Incentivizing the adoption of green technology on a global scale

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1 minute read: key messages

- Low-carbon innovation faces particular challenges due to a lack of market incentives.
- Today, technology development is concentrated in high-income countries such as the United States, Germany, Japan and the Republic of Korea, while China is also becoming a major innovator of environmental technologies.
- Intellectual property (IP) rights contribute significantly to the development and diffusion of low-carbon technologies by helping to establish secure channels for collaboration and technology transfer.
- Several additional factors also determine the direction and extent of technology flows: the overall business environment, macroeconomic stability, openness to international trade, technological and organizational capabilities to integrate new know-how, and the availability of skilled labor.
- Policymakers can support environmental innovation through a range of measures, including increasing public R&D spending, overseeing effective IP regimes and fostering international collaboration.

Environmental innovation to address climate change

Climate change is one of the most urgent challenges facing the planet, occurring largely as a result of increasing emissions of greenhouse gases, especially carbon dioxide. International targets that reduce global emissions of greenhouse gases will only be achieved with the development, diffusion and financing of a large number and variety of new green technology solutions in both developed and developing countries.

The specific nature of environmental innovation, however, poses particular challenges which require policy interventions. On the one hand, industrial polluters face few market incentives to develop greener technologies, as the cost of their pollution is born by society collectively. On the other, R&D and commercialization of green technologies inevitably entail leakages of knowledge, which may deter private-sector innovation in the absence of rapidly granted and readily enforceable IP rights. This situation is compounded by uncertainties such as the direction of future environmental regulations and policies, energy prices, and market demand. Various forms of policy incentives are therefore necessary to encourage private-sector innovators to commit their resources to the research, development and commercialization of green technology solutions.

Low-carbon technologies

The policy imperative to reduce levels of carbon dioxide emissions has given rise to a large family of low-carbon technologies. Three technology areas are of particular importance: renewables, energy efficiency, and carbon capture and storage.

Renewables include wind, solar power, and biomass. Worldwide, their collective power capacity has grown 85% over the past 10 years, reaching 1,700 GW in 2013. While renewables constitute 30% of all installed power capacity today, attaining global climate targets will require a significant acceleration of their development and adoption (Figure).[1] The potential of renewables is held back by the intermittency of generation, which a new generation of smart electricity storage systems may help to address. For instance, artificial-intelligence-based software can combine and process data from numerous wind turbines, weather stations, and satellites, to integrate wind power into electric grids.[2]

Significant reductions in carbon emissions can also be made from advances in energy efficiency. The "circular economy" aims to recycle, reuse and remanufacture resources to the greatest extent possible, requiring *inter alia* new materials technology that permits efficient recycling of used materials. Buildings are another important area that account for 32% of global energy consumption and 19% of energy-related emissions of greenhouse gases.[3] Innovations such as LED lighting, advanced thermal insulation, and new building techniques such as modular construction and pre-assembly, have the potential to contribute significantly to climate change targets.

Finally, carbon capture and storage technologies have the potential to safely store up to 90% of the carbon dioxide emissions produced from the combustion of fossil fuels in electricity generation and industrial processes. When combined with renewable biomass, these technologies allow for carbon-negative power generation, with the added benefit of removal of the carbon dioxide emissions from the atmosphere.

Technology transfer

Over the next three decades, developing countries' carbon dioxide emissions are predicted to outpace those from developed countries.[4] In 2013 China, for several years the world's largest emitter of carbon dioxide, accounted for 28% of global emissions, followed by the US (14%) and Europe (10%).[5] However, less developed countries are more vulnerable to the effects of greenhouse gas emissions, as they in most cases lack the infrastructure and technologies to adapt to a changing climate.

