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Intellectual Property: Cross-licensing, Patent Pools and Cooperative Standards as a Channel for Climate Change Technology Cooperation

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Abstract

This paper focuses on an additional dimension that is always present when technology cooperation is discussed in political terms – or for that matter explored in industry or academic environments: the question Intellectual Property Rights (IPRs) IPRs are seen by one group of stakeholders as potentially inhibiting or slowing down technology transfer and technology diffusion rates through exorbitant licensing rates, high information and negotiation costs for obtaining technologies, and even deliberately strategically blocking of the use of technologies by patent owners. Another group of stakeholders points to the role of patents in incentivising innovation, ensuring that firms' R&D investments receive adequate return on investment, thus ensuring commercial deployment of existing technologies and incentivising future investments. We take a fact-based approach by exploring how in practice industries have dealt with IPRs, and explore the linkage between different IPR strategies with broader industry business models that have worked well in stimulating innovation and technology diffusion in other industries

Keywords Intellectual property,technology

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Intellectual Property: Cross-licensing, Patent Pools and Cooperative Standards as a Channel for Climate Change Technology Cooperation

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ISDA Project

This paper is part of the project International Support for Domestic Action (ISDA). Case studies from five developing countries assess the barriers and drivers of actions that shift individual sectors onto low-carbon growth paths. Five cross-cutting papers then explore how international financial mechanisms, technology cooperation, intellectual property aspects, and suitable monitoring and reporting arrangements can enhance the scale, scope and speed of their implementation. The project is coordinated by Karsten Neuhoff, University of Cambridge; individual reports are available at http://climatestrategies.org/our-reports/category/43.html.

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1. Introduction

In the run-up to the Copenhagen negotiations, international technology cooperation is seen as one of the key drivers for a globally successful decarbonisation strategy. This will require both a rapid development and improvement of low-carbon technologies and their adoption and diffusion globally, including in developing countries. It has become increasingly accepted that adoption and diffusion of technologies in developing countries crucially depends on creating a suitable enabling environment; including regulatory structures, capacity building and access to finance. Many of the issues related to North-South and South-South technology cooperation are explored in greater detail in country case studies in the Climate Strategies project 'International Support for Domestic Actions'[1].

This paper focuses on an additional dimension that is always present when technology cooperation is discussed in political terms – or for that matter explored in industry or academic environments: the question Intellectual Property Rights (IPRs) (Tomlinson, Zorlu and Langley 2008; Lee, Iliev and Preston, 2009). IPRs are seen by one group of stakeholders as potentially inhibiting or slowing down technology transfer and technology diffusion rates through exorbitant licensing rates, high information and negotiation costs for obtaining technologies, and even deliberately strategically blocking of the use of technologies by patent owners. Another group of stakeholders points to the role of patents in incentivising innovation, ensuring that firms' R&D investments receive adequate return on investment, thus ensuring commercial deployment of existing technologies and incentivising future investments. In this view, patents are part and parcel of well functioning business models and corporate strategies (in both developed *and* developing economies), and tinkering with the patent system would result in increased uncertainty, further decreasing the incentives to invest in new technologies and transfer these to developing economies. Rather than taking a side with either of these groups, in this paper we take a fact-based approach by exploring how *in practice* industries have dealt with IPRs, and explore the linkage between different IPR strategies with broader industry business models that have worked well in stimulating innovation and technology diffusion in other industries (see Annex 1). We hope that lessons from successful IPR strategies can contribute to increasing consensus around IPRs in Climate Change negotiations, as well as to developing engagement strategies with industry in the low-carbon energy space.

In particular we focus on how other industries have used co-operative IPR arrangements as a way of 'cutting through' patent thickets, avoiding patent hold-ups in innovation, and accelerating the adoption of new technologies. We refer to co-operative IPR practices as the range of cross-licensing, patent pooling and technology standards agreements that are (a) backed by IPRs owned by companies, and (b) result in open (but not necessarily free) access to such IPRs by companies that are *not* part of the initial agreement (i.e. it is not a 'closed club'). Co-operative IPR arrangements have occurred in areas as diverse as aircraft manufacturing, semi-conductors, mobile telecommunications and electricity metering: industries that have seen significant rates of growth in innovation and technology diffusion, *as well* as a high-level of patenting activity. We provide initial evidence – using an albeit limited number of case studies – to discuss the question of whether:

(i) Co-operative IPR arrangements (cross-licensing agreements, patent pools and standards agreements) accelerate the development and diffusion of a technology?

We first provide an overview of the diverse strategic uses of IP by private sector actors followed by a summary of key factors that may be used to identify industries which are 'ripe' for cross-licensing, patent pool or co-operative standard setting. We then use two case studies of standards management bodies to illustrate how in practice a co-operative technology standard may emerge, with different levels of engagement of the public sector. We then use the emerging insights to discuss whether:

[1] http://www.eprg.group.cam.ac.uk/isdahome/

(ii) Cross-licensing agreements, IPR pools and patent-backed co-operative industry standards are essential for a rapid adoption and diffusion of a technology in developing countries?

Multiple interests can induce leading firms in a sector to initiate such co-operations, and anecdotal evidence suggests that this has contributed to a rapid improvement and broader diffusion of the technology. So in some low-carbon energy areas industry players themselves may come to adopt one of these co-operative IPR sharing mechanisms. However, there may be situations where high co-ordination costs, uncertainty about future markets and technology trends, and lack of interest by key players may delay or block the initiation of such IPR-sharing mechanisms. The paper raises the question of whether additional public intervention might be warranted to facilitate or accelerate the development of IP pools and open access to industry standards. This might be of relevance for the global advancement of low-carbon technologies but even more so for the adoption and diffusion in developing countries.

Where it is determined that there is a need for public policy intervention to accelerate or initiate the formation of such co-operative IPR agreements, the private sector may not yet be in a position (or may not be willing) to provide a self-governance structure. In such cases, it is important to consider what governance structures may be available for the public sector which on the one hand achieve the objective of accelerated formation of IPR sharing arrangements with effective governance structures, while on the other creating the opportunity for a 'handover' to the private sector when markets are mature, and self-interest is aligned. We hope that further exploring such options for public policy interventions facilitate the development of vibrant markets that would support the development and deployment of low-carbon energy technologies .

