exchange systems; Trough concentrators; Solar thermal plants for electricity generation, e.g. Rankine, Stirling solar thermal generators; Mountings or tracking; Mechanical power, e.g. thermal updraft	Y02E10:4
	Thermal-PV hybrids	Y02E10:6
Geothermal	**Geothermal energy** All subclasses, including: – Earth coil heat exchangers, incl.: Compact tube assemblies, e.g. geothermal probes – Systems injecting medium directly into ground, e.g. hot dry rock system, underground water – Systems injecting medium into a closed well – Systems exchanging heat with fluids in pipes, e.g. fresh water or waste water	Y02E10:1
Marine & tidal	**Energy from sea** All subclasses, including: – Oscillating water column (OWC) – Ocean thermal energy conversion (OTEC) – Salinity gradient – Wave energy or tidal swell, e.g. Pelamis-type	Y02E10:3
	Hydro energy – Tidal stream or damless hydropower, e.g. sea flood and ebb, river, stream	Y02E10:28
Hydro conventional	**Hydro energy** – Conventional, e.g. with dams, turbines and waterwheels, including: Turbines or waterwheels, e.g. details of the rotor; Other parts or details	Y02E10:20–22
Biofuels	**Energy generation using biofuels** All subclasses, including: – CHP turbines for biofeed; Gas turbines for biofeed; Bio-diesel; Bio-pyrolysis; Torrefaction of biomass; Cellulosic bio-ethanol; Grain bio-ethanol; Bio-alcohols produced by other means than fermentation	Y02E50:1
Energy from waste	**Energy generation using fuels from waste** All subclasses, including: – Synthesis of alcohols or diesel from waste including a pyrolysis and/or gasification step – Methane, including: production by fermentation of organic by-products, e.g. sludge; from landfill gas	Y02E50:3

[1] Based on http://v3.espacenet.com/eclasrch?classification=ecla&locale=en_EP&ECLA=y02

Patent search strategy for selected mitigation technologies[1]

Field	Description	ECLA Y-tag
Combustion	**Combustion technologies with mitigation potential** All subclasses, including: Combined combustion: – Heat utilisation in combustion or incineration of waste – Combined heat and power generation (CHP) – Combined cycle power plant (CCPP), or combined cycle gas turbine (CCGT), including: Integrated gasification combined cycle (IGCC); combined with carbon capture and storage (CCS) Technologies for a more efficient combustion or heat usage – Direct CO_2 mitigation, including: Use of synair, i.e. a mixture of recycled CO_2 and pure O_2; Use of reactants before or during combustion; Segregation from fumes, including use of reactants downstream from combustion or deep cooling; Controls of combustion specifically inferring on CO_2 emissions – Indirect CO_2 mitigation, i.e. by acting on non CO_2 directly related matters of the process, e.g. more efficient use of fuels, including: Cold flame; Oxyfuel combustion; Unmixed combustion; Air pre-heating – Heat recovery other than air pre-heating, including: at fumes level; at burner level	Y02E20
CCS	**Technologies specific to climate change mitigation** All subclasses, including: CO_2 capture or storage: – Capture by biological separation; by chemical separation; by absorption; by adsorption; by membranes or diffusion; by rectification and condensation. Subterranean or submarine CO_2 storage	Y02C:10
	Capture or disposal of greenhouse gases (GHG) other than CO_2: – of nitrous oxide (N_2O); of methane; of perfluorocarbons (PFC), hydrofluorocarbons (HFC) or sulfur hexafluoride (SF6)	Y02C:20
Efficient electricity GTD	**Efficient electricity generation, transmission, distribution:** All subclasses, including: – Flexible AC transmission systems (FACTS) – Active power filtering (APF) – Arrangements for reducing harmonics – Arrangements for eliminating or reducing asymmetry in polyphase networks – Superconducting electric elements and equipment – Methods and systems for the efficient management or operation of electric power systems, e.g. aiming at losses minimisation or emissions reduction, co-ordination of generating units or of distributed resources, interaction with loads (e.g. smart grids)	Y02E40
Energy storage, hydrogen, fuel cells	**Technologies with potential or indirect contribution to emissions mitigation** All subclasses, including: Energy storage: – Battery technology; Ultracapacitors, supercapacitors, double-layer capacitors; Thermal storage; Pressurised fluid storage; Mechanical energy storage; Pumped storage Hydrogen technology: – Hydrogen storage; Hydrogen distribution; Hydrogen production from non-carbon containing sources Fuel cells: – characterised by type or design, incl. Proton Exchange Membrane Fuel Cells (PEMFC), Solid Oxide Fuel Cells (SOFC), Molten Carbobate Fuel Cells (MCFC), Bio Fuel Cells, Regenerative or indirect fuel cells, e.g. redox flow type batteries – specially adapted for a certain application, incl. stationary, transport, portable – integrally combined with other energy production systems	Y02E60

[1] Based on http://v3.espacenet.com/eclasrch?classification=ecla&locale=en_EP&ECLA=y02

Annex 2 (contd.)

