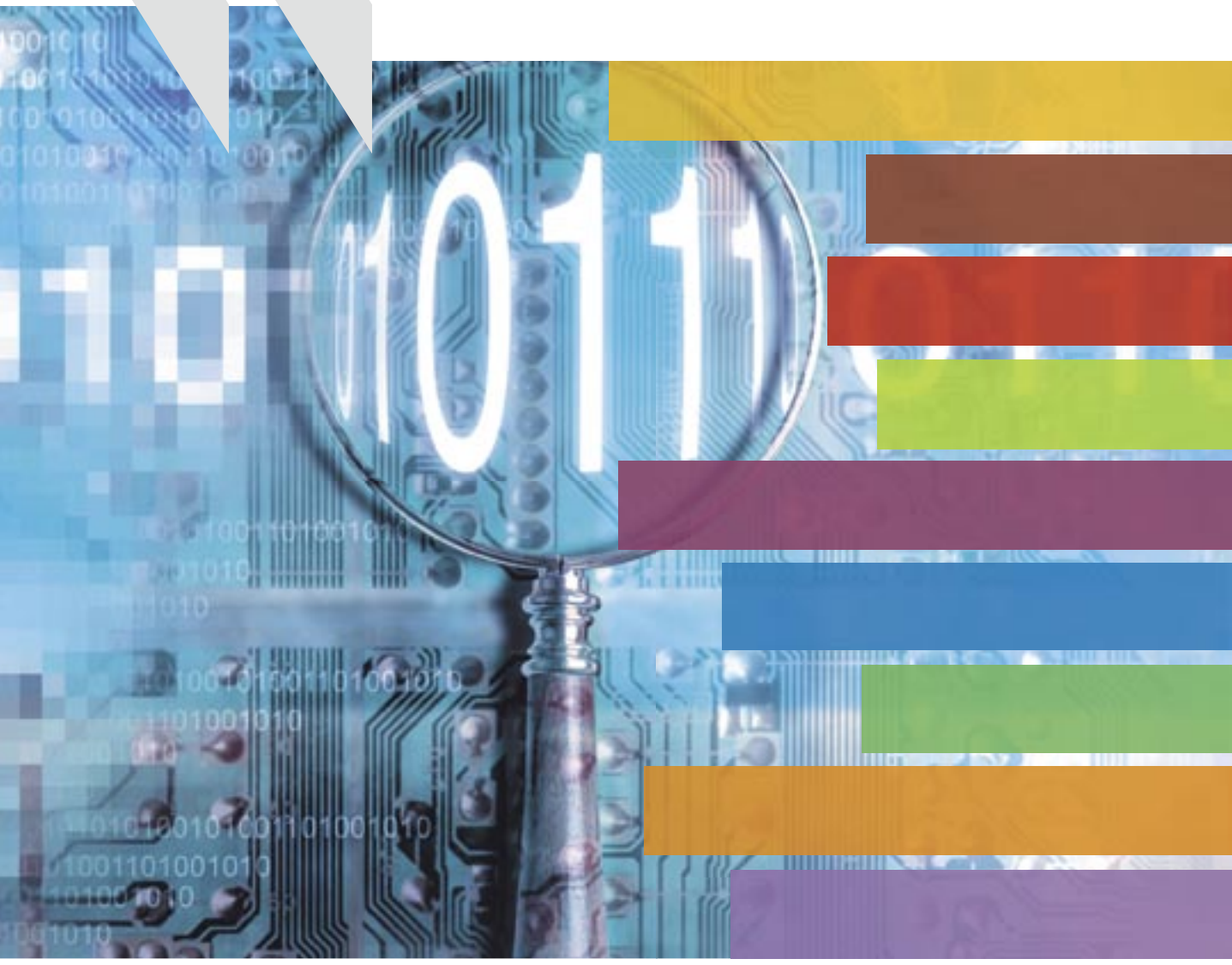
OECD Science, Technology and Industry Scoreboard 2007

INNOVATION AND PERFORMANCE IN THE GLOBAL ECONOMY



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F.9. ENVIRONMENTAL SCIENCE

■ A co-citation analysis identified three kinds of research in environmental science: "Climate change", "Air and chemical pollutants" and "Biodiversity". Research areas analysed here do not include all environmental science, but only a part of environmental science in which there has been active research in recent years.

