PATENT- OG
VAREMÆRKESTYRELSEN

Patents in the green transition

– trends in the global development of future technologies

Preface

In Denmark, we must create the framework for the business community to develop and utilise the latest climate solutions, so that the green transition can be a lever for creating future growth and jobs.

On 13 November 2019, the government presented a vision of creating a sustainable industry in Denmark that will show the outside world that the green transition can be both competitive and solidarity-based, while at the same time create growth and jobs. Against this background, the government has also entered into a green and strategic partnership with India, which aims to place Denmark in a good position in relation to delivering the green technological solutions that India demands. The Danish Patent and Trademark Office participates in the green and strategic partnership, which focuses on innovation and commercialisation of green technology.

In order to shed light on the development and patenting of green technology, the Danish Patent and Trademark Office presented a report for the first time in 2019 on Denmark's green technology development compared to selected countries. The report showed that Denmark had a clear position of strength in an international context, but also that the area was dominated by a few large companies operating within a narrow technological field.

Danish companies play a crucial role in the fight against climate change, as their technological solutions must contribute to achieve the government's objective of CO_2 reduction of 70 per cent by 2030.

But since 2019, the world has been characterized by a number of societal challenges in connection with the Covid-19 crisis. Despite this, the green transition has always been a high priority on the political agenda, and green technology is still a technology field that is developing rapidly and is characterized by many talented Danish companies.

Against this background, the Danish Patent and Trademark Office has prepared a report that, based on patent data, sheds light on the development of green technology. The report sheds light on Danish companies' patenting in green technology from 2011-2020 and compares this with general global trends and developments in a number of selected countries. In addition, the Danish, European and global development trends are compared in order to shed light on the Danish development in an international perspective.

The report thus provides an insight into Denmark's performance and development in the field of patenting green technologies over the past 10 years.

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Director, Danish Patent and Trademark Office

Introduction

Denmark must take the lead in the fight against climate change. Therefore, the government has a goal that Denmark must reduce greenhouse gas emissions by 70 per cent by 2030 and achieve CO_2 neutrality by 2050 at the latest.

The United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement, adopted at COP21 in 2015, set the framework for global climate action. But the green transition remains a global challenge. The UN's 2021 climate report made a big impact when it highlighted how the past five years have been the warmest since 1850, and that the concentration of CO_2 in the atmosphere has never been as high as it is today.

This exposes the need to accelerate innovation, which places great demands on Danish companies' development and adaptability if they are to stand strong in international competition. Today, Denmark has a strong position in the green area, and the export of green energy solutions has been steadily increasing since 2010 and up to 2019[1].

The latest update from the Global Innovation Index, which ranks countries based on their innovation, also shows that Denmark ranks ninth place among the 132 economies included in the report.

However, Denmark has unfortunately moved down three places on the ladder compared to last year.

It is therefore important that Danish companies continue to optimise the utilisation of their knowledge and innovation so that they can maintain - and if possible improve - their positioning and help make Denmark a pioneering country in the fight against climate change.

Here, patents can help support Danish companies' development of innovative green technologies and thus create good conditions for the development of the sustainable future.

However, it is crucial that companies actively use patenting to protect and commercialize their technology, so that they do not risk their products and new innovative solutions being copied by others.

This report presents the patterns of patent applications at Danish and foreign companies. The report thus contributes to shedding light on the extent to which Danish companies are able to develop and commercialise new technological solutions in the green area compared to their foreign competitors.

What is a patent?

- A patent is an exclusive right to a product or process that provides a new technical solution to a problem. In order to obtain a patent, the technical information about the invention must be published in a patent application.
- Patents can be valid for a period of up to 20 years from the date of filing of the patent application.
- Patents are geography limited rights. In general, the exclusive rights apply only in the country or region where the patent has been filed and is awarded in accordance with the laws of the country or region concerned.
- Patents have played a crucial role in technological development from the invention of electric light to microprocessors. Patents create incentives for technological development, protection of R&D investments, as well as opportunities for commercialisation and trade. This gives the inventor recognition for his creativity and financial incentives to invest in R&D. The mandatory publication of patents and patent applications disseminates new knowledge and accelerates innovation. In other words, the publication of the technical knowledge in the patent gives competitors the opportunity to be inspired by – and possibly further develop on – the original invention.

[1] *https://ens.dk/service/fremskrivninger-analyser-modeller/global-afrapportering-2021*

Overview of patent classes defined as green technology

Patent applications are placed in patent classes depending on the technology area. Below are the classes that are defined as green technology.

