



**Climate change mitigation  
technologies in Europe - evidence  
from patent and economic data**  
Executive Summary

The full report can be downloaded from:  
[www.epo.org/climate-europe](http://www.epo.org/climate-europe)

This study has been conducted in co-operation with the Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science (<http://www.lse.ac.uk/GranthamInstitute>)



Grantham Research Institute on  
Climate Change and  
the Environment



THE LONDON SCHOOL  
OF ECONOMICS AND  
POLITICAL SCIENCE

### Finding sustainable technologies in patents: the Y02/Y04S tagging scheme

In response to the demand from external organisations, the EPO has developed a dedicated classification scheme for climate change mitigation technologies (CCMTs), termed the Y02/Y04S tagging scheme. This scheme is part of the Cooperative Patent Classification (CPC) and available for public use within the EPO's Espacenet and PATSTAT services. It presents an overview of key CCMT areas, increasing the transparency of patenting activity and accessibility of these technologies, while also allowing trends and statistics to be derived.

The Y02/Y04S scheme covers:

- Y02B – CCMTs related to buildings
- Y02C – Capture, storage, sequestration or disposal of greenhouse gases
- Y02E – Reduction of greenhouse gas emissions, related to energy generation, transmission or distribution
- Y02P – CCMTs relating to production in energy intensive industries<sup>1</sup>
- Y02T – CCMTs related to transportation
- Y02W – CCMTs related to wastewater treatment or waste management
- Y04S – Systems integrating technologies related to power network operation, communication or information technologies for improving electrical power generation, transmission, distribution, management or usage, i.e. smart grids

<sup>1</sup> Completion is expected at the end of 2015.

## Countdown to reduced emissions

In October 2014, the European Union committed to reduce greenhouse gas emissions by at least 40% by 2030 compared to 1990 levels. This represents a significant challenge, which can only be met through the development and deployment of new climate change mitigation technologies (CCMTs).

This joint study conducted by the United Nations Environment Programme (UNEP) and the European Patent Office (EPO) analyses the position of Europe in the global race to develop new CCMTs, using data on patent applications, trade in CCMT capital goods, foreign direct investment in CCMTs, climate change policy stringency, carbon emissions and public expenditure on CCMT

research and development activities, to investigate inventive and associated economic activity in CCMTs in Europe.

The main source of data was the Worldwide Patent Statistical Database (PATSTAT), developed by the EPO. This publicly available database is the world's largest repository of patent information, containing data on over 82 million patent applications. The EPO has developed a dedicated classification scheme for CCMTs (using the Y02 and Y04S tags) that makes it possible to analyse CCMT-related trends in inventive activity and in the global technology market, and to provide evidence to support public and private decision-making.

## Climate change mitigation technologies on the rise

The report shows that at the global level, the past few decades have seen a continuous expansion of inventive activity in climate change mitigation technologies<sup>2</sup>. The growth in CCMT inventions has been much faster than in other technologies, and CCMTs today represent nearly 6% of global invention activity, up from 1.5%

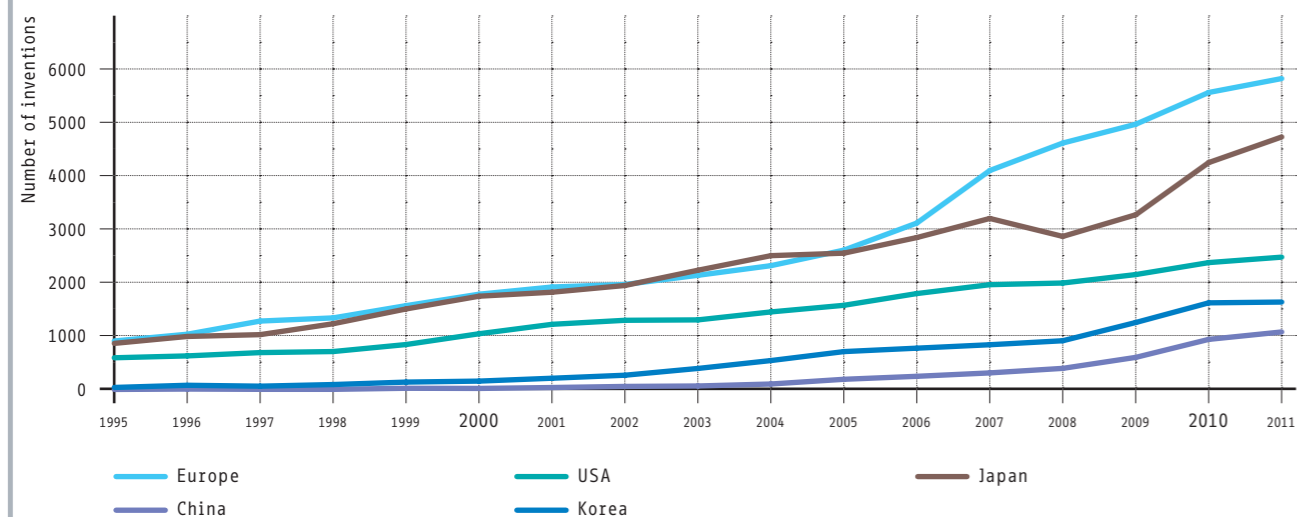
in 1990. There is good reason to believe that the implementation of climate change policies in many countries – such as taxes on polluting emissions, or feed-in tariffs for renewable energy – has played a key role in this development.