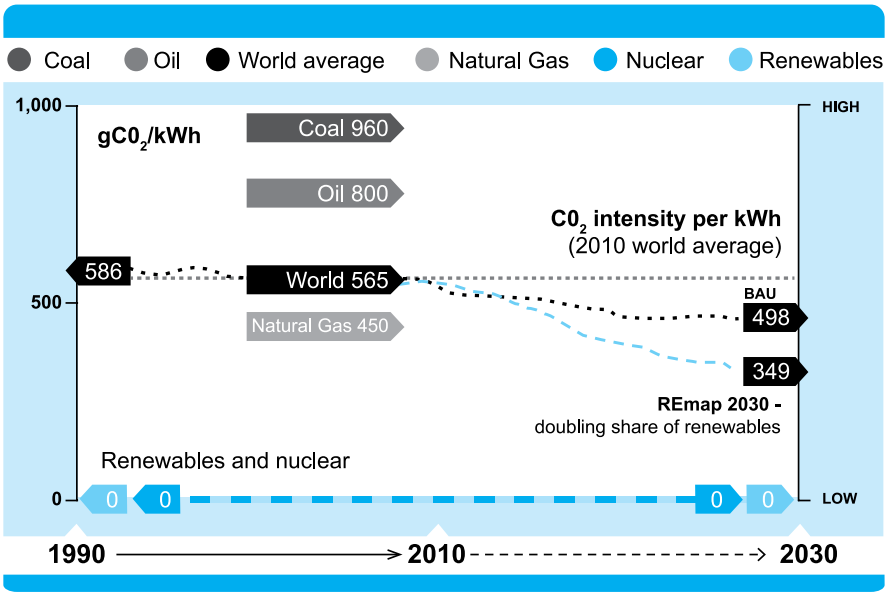
Environmental innovation, as measured by patenting activity, is concentrated in large, developed economies such as the United States, Japan, Germany and the Republic of Korea although China has become a major filer of climate change and mitigation technology patents.[6] The ultimate usefulness of environmental innovation to respond to climate change will depend on the effective diffusion of these technologies from the place of invention to the regions where they are needed most.

Three main vectors of international technology transfer are licensing, imports and foreign direct investment, all of which correlate positively with the strength of IP protection in the recipient country. Well-developed systems to protect and enforce IP rights have been found to stimulate technology diffusion by providing secure channels for sharing know-how.[7] By contrast, ineffective IP regimes, in particular inadequate enforcement, can dissuade foreign companies from licensing their technologies for fear of competitors using them without authorization. Additionally, inadequate IP systems often discourage foreign subsidiaries from increasing the scale of their R&D activities.[8]

The existence of IP rights does not appear to impede technology transfer to developing countries. In fact, most environmental innovation comes from incremental improvements to existing off-patent technologies. Even where these incremental innovations are patented – usually in only a few jurisdictions – there is sufficient room in the market for competing technologies. This limits the influence that specific patents have on the technological progress of most countries.[9]

In addition to the strength of IP regimes, other factors significantly impact on levels of technology transfer. Foreign direct investment requires *inter alia* political and

Figure: C02 emissions intensity (g per kWh) – 2030 outlook



Under current policies, average carbon dioxide emissions will fall to 498 g/kWh by 2030. This is insufficient to keep atmospheric carbon dioxide levels below the critical threshold of 450 parts per million. A doubling in the share of renewables could mitigate climate change by reducing the global average emissions of carbon dioxide to 349 g/kWh – equivalent to a 40% reduction compared to 1990 levels. *Sources: IAE (2010) & IRENA (2014)*

macroeconomic stability as well as the availability of low-cost skilled labor. Openness to international trade implies the absence of tariffs and quotas, and less restrictive rules of origin. A recent study has shown that the elimination of tariff and nontariff barriers on clean technologies could increase their traded volume by some 15% in 18 developing countries.[10]

To bridge the gap between exposure to new technologies and their adoption, a recipient country must possess an appropriate level of absorptive capacity, *i.e.*, the ability to do basic research, and to understand, implement and adapt technologies arriving from abroad.[11] Absorptive capacity depends on local companies' technological and organizational capabilities, as well as on access to sufficient financing. A country's ability to take up new technologies also depends on macroeconomic and governance conditions, which influence the willingness of businesses to take the financial risks associated with developing and commercializing new technologies.

Recent evidence suggests foreign technology suppliers take all these factors into account when defining their strategies for emerging markets.[12] Rather than focusing solely on IP protection, businesses assess the overall business environment, in particular the country's ability to coordinate institutional policies to attract technologies and investments.[13] In other words, the degree to which IP can be effectively protected in a given jurisdiction represents only one of several necessary factors which technology providers consider.

The role of intellectual property for businesses

IP rights, protected and enforced under patent and trade secret laws, enable inventors to bring new technologies to the market without ceding control of the valuable knowledge or know-how behind them. By temporarily conferring exclusive rights in those jurisdictions where granted, patents permit companies to capture the value of their inventions and the investments made in developing and bringing them to market. In addition, quality patents and robust IP strategies can help innovative businesses signal the value of their inventions to the market and to potential partners, including investors.[14] They thereby contribute to the reduction of information asymmetries that stem from the outsiders' incapacity to meaningfully assess R&D projects. Finally, predictable and well-enforced IP frameworks contribute to technology diffusion by facilitating IP management strategies such as licensing agreements (Box).