1. Y02A: Technologies permitting improvements to adverse effects of climate change in human industrial activities (storm surge protection, air purification technology, etc.).
2. Y02B: CO_2 reducing technologies in the construction industry.
3. Y02C: Technologies capable of extracting and storing CO_2
4. Y02D: Information and communication technologies that promote and streamline digital control systems (computer control systems for e.g. factories that can make robots and machines in production more efficient).
5. Y02E: Technologies that reduce greenhouse gases related to energy production (e.g. wind and water energy).
6. Y02P: Energy-reducing technologies related to agricultural and industrial prodcuts.
7. Y02T: Technologies related to the transport sector.

Green technology is experiencing a decline in the number of patent applications

The total number of patent applications from U.S. companies is larger than the other countries in the report. The number of patent applications from Denmark is on a par with Sweden and is the lowest measured in terms of the total number of applications to the European Patent Office (EPO). However, this is a natural reflection of the difference in size of the population figures.

If you take a closer look at the development in the application numbers, chinese companies have created the largest increase and more than quintupled their application numbers to the EPO in the period 2011-2020.

In the same period, Danish companies have experienced the second largest increase and have almost doubled the number of patent applications, while Germany is the only country lower in 2020 than in 2011, with a decrease of almost 10 per cent for the period.

Although Sweden has experienced an overall increase of 73 per cent during the period, they have had a slight decrease since 2019, like both the US and Germany. It should also be noted that the number of patent applications from both the United States and Germany is lower in 2020 than it was in 2013.

Fig. 1. Total number of patent applications in green technology

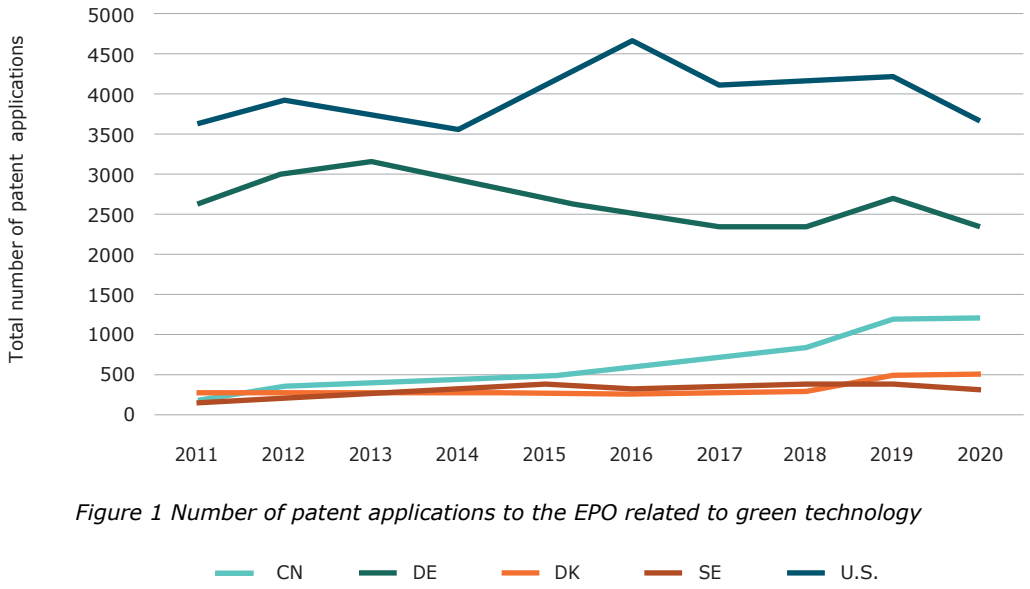


Figure 1 Number of patent applications to the EPO related to green technology

Denmark has a clear position of strength in the green area

Patenting technology plays a crucial role for Denmark and Danish companies when goods and services are to be exported abroad. This is especially true in technologies related to the green transition, where Danish companies have a clear position of strength measured by their patent activity.

Denmark is thus the country in the world with the highest patent intensity in green technologies measured as the green patents' share of the total number of EPO applications from Danish companies.

Since 2011, the proportion of Danish applications in green technology has been significantly higher compared to the other countries in the report and has maintained a stable level of around 17 per cent of all Danish applications to the EPO (see Figure 2).

However, there is strong growth from 2018 to 2020, where the share of patents related to green technology accounts for 27 per cent of all patent applications to the EPO. In the same period, none of the other countries in the report have experienced actual growth in the share of green patents.

