COALITION for INNOVATION, EMPLOYMENT and DEVELOPMENT

CLEAN TECHNOLOGY AND EUROPEAN JOBS

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INFORMED DECISIONS

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Authors: Project Manager partner Christian Jervelund, Senior Economist Svend Torp Jespersen, Economist Marcin Winiarczyk. Quality assurance carried out by Managing Economist Helge Sigurd Næss-Schmidt.

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Contact: SANKT ANNÆ PLADS 13, 2nd FLOOR | DK-1250 COPENHAGEN PHONE: +45 7027 0740 | FAX: +45 7027 0741 WWW.COPENHAGENECONOMICS.COM

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PREFACE

The Coalition for Innovation, Employment, and Development (CIED) has commissioned Copenhagen Economics to conduct a study on the relationship between intellectual property rights, innovation in carbon abatement (clean) technology and the impact on European jobs.

EXECUTIVE SUMMARY

The EU is set on substantially reducing the World's emissions of greenhouse gasses (GHG). At the Copenhagen summit in December 2009, the EU is hoping for an ambitious international agreement on reducing GHG. A focal point is the so called 450 ppm scenario whereby GHG emissions are reduced to a level equivalent to a 2-2.4 degree Celsius temperature rise according to scientists.

EU's commitment to fight climate change will lead to a massive need for 'clean' technology that is able to produce energy while emitting only a minimum or no GHG's. This technology does not exist in the necessary scale today. It has to be developed through research. The International Energy Agency estimates that some € 2,500 billion must be invested in the EU over the next twenty years, in order to research, develop, demonstrate and deploy the clean technology necessary for complying with the 450 ppm reduction target.

This investment will be driven by high prices on GHG through the emissions trading system, various GHG taxes and subsidy schemes for investment in clean technologies.

While the investment costs necessary are huge, they also present an opportunity. The obvious one is less global warming. But also, a large number of jobs will be created in the industries developing and producing clean technology; for example in the solar heating and the windmill industry as well as in energy saving technologies that can reduce CO_2 content from the use of fossil fuels.

The EU is well positioned to create jobs in these industries. It already today has a large industry, which produces clean technology. Moreover, this area is one of the only technological fields where the EU is more innovative than the USA and indeed the rest of the world. As many of these jobs will be high skilled research jobs, this opportunity may also help the EU achieve the goals in the Lisbon Agenda, which states that the EU should be the most competitive and dynamic, knowledge based economy in the world. Furthermore, the EU should seek to fully exploit the job creation opportunities as the transition to a low carbon economy will lead to transitional job losses in certain sectors as they adjust to e.g. higher energy prices.

We have summarised recent studies projecting EU job creation in renewable energy technologies over the next twenty years, and find this number could exceed 2 million jobs. This does not include the number of new jobs that might be created in transport and energy efficiency in buildings, whose number could be twice the magnitude.

While an ambitious GHG reduction agreement will create a big demand for clean technology, general framework conditions, including intellectual property rights, are necessary for EU firms to undertake investment in research and development of clean technology. Like with any investment; if the risk on returns increases, a firm will tend to invest less. This could seriously increase compliance costs in reaching GHG reduction targets and reduce the opportunities for job creation in the EU.

Environmental and economic considerations therefore speak against weakening the protection of intellectual property rights. Protection of intellectual property has, nevertheless, come under pressure recently, because developing and emerging economies demand transfer of clean technology in order to sign up to a global climate agreement. The countries are pointing to a range of measures, which reduce the protection of intellectual property, one of which is compulsory licensing.

The EU has an opportunity to kill two birds with one stone: to protect the environment and further its ambitions stated in the Lisbon Agenda. But it rests on firms being willing to take on risks and invest massively in innovation. Weakening the intellectual property rights system could jeopardize both, while not furthering the transfer of technology.

If developing and emerging economies should be compensated for entering into an ambitious agreement at the Copenhagen summit, this could much better be done simply through a transfer of financial funds from the developed countries to the emerging and developing economies. Such financial funds can be targeted much more precisely, which result in at least two types of benefits: First, it allows financial relief to countries that need it the most. Second, it allows the recipient countries to buy precisely the technologies they need in order to reduce emissions cost efficiently. This is in contrast to a general agreed weakening of IPRs that may benefit receiving countries in a highly uneven manner at higher cost.

Chapter 1 POLICY CONTEXT AND SUMMARY OF FINDINGS

At the Copenhagen 2009 summit on climate change, an agreement on binding commitments to reduce greenhouse gas (GHG) emissions will be sought. The main scenario under consideration is the so-called '450 ppm scenario' with the participation of all countries, developed, emerging and developing. The 450 ppm scenario refers to a level of atmospheric CO_2 concentration to be reached, so that global temperature rise does not exceed about 2 degrees centigrade.

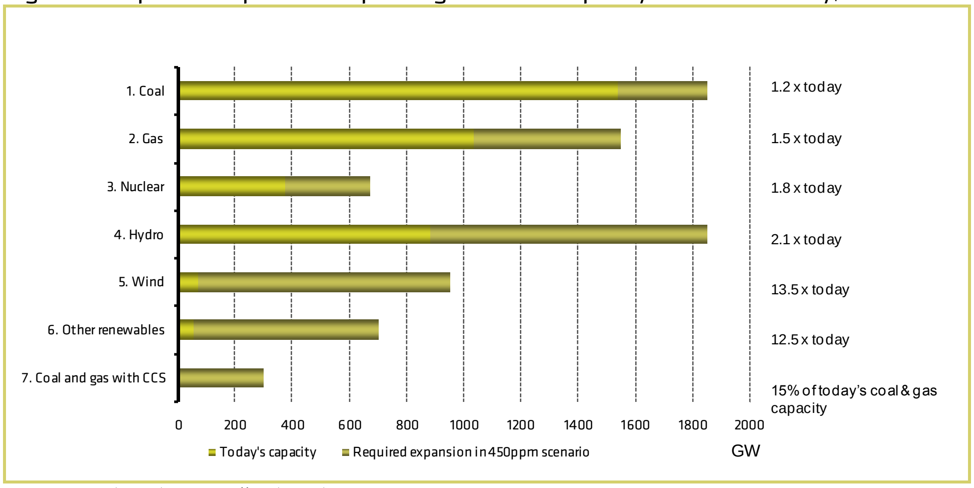
1.1. MASSIVE INVESTMENT NEED

The scenario requires reductions in worldwide CO_2 emissions, which can only be achieved through development and deployment of a variety of new or currently immature technologies for carbon abatement (clean technologies).