Patent search strategy for selected mitigation technologies[1]

Field	Description	ECLA Y-tag
Nuclear	**Nuclear energy generation** All subclasses, including: — Fusion reactors: Magnetic plasma confinement (MPC), e.g. tokamaks, stellarators; Inertial plasma confinement; Low temperature fusion, e.g. "cold fusion" — Nuclear fission reactors: Boiling water reactors; Pressurised water reactors; Gas cooled reactors; Fast breeder reactors; Liquid metal reactors; Pebble bed reactors; Accelerator driven reactors; Fuel; Control of nuclear reactions; Other aspects relating to nuclear fission	Y02E30
Other Y02	**Other energy conversion or management systems reducing green-house gas (GHG) emissions** All subclasses, including: — Hydrogen from electrolysis with energy of non-fossil origin, e.g. PV, wind power, nuclear — Systems combining fuel cells with production of fuel of non-fossil origin — Systems combining energy storage with energy generation of non-fossil origin — Batteries, ultra-capacitors, super-capacitors or double-layer capacitors, charging or discharging systems or methods for reducing GHG emissions, e.g. auxiliary power consumption reduction, resonant chargers or dischargers, resistive losses minimisation, including those specially adapted for vehicles, for portable applications, etc.	Y02E70

[1] Based on http://v3.espacenet.com/eclasrch?classification=ecla&locale=en_EP&ECLA=y02

Annex 3

Summary of statistics for the selected mitigation technologies

Field	Application id's in PATSTAT
Renewable energy	152 347
Wind	31 354
Solar PV	59 762
Solar thermal	38 147
Geothermal	5 321
Marine & tidal	10 984
Hydro conventional	19 619
Combustion-related techs	
Biofuels	18 037
Energy from waste	11 473
Combustion	20 793
CCS	19 479
Efficient electricity gen., trans., distr.	11 823
Energy storage, hydrogen, fuel cells	292 911
Nuclear energy	65 625
Other Y02	2 756
Y02-Tag total	580 154

Annex 4

Patent search strategy for selected adaptation technologies[2]

Field	Description	Temporary (Z) tag
Desalination	Membranes especially made for desalination and desalination processes using membranes are included. Processes for producing membranes, potentially suitable for desalination, are not included.	A_desalination
Rainwater_collection	Methods or installations for obtaining or collecting drinking water or tap water from rain water.	A_rainwater
Solar/wind_water_pump	Solar- and wind-powered water pumping.	A_solarwind pump
Solar_water_treatment	Water treatment using solar energy, include sewage treatment, wastewater treatment and drinking water treatment. (Remark: Does not include treatment of sludge. May include some instances of use of other local power sources such as wind.)	A_solarwater treatment
Solar_water_potabilisation	Potabilisation of water by means of solar power. (Remark: This is a sub-group of the more general SOLAR_WATERTREAT)	A_solarwater potabilisation
HVDC	High-voltage direct current (HVDC) electricity transmission, incl. associated power electronics.	A_HVDC
Energy_supply_remote	Solar energy for remote locations (off-grid solar power, solar home systems, solar water heating, solar drying, energy storage), and similar wind-powered applications. (Remark: In 95% related to solar and/or wind, but other renewables at "home" level are included as well. Includes also other "solar household devices" (e.g. air conditioning), home photovoltaics, some grid-connected PV applications characterised by being remote/dispersed/distributed, either because of being presented as both (off-grid and grid-connected) or simply because the concept "off-grid" sometimes is difficult to screen.	A_remote
Eff_lighting_remote	Lighting systems specially adapted for remote locations wherein alternative power sources may be required.	A_efflight
Solar_cooking	Solar cooking devices, e.g. solar ovens. (Remark: Documents relating to solar water heating (for hygienic purposes etc.) are tagged in A_remote. Some double classification may occur.)	A_solar cooking
Resilience	Resilience of electricity supply systems to extreme weather events: strengthening power-lines, (under) ground power cables, etc. (Remark: Documents dealing with power cables/line/wires that are resilient to water, moisture and corrosion, independently of whether they are underground or aerial.)	A_resil
Severe_weather	Prediction and early warning for extreme weather events, such as storms and floods (Remark: Tsunami-warning systems are in principle excluded as tsunamis originate from earthquakes, which are not weather events.)	A_severe weather

[2] Based on information provided by the European Patent Office (Konstantinos Karachalios, Victor Veefkind, Javier Hurtado-Albir, and colleagues).