<sup>2</sup> In this report, the number of patent families (patent applications for the same invention filed at multiple patent offices) is used as an indicator of the number of inventions.



Wind power, Bouches du Rhone, France

1 "High-value" CCMT inventions<sup>3</sup> in the major innovation centres 1995-2011



## Europe: a world leader in CCMT inventions

Europe appears as a major centre for CCMT invention activity. The data indicates that Europe is now a global leader in CCMT inventions, together with Japan, the US, Korea and China. European inventors were responsible for around 18% of CCMT inventions developed in the world during the period studied, despite the increasing competition from China and Korea. Most importantly, in CCMT inventions for which patent protection is sought

in at least two jurisdictions, reflecting their higher value, the European share rose sharply, to almost 40% (Figure 1). Europe's contribution to global inventive efforts is highly significant across all CCMT areas. Comparing CCMT invention activity with general inventive performance, Europe also appears as the most CCMT-specialised region in the world.

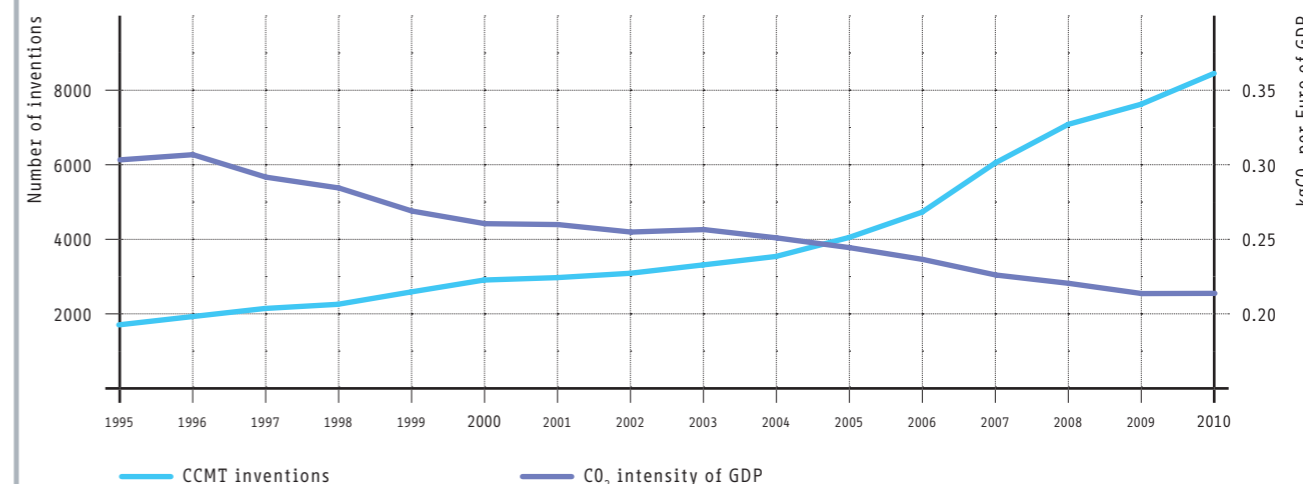
## Germany leading in European inventions

Within Europe, inventive activity in CCMTs appears highly concentrated, with five countries accounting for 80% of overall activity. It is clearly dominated by Germany, with almost half of Europe's CCMT inventions in the most recent period, followed by France, Italy, Spain and the UK. Germany's performance is partly a reflection of its economic size, but it also has the

highest number of CCMT inventions per unit of GDP. In terms of this indicator, it is followed by Sweden, France and Finland. Interestingly, the data reveals that countries such as Greece and Portugal, which show less inventive activity overall, nevertheless appear highly specialised in CCMTs.

<sup>3</sup> "High-value" inventions are defined as inventions with a patent family size of at least two, meaning that patent protection has been sought in at least two jurisdictions.

2 CCMT inventions and CO<sub>2</sub> intensity of GDP in Europe 1995-2010



## Policy supports progress

The data suggests that public policies have been successful in encouraging the development of CCMTs in Europe. Probably as a consequence of these policies and of the induced inventive response,

the carbon intensity of Europe's GDP has fallen by 30% in the last decades (Figure 2) and has remained the world's lowest since 2000.