To illustrate this, according to the International Energy Agency (IEA) in the 450 ppm scenario, the power sector is expected to undergo a dramatic change. Some renewable technologies must expand[1] to about 13 times their capacity today while a currently immature technology as Carbon Capture and Storage (CCS, a technology allowing carbon dioxide to be captured and stored under ground) must be fitted on the equivalent of 15 percent of today's coal and gas power generation capacity, cf. Figure 1.1. Notice that the energy production from coal as a whole is expected to rise according to the IEA. The reason is that the IEA predicts a gradual replacement of smaller inefficient coal power plants, along with upgrading the efficiency in larger power plats and the deployment of new advanced coal technologies such as integrated gasification combined cycle (IGCC) and ultra-supercritical steam cycles (USCSC).

1 In March 2007, the EU agreed that by 2020 renewable energy should account for 20 percent of the EU's final energy consumption (9.2 percent in 2006). In 2008, individual targets were formulated for each of the EU countries. The countries have a deadline by June 2010 to present 'National Renewable Energy Action Plans' that will outline the measures to be taken to reach the renewable energy targets. The countries are free to decide their preferred mix of renewables in order to take account of different potentials; however, abatement must take place in electricity, cooling and heating and transport.

Figure 1.1 Expected expansion in power generation capacity relative to today, World



Source: IEA (2008) in Brandley (2008)

An unprecedented, revolutionary technological breakthrough is required to foster the necessary clean technologies and energy efficiency measures within renewable energy, energy efficiency in buildings, transport etc. Consequently, the projected future need for innovation and deployment in clean technology is massive. The IEA projects that around $ 2,500 billion dollars needs to be invested in Research, Development, Demonstration and Deployment (RDD&D) in the EU over the next 25-30 years, cf. Table 1.1.[2]

[2] The estimates for RDD&D originate from IEA (2008) Energy technology perspectives which outlines 'roadmaps' for 17 individual abatement technologies to comply with the 450ppm scenario in an aggregate table on p.132. For each of these technologies, the roadmap projects an interval for the required RDD&D investment in Europe in Chapter 3 of the publication. Our figure is the sum over the 17 technologies. Note that for technologies in the transport sector, the figure for "deployment" is separately given in the respective 'roadmaps' and we add it back to the total. The IEA estimates of RDD&D costs are rooted in a survey of individual studies reporting the costs and deploying different methodologies and IEA's adaptation of these findings for the purposes of the 450 ppm scenario. These studies do not offer a rigorous conclusion whether an increased R&D spending will automatically translate into higher success with technology commercialization. Therefore, the IEA makes its own expert judgment, based on the studies, to arrive at the required level of R&D spending. IEA (2009) assumes that the required R&D expenditures are about 10% of the required cost of deployment.

Table 1.1 Estimated investment outlays to meet the 450ppm scenario, 2005-2030

	Research, development, demonstration and deployment
The World	$ 4,000 billion
of which, in Europe	$2,300- $2,800 billion

Note: International Energy Agency's BLUE scenario assumes 2 – 2.4 degrees centigrade warming equivalent to the 450 ppm scenario. Numbers for OECD Europe.
Source: IEA (2008)

There is evidence that the technological breakthrough has begun already. HSBC Global Research has recently estimated that global revenues from climate-related businesses including among others, energy production and energy efficiency, rose by 75 percent in 2008 alone. HSBC estimates that revenues will exceed $2,000 billion by 2020.[3]

1.2. INVESTMENTS CREATE JOBS

These massive investments in RDD&D in clean technologies may create thousands of highly knowledge intensive jobs in EU in the future. This would support the wishes of the EU as being the World's most dynamic and knowledge based economy expressed in the Lisbon Agenda, cf. Box 1.1.

Box 1.1 European goals as defined in the Lisbon Agenda

"EU has today set itself a new strategic goal for the next decade: To become the most competitive and dynamic knowledge based economy in the world, an economy which can create sustainable growth with more and better jobs and greater social coherence."

Source: From the conclusions of the Chairmanship, Lisbon, 2000.

Summarising a number of recent studies on job creation do suggest a significant job potential at around 2 million jobs in renewable energy alone, cf. Table 1.2.

We have also made an own renewable energy job estimate based on two approaches. The first approach is based on existing sector studies for individual renewable energy sources. The second approach is based on the IEA capacity prediction. In this approach we have multiplied the IEA percentage forecasts for future capacity developments within individual renewable technologies (in Figure 1.1) with current employment within each renewable energy technology. On the one hand it is a rough approach as it assumes, among other, a stable proportional relationship between mega watt capacity and employment. On the other hand, it applies some consistency to the overall renewable job estimate by relating it to comparable capacity expansions and not individual sector experts' estimate for each technology alone. The two approaches together provide an estimate of 2.4 million jobs to 3.2 million jobs in renewable energy, cf. Table 1.2.

[3] Euractiv (2009)

Table 1.2 New jobs in the renewable energy sector in the EU, by 2020

Source	New jobs, thousands
ALTENER (2002)	900[a]
European Renewable Energy Council (2007)	2,000[b]
European Commission (2003)	2,500[c]
Ecofys et al. (2009)	2,800[d]
Estimate by Copenhagen Economics based on IEA	2,400- 3,200*

Note: The estimate compiled by Copenhagen Economics encompasses onshore and offshore wind, biomass integrated gasification, photovoltaic systems, concentrating solar power (CSS).

** For detailed information about the different estimates compiled by Copenhagen Economics, cf. Chapter 3*

Sources:

a) Quoted in Ecotec (2002), p.13.

b) European Renewable Energy Council (EREC), Renewable Energy Technology Roadmap up to 2020 (Brussels : January 2007), p. 12, originally quoted in WWF (2009).