2. The Impact of Co-Operative IPR Arrangements: Some Examples

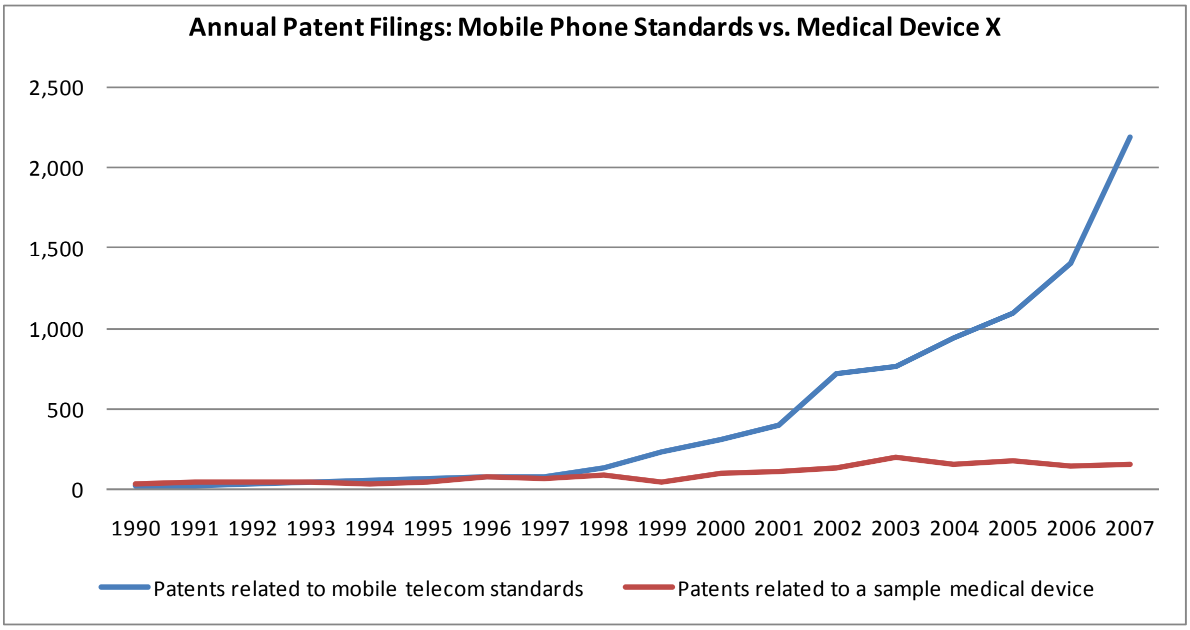
Technology Standards: Mobile Telecoms

Co-operative technology standards arrangements are formed by groups of key players who agree to provide access to each others' IPRs with the purpose of stimulating the adoption and diffusion of a particular shared or complementary technology, in return for a modest royalty (or even for free). Patent-backed technology standards are formed around key technology system intersections where interoperability between system components is a key concern. Well known examples include the GSM and Bluetooth telecoms standards, the VHS and Compact Disk formats, the TCP/IP protocols in internet communications, Symbian Smartphone software system, or the USB plug in laptops. By contrast, 'proprietary standards' represent cases where technology owners have chosen to keep a standard closed to other participants: the Apple Mac, Gillette razorblades, or the testing kits for medical diagnostic devices. Proprietary standards often become market dominant after a standards war (such as the VHS vs. Betamax war in the 1980s), or co-exist over time leading to duplication. Where such a proprietary approach has been successful, it has allowed the technology owners to charge a price premium, and benefit from lock-in of consumers into the technology. Such business models may be expensive to protect and maintain: e.g. through patent litigation, but also by competing against other proprietary standards.

The linkages between technology standards adoption, economies of scale and accelerated technology diffusion have been considered before in the academic literature (Arthur, 1994; Kirsch, 1997). Yet the question we are considering here is slightly different, as it relates to the adoption of technology standards *in the presence* of strong IPRs by leading technology players. Our research shows anecdotal evidence of how in such cases the adoption of standards (backed by cross-licensing agreements or patent pools) may indeed lead to accelerated technology development.

Figure 1 illustrates this point, comparing patenting trends between two technology spaces. First, patents related to mobile telecoms standards (GSM, GPRS, 3G, WiMax and other telecoms standards), the technology space that falls within the remit of ETSI (European Telecommunications Standards Institute). Second, patents related to a specific medical devices field, which is characterised by proprietary and vertically integrated systems, dominated by a small number of players[2]. To ensure some level of comparability, the medical devices application relates to a mass use self-diagnostic need for a clinical condition common to both developed and developing economies.

Figure 1: Comparison of Patenting Rates Between Industries with co-operative and non-cooperative IPR Arrangements



Source: Cambridge\IP research

In the early 1990s annual patenting trends in the two fields were broadly similar. While ETSI was founded in 1988 and the GSM standard was launched in 1992 in Finland, it was only in the late 1990s that patenting rates for the mobile-related patents accelerated. In that same period the mobile telephone industry experienced explosive growth, accompanied by accelerating rates of innovation, decreasing equipment costs (both phone sets and switching equipment), *and* the rapid adoption of the technology in developing countries. By contrast, patenting in the medical devices space has remained broadly at the same patenting rates, and even dropped in 1999. While revenues by the main participants have increased, penetration has remained broadly focused on developed economies, despite a large potential market in the developing countries. Key players in the medical devices industry are now investigating ways of emulating the success of the mobile telecoms by seeking to accelerate the adoption of industry standards[3].

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[2] For reasons of respondent confidentiality, the medical device industry cannot be named and the interviewees' names have been withheld. The case study draws on strategy consulting work conducted for a corporate client. The strategic considerations of the engagement support our broad argument that frequently private sector companies themselves *would like to* move toward a cross-licensing/shared standards situation, but are hindered by high co-ordination costs, vested interests, fears of cannibalisation of existing revenue streams, and other lock-in factors.