Annex 5

Summary of statistics for selected adaptation technologies

Field	Application id's in PATSTAT
Desalination	15 889
Off-grid water supply	
Rainwater_collection	3 828
Waterpump_solar_wind	1 995
Solar_watertreat	7 073
Solar_watertreat_potabilisation	1 177
Dispersed electricity transmission[3]	
HVDC	2 593
Remote energy services	
Energy_supply_remote	17 800
Eff_lighting_remote	2 138
Solar_cooking	729
Weather-related	
Resilience_elect_grid	4 462
Severe_weather	847
Selected adaptation technologies Z-tags	54 376

[3] http://www.eepublishers.co.za/images/upload/Trans%20PB%20Power.pdf

Annex 6

Number of patent applications registered with African authorities 1980–2009 (selected mitigation technologies – Y02-tags)

Application authority	Wind	Solar PV	Solar thermal	Geothermal	Marine & tidal	Hydro conv.	Renewable energy (overall)	Biofuels
South Africa	142	143	177	12	70	50	533	176
OAPI	12	7	49	7	11	14	86	24
Morocco	32	7	38		7	7	86	8
Egypt	6	8	20		6	8	45	8
Algeria		4	9			4	14	1
ARIPO	3	3	6	3	2	3	14	2
Zimbabwe	1	2	2		1	3	8	4
Malawi			1				1	2
Kenya			1	1			2	2
Zambia					1		1	
Sudan	2		1				2	
Ghana	1				1		1	
Tunisia								
Liberia								
Lesotho								
Libya								
Grand total*	199	174	304	23	99	89	793	227

* Because of rounding, the totals may not exactly match the sum of the amounts shown in the column.

Energy from waste	Combustion	CCS	Energy storage, hydro, fuel cells	Nuclear energy	Efficient elect. gen., trans., distr.	Other Y02	Y02-tags Total	PATSTAT Total
76	194	203	771	376	62	11	2 309	131 507
21	6	6	31		1		161	6 280
6	10	3	25	5	1	1	138	8 280
4	11	8	24	20			114	8 149
1	4	5	4				28	1 391
1	2	2	3			1	22	5 077
1		2	3				17	2 089
		2					5	429
1							4	557
		2					3	788
							2	31
							1	6
								22
								2
								1
								1
111	227	233	861	401	64	13	2 804	164 610

Annex 7

Number of priorities invented in African countries 1980-2009 (selected mitigation technologies – Y02-tags)

Inventor country	Wind	Solar PV	Solar thermal	Geothermal	Marine & tidal	Hydro conv.	Renewable energy (overall)	Biofuels
South Africa	22	41	28		14	10	105	32
Egypt	1	3	3		4	3	13	0.3
Algeria		8	8				8	
Morocco	3	2	4			2	6	
Kenya								5
Burundi	6		6	5			6	
Ghana	6				1		6	0.3
Mali			1				1	2
Zimbabwe	2	1	2				4	
Senegal			4				4	
Tunisia		1	2				3	
Côte d'Ivoire			2	1			2	1
Cameroon		1				1	2	
Libya				1			1	
Mauritius					2		2	
Chad								
Saint Helena								2
Gabon								
Nigeria								
Sao Tome/Pr.								
Eritrea								1
Sudan	1		1				1	
Mauritania	1						1	
Sierra Leone						1	1	
Ethiopia								
Liberia								
Niger								
Swaziland			0.3				0.3	
Rwanda		0.3					0.3	
Seychelles								
Madagascar								
Namibia								
Congo								
Uganda								
Tanzania								
Burkina Faso								
Guinea								
Zambia								
Benin								
Togo								
Botswana								
Angola								
Reunion								
Gambia								

Energy from waste	Combustion	CCS	Energy storage hydr., fuel cells	Nuclear energy	Efficient elect. gen., trans., distr.	Other Y02	Y02-tags Total	PATSTAT Total
13	24	27	222	137	4		553	18166
	0.3		4	1			18	970
		2	2				12	160
		1	6		1	2	12	906
5		1	2				8	211
							6	21
							6	65
2			2				5	41
							4	139
							4	63
			1				4	258
1							3	59
			1				3	111
			2				3	17
		0.3					2	90
			2				2	8
			1				2	19
			2				2	38
		0.3	1				2	146
			2				2	66
							1	8
							1	61
							1	23
							0.5	80
			1				0.5	51
			1				0.5	10
		1					0.5	33
							0.3	29
							0.3	3
								49
								38
								35
								28
								28
								25
								21
								18
								18
								16
								14
								9
								9
								8
								8

Annex 7 (contd.)