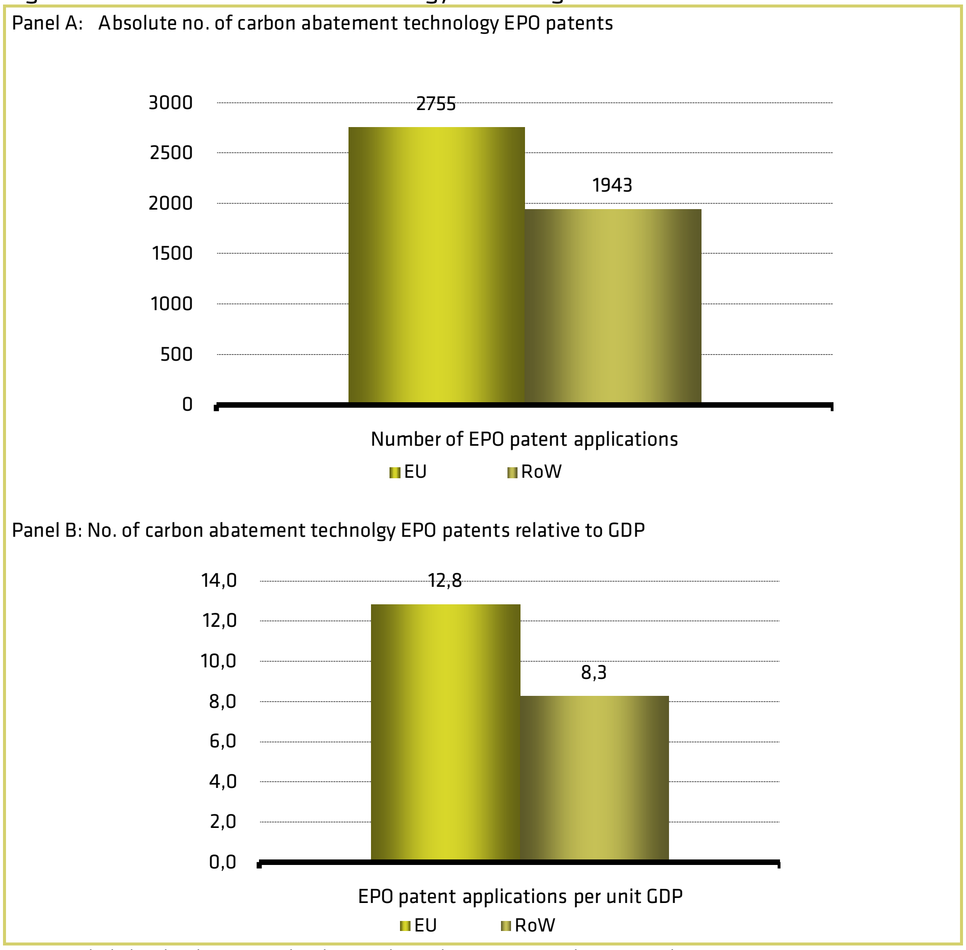
c) European Commission, Monitoring and Modelling Initiative on the Targets for Renewable Energy, 2003, originally quoted in WWF (2009).

d) Ecofys et al. (2009), p. 140.

The estimates in Table 1.2 cover only renewable energy technologies. The reason is that by far, more technology studies (and the IEA capacity forecasts) on renewable energy technologies are, relatively, comparable. It is less the case for e.g. the energy efficiency and transport technologies. Jobs will, however, also be created within these technologies. In chapter 3 we present estimates for these technologies, which suggest an additional several million jobs may be created.

The EU is in a good position to carry out R&D in clean technologies as it is currently a leader in this field. Measured by patents in renewable technologies, EU is ahead of the rest of the developed world, cf. Figure 1.2.

Figure 1.2 Patents on 6 renewable energy technologies



Note: Included technologies: wind, solar, geothermal, ocean energy, biomass and waste.
Source: Adopted from Johnstone et al. (2008)

OECD Forum (2008) concludes that EU firms today hold a leading positions in energy efficiency in motor vehicles, as well. Case evidence based on an interview with a European auto manufacturer, Daimler AG, suggests the same, cf. Box 1.2. However, as Daimler also points out, there mere fact that EU today is a leader in energy efficiency in cars is by no means a guarantee for the EU to continue to be a leader in the future.

Box 1.2 A leading position in the auto industry

The European auto manufacturer Daimler AG is a leading car manufacturer, producing among other the Mercedes cars. The company spends a large fraction of its revenues on research and development, currently giving rise to more than 20,000 research and development jobs.

A major share of the company's research and development relate directly to improving energy efficiency and reducing pollution of cars. Other areas of research and development focus on for example safety and comfort.

The company recognises the description of EU as a world technological leader in energy efficient and low-pollution cars. However, in the company's opinion, the technological development is currently moving faster in Asia than in the EU; and hence the historical leading position of the EU car industry in this area is not guaranteed to continue in the future. For example, China is currently making massive, coordinated investments in developing fuel cells for cars, whereas the efforts in the EU in the area of energy and pollution efficient cars are much more fragmented and un-coordinated.

Source: Interview with person in Daimler AG, Intellectual Property & Technology Management.

EU's strong position in clean technology is an exception in what is sometimes referred to as the EU-US 'innovation gap'. Examining innovation in other sectors, the EU is generally behind the US. Take for example the latest 2008 European Innovation Scoreboard published by the European Commission, which indicates that the EU is behind the US on a number of measures of innovation[4]. With respect to EPO patents, the US outperformed the EU on the level of patents in 2008, as well as in terms of average annual growth rates measured over a 5-year period (2003-2008), indicating an increase of the gap for this indicator in this period.

Such 'comparative' advantage in clean technology could translate into large exports of clean technology also contributing to job creation in the EU. This is important to fully exploit as the transition to a low carbon economy will lead to transitional job losses in certain industries as they adjust to e.g. higher energy prices. It is therefore important that the EU get as much benefits and jobs from the expanding clean technology industries to ease the job creation process.

Hence, the EU needs to provide the clean technology industry with good framework conditions, including an IPR framework that allows EU to grow an industry with an already strong growth potential.