Trade secrets comprise any business information that is not generally known and that confers a competitive advantage to the owner. Frequently used in combination with patents and other forms of IP rights,[15] they are useful in protecting knowledge that cannot be patented or

Box: Clean technology transfer to emerging markets – innovative solar power plants for China and India

This case study illustrates how IP rights can facilitate the transfer of low-carbon technology to emerging economies.

A Californian startup founded in 2007, eSolar develops solar power plants using flat mirrors, or heliostats, to concentrate sunlight onto a centrally located water tank suspended from a tower. Since the mass-manufactured components are designed for rapid construction, uniform modularity and unlimited scalability, the company can offer cheap utility-scale power plants, thereby achieving a significant competitive advantage.

In 2010, eSolar partnered with two companies in emerging markets willing to deploy its innovative technologies. Penglai Electric Company, a privately-owned Chinese electrical power equipment manufacturer, will construct 2GW of solar thermal power plants in China by 2021, one of the largest solar thermal projects in the country. Indian developer ACME will build, own and operate 1GW of solar power plants in India. Furthermore, it will collaborate with other companies to build additional plants using eSolar's technology. As a part of the deal, ACME will make a USD 30 million equity investment in eSolar.

eSolar has protected its innovations by filing patent applications both in the US and internationally, relating to solar receivers, tracking control systems for heliostats, and heliostat array layouts. Both deals were structured as master licensing agreements that grant Penglai and ACME exclusive rights to use eSolar's technologies in their respective home markets.

Eligible for protection in China and India, eSolar's international patent applications have helped the company to find partners in emerging economies. It is unlikely that Penglai and ACME would have invested in such large-scale projects without the exclusivity in their domestic markets provided by the licensing agreements. Without these exclusive and enforceable rights, Penglai and ACME would have no protection against competitors copying the technology in question in their home markets. What is more, the exclusive licensing protects both companies against eSolar's concluding similar deals with other developers in China and India.

Source: Lane E (2011) Clean Tech Intellectual Property. OUP.

Key Implications & Considerations for Policy & Policymakers

The following considerations for policy and policymakers are intended as starting points for reflection, to be adapted to specific needs and circumstances.

- *Effective IP regimes* that allow for timely, high-quality patents have proven positive forces for technology transfer. This may require both substantive and procedural reforms to patent administration, including provisions to reduce patent pendency. Policies that ensure IP rights are available and enforceable at reasonable cost are valuable instruments. These should be balanced with modern trade secret laws and complemented by competition policies with clear and enforceable provisions. Finally, practical IP management training for companies, in particular SMEs, can facilitate job creation, as well as the sale and acquisition of technology.

- *Financial support*, especially for basic research, plays a crucial role in encouraging companies to invest more in research and development. It is particularly important for SMEs that generally face resource constraints. Well-funded educational and public research institutions are critical to providing the labor force and expertise that enable companies to absorb and deploy innovative green technologies.

- *International cooperation* should be increased in order to develop further policy instruments aimed at stimulating technological advancement and transfer. Value could be added through information exchange systems, the coordination of national research agendas, and the use of voluntary standards and labeling schemes. Through *cost-sharing agreements* multiple countries can subsidize the joint development of promising technologies. In addition, plausible *market-based interventions* can help promote technology transfer between industrialized and developing countries.

copyrighted, such as the non-codified know-how needed for the manufacture and distribution of an innovation. Trade secrets help create secure channels to exchange know-how, creating a safe environment for the diffusion of proprietary knowledge.[16] At the same time, they provide businesses with a low-cost mechanism to avoid over-investing in physical secrecy,[17] and are particularly useful for small and medium-sized enterprises (SMEs) as they can be protected without registration or any other procedural formalities.

The benefits that flow from both patents and trade secrets are prerequisites for "open innovation", which may become the dominant approach to innovation in the twenty-first century.[18] Rather than developing and commercializing processes exclusively within the boundaries of a single company, companies work with external actors in order to enhance the innovative process. They therefore need to simultaneously disclose and protect their know-how. Given the complexity of the technology involved and the global nature of climate change, open innovation is of particular relevance for environmental innovation.

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