Fig. 2. Green patent applications' share of all patent applications to the EPO

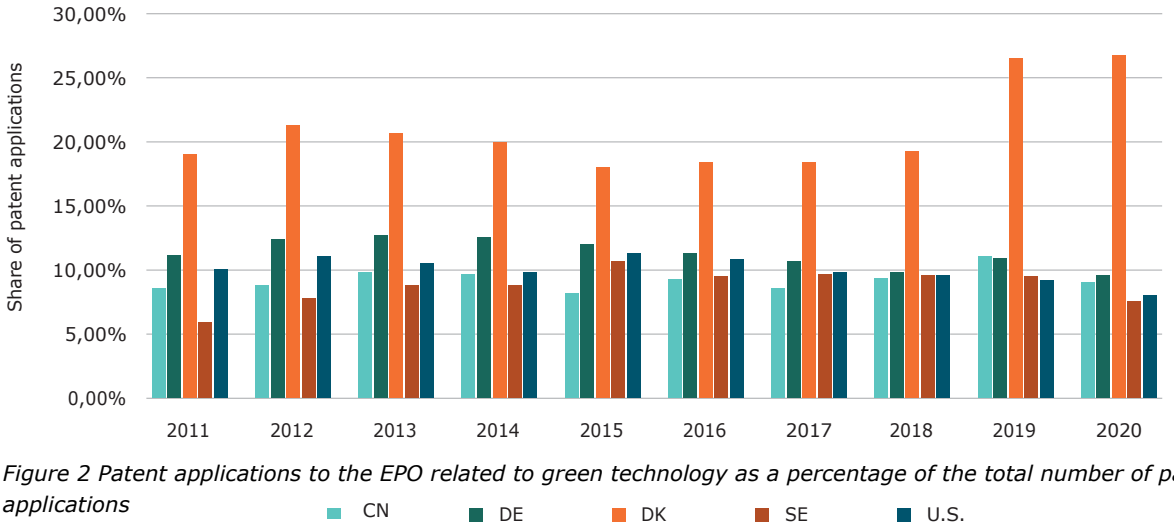


Figure 2 Patent applications to the EPO related to green technology as a percentage of the total number of patent applications

Looking at the relative strength between the countries (measured by patent applications per million inhabitants), Denmark also differs from the other countries in the report. Although China's application numbers in green technology are growing rapidly, the country still has the fewest patent applications per million inhabitants.

This places China far behind the other countries in the report. Sweden and Germany are in the middle of the field, while the United States are lagging somewhat behind. This indicates that Denmark has a clear position of strength when looking at how patent-active Danish companies are in the green technology area.