1.3. IPR FACILITATES COST EFFECTIVE INVESTMENTS

While it is an ambitious GHG reduction agreement that will create or drive demand for clean technology through e.g. high prices on GHG's, other factors are necessary for EU firms to undertake investments in research and development of clean technology. This is where intellectual property rights come into play. General framework conditions, including IPR, are necessary for EU firms to undertake RDD&D investments.

The massive lift in investment in developing clean technologies would be retarded without IPR. Like with any investment; if the risk on returns increases, a firm will tend to invest less.

[4] Quoted in European Commission (2008).

This could seriously increase compliance costs in reaching GHG reduction targets and reduce the opportunities for job creation in the EU.

Studies show that a strong IPR regime increases innovation, because firms are more likely to recoup their R&D investments. In fact, Kanwar and Evenson (2001), which try to quantify the relationship between strength of an IPR regime and the level of innovation, found that a weakening of intellectual property rights by 10 percent would reduce research and development by 5-11 percent on average.

Developing and emerging economies are pointing towards compulsory licensing of clean technologies[5] invented in the developed countries as a way of financing their emission reductions. However, as we have seen, weakening the IPR system would reduce investments in RDD&D and job creation. Furthermore, we find that intellectual property rights are not a barrier to clean technology transfer from developed countries to developing countries. A series of recent papers, including Copenhagen Economics (2009), provide evidence that compulsory licensing is not facilitating transfer of clean technology from developed to developing or emerging economies. In fact, evidence suggests that intellectual property rights are a *prerequisite* for transfer of technology. The reason is that with a strong intellectual property regime, firms are granted a guarantee that their technology is protected when licensing it off to other countries or when setting up subsidiaries where local employees gain access to key technical knowledge, which they could bring with them to competitors.

There is little evidence that strong IPR in clean technology creates monopoly rents. On the contrary, strong competition exists within and between technologies reducing potential rents from IPR protection.

If developing and emerging economies should be compensated for entering into an ambitious agreement at the Copenhagen summit, this could much better be done simply through a transfer of funds from the developed countries to the developing and emerging economies. Also proper incentives to deploy low cost technologies in developing and emerging economies could be considered. For example, some emerging and developing economies have a history of subsidising fuel and energy consumption leading to over consumption of fuel and energy and thereby larger GHG emissions.

[5] Compulsory licensing is a feature of IPR law, whereby an authorisation can be issued by a government to allow itself or manufacturers to produce patent-protected goods without patentee's permission and with or without payment, cf. Nanda (2009).

Chapter 2 IPR, INNOVATION AND TECHNOLOGY TRANSFER

In this chapter we present evidence on the positive link between IPR and the level of innovation in firms and industries. We find that IPR stimulates innovation, and companies become more innovative when they are more certain that their inventions will be protected by IPR. Next, we give the evidence that IPR is not an obstacle to the transfer of carbon abatement technology to developing countries, where a significant fraction of the abatement effort is likely to take place. This section builds on the extensive results of our earlier study, and the reader interested in more details behind our findings is advised to refer to Copenhagen Economics (2009).

IPR is a part of firms' innovation strategies, and strengthening of IPR protection improves firms' ability to innovate as it increases chances of recouping the investment made. Firms innovate for commercial reasons and they consider whether a given IPR regime can help them to be successful. From a financial perspective, the decision to innovate is like any other investment that requires a capital outlay. It carries a certain risk and expected return. In this sense, IPR works as a means for protecting the cash flows that the firm intends to generate following its capital outlays on innovative activities. A patent gives the holder the sole right to use an innovation commercially and with it the ability to obtain prices which exceed production costs and a normal rate of return for that innovation. Thus, IPR does not increase the return on investment but it minimises the risk of achieving no return when the innovation is successful, but prone to being copied by others.

IPR not only means that firms are likely to devote more resources to innovation (increasing their chance for success) but also increase their turnover once they are successful. The investments in innovation are of course closely linked to higher employment. Firstly, innovative firms employ R&D staff to carry out innovative activities. Secondly, firms that are successful with their innovative efforts employ greater production workforce to keep up with the increased demand for their products. In this way, IPR contributes not only to firms' improved profitability, but also to greater employment.

In a future where innovation in carbon abatement technology must increase substantially, IPR serves to facilitate innovation by providing an incentive to innovate. In short, strengthening IPR will be good for innovation in carbon abatement technology and consequently for employment in this sector. The IEA projects a need for massive investments of thousands of billions of US dollars for the World, a large proportion of which are expected to be in Europe, cf. Table 2.1.

Table 2.1 Estimated investment outlays to meet the 450ppm scenario, 2005-2030

	Research, development, demonstration and deployment, 2005-2030
the World	$ 4,000 billion
of which in Europe	$2,300- $2,800 billion

Source: IEA (2008)

2.1. IPR AND INNOVATION

IPR appears to be good for innovation in carbon abatement technology. Studies looking at the role of IPR for innovation in carbon abatement technologies claim that IPR is good for innovation, cf. Table 2.2 In general, studies find that IPR works either to provide an incentive to start innovating in carbon abetment technologies or to secure the return on investment following the commercialisation of a successful innovation, and thus stimulating future investments.

Table 2.2 Positive effect of IPR on innovation in clean technology

IPR measure	Study	Findings (quantitative effects, where possible)
Patent system in general	Carbon Trust (2003)	Patents in the energy industry should be used to break the dominance and the "lock-in" effect of incumbent energy generation technologies.
Patent applications	Foxon et al. (2005) covering 6 renewable energy technologies	Difficulties with registering patents hinder collaboration between SMEs and universities. Patents are important to obtain financing required for commercialisation of technology
Patent system in general	OECD Forum (2008)	By granting high-quality patents that we can ensure the marketability and economic success of landmark inventions. Patents have already contributed to innovation in developing climate change technologies, they should further be supportive.
IPR protection in general	E3G (2008)	Without effective returns from IP the private sector will not continue increasing its investment in low carbon technology.

Source: Copenhagen Economics

Some try to quantify the relationship between how strong an IPR system is and the level of firm innovation this leads to. On study, however, is that of Kanwar and Evenson (2003).