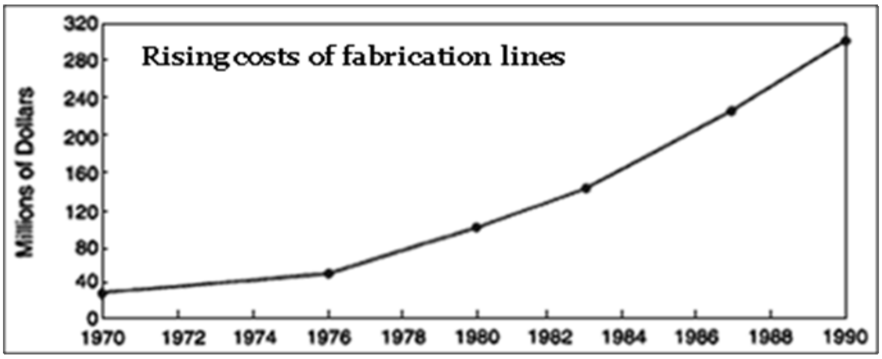
[3] A related initiative, the Continua Alliance is an umbrella organisation of medical device manufacturers, healthcare service providers and telecoms companies that is focused on ensuring inter-operability of various medical diagnostic devices.

Cross-Licensing: Semi-Conductors

The semi-conductors industry provides another example of the impact of a cross-licensing agreement. As technology complexity increased, increasing number of in-house technologies had to 'borrow' from others' developments. Strict adherence to non-infringement would have slowed down innovation in the industry *or* led to series of lawsuits. Cross-licensing was a way of ensuring strong synergies in IP portfolios were captured by the industry as a whole (rather than dissipated through litigation). Hence the 1980s saw a series of industry cross-licensing agreements that allowed the big players to share risks, avoid litigation, but also attracted a number of new players in the industry. One way of measuring the impact of a cross-licensing agreement is by looking at the value-chain composition. A cross-licensing agreement allows companies to move away from an (expensive) vertically integrated model, towards a diversification of the specialism's of key players. By that measure the cross-licensing agreements in the semi-conductors industry have had a major impact: while in 1980s 95% of semi-conductor equipment was made in-house by chip manufacturers, by the 1990s this number decreased to only 7%: as a result 90+% of the industry became 'fabless'. Some design-based businesses such as ARM rely entirely on licensing revenues as a source of revenues, while semi-conductor fabrication lines can serve multiple clients and multiple chip designs. A study of the impact of US-Japanese corporate cross-licensing agreements concludes:

> "For Japanese companies, the immense benefits included crucial time saved, large uncertainties were eliminated, promising R&D pathways were clarified, there was rapid movement down technological and commercial learning curves, resources were freed to focus on incremental adaptations, and new commercial opportunities opened up. Without the infusion of key foreign technology, Japanese industry probably would have advanced less rapidly and not as synergistically across so many fronts." (US Offices of International Affairs, 1992)

Figure 2: Rising Capital Costs of Semi-Conductor Industry



Source: Kogut, 1991

Further research in this area is needed to systematise the evidence about the impact of specific forms of co-operative IPR agreements on innovation, value-chain evolution and product costs. The purpose here is to demonstrate on an anecdotal basis the types of impact that such industry agreements can have on a new industry.

Potential Negative Impact: Examples

In the past also some negative outcomes have been associated with standards adoption. In the context of this paper, these standards fail on the point of being non-cooperative: rather it was the case of either a single industry player pushing through the adoption of a proprietary (non-shared) standard, or a group of dominant players setting up a closed patent pool.

Anti-trust: A frequent consideration raised against technology standard bodies or patent pools is the possibility of a cartel being formed, or other anti-competitive behaviour being exercised. This was the reason that the US automotive industry had to abandoned attempts at establishing shared standards in the 1950s. There are likely to be many other standards or patent pool negotiations that never came to light as participants determined that these would not pass anti-competitive standards. While such considerations continue, IP practitioners have identified standards formation practices that notify at an early stage anti-trust bodies[4].The most important aspect is that the resulting technology standards bodies are open to outsiders to enter, allowing for he use the technology under the fair and reasonable terms (discussed below).

Monopoly power: One example relates to the role of Unocal in promoting the adoption of a gasoline formulation as a standard by the California authorities as the CARB-2 standard in the mid-1990s. In a subsequent Federal Trade Commission lawsuit, during the standards-setting process Unocal misled the California authorities, saying that formulations around the CARB-2 standards of gasoline were not proprietary. Once the CARB-2 standard was adopted it emerged Unocal had obtained patents on the process and began to charge others to use it, and suing other competitors for patent infringement. Unocal initially won a patent lawsuit, but that was subsequently overturned by the Federal Trade Commission (Stern, 2004). In 2003 the FTC accused Unocal of fraudulent and anticompetitive practices in obtaining patents for the production of cleaner-burning gasoline, a dispute that was won by the FTC[5]. From this paper's perspective, there are several shortcomings in this standards setting process: Unocal had not contributed essential IPR to the standards and there was no formal standards governance structure that would ensure fair access to other participants.

3. Key Corporate Motives for Adopting Co-operative IPR Practices

It is not inevitable or automatic that co-operative IPR arrangements will emerge in an industry: There are numerous examples of industries or market segments with vertically integrated and proprietary technology systems which are plagued by numerous patent lawsuits between competitors or by patent trolls, where patent pools cannot emerge due to anti-trust considerations, or a standards agreement simply does not make sense. And it is not necessarily the case that technology standards are always the best route for a technology system's development. It is therefore important to consider the types of conditions under which an industry is most likely to move toward any one of the co-operative IPR sharing forms we discussed. These sets of conditions can provide policy and industry participants in the low-carbon technology space with a set of criteria that can focus engagement efforts with the private sector where the positive impact is likely to be maximised. For instance, a push for standards at a too early stage may lead to lock-in into inferior and underdeveloped technologies, while a push too late may see high switching costs from proprietary systems. A policy push for cross-licensing in an industry where there is little use of such IPRs may lead to waste and conflicting incentives for key players.