Fig. 3. Green patent applications per million inhabitants

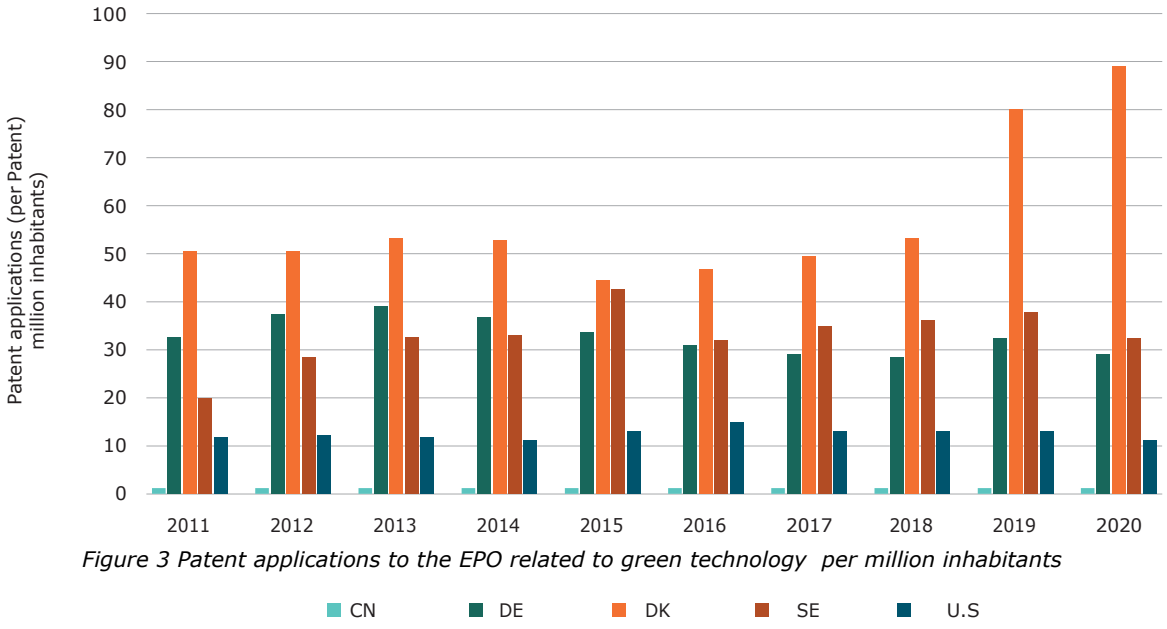


Figure 3 Patent applications to the EPO related to green technology per million inhabitants

The above indicates that Denmark has a clear position of strength when looking at how patent-active Danish companies are in the green technology area. There may be several explanations for why Danish companies have this position. It may play a role that Denmark's modest size means that Danish companies must to a large extent orient themselves towards the European and global market when they sell their green technology solutions.

Here, patents play a crucial role in the success of Danish companies, and this underlines the importance of companies taking a stand on how they can use patents to create growth and access to international markets.

A closer look at the Danish position of strength

To shed further light on the Danish position of strength, it is relevant to delve into the underlying green technology areas.

Danish companies have a clear position of strength in wind energy (class Y02E), which comprises 60 per cent of all applications from Danish companies. This is followed by energy reducing technology manufacturing (class Y02P) as the second largest with 19 per cent.

From a Danish perspective, it is positive that we have a solid wind energy industry that exports sustainable wind energy solutions to the whole world, and which at the same time contributes to Danish growth.

Furthermore, it seems that Danish companies are focusing on green production solutions when it comes to the development of more sustainable ways of Y02P (technology development for agriculture and industry, among other things) is the second largest green patent class in Denmark.

Fig. 4. Size distribution of green technology classes

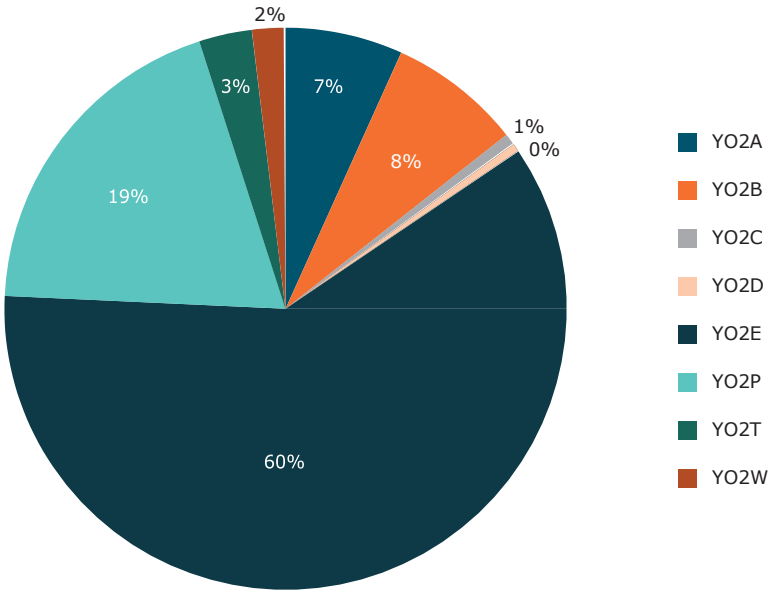


Figure 4 Distribution of patent applications from Danish applicants to the EPO related to green technology by technology classes

Patent applications by green industry

If we look at the other countries in the report, the application trends are somewhat different. In Sweden, Germany and the United States, technologies that include sustainable transport and the production of e.g. electric motors (Y02T) play a major role. Increasing political pressure and increased demand for sustainable transport have had a direct knock-on effect on car manufacturers' incentives to develop more environmentally friendly vehicles and engines. This is reflected in Sweden, Germany and the United States, which are known for their truck and car production. At the same time,

Sweden, together with China, is further ahead in information and communication technology (Y02D) when measuring the number of patent applications in this area. Sweden's ICT (Information and Communications Technology) market is one of Europe's most advanced, which is also reflected in the application figures. Overall, however, China is significantly further ahead than Europe and is putting a lot of pressure on the European ICT developments, e.g. with the development of artificial intelligence and the 5G network[2].