Number of priorities invented in African countries 1980 - 2009 (selected mitigation technologies – Y02-tags)

Inventor country	Wind	Solar PV	Solar thermal	Geothermal	Marine & tidal	Hydro conv.	Renewable energy (overall)	Biofuels
Malawi								
DR Congo								
Somalia								
Central African Republic								
Cape Verde								
Lesotho								
Equatorial Guinea								
Djibouti								
Mozambique								
Comoros								
Grand total	42	57	61	7	21	17	167	43

Annex 8

Number of patent applications registered with African authorities 1980 - 2009 (selected adaptation technologies - Z tags)

Application authority	Desalination	Solar water treatment	Energy supply remote	Solar/wind water pump	Solar water potabilisation	HVDC	Rainwater collection	Solar cooking
South Africa	80	35	52	14	6	10	7	4
OAPI	18	13	11	5	5	2	2	2
Morocco	25	10	2	7	3		3	
Egypt	27	13	3	3	4			2
ARIPO	19	12	9	3	6	4	1	4
Algeria	4	3	1	1	2			
Zimbabwe			1	1				
Tunisia	1							
Malawi	1							
Zambia								
Kenya								
Sudan								
Ghana								
Liberia								
Lesotho								
Libya								
Grand total*	175	86	79	34	26	16	13	12

* Because of rounding, the totals may not exactly match the sum of the amounts shown in the column.

	Energy from waste	Combustion	CCS	Energy storage hydr., fuel cells	Nuclear energy	Efficient elect. gen., trans., distr.	Other Y02	Y02-tags Total	PATSTAT Total
									7
									7
									7
									6
									4
									4
									3
									3
									1
									1
	21	24	31	249	138	5	2	657	22 220

	Resilience	Efficient lighting remote	Severe weather	Z-tags Total	PATSTAT Total
	11	2	3	198	131 507
		2		48	6 280
		2		44	8 280
	1			44	8 149
				43	5 077
				9	1 391
				2	2 089
				1	22
				1	429
					788
					557
					31
					6
					2
					1
					1
	12	6	3	390	164 610

Annex 9

Number of priorities invented in African countries 1980 – 2009 (selected adaptation technologies – Z-tags)

Inventor country	Desalination	Energy supply remote	Solar water treatment	Rainwater collection	Solar/wind water pump	Resilience	Z-tags Total	PATSTAT Total
South Africa	13	10	4	2	1	1	30	18 166
Morocco	4		1	2	2		8	906
Egypt	6	1	1				7	970
Tunisia	1	1	1				3	258
Senegal		1	1				2	63
Algeria	2						2	160
Côte d'Ivoire		1					1	59
Libya					1		1	17
Mali		1					1	41
Cape Verde	1						1	4
Sudan	0.7						0.7	61
Cameroon			0.3				0.3	111
Niger	0.3						0.3	33
Kenya								211
Nigeria								146
Zimbabwe								139
Mauritius								90
Sierra Leone								80
Sao Tome/Pr.								66
Ghana								65
Ethiopia								51
Seychelles								49
Madagascar								38
Gabon								38
Namibia								35
Swaziland								29
Congo								28
Uganda								28
Tanzania								25
Mauritania								23
Burkina Faso								21
Burundi								21
Saint Helena								19
Guinea								18
Zambia								18
Benin								16
Togo								14
Liberia								10
Botswana								9
Angola								9
Reunion								8
Gambia								8
Eritrea								8
Chad								8
Malawi								7
DR Congo								7

Number of priorities invented in African countries 1980 – 2009 (selected adaptation technologies – Z-tags)

Inventor country	Desalination	Energy supply remote	Solar water treatment	Rainwater collection	Solar/wind water pump	Resilience	Z-tags Total	PATSTAT Total
Somalia								7
Central African R.								6
Lesotho								4
Rwanda								3
Equatorial Guinea								3
Djibouti								3
Mozambique								1
Comoros								1
Grand total	26	15	8	4	4	1	56	22 220