Table 1 lists some of the reasons cited by corporate players for their entry into co-operative IPR arrangements. Firstly, cross-licensing can be a source of revenues from royalties from the use of their IP within a broader patent pool of a technology standards agreement. Avoiding the risk of litigation is another important factor: for major corporate players working in the same space increasing complexity of technology systems increases the chance of patent infringement, as innovation spreads across an industry. Correspondingly, major players in the semi-conductors or motor vehicle industries have implemented cross-licensing agreements to manage the risks of litigation: and allow a focus of resources on innovation within an industry. In addition, the setup of cross-licensing/patent pool agreements with easy and accessible licensing terms makes it easier for newcomers to pay a royalty fee than to run the risk of patent. In exchange for the royalty payments, companies may also gain access to various value added resources that further facilitate innovation. Initiators of technology standards may also focus on remaining a technology

[4] See Deparment of Justice's anti-trust guidelines for licensing of IP: http://www.usdoj.gov/atr/public/guidelines/0558.htm
[5] See coverage by New York Times and San Francisco Business Times in references for more detail.

leader: where the technology is provided to the market at a relatively cheap rate (cheaper than the invent-around option) the leader achieves a higher number of adopters of a technology. That in turn provides the standards initiator with exposure to innovation and user needs across a much larger part of the market-place, and possibly rights of use of other participants' complementary technologies. Thus the ecosystem around a particular technology standard becomes continuously enriched, ensuring continued market leadership of the technology at a lower overall R&D cost to the standards initiator. Frequently, such an ecosystem may be challenged by another 'big gorilla' entrant: for instance iPhone's entry (with Apple's innovation ecosystem) represents a challenge to Nokia's Symbian Smartphone operating system and supplier network. Here the leader/'owner' of the ecosystem continues to invest in leading and maintaining a standard, possibly even licensing out the core IP for free to entrants in the alliance as a strategic defence against another major ecosystem developing. Finally, the use of cross-licensing patent pools and dynamically updating technology standards can facilitate continued increase in the applications of a technology. For instance the Symbian Smartphone system has expended from mobile telecoms and e-mail to digital content provision, payment systems and music content management. Similarly, the ETSI body (discussed below) was initially set-up to cover only mobile telecoms and 2-way radio communications in their traditional domain, but its mission has expanded to cover E-Health and intelligent transport systems.

A key implication therefore is that *in practice* corporate players across many industries have developed complex and highly strategic uses of IP that does not fit the more simplistic picture of the role of patents in corporate strategy that policy makers occasionally hold: as primarily consisting of patent litigation and threat thereof. In many of the co-operative IPR examples we have examined corporate participants may be foregoing short-term revenue opportunities in favour of improved positioning in a market, continued leadership in the value chain, exposure to market innovation and so on. While patent litigation takes place, its purpose is frequently strategic and in support of a broader IP strategy. It is not a default action or reaction.

Table 1. Strategic Drivers for Entering into Co-Operative IPR Arrangements

Considerations	Rationale	Examples
Remain a technology leader	In a rapidly changing industry, remain at the head of technology change	Motorola: semi-conductor cross-licensing
		Nokia: licensing of technology to Siemens
Avoid litigation (defensive and offensive)	Low-cost/reasonable royalties for use of technology: for industry players it is cheaper to license than to risk litigation	Motorola: non-discriminatory/blanket 5-year renewable agreements to both competitors and others
Accelerate innovation	Expose your technology to greater number/type of users	Nokia: licensing of technology to Siemens
Revenue generation	Unilateral licensing out of key IP can generate significant revenues	Motorola: semi-conductor licensing was generating $50mln p.a. in 1990s
Protect value chain against big outsider entrants	Meet challenge to leadership *outside* of industry – retain leadership of the industry	Nokia licensing of S60 platform to counter Windows Mobile entry threat
		Symbian Foundation: royalty-free licensing model to protect against Google Android & Apple
'Increasing the pie'	Change model to redefine the market boundaries & increase services accessible on back of platform	Revenue sources for Smartphones are changing from calls to data and content – even payment services (e.g. Visa mobile payments solutions)

Source: CambridgeIP interviews of industry experts

4. The Governance and Dynamics of Co-operative IPR Practices: Case Studies

So far we have illustrated some of the key corporate strategy drivers behind the development of standards and cross-licensing agreements. Yet technology standards are not automatically adopted and maintained: high transaction and co-ordination costs and different incentives structures by participants require the adoption and maintenance of complex governance structures. What makes such governance structures effective in implementing the technology standards/agreements in the market place, and keeping them up-to-date and relevant? And is there a role for early standards adoption in technologies at an earlier stage of development? We use two case studies to show how in practice technology patent pools and co-operative technology standard bodies function. In the early stages of a technology's development much of the governance may be provided by a leading player or strategic alliance leader. Here we consider the case of a Eskom, a para-statal company, which led the pre-paid meter development. Once a technology is relatively mature and there is a critical mass of major private sector players, the governance role can be played by a 'standards management' body which acts on behalf of its key stakeholders. The ETSI case study is shows the dynamics around the evolution and maintenance of such a body, while the STS Association in pre-paid metering shows how a strategic leader (ESKOM) can 'hand-over' a technology standard to the market through such a standards management body.

4.1 Case Study 1: Communications Standards and the Mobile Telecoms Industry: European Telecoms Standards Institute (ETSI)[6]

The European Telecommunications Standards Institute (ETSI) is the leading standards-setting and management organization of the telecommunications industry. Created 1988, its initial purpose was around the management and dissemination of the GSM standard and 2-way radio communications. Gradually, ETSI's activities have expanded over a wide range of other standards, including 2G/GPRS/2.5G, 3G,Wi-Fi, GSM for rail and air travel, E-health, and emergency services radio communications (TETRA standards). While initially the organisation was focused on Europe, its mission has expanded *de facto* to cover the promotion of standards globally. It has a global membership of around 700 equipment manufacturers, software developers, network operators, regulators and other key stakeholders in the industry. The organisation is independent and not-for-profit, but frequently works closely with EU and other regulators and policy makers. By the end of 2007 ETSI had published close to 20,000 standards, reports, specifications and technology guides (ETSI 2008)[7].

4.2 Governance Structure

Contributors and Management of IP: Underpinning the telecoms standard is a patent pool of IP contributed by the participating members in a telecoms standard. Upon joining a particular standard, contributing members allocate the 'essential IP' to the patent pool. If they choose to 'opt out' they will be unable to use IP on the same terms as other contributing members. Where a company has joined the standard but found at a later point not to have disclosed all the 'essential IP' to the patent pool, members gain automatic access to it. The contributed IP to a pool is maintained by an online registrar to which all members of the association (full and associates) have access to. ETSI manages the IP on behalf of its members, and users of the technology pay royalties for using the standard in their equipment to the patent owners. Licensing is guided under the FRAND (Fair, Reasonable and Non-Discriminatory) terms guidelines: ensuring a relatively low level of royalties is paid in aggregate by all participants, but also that competitors

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[6] This section is based on Interviews with a former senior IP counsel for Motorola, and IP partners of law firm specialising in telecoms., as well as desktop research.
[7] ETSI's 2007 budget was €22.5mln, coming from a mixture of membership fees and research contract revenues (ETSI 2008).

and non-competitors alike have similar terms of access to the technologies. The royalties issue can become difficult when there is a larger number of players that would require license royalties: which became an issue with 3G where the cumulative sums could reach up to 30% of overall manufacturing costs.