■ There are two groups of scientific articles in the co-citation analysis. Highly cited articles aggregated by co-citation are referred to as "core articles". The articles that cite the core articles are referred to as "citing articles". As in bioscience, the United States has the largest share of core articles, followed by the EU15. Nordic countries, Brazil, Canada and New Zealand have a large share in both core and citing articles compared to the country average. Except for Brazil, the shares of Brazil, Russia, India, China are not large at present.

■ Most countries are actively engaged in collaboration with foreign researchers (over 40% of articles). The United States, Spain and Turkey are exceptions. Among Asian countries, Korea and China conduct more international co-operative research in environmental science than in other scientific fields. Approximately 60% of articles from Korea and China have co-authors from abroad.

■ Environmental science is multidisciplinary. Geosciences have the largest share of core articles, followed by engineering and environment/ecology. The distribution of core and citing articles by field differs. There is a sharp increase in the shares of chemistry and basic life sciences, especially plant and animal sciences, among citing articles.

Source

- Igami, M. and A. Saka (2007), "Capturing the evolving nature of science, the development of new scientific indicators and the mapping of science", *STI Working Paper*, 2007/1, OECD, Paris.

Environmental science captured by a co-citation analysis

A co-citation analysis found three kinds of environmental science in which there has been active research in recent years: "Climate change", "Air and chemical pollutants" and "Biodiversity". Research on climate change consists, for example, of research on the global carbon cycle, the North Atlantic Oscillation, and the paleoclimate. The impact of increasing greenhouse gases on global climate is extensively studied. Owing to increasing awareness of global warming, research on climate change is likely to be a big issue for environmental science.

Research on air and chemical pollutants appears to be another important domain. It models generation and diffusion processes of aerosols and air pollutants and studies their impact on climate. It also covers aquatic pollution by toxic chemical compounds and environmental pollution caused by persistent organic pollutants.

Biodiversity was defined in the 1992 United Nations Earth Summit in Rio de Janeiro as "the variability among living organisms from all sources, including, *inter alia,* terrestrial, marine, and other aquatic ecosystems, and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems". Scientific research on biodiversity reflects increasing awareness of its importance.

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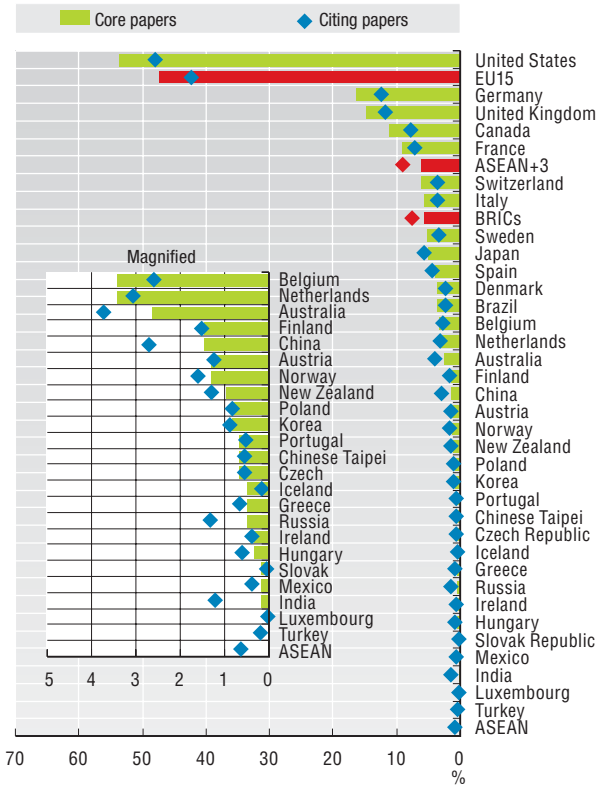
F.9. ENVIRONMENTAL SCIENCE