Kanwar and Evenson (2003) estimate the relationship between a patent protection index and the amount of R&D investment in a country, and estimate elasticities in the interval 0.5-1.1. This means that a reduction of patent protection strength by 10 percent would lead to between 5 and 11 percent reduction in world R&D expenditure. Thus, if the international patent system were weakened corresponding to the removal of the Paris Convention, world R&D would drop dramatically. Such a reduction in R&D expenditure would of course also have significant employment effects.

It was actually Ginarte and Park (1997) that developed the index of the strength of patent protection that Kanwar and Evenson (2007) used in their study. The index is widely used for studying the impact of patent legislation on research and innovation.[6]

[6] The index is constructed from scoring countries on five categories: 1) Patent coverage, 2) Membership in international treaties, 3) Loss of protection measures against losses, 4) Enforcement and 5) Duration. Under each score

Assume hypothetically that all countries of the world were initially members of the Paris Convention, but decided no longer to obey the convention. Then the patent protection index would drop by one third, amounting to approximately a 13 percent decline.

Box 2.1: IPR and innovation in GE Digital Energy

GE Digital Energy develops solutions for power generation, power transmission and electronic communication. Some of the company's products and services help firms achieve a reliable supply of energy while reducing the energy consumption. The firm employs some 2,000 people worldwide. In Spain, 10 employees are working with innovation.

GE Digital Energy does not undertake innovation unless it obtains intellectual property rights protection of the innovations made. Intellectual property rights are an integrated part of the company's approach to innovation. It is not just about ensuring that the company's investments in R&D have a payoff, but also a matter of ensuring that the company does not initiate the development of products which are somebody else's intellectual property.

Source: Interviews *with GE staff carried out by Copenhagen Economics, September 2009*

2.2. IPR AS A POTENTIAL BARRIER TO TECHNOLOGY TRANSFER

While the positive effect of IPR on employment and innovation is well documented and relatively uncontroversial, the role of IPR on technology transfer is more often contested. A frequent view is that patents, by grant a temporary monopoly on a technology, allow the IPR holder to charge a monopoly mark-up beyond what the specific patented improvement delivers in terms of increased efficiency. In other words, maybe patents limit competition and make a given technology too expensive.

there are a number of indicators. For example, the value of the Membership in international treaties score is one if a country has signed up to both the Paris convention, the Patent Cooperation Treaty and the Protection of new Varieties. If a country has signed up to only one, the value of the score would be one third. The value of the index is calculated by summing over the individual scores. Ginarte and Park (1997) calculate an average for the world of 2.46 in 1990 for the index for patent protection; the higher the score, the better the patent protection.

As a result of extensive research, the current study claims that this is not the case. On the contrary, in the case of carbon abatement technology IPR is not a barrier to transfer of technology.

This is because IPR does not harm competition between different carbon abatement technologies. Competition is in fact present and it improves access to technology in two ways.[7]

Firstly, the individual carbon abatement technologies are competing. Thus, no single firm controls access to any technology. As documented in Copenhagen Economics (2009), CO_2 abatement is expected to be delivered through the deployment of many technologies. Moreover, many of them are already in the public domain.

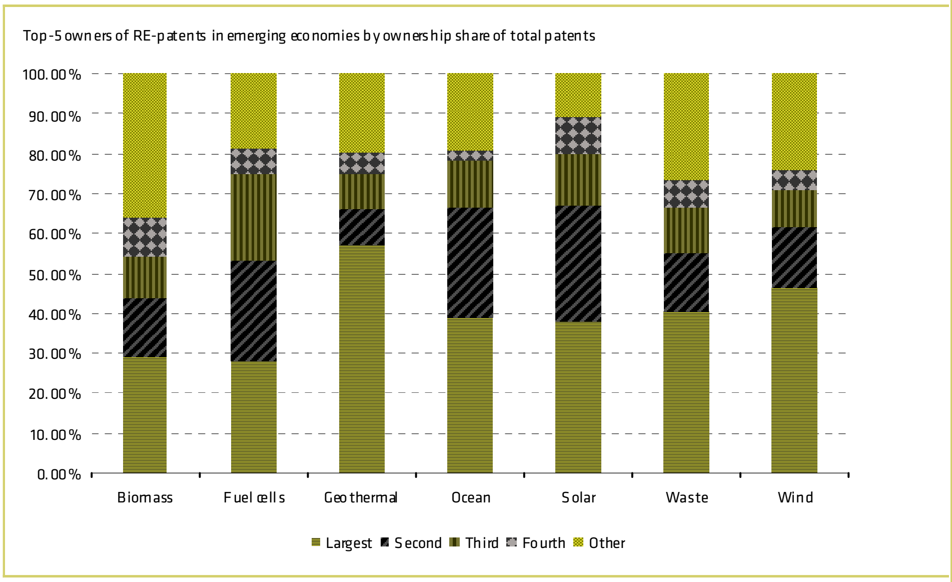
Secondly, no single country possesses control over all intellectual property which is protected. No economies will be in a position to bar others from accessing a given technology. For example for wind technology the country which designates most patents in developing countries accounts for only about 40 percent of all the wind technology patents designated in developing countries. The second, third and fourth largest patent holding nations account for 20 percent in total. The ownership of the remaining 40 percent of patents are scattered over a wide range of countries, cf. Figure 2.1. This suggests the presence of competition.[8]

In the case of developing economies, there is hardly any protected intellectual property regarding carbon abatement technologies.

[7] See Copenhagen Economics (2009) for details.

[8] It may even understate the degree of competition between different suppliers of green technologies because there is also competition between different firms residing in the same country.

Figure 2.1 Share of patents protected in developing countries held by the largest owner countries, percent, 1998-2008



Note: See Copenhagen Economics (2009) for a list of the developing countries used in the patent data analysis.
Source: Danish Patent Office.

Empirical evidence of positive role of IPR for technology transfer

IPR tends to be good for transfer of technology to developing countries. When firms believe that their intellectual property rights are safe, they will not be afraid to licence production to firms abroad or set up a subsidiary. The Vestas case presented in Box 2.2 provides an illustration of this.