IPR Disputes: The presence of a standards body does not prevent the occurrence of IPR disputes. It may be that non-participants challenge individual association members against their use of IP, or that disputes arise around the boundaries of essential IP, or about the countries where the contributed IP is used. At the same time there is a perception that a critical mass of large players who have interest in maintaining the stability of the association provides some 'protection' to smaller members (or developing country participants with lower levels of resources or experience in dealing with complex IP disputes).

- **Disputes around essential IPRs:** As a particular technology standard is drafted and released, participating members are required to identify the 'essential IPR' that they are contributing. While they will receive royalties for the use of such IPRs, they will be unable to allege infringement by other companies, or attempt to block its use. In some cases, subsequent to a standard's definition ETSI members have sought to redefine or clarify the boundaries of essential IPR, so as to define the IPR boundaries over which they have discretion. While ETSI has a mechanism for adjudicating in such disputes, in some cases ETSI members have used patent litigation alleging infringement. Over time essential IPR rules have been clarified to minimise ambiguity in the definition of essential IPRs.

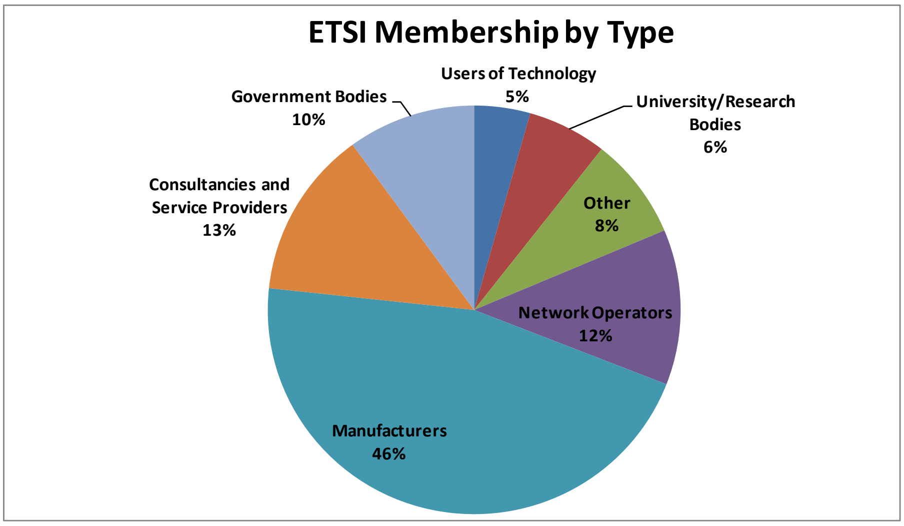
- **Disputes around royalty rates:** The FRAND definition of 'fair and reasonable' is intentionally vague in not specifying specific royalty rates that would apply in all circumstances: the value and role of a technology differs on a case-by-case basis, and it would be difficult to define a blanket royalty rate to address all circumstances. Therefore there may be disputes between alliance members around the exact level or royalties that should be paid. On a case-by-case basis licensing specialists would typically use benchmarks and past cases to define 'fair and reasonable'. Another option in patent pool arrangements has been for the initial contributing members to agree on a one-off 'equalisation charge' that would recognise the higher level of importance of essential IPR contributed by some members, and a blanket royalty rate to be shared by the members thereafter.

- **Disputes around boundaries of application:** Members may also perceive ambiguities about the boundaries of application of a technology (by industry or geography). For instance when ETSI rolled out the MPT 1327 2-way public safety standard radio communications standard, there was a dispute around whether it should be global or only cover the EU. Motorola (a key contributor of essential IP) tried to limit the standard's use into US, as it conflicted with its own products sold in the US. This led to legal action between Motorola and importers of equipment into US. ETSI rules and practices were clarified to show that the intended standards use is global.

Processes for Adoption of Standards: Over time ETSI has added or initiated investigations around many other standards. ETSI members can come to the organisation and make suggestions about areas of standardisation, possibly based on their own technology. In addition, the organisation itself monitors areas of priority identified by members for standardisation developments through various sub-committees: for instance into E-Health or Intelligent Transport Systems. The organisation periodically releases new standards when these have gone through the standards management and definition process, and essential patents have been defined and agreed on.

Membership and Influences: While the underlying IP is contributed predominantly by manufacturers, the membership composition is diverse. The complexity of membership indicates the strong interest by different stakeholder types to get early exposure to changes in a standard, exchange knowledge about technologies, as well as influence the direction of research. While cross-licensing agreements and standards are typically the result of private sector initiatives, at least in the case of ETSI there is a substantial involvement by public sector organisations, regulators and public sector research. In addition, there is a relatively high level of participation by developing country organisations. The governance structure of the organisation and its various functions have seen it play a role in moderating potential trade disputes between the US and EU, as well as to facilitate the solution of potential IP litigation. In addition, the participation by manufacturers, service providers and regulators from developing countries have facilitated the diffusion of the telecom standards in these economies for users as well as in locally manufactured products.

Figure 3: Membership Composition of ETSI by Type



Source: ETSI Website, 2008

Manufacturers come from 30 countries, network operators from 34 countries, and Universities and Research Institutes from 21 countries. While the geographical origin is predominantly within the OECD, there are a number of important non-OECD participants across all three types. Consider the composition by country of manufacturer members[8]: while the UK, Germany, USA and France account for close to 60% of all manufacturer members, there are 43 Universities or other research bodies from 21 countries, and 86 network operators from 34 countries. The high levels of diversity in member types and countries of origin contribute to ETSI's role as a key knowledge transfer and community formation mechanism. The strategic reasons for participating in ETSI differ by member types. Manufacturers, as the initiators of the standards association and as most important contributor of IP play a central role in determining the types of activities. Telecom regulators and other public sector entities are able to get sight of future market developments while these are at the drawing board, and influence the direction of standards development. Telecoms operators/service providers have a key interest is to remain at centre of revenue streams, and so seek to understand and influence how different standards impact their value chains.