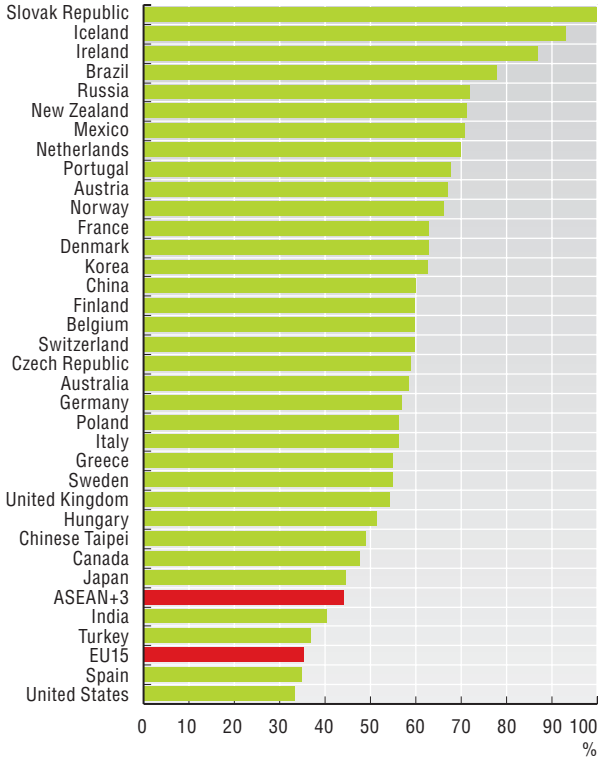
Countries' share in core and citing articles[1, 2]

1999-2004

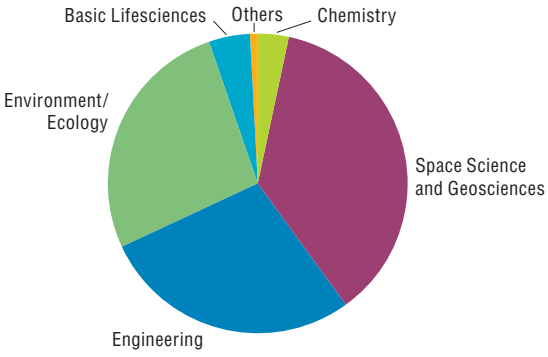


International co-authorship ratio in citing articles[3]

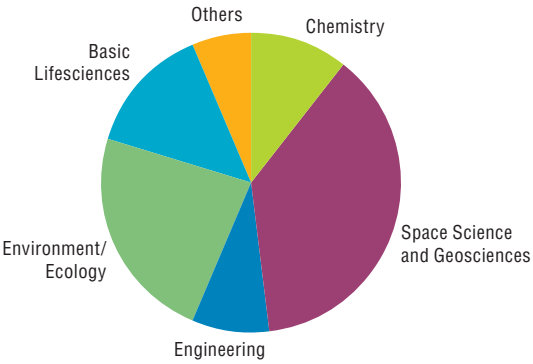
1999-2004



Distribution of fields in core articles[4]



Distribution of fields in citing articles[4]



StatLink http://dx.doi.org/10.1787/118548020778

1. Article counts are based on whole counts.
2. EU15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom. ASEAN countries: Brunei Darussalam, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam. ASEAN+ 3 countries: ASEAN countries + China, Japan and Korea.
3. Ratios of international co-authorship in EU15 and ASEAN+3 show collaboration with outside EU15 and ASEAN+3, respectively.
4. The scientific field of the articles is identified on the basis of the field of the journals in which they are published.

F.10. PATENTS IN ENVIRONMENT-RELATED TECHNOLOGIES

■ Technological change plays a crucial role in reducing pollution and in coping with environmental constraints. Compared to pollution control and waste treatment technologies, which are generally imposed by law, energy-efficient innovation is the result of both stronger regulation and the need for alternative sources of energy in the face of rising fuel prices.

■ Overall, there has been a modest increase in patenting in renewable energy and in motor vehicle abatement technologies. Technologies related to renewable energy appear as the most dynamic group. They include wind, solar, geothermal technologies, wave and tide, biomass and waste technologies. Within this group, solar, wind power and waste-to-energy have exhibited rapid growth, particularly since the mid-1990s.