Box 2.2 Vestas' IPR strategy

When Vestas set up production of complex components abroad, the foreign employees obtain key technical knowledge which they could in principle use to establish new companies which compete with their old employer, or which they can bring with them to competitors when they change job. Companies which develop in this way have not had to make any investment in developing the technology and the expertise, so they do not have old investments to recuperate and they can charge a lower price for their products.

Vestas wanted to avoid a situation in which the knowledge transferred by the company to foreign subsidiaries is turned to use against the company.

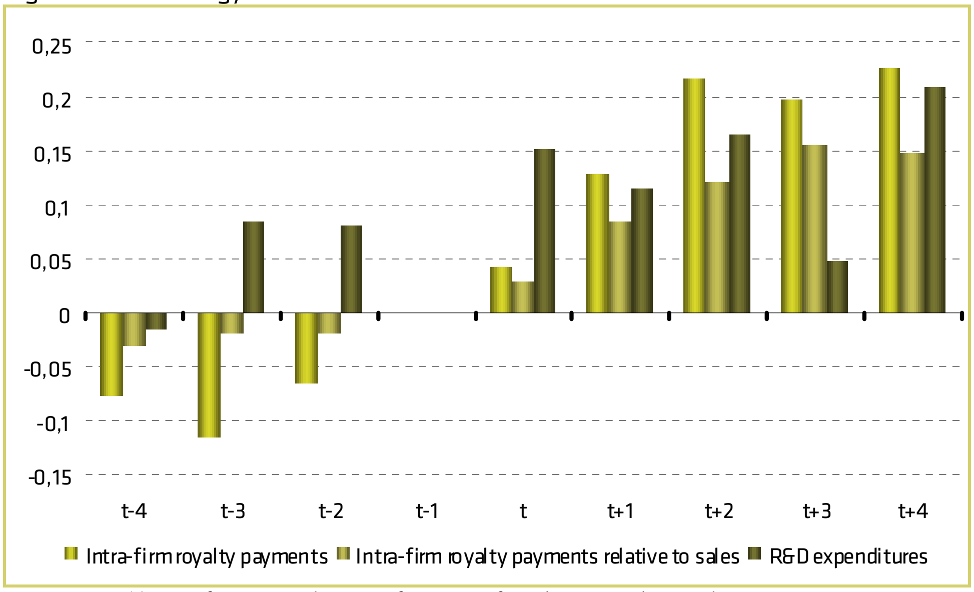
Intellectual property rights is part of the strategy, Vestas ended up using in order to avoid leakage of key technical knowledge to competitors. The international system for protection of intellectual property rights is well known and constituted a relatively cheap way of obtaining a high degree of certainty that inventions are safe from counterfeit when production is set up abroad.

Source:Interviews with Vestas staff conducted by Copenhagen Economics, September 2009

Literature gives some further evidence that the Vestas strategy on IPR is not an isolated case. Branstetter et al. (2002) has examined how the scope of technology transfer[9] within US multinationals changes as a consequence when a series of IPR reforms[10] in a country[11] are implemented.

Branstetter et al. (2002) found that royalty payments for the use or sale of intangible assets made by affiliates to parent firms increase when IPR legislation increase following IPR reforms. This shows that US multinational companies are more actively transferring intangible assets (that might or might not be protected by IP rights) to their own affiliates in other countries, after the country has strengthened its IP legislation, cf. Figure 2.2. The results from Branstetter et al. (2002) also suggest that trade is stimulated by strengthened IP legislation, because royalty payments represent the sale of IP rights between subsidiaries of a firm.

Figure 2.2 Technology transfer before and after IPR reforms



Note: At time 't' IPR reforms strengthening enforcement of IPR law are implemented.
Source: Branstetter et al. (2002).

[9] Technology transfer is normally defined as a comprehensive set of activities where a technology owner may on the basis of a concluded license agreement transfer rights to the use of a given technology to other persons or legal entities. In Branstetter article, the term "technology transfer" (most unusually) refers to the transfer of rights between company headquarters and group affiliates in other countries.

[10] IPR reforms which strengthen the IPR legislations

[11] Countries examined: Argentina, Brazil, Chile, China, Colombia, Indonesia, Japan, Mexico, Philippines, Portugal, South Korea, Spain, Taiwan, Thailand, Turkey and Venezuela.

In addition to the Branstetter et al. (2002) study, there is more evidence that IP generally facilitates technology transfer. We have summarized the findings from a selection of the literature in Table 2.3, which documents a predominantly positive effect that technology transfer increases following IP reforms, both through trade but also foreign direct investment channels.

Table 2.3 IP reforms facilitate technology transfer

Technology Transfer	Study	General Findings
Trade	Maskus and Penubarti (1995)	+ , 0 in patent sensitive industries
Trade	Fink and Braga (1999)	+, 0 for hightech goods
Trade	Smith (1999)	+ , - in patent sensitive industries
Trade	Co (2004)	+, - in high R&D sectors
FDI	Lee and Mansfield (1996)	n/a
FDI	Braga and Fink (1998)	0
FDI	Nunnenkamp and Spatz (2004)	+
FDI	Branstetter et al. (2005)	+
FDI	Mayer and Pfister (2001)	-
FDI	Javocik (2004)	+, 0 for low tech sectors

Note: "+" means that IPR strengthening results in more technology transfer. "-" means that IPR strengthening results in less technology transfer. "0" indicates no measurable effect.

Source: Park (2008) and Copenhagen Economics

Chapter 3 INNOVATION AND JOB CREATION

In this chapter, we present the empirical evidence of the general relationship between innovation and job creation in firms. Then, we explain the role IPR is likely to play in determining employment in European firms, and finally provide detailed estimates of current and new jobs created as a result of investment in various clean technologies.

3.1. INNOVATION, GROWTH AND EMPLOYMENT

Firms which innovate in both products and processes grow faster and are more likely to expand employment than non-innovative firms, regardless of industry, size or other characteristics (Pianta (2003)).

In Table 3.1 we have summarized further studies which give quantitative estimates of the effects. The studies show that innovative firms have, on average, higher employment than non-innovative firms. In particular, the study by van Reenen (1997) estimates that for each innovation, employment increases by 1-3 percent.