Table 2: Geographical Composition of Manufacturer Members of ETSI

Manufacturers by Country		*Manufacturers by Country*	
Country	**Number**	**Country**	**Number**
Total	***324***		
UNITED KINGDOM	62	ISRAEL	5

[8] ETSI membership can be full or on an associate basis. In our analysis we merged the full- and associate-membership types.

GERMANY	46	JAPAN	4
UNITED STATES	45	CHINA	3
FRANCE	40	NORWAY	3
NETHERLANDS	15	SPAIN	3
SWITZERLAND	14	TURKEY	2
DENMARK	12	CZECH REPUBLIC	1
ITALY	11	GREECE	1
FINLAND	9	INDIA	1
SWEDEN	9	LATVIA	1
BELGIUM	7	LIECHTENSTEIN	1
CANADA	7	POLAND	1
TAIWAN	7	ROMANIA	1
IRELAND	6	RUSSIAN FEDERATION	1
AUSTRIA	5	SLOVENIA	1

Strategic Drivers for the Establishment of ETSI

The different participants in ETSI had different rationales for pushing for the establishment of a standard. For manufacturers (the contributors of the majority of essential IPR to ETSI), the impetus behind the establishment of the standard was the desire by various telecoms equipment manufacturers to capture economies of scale through the consolidation of geographical markets. It was initially EU players that decided to internationalise. Players such as Siemens, Alcatel, Ericsson and Nokia all had leading market shares in their home markets, but a limited market share elsewhere. For them the consolidation of the standard in Europe would increase the market size, but from the outset they also sought to extent the standard outside of the EU. By contrast, US players such as Motorola saw GSM as an ‘EU-only problem’. It was the desire for globalisation and multiplying the marketplace that pushed cross-licensing: increasing opportunities for manufacturing. Similarly in the ‘safety services communications’ standard market, the UK, Netherlands and other countries each had a different standard. The consolidation around the MPT1327 standard allowed a scaling up of the market. The establishment of common standards also allowed the entry into the mainstream of otherwise niche technologies and product features: providing more opportunities for product differentiation.

Motorola's IP Strategy Evolution: Cross-Licensing to the GSM Standard

Motorola is one of the founding members of ETSI and a key contributor of IP around the GSM standard (and others). Motorola's IP strategy varied between industries. It was one of the initiators of cross-licensing agreements in the semi-conductors field, yet in other fields such as radio communications for emergency services it was less willing to cross-licence. Motorola was willing to license IP related around mobile telecoms (and contributing to the GSM standard). However, SMS services were seen as impinging on its major paging business (especially in the US): Motorola's technology transfer policy was that a firm-wide technology transfer board would review potential licensing deals, so that licensing activities by one business unit would not hurt the interests of another. The company attempted to exclude all paging issues from any commitments to grant licenses from ETSI standard. Through various interactions with ETSI, it was determined that ‘SMS is not directly competitive/affecting paging business’, and so the licensing to ETSI went ahead. There was an additional strategic imperative, as a Motorola respondent noted: “Motorola knew it had to get in the middle of standards so as to control the direction of the industry; a key thing – otherwise you'd be separated from the rest of the world”. The entry into a standards body may also involve a cultural shift for some of a big player such as Motorola, who may have had a more aggressive approach to cross-licensing. As a former Motorola representative to ETSI explained: “Motorola had to transform itself from a:

‘difficult adversary’ into a cooperative and supportive player”.

Operators: A key consideration of initial operator participants was to increase the diversity of their supplier base. Consolidating the market would lead to the entry of many more players to choose from. As the products evolved, participation in the standards body also allowed inputs into the types of user features that were included in the standard designs, as well as considerations about their value chain.

Problems / Weaknesses:

As the organisation's mission has expanded the complexity of operations and interactions between members have increased. It became at times difficult to get things into standards, due to the large number of players. A large portfolio of new standards is underpinned by an increasing in size patent portfolio: correspondingly the complexity of overlapping claims has increased, and with it the risk of patent conflict. Some participants have argued that the there is a significant scope for ambiguity in the interpretation of the FRAND guidelines, possibly leading to hold-ups and high royalty fees[9].

4.3 Case Study 2: South Africa's Pre-Paid Metering Program and the STS Association[10]

Background

In the early 1990s South Africa's state-owned power utility ESKOM launched a major residential electrification programme of poorer areas. A major problem identified early on was the absence of a billing infrastructure, as well as the prohibitive cost of traditional manual meter reading. ESKOM therefore identified a need for secure and low-cost pre-paid meters which could be fitted at the newly connected areas. No such technology existed globally, as existing solutions were primarily developed for developed economies.

ESKOM embarked on a strategic technology development programme, whereby it assembled an alliance of domestic electronics manufacturers for the development of the new technology system. ESKOM's key leverage for stimulating the engagement by alliance members was through a pre-commitment to purchase over 1 million meters from the device manufacturers over a decade, if these fulfilled certain basic initial criteria. In addition, it used a mixture of subsidies and providing access to R&D facilities, and ensuring that the 'club members' would share knowledge: accelerating product development.

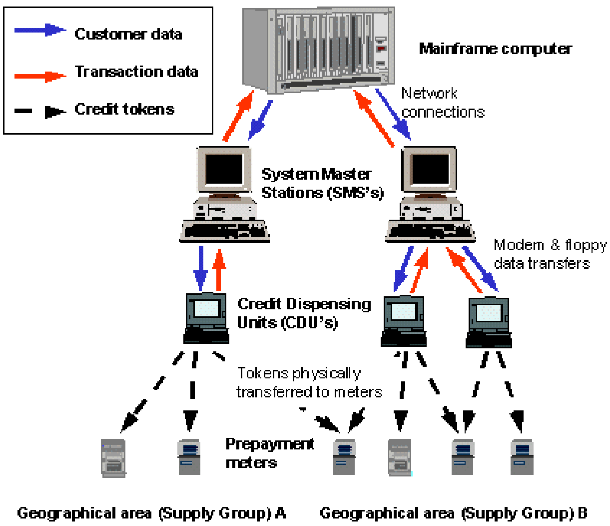
Today the pre-paid metering technology is globally adopted in both developed and developing economies. The technology standards embedded in the system have been adopted by the International Electrotechnical Commission as a standard. Most of the original developer companies were bought by Multinational companies such as Schneider Electric, Siemens or metering specialist Landis and Gyr. Recent generations of pre-paid meters are also seen as having a role to play in early deployment of smart metering and Smart Grid deployment[11].