[2] *https://borsen.dk/nyheder/generelt/kina-storsejrer-over-europa-paa-ny-teknologi-grundlaget-for-hvem-der-vinder-oekonomisk-og-politisk-kaploeb*

Figure 5 shows that Denmark is in the lead when it comes to energy technology and sustainable industrial production. However, there is also a risk that Danish companies' focus on a few key industries could put Denmark in a position to a vulnerable position.

Sweden, Germany and the United States thus have a broader application pattern, which may indicate that their sustainable economy is more broadly based than the Danish one.

Fig. 5. Distribution of technology classes

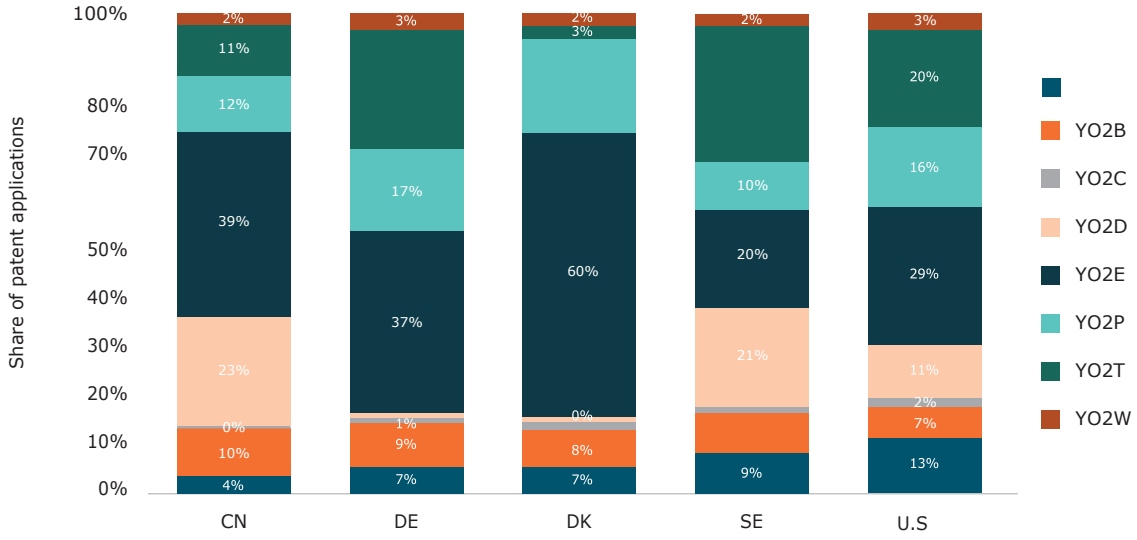


Figure 5 The percentage distribution of patent classes related to green technology

Large companies account for the majority of patent applications

The report shows that Denmark is doing well compared to the other countries. Denmark is a leader in green technological development and can be considered a pioneering country that sets the standard for green growth in the business sector measured by patent activity. However, if the high level of competitiveness is to be maintained, it is important that there is a strong ecosystem of new companies that develop new innovative solutions and contribute to keeping the Danish business community at the forefront of sustainable development. It is therefore relevant to investigate which Danish companies are driving the innovative development and patenting.

Wind energy is not surprisingly a clear Danish position of strength in the green industry and plays a crucial role in the total number of applications.

Vestas is thus by far the company with the most patent applications in green technology, followed by Siemens Gamesa and LM Wind Power. Together, these three companies account for more than half (51 per cent) of all patent applications in the green area. On the whole, the large companies dominate when it comes to the total number of patent applications in green technology.

The 10 most patent-active companies thus account for 72 per cent of all patent applications related to green technology. This testifies to a concentrated industry that is mainly run by a few large companies.