## Europe: world's biggest market for CCMTs

Europe also appears as the world's main market for CCMTs, measured by patents filed in Europe. Although European countries, in particular Germany, France and the UK, are the main sources of European patent applications, the origin of European filings is much

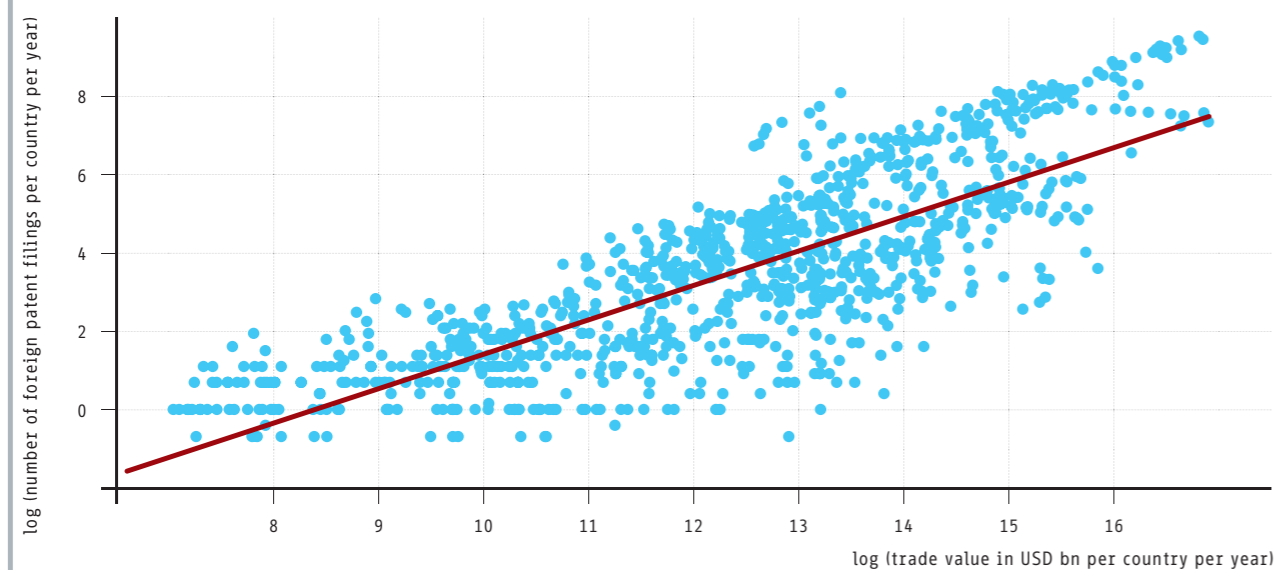
broader. Inventors from the US, Japan and Korea are among the top ten contributors to CCMT patent filings in Europe. Furthermore, Europe has been the main destination for worldwide exports of CCMT goods and CCMT-related foreign direct investment.

## European innovation - at home and abroad

Patent rights associated with European inventions are primarily protected in Europe, but protection is also increasingly sought around the world. For example, in 2010, 38% of European CCMT inventions led to patent applications in the US, 25% in China, 14% in Japan and 10% in Korea. Hence, the market for European CCMT inventions is by no means limited to Europe. With its strong inventive activity, Europe is one of the world's main exporters of CCMT products, such as wind

turbines, solar panels and batteries. Europe is also a major source of foreign direct investment in CCMT, with investment spanning all continents. However, Europe has a trade deficit in CCMTs, importing even more CCMT capital goods than it exports. A possible explanation lies in the persisting discrepancy between high tariffs on European CCMT exports (4% on average) and low tariffs on European CCMT imports (less than 1% on average).

### 3 Relationship between patent filings and imports of CCMT goods



### Patent filings go hand in hand with trade and investment

Importantly, the analysis reveals a strong statistical relationship between cross-border patent filings and trade flows (Figure 3), as well as cross-border patent filings and foreign direct investment. This provides evidence that patent protection is conducive to incoming trade and investment flows, and may thus encourage the international transfer of CCMTs through these channels. As international diffusion of CCMTs is considered a key objective under the United Nations Framework

Convention on Climate Change (UNFCCC), policies that facilitate trade, investment and patent flows should be supported. The provision of effective patent protection and the improvement of technological absorptive capacities are policies that could promote the diffusion of CCMTs and have important benefits in terms of mitigated climate change, as well as enhancing the prospects for growth and jobs.

### Europe's renewable energy potential

The study also provides an overview of the current level of deployment of renewable energy (RE) in Europe, against its potential, analysed by the main types of RE and by different geographical areas within Europe. Policy has had a marked impact on European RE developments. Solar and thermal photovoltaic energy has been strongly supported in Germany and Spain, and many regions have backed the use of wind power. Biofuels have also had pan-European support.

RE accounted for some 15% of energy in the European Union (EU-28) in 2013, and the EU can already claim three times more renewable power per capita than

anywhere else in the world. It has further ambitious goals to reduce CO<sub>2</sub> emissions, by 20% in 2020, and 80% by 2050. Over 50% of the European Union's RE is currently derived from biomass, followed by hydro (18%), wind (10%), solar (5%), heat pumps (4%) and geothermal (nearly 1%), but all of the European regions still have huge untapped potential in different RE mixes. For instance, biomass could account for two-thirds of the RE target in 2020, while wind power is projected to supply half of Denmark's electricity by 2020 – and the raw potential of this source alone could meet the EU's energy needs 20 times over.

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**Y02 and Y04S**  
The tagging scheme for patent documents related to  
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Hydroelectric Power Station, Wales, UK



Solar, wind and biomass energy sources, Germany

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