■ Patenting activity in motor vehicle abatement technologies is strong, although the average annual growth rate lags that of renewable energy. The rise in innovation activity in this area is positively related to changes in the regulatory framework (*i.e.* automotive emissions control) in the main producer countries. Furthermore, foreign regulatory pressures appear to influence domestic innovation. For instance, Japanese inventors played a lead role in the development of catalytic converters, even though the regulatory "shock" initially came from the United States. Japan, the United States and Germany dominate innovation activity in this field.

■ Overall, EU (25) has the largest share for the three technology fields. Japan leads in solid waste technologies and Germany in motor vehicle abatement technologies. For renewable energy, Japan, the United States and Germany report a similar performance. Other countries reporting a share above 5% are the United Kingdom (solid waste and renewable energy), Denmark (renewable energy), and France (motor vehicle abatement).

Source

- OECD, Patent database, April 2007, available at: *www.oecd.org/sti/ipr-statistics*.

For further reading

- Johnston, N. and I. Hascic (2007a) "Environmental Regulation and International Innovation in automotive Emissions Control Technologies", OECD, Paris.
- Johnston, N. and I. Hascic (2007b). "Renewable Energy Policies and Technological Innovation: Empirical Evidence based on Patent Counts", OECD, Paris.

Identifying patents related to environmental technology

World Intellectual Property Organization (WIPO) descriptions of the IPC classification (8th edition) were used to identify IPC classes that matched environmental technologies more closely. Keyword searches were also conducted to find patents embedding technology specific to a particular field (see Johnston and Hascic, 2007a, 2007b).

Renewal technologies: Based on an extensive literature on technology developments in the area of renewable energy, a set of keywords was identified. These were used to determine IPC codes which relate directly to renewable energy in the areas of wind, solar, geothermal, wave-tide, biomass and waste (see Johnston and Hascic, 2007b).

Motor vehicle abatement: Identifying IPC classes and relying on keyword searches, a set of technologies relating to emission control was identified. Automobile pollution control technologies comprise all technologies used to reduce pollutants produced and released into the atmosphere by automobiles. These automotive-generated emissions fall broadly into two categories based on the point of emission: *i)* tailpipe or exhaust emissions; and *ii)* evaporative emissions (Johnston and Hascic, 2007a). Abating pollution from vehicles must target both tailpipe and petrol tank venting. Searches conducted for these technologies are primarily based on specific regulations imposed on the automobile sector such as the US Tier standards and the European Union's Euro standards. The IPC classes identified are broadly categorised into the three major technology groups identified above: *i)* those that relate to improvements in engine (re)design and therefore generate fewer emissions; *ii)* those that treat pollutants produced before they are released into the atmosphere; and *iii)* those that reduce evaporative emissions. Unfortunately, the last category is somewhat opaque, because there is no IPC sub-classification that clearly defines improvements to nozzles and/or canisters.

For further details on the IPC classes (IPC, 8th edition, 2006): *www.wipo.int/classifications/ipc/ipc8*.

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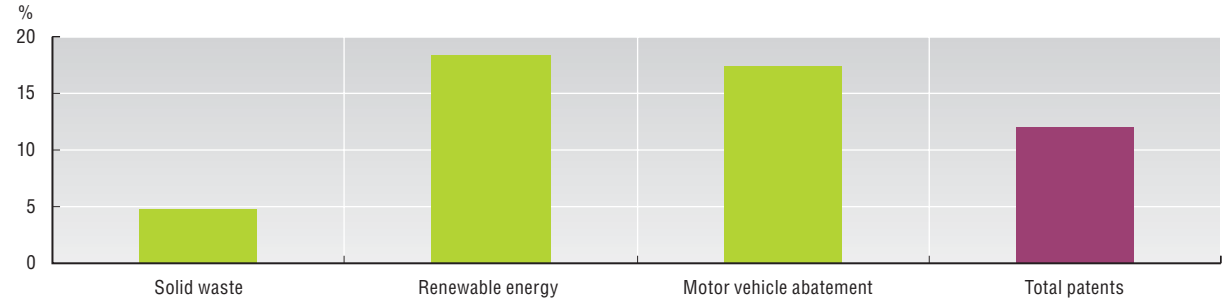
F.10. PATENTS IN ENVIRONMENT-RELATED TECHNOLOGIES