Table 3.1 Studies quantifying positive effects of innovation on employment

Study	Effect on employment
Greenan & Guellec (2003)	Innovative firms have 1.6 percent higher average annual employment growth
Harabi (2000)	Eco-innovating firms have 0.41 higher probability of higher employment than non-investing firms in the long run.
Horbach (2008)	An innovative firm has 0.61 higher probability of increased employment and a 1.04 higher probability of higher employment expectations
Van Reenen (1997)	For one innovation, employment increases by 1%-3%

Source: Copenhagen Economics

3.2. LOCATION OF NEW JOBS

In this section, we investigate the mechanisms that will likely shape the decisions about where to locate the extra jobs that will result from the innovative activities of European firms. IPR facilitates an increase in the global number of production jobs, but *a priori* it is not certain whether these jobs will be located in Europe or elsewhere.

European firms that wish to invest money in innovating in carbon abatement technologies will require two kinds of employees:

- R&D staff – to carry out innovative activities
- Production staff – to carry out production once the innovations have been successful

The new jobs in R&D are likely to remain in Europe. As IPR gives rise to more innovation, this in turn will increase the demand for employees capable of delivering innovation. IPR is thus good for the employment of highly skilled employees. Highly skilled jobs will tend to be located where the labour force is highly educated and experienced with carbon abatement technology. As argued in Chapter 1, the EU at present holds a very strong position as an early mover in carbon abatement technology. Therefore it is reasonable to expect that the EU will most likely experience job creation within these high skilled groups.

It is less certain how many production jobs will be created and whether these jobs will remain in Europe. Although it is likely that innovation will increase the demand for production employees, IPR can exert opposing influences on where production jobs will be located. This is because opposing forces are at work.

On the one hand, IPR may facilitate offshoring of jobs. IPR allows EU firms to offshore production and move technical knowledge abroad without the fear of 'technology leakage'. This argument indicates that IPR may be bad for EU production jobs.

On the other hand, IPR should not be seen as the culprit in the case of a potential job loss. Should there be no IPR protection, EU firms would have no choice but to move production to where the unit costs of production are the lowest – which may very well be outside the EU, cf. Table 3.2.

Table 3.2 Likely employment effects in R&D and production activities

Employment effects in EU carbon abatement technology industry	
R&D activities → positive	Production activities → uncertain

Source: Copenhagen Economics

IPR also reduces the risk of low-quality counterfeit products, which could give rise to negative image effects, cf. Box 3.1.

Box 3.1: IPR and licensing

Daimler AG expects to increase research and development efforts substantially in the future, and obtaining IPR protection of the company's technological developments is an integrated part of its innovation strategy.

The company stresses that a major concern relating to IPR protection is that weak IPR protection allows for the proliferation of low-quality counterfeit components. It is a great problem for the company when low quality counterfeit components suffer from defects, because of the negative image effects when the company's cars break down, even though the problems are due to counterfeit components. A strong IPR regime allows the company to control the quality of the production which is licensed to firms abroad.

Source: Interview with person in Daimler AG, Intellectual Property & Technology Management.

3.3. ESTIMATES OF JOB CREATION

We present estimates of the number of jobs that will be created at the level of the individual carbon abatement technologies. Table 3.3 gives (the current and) new jobs in the power generation sectors, while Table 3.4 covers the technologies that will be deployed in the building (construction), transport and industry sectors. The estimates of the number of new jobs are sourced following two approaches. The covered technologies are those which have been identified by IEA (2008) as the most likely ones to take a significant share of the required carbon abatement in the world – and hence for which a significant investment will be necessary.

The first approach was to carry out a thorough survey of studies, which report estimates of current and new jobs at the level of individual technologies. In particular, WWF (2009), ETUC et al. (2007) and Ecofys et al. (2009) provide a number of the figures.[12] All the sources we consulted are duly referenced in the notes to the tables and in the bibliography.

The studies contain both current as well as projected employment. Current employment figures reported in these studies have (where possible) been sourced from official statistical sources, including Eurostat. In cases where the technologies are not included as separate categories in statistics, the studies have interviewed experts in the industries concerned, e.g. in windmills or in the case of fuel cells, made a survey of the companies in the industry.

Regarding employment projections, we extracted those which conform to the required capacity to be installed by 2030, consistent with the 450 ppm scenario. The approach used in a number of sectoral studies has been to extrapolate current employment levels based on assumptions about the development in productivity levels and knowledge of the required capacity to be installed. More sophisticated modelling studies operate with additional assumptions of which the most important ones concern projections of energy demand, energy prices, and costs of installed capacity for the individual carbon abatement technologies.

The second approach we followed was to develop our own 'capacity based' estimates of new jobs. To do this, we followed a simple methodology, which was to assume that the number of new jobs will be proportional to the required expansion in capacity as given by the IEA (2008) and shown in Figure 1.1. We call these estimates "Based on IEA capacity projection".

Jobs in the power generation sector

Table 3.3 gives the overview of the energy generation technologies, including renewable energy and other energy technologies. According to IEA (2008), both of them are set to play a significant role in delivering abatement in the 450 ppm scenario in Europe.

Renewable energy technologies are expected to generate 2.4-3.2 million (the 2,360-3,235 thousand in the table) new jobs in Europe by 2030. The most important sectors in terms of new jobs will be the solar technologies: photovoltaic and concentrating solar power. Biomass and wind will be significant, though account for less new jobs.

Regarding the other energy generation technologies, most new jobs will likely be created due to the deployment of carbon capture and storage. While employment in carbon capture and storage is negligible today, the available sectoral studies estimate between 70-120 thousand

[12] ETUC et al. (2007) and WWF (2009) contain a compilation of figures from various sources, including sectoral studies. Ecofys et al. (2009) is a standalone modelling study.

new jobs in the UK and Germany alone. Hence, total new power generation jobs are estimated at 2.4-3.4 million.

