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Executive Summary and Recommendations

# Who Owns Our Low Carbon Future?

## Intellectual Property and Energy Technologies

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A Chatham House Report

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# Executive Summary and Recommendations

Ensuring access to climate-friendly technologies at affordable prices is a critical issue for international public policy – and one that cuts across economic, legal, security and geopolitical concerns. To keep the rise in average global temperatures below 2°C, global greenhouse gas emissions must peak before 2020 and be reduced to 50–85 per cent below 2000 levels by 2050. Achieving these ambitious targets requires a critical mass of low carbon investment, innovation and deployment that meets mid- and long-term goals. The implications for corporate strategies and business models are profound.

This report examines two issues: patent ownership of climate-friendly technologies, and the rate of technology diffusion. A polarized debate continues between proponents of strengthening intellectual property rights (IPR) regimes to encourage innovation of climate technologies on the one hand, and those calling for more IP-related flexibilities to ensure access to key technologies by developing countries on the other.

In order to bring empirical evidence to these discussions in advance of the Copenhagen Summit in December 2009, Chatham House and CambridgeIP have conducted an extensive analysis of patent ownership and the market adoption rates of six energy technologies: wind, solar photovoltaic (PV), concentrated solar power (CSP), biomass-to-electricity, cleaner coal and carbon capture. The study involved nine months of research across the technologies (and over 30 sub-sectors). A database of close to 57,000 patents over 30 years has been compiled and profiles were developed of selected patent owners. In addition, the team reviewed aspects of corporate

strategy and practice, such as collaboration, licensing, litigation and mergers and acquisitions.

Most energy technologies are part of complex global technology systems. Their development does not often follow a linear logic or evolve within the boundaries of individual economic sectors. Many breakthrough innovations occur when different fields interact. For example, innovation in solar PV technologies has benefited from developments in consumer and industrial electronics, and advances in CSP derive from aerospace and satellite technologies.

## Findings

Policy-makers managing the transition to a global low carbon economy will struggle when making the critical choices unless they have a clear understanding of the range of technological options available from different sectors within specific time horizons, and they will also require an appreciation of how their technological interactions will affect industrial structures.

Technological innovation and diffusion take too long under business-as-usual practices. Our findings confirm the mismatch between the urgency of climate challenges as set out by the Intergovernmental Panel on Climate Change (IPCC), and the time taken historically for technology systems to evolve and provide a return on investment. Sticking to what we know – and business-as-usual practices – will not bring these much-needed technologies to markets fast enough.

Analysis shows that inventions in the energy sector have generally taken two to three decades to reach the mass market. This time lag is mirrored by the time it takes for any patented technology to become widely used in subsequent inventions. Data on the top 30 most-cited patents from each of the six sectors examined here indicate that it takes between 19 and 30 years with an average of around 24 years. The process of registering a patent can take up to three years. The diffusion time for clean technologies globally will need to be halved by 2025 to have a realistic chance of meeting climate goals.

Targeted policies will be needed if accelerated and wholesale deployment of these technologies is to be achieved. There is encouraging evidence that policy interventions to encourage demonstration and deployment –

learning-by-doing – can be a major accelerator of the innovation process. Patenting rates and deployment in wind, solar PV and CSP (a good indicator of innovative activities) took off from the late 1990s, driven by policy interventions to create market demand in key countries such as Germany and Japan, and at regional level in the United States.

Companies and institutions in OECD countries will determine the speed of diffusion of the most advanced energy technologies in the next decade. Innovation and technological development primarily take place within the OECD countries and companies. This research finds no exceptions among the six selected technologies, including all the sub-sectors. Apart from in carbon capture, where the United States is far ahead of all other countries in terms of patents registered, companies and research institutions from the United States, Japan and Germany are clear leaders in energy innovations. Much has been made of the fast growth in innovation capacities in emerging economies such as Brazil, China and India. But these countries have no companies or organizations in the top 10 positions in any of the sectors and sub-sectors analysed. (A few can be found among the top 20, pointing to these economies' growing innovation capacities.)

Further data analysis shows that large incumbent companies – whether multinationals or national corporations – are the main players today. Small and medium-sized enterprises (SMEs) account for a relatively small part of overall patenting in these sectors, in contrast to biotechnology and information technology. The median age of wind-energy patent owners – the 'youngest' sector – is 54 years. This suggests that the most successful strategy for developing countries wishing to enter these areas may initially be driven by larger firms and be pursued through acquisition of foreign technologies rather than internal growth. It is important that such strategies for technological acquisitions are complemented by investment in indigenous innovation capacities in developing economies.

High-carbon companies control some of the key knowledge assets needed for the low carbon economy. Seven out of the top 20 owners of cleaner-coal patents are from the steel sector. Carbon capture and storage (CCS) technologies originate in a range of applications in the petrochemical, fertilizer and enhanced oil-recovery sectors.