Annex 10

African inventions patented worldwide 1980 – 2009 (selected mitigation technologies – Y02-tags)

Application authority	Wind	Solar PV	Solar thermal	Geothermal	Marine & tidal	Hydro conv.	Renewable energy (overall)	Biofuels
United States	8	13	14	2	3	2	35	12
WIPO	8	7	12		9	6	35	9
EPO	9	10	9	1	1	1	25	6
Germany	2	4	1				7	1
Canada	2	5	2		1	1	8	5
China	3	3	5	1		1	8	2
South Africa	4	1	7		5	5	18	3
Austria	2	4	1				6	1
Korea		3	0			1	4	2
United Kingdom	2	1			2	1	6	2
Japan	1	1					2	1
OAPI	1	1	7	1		1	10	3
Australia	2	1	4				6	0
Spain	1	1					2	2
Mexico	1	3	3	1			5	1
Egypt	1	0	1		3	2	7	1
Denmark	2	1					3	1
Norway		1	1				1	0
Morocco		2	3				3	
Russia								1
France								
Chinese Taipei								
EAPO		2					2	1
ARIPO		2	1				2	
Netherlands								
Hong Kong, China		1	1				1	
Portugal		1					1	1
Algeria		2	2				2	
Belgium	2		1	1			2	
Brazil			1				1	
Indonesia		1					1	
Poland								
Israel								
Zimbabwe								
ROW	2		1		1		2	2
Grand total*	52	71	78	7	24	19	204	53

* Because of rounding, the totals may not exactly match the sum of the amounts shown in the column.

	Energy from waste	Combustion	CCS	Energy storage hydr., fuel cells	Nuclear energy	Efficient elect. gen., trans., distr.	Other Y02	Y02-tags Total	PATSTAT Total
	6	5	7	93	24	1		178	5 797
	5	6	3	18	32		1	102	2 714
	2	4	4	33	20	1		95	4 212
		0	3	59	11	2		83	2 138
	2	3	2	32	17			67	2 064
		2	0	12	17			41	1 298
	3	1	1	12				34	2 092
			2	12	11			32	1 268
		2	1	8	5			22	742
	2	2	4	6				18	940
		1	2	10				17	785
	3			2				15	275
		1	1	7				15	1 011
			2	7				13	692
		2		4				12	404
				1				9	302
			1	1				6	258
		2	3					6	280
				2		1	1	5	634
		1		4				5	338
				4				4	298
			1	2	1			4	198
		1	1					4	89
				1				3	309
			2	1				3	73
				2				3	72
			1					3	216
								2	61
								2	37
		1						2	370
			1					2	55
									171
									148
									40
		1	2	2				9	1 492
	23	31	45	336	138	5	2	811	31 876

Annex 11

African inventions patented worldwide 1980 – 2009 (selected adaptation technologies – Z-tags)

Application authority	Desalination	Solar water treatment	Energy supply remote	Solar/wind water pump	Solar water potabilisation	HVDC
South Africa	11	3	9	1		
United States	7	3	2	2		
WIPO	6		5	2		
EPO	7	1	1			
Australia	6	1	1	2		
United Kingdom	6			1		
Canada	5	1	1			
Germany	5	1	1			
OAPI	2	1	3			
Morocco	3	1				
Egypt	4	0.3	1			
Norway	5					
China	3	1				
Spain	3	0.3				
Brazil	3					
Czech Republic	3					
Israel	3					
Hungary	3					
EAPO	3					
Austria	3					
Japan	2					
Korea	2	1				
Portugal	2					
Hong Kong, China	1					
Chinese Taipei	2					
Slovakia	2					
New Zealand	2					
Iceland	2					
Bulgaria	2					
ARIPO	2					
Mexico	2	0.3				
Russia						
France						
Denmark						
ROW	13					
Grand total*	115	12	24	8		

* Because of rounding, the totals may not exactly match the sum of the amounts shown in the column.