Table 3.3 Current and new jobs in the power generation sector

IEA technology	Employment, today	Projected job growth, 2030		RDD&D in Europe, USD billion [h]
		Sector studies	Based on IEA capacity projection*	
Renewable energy technologies				
Onshore and offshore wind	110 [d e f]	260d [e f]	1,485	230-250
Biomass integrated gasification	30[d]	300[g]	375	25-30
Photovoltaic systems	52-90 [f]	1,300 [f]	650 – 1,125	45-55
Concentrating solar power (CSS)	20-30 [f]	500 [f]	250	85-95
Subtotal:	*212-260*	*2,360*	*2,760-3,235*	*385-430*
Other energy technologies				
Carbon capture and storage	-	70-120 [a b]	39	30-35
Nuclear power plants	71 [c]	-10 to +26 [c]	125	120-140
Coal integrated gasification combined cycle (IGCC) Coal ultra-supercritical steam cycle (USCSC)	34 [c]		41	180-200
Subtotal	*105*	*60 - 146*	*205*	330-375
Total energy generation	**317-365**	**2,420-2,506**	**2,965-3,440**	**715-805**

Note: Estimates for "solar space and water heating" from the buildings sector are included in "concentrating solar power" (CSS) in the power sector since separate employment estimates were not available. Estimates for IGCC and USCSC have been summed.

** Developed based on the IEA (2008) forecasts of capacity expansion.*

Sources:

a) 30.000-60.000 jobs in Germany by 2020, Prognos AG in WWF (2009)

b) 40.000 – 60.000 jobs in the he UK, NCE (2009)

c) ETUC et al. (2007). The current number of jobs is estimate of jobs in construction, manufacturing, installation jobs and excluding operations, maintenance and fuel processing jobs, ETUC et al. (2007) in table III.8, in 2010 under BAU. Projections are based on the P&M Wuppertal and EEALCEP scenarios in 2020.

d) Ecofys et al. (2009)

e) EWEA (2009)

f) WWF (2009), employment for electric and hybrid cars is estimated as production of fuel efficient cars with emissions below 120g CO2 per km.

g) European Commission (2007) in http://www.climatechangecorp.com/content.asp?ContentID=5328

h) IEA (2008), Chapter 3

Current and new jobs in buildings, transport and industry sectors

Table 3.4 gives estimates of current employment and new jobs in buildings, transport and industry sectors. Abatement in these sectors mostly concerns the implementation of various energy efficiency measures, but also new technologies such as hybrid cars in transport and carbon capture and storage in industry.

The bulk of new jobs will be sustained in the transport and buildings sectors. In transport, the new jobs will stem from increased fuel efficiency. Second-generation bio fuels are also poised to provide a significant number of new jobs. In construction, the bulk of new jobs will be in energy efficiency in buildings and household appliances. Jobs in 'energy efficiency in buildings' will be increased through the construction of new, efficient buildings and retrofits. The efficiency of household electric appliances will increase when the old stock of appliances, such as white goods and consumer electronics, is replaced with more efficient stock.

Table 3.4 New jobs in the buildings, transport and industry sectors

IEA technology	Employment, today	Projected growth, 2030 Sector studies	RDD&D in Europe, USD billion [h]
Buildings sector technologies			
Energy efficiency in buildings and appliances	15,700[j]	275-850[i] 1,000-1,500[j]	N/A
Heat pumps (geothermal)	12[d]	150[d]	30-35
Subtotal:	*15,700*	*1,425-2,500*	*30-35*
Transport sector (total)			
Energy (fuel) efficiency in transport	4,480 [k]	2,170 [k]	N/A
Second-generation biofuels	50 [l]	370 [l]	15-20
Electric and plug-in hybrid vehicles	150 [f]	N/A	815-920
Hydrogen fuel cell vehicles	1-2 [m]	N/A	758-960
Subtotal:	*4,680*	*2,540*	*1,588-1,900*
Industry sector			
Carbon capture and storage	N/A	N/A	14-16
Subtotal:	N/A	N/A	14-16
Total Buildings, transport and industry	20,000*	4,000-5,000	1,632-1,951
GRAND TOTAL (including Table 3.3)	20,500*	7,000-8,500*	2,343-2,754

Note: "Industrial motor systems" have been excluded from the table since neither the IEA investment figure is available, nor employment statistics or estimates.
** The grand total figure is rounded off to the nearest ½ million*

Sources:
i) Eurima in WWF (2009)
j) European Construction Industry Federation and Eurostat in ETUC et al. (2007)
k) ETUC et al. (2007), for energy efficiency in transport ETUC estimates total employment in the transport sector.
l) First and second generation bio fuels, projection by 2010, EREC in WWF (2009)
m) PWC (2009), approximated as total employment in the fuel cell sector in Europe
n) Extrapolative projection assumed based on IEA (2008) expected expansion in installed capacity.
o) For coal technologies in general, the IEA expects the need for a 20%increase generation capacity.1

The number of jobs created in transport may seem large. However, the area of energy efficiency in the automotive industry is highly prioritised as illustrated by the Daimler AG case interviews already mentioned in the previous parts of the report. This is further demonstrated by the fact that Daimler AG does not expect e.g. the current financial and economic crises to affect its research and development effort in this area.

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APPENDIX

Table 3.5 Scenarios used in employment projections

Study	Scenario description
IEA (2008)	BLUE scenario: IPCC recommendation to reduce emissions by 50-80% by 2050 to contain global temperature rise to 2 – 2.4°C – consistent stabilisation in atmospheric CO_2 concentration at 450ppm.
CE capacity based projection	Required expansion of energy generation capacity according to IEA's BLUE scenario
Ecofys et al. (2009)	Accelerated deployment policies (ADP) include policies designed to meet the agreed EU target of 20% renewable energy generation by 2020, on the EU and national levels; a continuation of national renewable energy policies is assumed until 2030. Consistent with the BLUE scenario.
WWF (2009)	EU official target from the December 2008 climate and energy package (20% CO2 emission reductions by 2020 relative to 1990 levels, rising to 30 if other industrialised countries join the effort), and increasing the share of renewables of all primary energy consumed by 20 percent. Consistent with the BLUE scenario.
ETUC et al. (2007)	ETUC et al. (2007) are consistent with the EU goal for 20% renewable energy in 2020 and the 450ppm scenario. The study reports projections based on two scenarios that are compatible with the ambitious EU targets: the P&M Wuppertal and EEA LCEP.

Source: Copenhagen Economics based on the sources