The use of advanced alloys is critical for the next generation of wind, PV, CSP and cleaner-coal power generation.

“The top four wind-energy patent owners – who collectively own 13 per cent of all wind patents – have a 57 per cent share of the global market for wind turbines, whereas for solar PV, many of the top 10 manufacturers are not patent holders”

The key question is how to identify the assets in high-carbon industries and harness them for low carbon technologies, in developing and developed countries alike. It is also important to ensure that climate policies offer sufficient incentives for innovation among important technology players. The current trend towards excluding heavy industry from climate-change regulations (e.g. by issuing free emission permits) may reduce these incentives, with negative spillover effects on the rest of the economy.

The concentration of patent ownership cannot be assumed to be synonymous with a lack of competition or a monopoly, but it can slow innovation and diffusion in some types of markets depending on companies' business models. Company strategies will vary owing to differences in the composition of industries, the level of competition, stages of development and market structure of specific energy systems. There are also fundamental differences in terms of organizational and capital requirements between (for instance) the manufacture of solar cells and CCS retrofitting of 1GW coal power plants. In practice, companies with smaller patent portfolios can be more influential than is suggested by their patent rankings. But ownership (and maintenance) of a large number of related patents does imply a recognition of the commercial value of the inventions.

This study finds considerable variation in the levels of patent-ownership concentration. For instance, in terms of cleaner coal technology, the top 20 companies own around 42 per cent of total patents, whereas in CSP, the top 20 only have around 12 per cent of total patents. Consolidation is expected across the solar energy sector in the near future – a development that will change the composition of patent ownership. There are wide variations across sectors: the top four wind-energy patent owners – who collectively own 13 per cent of all wind patents – have a 57 per cent share of the global market for wind turbines, whereas for solar PV, many of the top 10 manufacturers are not patent holders.

Intellectual property rights can be a factor affecting the speed of technology diffusion. A patent portfolio is a form of currency that can be used to attract venture capital, facilitate entry into strategic alliances, provide protection against litigation, and create opportunities for mergers and acquisitions. Many of the energy patent owners listed in this report are established industrial giants. Their perception of market conditions and of the level of IP protection in developing economies will do much to determine the rate of roll-out of the next generation of low carbon technologies – whether through investment, licensing, joint ventures or other forms of knowledge-sharing.

One worrying trend is the increase in patent-related litigation in fast-maturing technologies. While it is understandable that patent owners seek to assert their right to protect their inventions and markets, protracted lawsuits can slow the diffusion of key technologies by decades. Litigation poses particular difficulties for smaller companies with only a few key inventions.

Transformative change cannot be achieved by domestic action alone. Cross-border trade and investment in low carbon and energy-efficient goods, services and technologies need to be encouraged and scaled up. Stimulating low carbon trade will create virtuous cycles, creating further investment opportunities and expanding the market for key technologies.

In a global market, the cost of technology can come down quickly as economies of scale are achieved through large-scale deployment. Since the 1970s, with the

exception of nuclear power, the costs of energy production and use from all technologies have fallen systematically as innovation and economies of scale have increased in manufacture and use. An ultra-supercritical power plant – using an advanced cleaner-coal technology – can now cost a third less in China than a less efficient coal-fired power station of similar scale in the United States, largely because China is building many identical power plants at the same time.

By adopting advanced technologies – and strengthening their innovation capabilities – developing countries have an opportunity to leapfrog the resource-intensive, highly polluting growth phase experienced by Western countries, but they will need a great deal of help to do so. Among emerging economies, China is in a unique position to bring new, clean energy technologies to maturity because of the size of its domestic market and its position as a supplier of consumer and industrial goods to international markets.

The analysis in this report also demonstrates that as energy technologies mature, advances in design, site selection and operation increasingly depend on innovation in information and communication systems. Many energy technologies are also dependent on innovation in advanced materials, e.g. alloys. This means that developing countries such as India and South Africa with strengths in these sectors are well placed to capitalize on the growth opportunities that will emerge as these technology systems evolve, since they can benefit from shifts in global investment patterns towards low carbon energy and production methods with targeted assistance. There is mutual global benefit in ensuring that climate and technology policies would support such a shift.

Greater international cooperation is needed to double technology diffusion rates. Today, cooperation on innovation is primarily a national, not an international, activity. Across the six sectors, only 1.5 per cent of total patents are co-assigned (i.e. list more than one company or institution as co-owners). No fewer than 87 per cent of co-assigned patents are the results of collaboration between companies and/or institutions from the same country. This internalization of collaboration is especially noticeable in the data for Japan. While there is some

collaboration among OECD countries, only two per cent of joint patents are shared between companies and institutions from developed and developing countries. The lack of data means it is impossible to analyse intra-company cooperation across borders.