Figure 4: Pre-paid Metering System Structure

[9] Some critics argue that in many cases standards bodies may raise significant anti-trust issues (see http://www.iprstrust.org/), as well as that the FRAND principles are insufficient for ensuring reasonable royalty rates, and may be barriers to innovation and technology diffusion.

[10] This section is broadly based on previous research conducted under the auspices of South Africa's Human Sciences Research Council (Iliev, 2005), and was part of the broader 'Resource-based Technology Innovation in South Africa' project by the Human Sciences Research Council (see www.hsrc.co.za/)

[11] See interview with the CEO of Landys & Gir who acquired one of the participants in the Eskom pre-paid metering alliance: http://www.greenbang.com/charting-the-smart-meter-way-forward_11052.html



Source: Eskom website

Pre-paid Metering Alliance Governance Structure

Evolving Governance Structure in line with Technology Maturity

At the early stages of prototype development ESKOM was played a very directive role, and managed key IP aspects around critical systems components. The participants in the alliance provided ESKOM prototypes of their meters, and ESKOM's R&D unit shared with the other alliance members individual prototype test results and made suggestions on overcoming technological barriers. ESKOM also shared know-how around critical areas such as lightning protection (a major problem in some areas in South Africa). While each of the alliance participants may have feared to an extent the risks of IP leakage to their competitors, this was balanced by the commitment to purchase significant quantities of meters from *each* of the participants for several years ahead, as well as the reciprocity of the knowledge-sharing arrangement. As the technology matured, ESKOM's role switched from a focus on diversity of designs to selecting and pushing through a set of 'winning' designs, and the adoption of standards which would decrease the risk of a lock-in with any one supplier design, and improve economies of scale. At this point ESKOM still accounted for the majority of the market, and therefore it had the ability to shape incentives in line with its strategic objectives. As market volumes continued to increase, and especially as manufacturers sought markets outside of South Africa, ESKOM focused on disengaging from active management of the technology. Within a few years ESKOM had transitioned to a passive 'procurement' role, focused on cost minimization, as the industry continued to grow independently.

IPR Strategies: The alliance members used different IPR strategies. One of the manufacturers chose to patent heavily around one product line (rail-mounted circuit breaker) while releasing publicly the technology standard for another technology (flat-rate meters). Another alliance participant 'broke ranks' and patented a keypad for use in pre-paid meters: resulting in substantial royalty fees from the other alliance members. However, through its procurement role ESKOM retained control to what it saw as the core parts of the technology related to system-wide deployment costs and interoperability: ultimately ESKOM could specify the technology requirements of the *next* procurement round, and so had some buyer power over the alliance members. It also pushed for the adoption of two standards.

Physical Plug-in Base: The standardised plug-in base was a technologically simple solution to a potentially significant problem: the size and shape of the nacelle within which the electrical meters were installed differed between each of the manufacturers. The specification of a single-size plug-in base meant that meters would be inter-changeable at a very low-cost: avoiding lock-in into any suppliers' system.

STS Standard: ESKOM also initiated the development of a Standard Transfer Specification (STS) standard: a technologically more challenging initiative. The system developed a uniform secure credit transfer mechanism that would allow for the transfer of credit from any vending system to any STS-compliant pre-paid meter. ESKOM developed the STS standard in collaboration with international academic experts and the other alliance members. ESKOM reatined the IP rights to the STS standard: allowing it to retain control of the critical functionalities. The STS specification was released in 1993 as a free and open standard to the industry: allowing manufacturers to integrate the STS standard as part of their design, whether the units would be focused on the domestic or international markets.

STS Association: As STS was adopted more widely by the industry and the use of STS-compliant prepaid meters spread beyond the Eskom market, producers began to pressure Eskom to release ownership of the standard in order to facilitate its evolution and decrease dependence on Eskom. In 1997 Eskom formed the STS Association, to which it transferred ownership of the IP rights to the STS standard. The STS Association is in charge of the control, development, and promotion of the use of the STS standard (the association's objectives are listed in the table below).

STS Association Objectives

- To support and actively encourage the use of STS by utilities and manufacturers worldwide;
- To develop and enhance the STS standards in a way that adapts to the needs of the growing international market: for instance with the release of the STS2 standard in 2006
- To establish a technical guide to educate potential users and standardise the interpretation and implementation of STS;
- To accredit equipment as complying with STS standards by issuing certificates, maintaining a register of organisations approved for testing, and maintaining an accreditation test specification
- To maintain a register of manufacturer identifiers to enable the unique serialisation of products
- To improve key management procedures and approve or operate key management centres
- To ensure that accredited manufacturers make client keys available to the industry to allow clients to find alternative sources of vending and metering equipment
- Operation of a Key Management Centre (an escrow for the encryption algorithms underlying the standard)
- Establish the STS standard as the IEC standard for pre-paid metering

Source: (STS Association, 2001) (STS Association, Chairman's Note, 2003)

4.4 Other Examples of Technology Standards / Patent Pools

There are numerous other examples for technology standards bodies backed by patent pools owned by one or more of the standards participants.

The Continua Alliance is a non-profit, open industry alliance of leading healthcare and technology companies, focused on developing inter-operability standards for medical devices used in personal healthcare Founded in 2006the alliance seeks to address is the proliferation of proprietary medical diagnostic device platforms, their high costs and lack of integration with E-Health networks. Increased economies of scale and inter-operability can increase the market adoption of such products, but also enable a decentralisation of healthcare for patients with chronical diseases to the home. The alliance was initiated by large telecoms and computing equipment manufacturers looking for entry into the healthcare space, and in partnership with healthcare service provider organisations, and major medical devices manufacturers. Some of the founders see the ETSI alliance as a model for the Continua Alliance, with founding members contributing essential IPR around device inter-operability and E-Health systems. In addition to access to essential IPR, members contribute to the alliance written source code which can be adopted rapidly in other members' products. Continua estimates savings for members in the order of $500-600,000 in product development costs.

Nokia's Symbian/S60 Platform: The Symbian Foundation was initially set-up by key producers of mobile phones as a way of providing a common operating platform for the next generation of Smartphones. It was also intended as a defensive alliance to avoid a Microsoft dominance of the mobile telecoms space similar to personal computer operating systems. In 2007 Nokia bought out the other owners of the Symbian operating system, and proceeded to open up the standard even more widely. Currently, users of the S60 system (based on Symbian) can use it *free of royalties*, based on a non-discriminatory, capabilities based accreditation program: 'Accredited S60 developer'. Currently S60-based Smartphones have the dominant market share, with many of Nokia's competitors (such as Samsung) using the system. Nokia's key strategic consideration appears to be related to ensuring continued market leadership, and protecting its ecosystem against new and independent entrants such as iPhone and Google's Android systems.