Fig. 6. Top 10 companies with the most green patent applications to the EPO

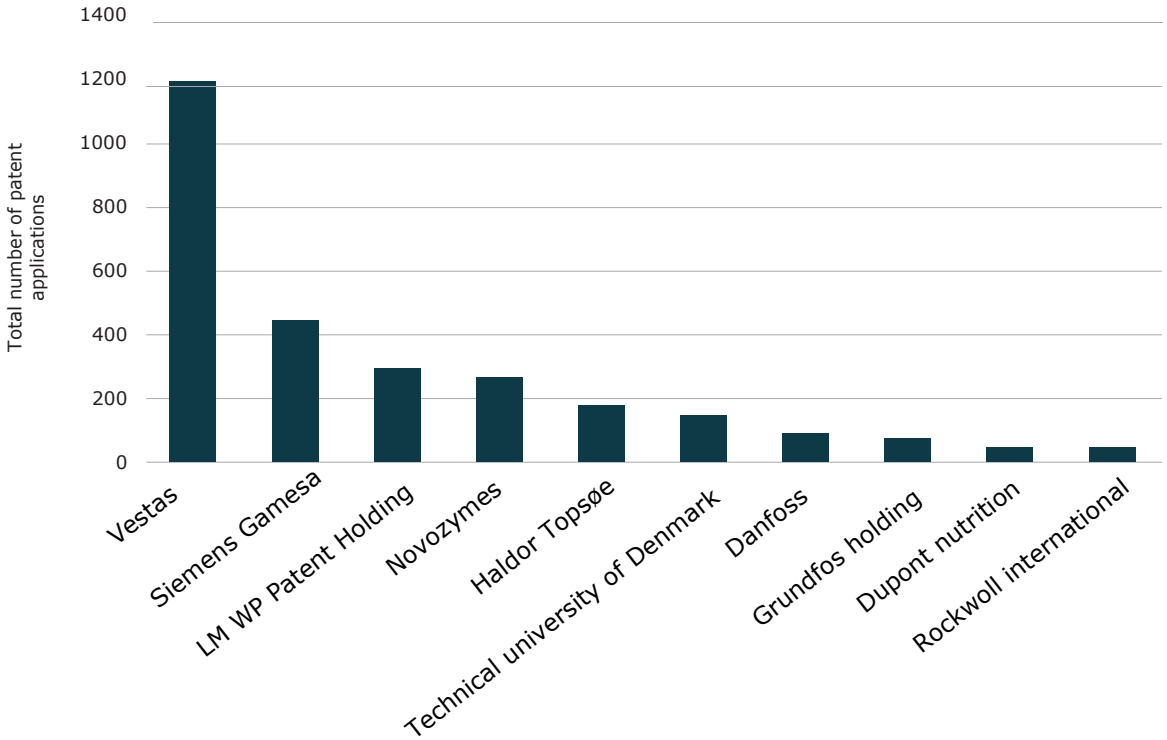


Figure 6 Number of patent applications to the EPO within the green area - by Danish companies

The role of SMEs in green technology patenting

Although large companies account for a significant share of all patent applications, the figures below indicate that there is also a burgeoning ecosystem of small, patent-active Danish companies with a focus on the green transition. The enterprises are divided by number of employees.

Micro-enterprises make up more than half of the companies with patent applications (51 per cent), while small enterprises accounts for 21 per cent and medium-sized enterprises 12 per cent. This indicates that there is an innovative ecosystem of small businesses contributing to the green transition.

SMEs			
Number of employees	Mirco enterprises 0-9	Small enterprises 10-49	Medium-sized enterprises 50-249

However, the picture is different when it comes to which companies apply for the most patents. Here, the large companies dominate, which account for the vast majority of all patent applications (79 per cent), cf. Figure 8. This is despite the fact that large companies make up less than a fifth (17 per cent) of all companies.

Overall, SMEs alone account for 21 per cent of all patent applications, even though they make up the vast majority of all companies that have applied for at least one patent (83 per cent).