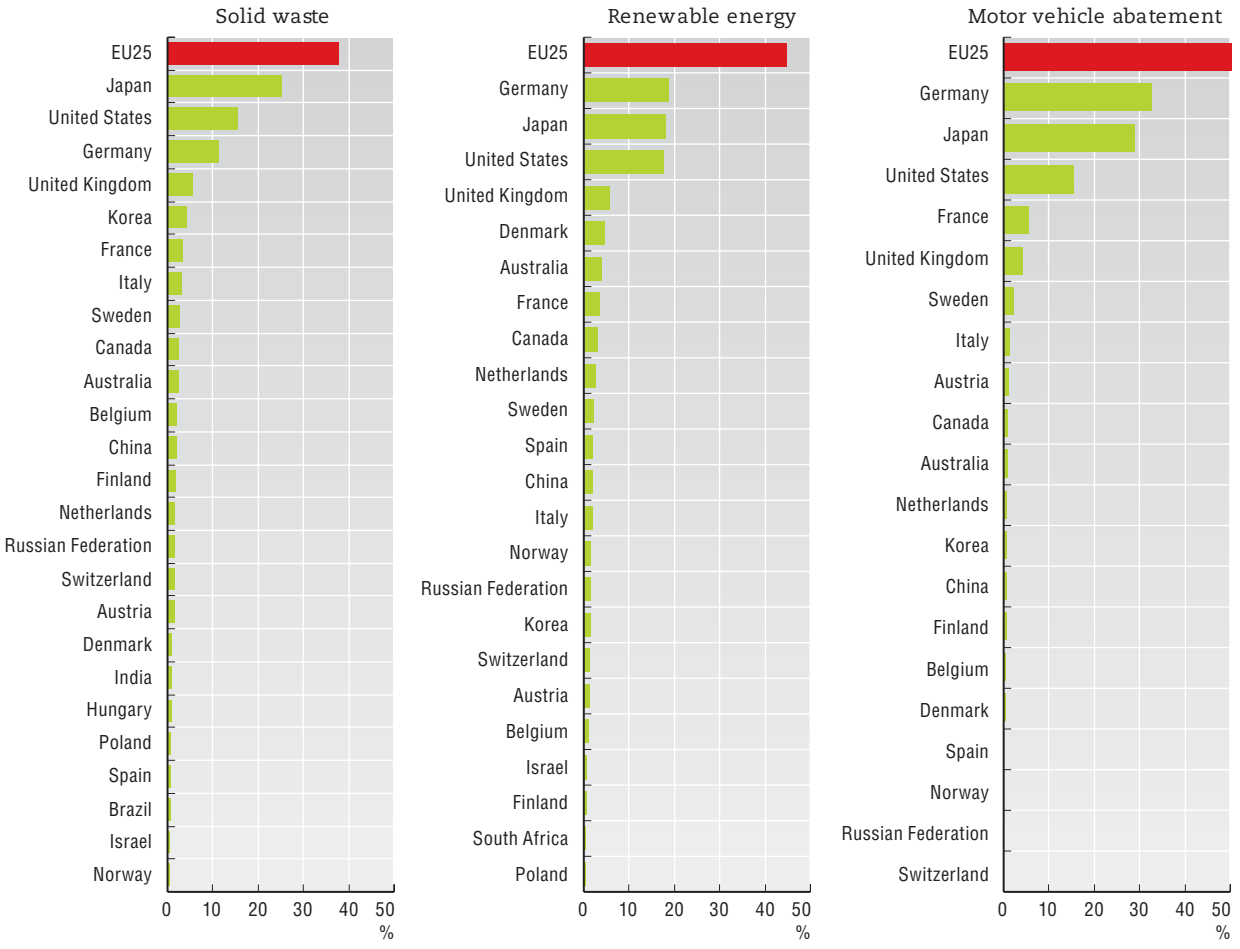
Trends in patents filed under PCT in selected environmental technologies[1]

Average annual growth rate 1995-2004



Countries' shares in environmental technology patents filed under PCT[1]

2000-04



StatLink http://dx.doi.org/10.1787/118555582818

Note: Patent counts are based on the priority date, the inventor's country of residence and fractional counts.

1. Patent applications filed under the Patent Co-operation Treaty, at international phase, designating the European Patent Office.