	Rainwater collection	Solar cooking	Resilience	Efficient lighting remote	Severe weather	Z-tags Total	PATSTAT Total
	2		1			26	2 092
	1					15	5 797
			1			13	2 714
	1					10	4 212
						9	1 011
						7	940
						7	2 064
						6	2 138
						6	275
	2					6	634
						5	302
	1					5	280
						4	1 298
						3	692
						3	370
						3	125
						3	148
						3	104
						3	89
						3	1 268
						2	785
						2	742
						2	216
	1					2	72
						2	198
						2	57
						2	110
						2	14
						2	33
						2	309
						2	404
							338
							298
							258
						13	1 486
	8		2			166	318 756

Annex 12

Brief summary of "Other use" allowable under Art. 31 of TRIPS

Compulsory licenses

Compulsory (or non-voluntary) licenses are issued by an administrative or judicial body and allow third parties to exploit a patented invention without the consent of the patent owner. Article 31 of the TRIPS Agreement allows such licences, in recognition of the fact that in certain circumstances, if the patent owner is unwilling to grant voluntary licences in critical technologies on reasonable terms, the relevant body of a Country can intervene and grant them in the public interest. In order to put such a mechanism into practice, some specific conditions have to be met. As well as a refusal by the patent owner to license reasonably, these are; public interest (which is defined differently depending on the country and the situation); national emergency and situations of extreme urgency; combating anti-competitive practices in a particular sector or industry; and the failure of the patent owner to exploit or work the patent in the country concerned. The scope and duration of such use must be limited to the purpose for which it is authorized, it is non-exclusive and non-assignable, it shall predominantly be for the supply of the domestic market, and the right holder shall be paid adequate remuneration in the circumstances of each case, taking into account the economic value of the authorization.

Government use

Where licenses are typically issued to competitor companies on commercial terms, the right of the state to exploit patented technology, either itself or through its agencies or agents, is also an alternative possibility in case of blockage. These licenses are commonly known as government use or ex officio licenses. The TRIPS Agreement recognizes them as a way to permit public, non-commercial use of the patented technology.

Limitation to the patent right

It is also sometimes possible to depart from the exclusive rights conferred to the patent owner under very specific and restrictive conditions (Article 30 TRIPS agreement) "provided that such exceptions do not unreasonably conflict with a normal exploitation of the patent and do not unreasonably prejudice the legitimate interests of the patent owner, taking account of the legitimate interests of third parties."

Research exemption

The research exception is critical for technology transfer and diffusion, as it allows third parties to experiment and undertake further research on a particular invention, and thus advance learning. It can therefore permit work but no commercialization, including by commercial entities, to invent around or improve on a protected invention.

Exhaustion of IP rights

(Article 6 of the TRIPS Agreement) refers to the point at which the holder loses legal control over the protected product by releasing it into the channels of commerce. With patents, the rules on exhaustion determine whether the patent holder and/or his licensees can prevent third parties from importing an invention or product from abroad where he or his licensee may have sold the product (termed " parallel importation"). Under Article 6 of the TRIPS Agreement, each WTO member is free to determine whether or not to permit parallel importation.

Regulation of anti-competitive behavior

The TRIPS Agreement recognizes that there is a need to permit special conditions in exceptions where practices are determined to be anti-competitive.

Exploitation of a second patent

Under the TRIPS Agreement, "other use" may be authorized to permit the exploitation of a patent ("the second patent") which cannot be exploited without infringing another patent ("the first patent")

ACRONYMS

Acronyms	
AfDB	African Development Bank
ARGeo	African Rift Geothermal Development Programme
ARIPO	African Regional Intellectual Property Organization
AU	African Union
BRIC	Brazil, Russia, India and China
CCD	Common Citation Document
CETs	clean energy technologies
COMESA	Common Market for Eastern and Southern Africa
COP	Conference of the Parties
CPC	Cooperative Patent Classification
CSP	concentrated solar power
EPO	European Patent Office
GEAI	Geothermal East Africa Initiative
GW	gigawatts
Gwh	gigawatt-hour
HVDC	high-voltage direct current
ICT	information and communications technology
ICTSD	International Centre for Trade and Sustainable Development
IEA	International Energy Agency
IP	intellectual property
IRENA	International Renewable Energy Agency
KenGen	Kenya Electricity Generating Company Limited
KW	kilowatts
KWh	kilowatt-hour
LDCs	least developed countries
MDGS	Millennium Development Goals (of the UN)
MW	megawatts
OAPI	African Intellectual Property Organization
OECD	Organisation for Economic Co-operation and Development
PATSTAT	EPO Worldwide Patent Statistical Database
PCT	Patent Cooperation Treaty
PV	photovoltaic
R&D	research and development
ROW	rest of world
RTA	relative technological advantage
SAPP	Southern Africa Power Pool
S&T	science and technology
STI	science, technology and innovation
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UN	United Nations
UNDESA	UN Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WTO	World Trade Organization

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