Fig. 7. Breakdown by company size

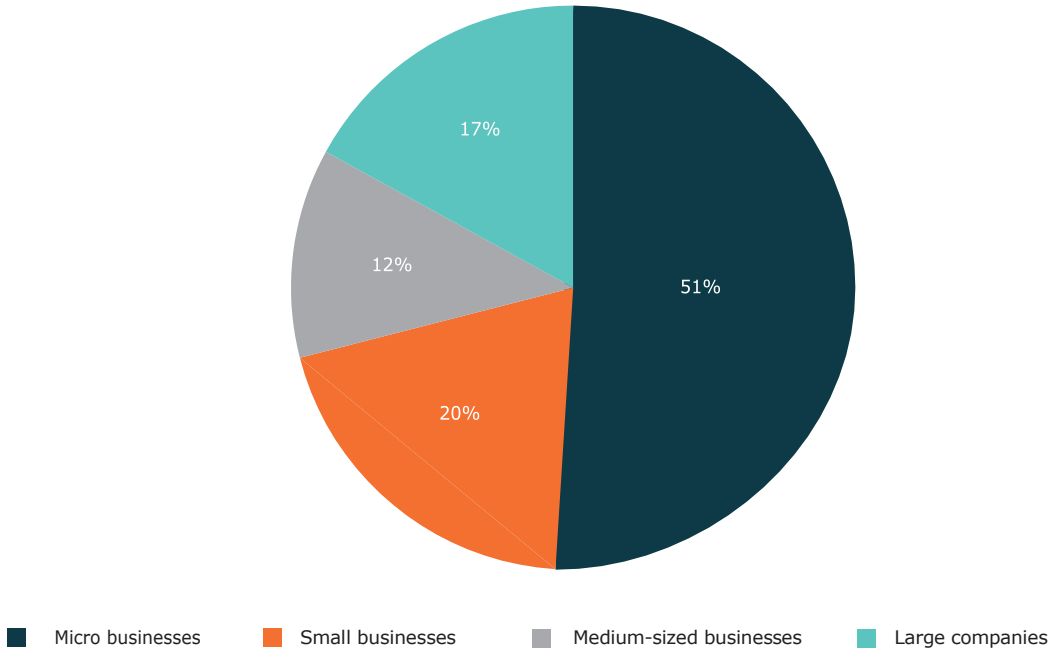


Figure 7 Danish companies with green patent applications by size (accumulated patent applications from 2011-2020)

Fig. 8. Share of patents by company size

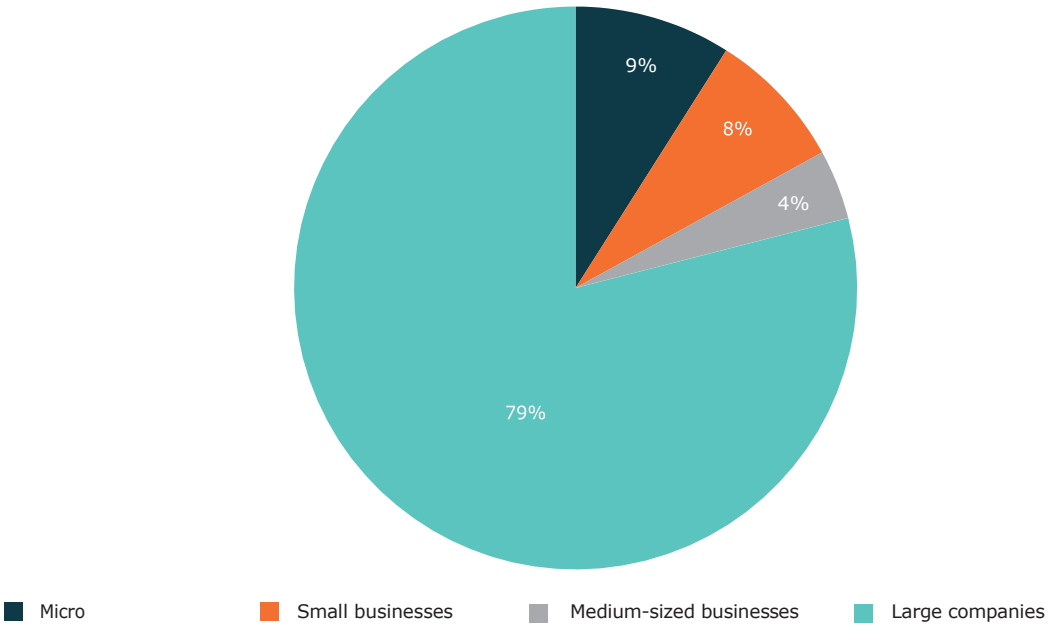


Figure 7 Danish companies with green patent applications by size (accumulated patent applications from 2011-2020)

The data above shows that there is a large group of SMEs that contribute to the development of new green inventions and products that can be crucial in the fight against global climate crisis.

However, it is also clear that large companies are behind the vast majority of patent applications and still dominate the development of green technological development.