Technological-system overlaps mean that no one country can provide all the options. Analysis of inventor networks shows a very high level of private-sector cross-fertilization among companies and institutions in the development of new technologies. To speed up diffusion, there is a need to broaden these inventor networks to encourage faster cross-fertilization between inventions from different sectors in different countries.

Government policy that aims to be technology-neutral and support national champions may hinder global innovation in energy systems. To some extent, existing industrial structures, regulatory regimes, research capabilities of private and public institutions as well as other supporting infrastructure are already pre-determining the types of investments or technologies that are most likely to take off in the coming decades. Given the importance of innovation from outside the energy sector to the development of energy technologies, proactive innovation and climate change policy-makers face a complex challenge in both monitoring technological and commercial developments across a wide range of sectors and devising interventions that promote change.

International cooperation is needed to build and strengthen innovation linkages among different industrial sectors, especially those between developed and developing economies. Ultimately, the bulk of the decarbonization needed in fast-industrializing countries will be delivered by their own businesses and institutions. Coordinated action is not just optimal but critical. In designing global solutions it will be necessary to strike a careful balance between private interests and the delivery of global public goods, and to take into account the social and economic needs of developing countries. New incentive systems and collaborative mechanisms at bilateral, regional and international levels will be essential to encourage technological innovation, demonstration and diffusion.

## Recommendations

### Transforming the marketplace through international cooperation

At the global level, the Copenhagen Summit must send credible and unambiguous signals to the global markets that far-reaching change is imminent and inevitable. Joint-venture companies, cross-training programmes, cross-licensing arrangements, trade tariff exemptions on selected technologies and joint manufacturing programmes are all tried-and-tested methods that could be stepped up at national and local levels. Governments can also help shape the global value chains of clean energy sectors through:

- *Supporting global demonstration programmes.* These are required for large-scale, high-risk technologies such as CCS and CSP. The size and complexity of demonstrating these technologies, which often includes intricate planning and infrastructural support, make it difficult for the private sector to independently finance demonstration. Public funding in the form of grants, loans and risk guarantees is therefore necessary to ensure these technologies can become fully commercial. The joint nuclear-fusion project ITER is an example of a wide-ranging international collaboration project.
- *Maximizing the potential of technology standards bodies.* Technology standards can play an important role in accelerating innovation in an industry, by removing bottlenecks and encouraging economies of scale. This report demonstrates the value of maintaining ongoing maps of potential technology standard hotspots, including the patents that underpin them. There is scope for the formation of industry-level technology standards bodies to set increasingly high standards, bring in the laggards and accelerate diffusion.
- *Supporting open innovation mechanisms.* A range of climate technology prizes should be established to promote innovation in all areas that support climate mitigation and adaptation. Other forms of open innovation platforms should be developed to strengthen incentive structures for innovation and knowledge-sharing.

### Forging more collaborative rules of the game

There are significant opportunities to accelerate bilateral and multilateral collaboration on R&D and technology development. Greater incentives are needed to accelerate collaboration across national boundaries, without relegating national priorities to second place (something that is unlikely to be politically sustainable). Potential avenues include:

- *'Model' R&D cooperation agreements.* Government support for clean energy innovation is more likely to be effective at the early stages of the development of technology systems. There is a need for 'model' technology cooperation agreements that would limit the potential of patent-related conflicts and encourage joint development, especially those between developed and developing economies.
- *Publicly backed energy patent pools and knowledge-sharing platforms.* Through tax, other fiscal or investment incentives, the public sector should support the design and creation of patent pools and cross-licensing schemes to encourage innovation and mass diffusion for relevant technologies. These patent pools can be used to support innovation in SMEs and emerging markets in exchange for a royalty fee. Collaborative initiatives such as the European Commission's European Technology

Platform for Zero Emissions Fossil Fuel Power Plants (ZEP) demonstrate the potential of stakeholder advice platforms, and can provide support for knowledge-sharing structures at the regional level (in this case the EU). Such initiatives could be emulated in other regions or used as a starting point for multilateral efforts.

- *A global database on licensing data and best practices.* Very few data on licensing deals, cross-licensing initiatives or patent pools are available in the public domain. The development of a reliable patent-licensing database could assist in setting benchmarks and sharing best practices. As a first step, there is a role for an escrow service, provided by a trusted third party, through which private-sector data are pooled and shared on an anonymous basis on the open market to set benchmarks. There is also a role for institutions such as the World Intellectual Property Organization (WIPO) to set up global databases on licensing and cross-licensing regimes as well as patent pools on climate-friendly technologies. Patent owners could register their licensing deals (and showcase their latest commercial success) within a specified time period (such as 18 months) to protect their latest commercial interests.