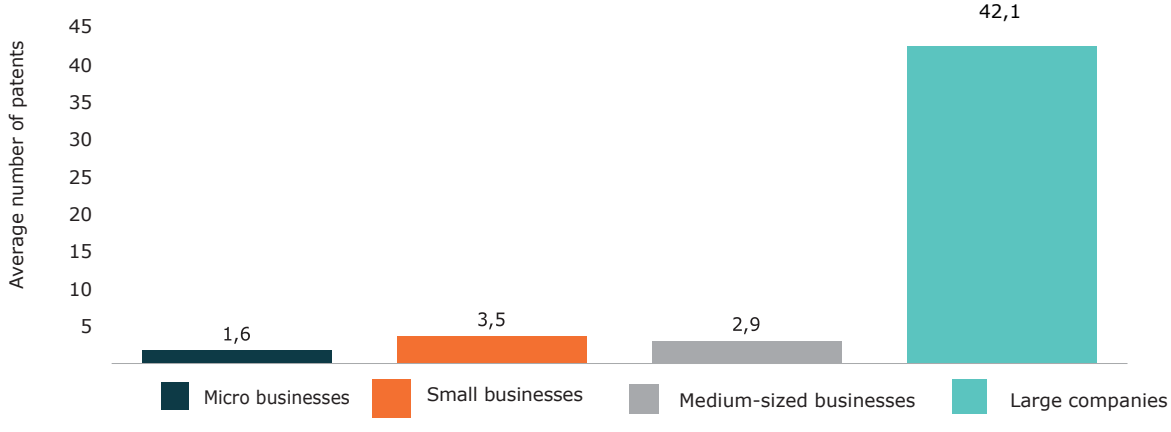
Average number of patent applications based on company size

If we look at the number of patent applications by company size, large companies have, not unexpectedly, more applications on average than SMEs. Thus, large companies have an average of 42 patent applications per company (Figure 9). In comparison, SMEs have an average of 2 applications per company.

However, if you segment the SMEs, the picture becomes more nuanced. Among SMEs, it is thus the small businesses that have most applications, followed by medium-sized and micro-enterprises.

Based on existing data, it is difficult to draw any conclusions about the cause, but it indicates that there may be untapped potential in medium-sized companies when it comes to green technology development.

Fig. 9. Average number of patents



Conclusion

Denmark has a clear position of strength when it comes to technology in the green transition, and the report shows that the development is going in the right direction: Since 2011, Denmark is thus the country – apart from China – that has experienced the greatest growth in patent applications related to green technology.

The report shows that Danish companies that patent in green technology have a high level of patenting activity compared to companies in other countries. The number of applications for the EPO by Danish companies has thus increased significantly in recent years.

In recent years, Sweden, Germany and the United States have experienced a decline in the number of patents related to the green transition.

According to the report, Danish SMEs do not take out very many patents in the green area, even though they make up the vast majority of the companies that deal with green technology. Although the report indicates that there is an innovative ecosystem of small businesses that contribute to the green transition, it also indicates that there is an untapped potential for SMEs' use of patenting in connection with the development of new green technology, so that they can be stronger in the future.

Although the report indicates that there is an innovative ecosystem of small companies that contribute to the green transition, large companies dominate the green technological development in Denmark.

In particular, the three largest players, which are all in the wind energy area, account for 51 per cent of all patent applications, while the 10 most patent-active companies account for 72 per cent of all patent applications related to green technology. This testifies to a concentrated industry that is mainly run by a few large companies.

The relatively narrow green technology development in Denmark may thus risk having an impact on how adaptable Danish industry is in an area that is constantly developing and is characterized by new green players and solutions from, for example, Chinese companies, which have significantly increased their focus on the European market over the past 10 years. The increasing competition can potentially lead to changes in market structures and put Danish companies under pressure.

Method

The report analyses Danish companies' patenting in green technology measured by patent application activity to the EPO.

To ensure a uniform approach in the extraction of data on green patent applications, a common grouping of classes that are internationally recognised has been used. The search has been carried out using the EPO's patent classification CPC, including the preparation of a climate-targeted common class, called Y02, which covers all climate-oriented technological initiatives. The report is based on published patent data from the database PATSTAT online. The datasets used have been generated by searches where the common class Y02 (and all subclasses for it) have been found. In this connection, the report has also drawn on the Danish Patent and Trademark Office's professional knowledge in the field of patents. PATSTAT online is updated twice a year, and all data used in this report is taken from the database version of spring 2021, thus there is complete data up to and including 2020.

In order to create a better data basis, the EPO is continuously working to improve the green classification Y02. This means that the patent applications have been classified within the common class Y02, which has meant that there has been a greater jump in the number of patent applications in green technology in 2019.

The report is based on data consisting of all the patent applications filed with the EPO and published in the period 2011-2020. Overall, each application represents one invention, although there may be special cases that deviate from this general trend. As part of the report, the patent applications have been divided by place of origin based on data on the applicant's geographical location and form the basis for a comparison of technology developments in different countries in the world.