5. Co-Operative IPR Practices: Key Enabling Factors and Implications for Low-Carbon Energy Technologies

Each of the case studies we discussed represents a form of co-operative IPR sharing mechanisms and governance structure for technology development and diffusion. However, where these differ is in the level of development of the technology and market. Broadly, the ESKOM case study shows how a key industry player can accelerate the emergence of a new technology, and 'hand-over' to the market when maturity levels and market size is sufficient to ensure independent growth. The ETSI case study shows how the adoption, diffusion and further innovation of a relatively well developed technology can be accelerated through the collective formation of a co-operative standards setting body. We discuss these separately below: but we should keep in mind that elements of each 'model' can be found 'crossing-over'. To the extent possible we provide some observations about implications for low-carbon energy technologies.

5.1 Co-operative IPR Sharing and Technology Acceleration with Strategic Leader

Industry Leader IP Ownership and Open Standards: Key to the establishment of the STS standard as dominant in the industry was Eskom's willingness to keep access to the standard as open and free to all interested manufacturers[12]. The open standard allowed new manufacturers to enter the industry (from South Africa and beyond). The openness spirit was further consolidated after Eskom transferred ownership to the STS standard to the STS Association: again signalling to the industry that the access to the technology would remain open, and mechanisms for keeping the standard up-to-date are being put in place

It is worth noting that even as a mass market was developing Eskom did not attempt to extract licensing revenues from its IPRs, once its success became obvious. Eskom's strategic needs were better served by an independently managed standard, which would facilitate the growth of the industry, and improve the product. Keeping the STS standard in-house any longer would slow down its development, and hence the development of the industry. In addition Eskom's mandate was to provide electricity at the lowest cost for the market, and therefore the widespread use of the standard would lead to economies of scale, and hence to lower prices. .

Keeping the Standards Relevant: It is likely that whenever there is systemic innovation, the presence of an independent standards authority representing the interests of the various stakeholders in the industry could facilitate the responsiveness of the technological standard to changes in the industry and to novel technological opportunities. The adoption of any standard necessarily implies that some technological trajectories are locked out and that inferior aspects of a standard can become built-in. The open-ended and evolutionary nature of technological change means that it is always possible that a standard will be inferior to a technology that is developed

[12] There are parallels here to similar free/open standards by major corporate players in other industries: for instance Nokia's Symbian platform was initially open but royalty-based for application developers and competitors alike. It is now open and royalty-free

after the standard is set, or could have been developed in its absence. It is unlikely that such risks can ever be eliminated. However, an independent standards manager (such as the STS Association) can provide channels for keeping a standard up-to-date with market requirements. The STS Association provided a forum where interaction between users and producers could take place, and where changes to the standard that would affect multiple participants could be negotiated and formulated.

Technology Standards Impact on Specialisation and Value Chain Diversification: At the early stages of the technology's development Eskom explicitly encouraged the different manufacturers to develop alternative systems: reducing lock-in risk into any single solution. In 1992 there were five proprietary PPM systems in operation. Eskom absorbed the cost of running several systems in return for the additional technology options it expected to get from the different manufacturers' independent innovative efforts. With increasing procurement volumes the costs of running parallel system increased rapidly through for instance: duplication through multiple vendor systems, multiple unit inventories, inconsistent quality, operator training costs, the difficulty of coordinating changes across many platforms, switching costs to a future standard, limited economies of scale, and last but not least, the increasing pricing power of suppliers with increasing lock-in. Standardisation at critical points in the system would resolve these cost problems by eliminating duplication costs, increasing the incentives for competition and further innovation, and allowing increased economies of scale across key components, and leading to specialisation between market participants (rather than the development of vertically integrated systems). Some examples of the impact of the introduction of the STS standard:

- **Software specialists:** the common STS standard standardised the transfer of credit between vendors and domestic meters. That allowed the development of third-party vending software providers, and the emergence of vendor software as an autonomous market segment

- **Volume manufacturing:** electrical equipment manufacturers could choose what component of the full pre-paid metering system they would focus on without dependence on 3rd party standard changes: and focus on building mass production

- **Innovative payment mechanisms:** The STS standard was open ended in terms of the medium through which 'tokens' (the credit to the meters) would be transferred. South African telecom operators were some of the first globally to implement SMS-based payment for pre-paid metering: increasing the attractiveness of the pre-paid metering system beyond the poorest segments of the population

- **Application of the system outside of electrical metering:** System adaptations have been made in water and gas metering, the implementation of multiple/complex tariffs, value added services, and multi-lingual support

The Disproportionate Role of 'Simple' Standards: The importance of a coordinating actor in the implementation of standards is also illustrated by the adoption of the 'plug-in base' standard. In terms of technological intensity the plug-in base was very simple: essentially asking all manufacturers to produce pre-paid meters in the same casing size. However, this simple standardisation step was an inexpensive way of removing a major physical barrier to a fully inter-changeable installation base, and removing duplication costs in the system.

Market Power as an Enabler for Standardisation: At the time when Eskom implemented the standardisation moves it was in a monopsonist position in the PPM market. Only about 20% of the procurement commitment of 1 million PPM meters was executed, while the export markets for the technology were still not well developed. Eskom's monopsonist position gave it the power to impose penalties on non-conformist members of the alliance, hence providing a powerful disincentive for deviation from Eskom's strategy, as the 'deviant' could be locked out from the market altogether. At this point the firms involved in the development of the technology did not have the resources to develop the market beyond Eskom, or the channels to access it. In this restricted environment Eskom gave participants in the strategic alliance a strong incentive with precommitments to purchase and by providing the non-financial resources that the technology developers needed. Eskom was able to propagate the STS standard by changing the specifications of its procurement tenders, and replacing the proprietary meters with STS-compliant meters, leading to a fully STS-compliant metering base. But Eskom also used its lockout power to force manufacturers to invest in integration of its technological specifications, to block the entry of whole classes of products that provided an alternative to the PPM technology (such as flat-rate meters and drive-by metering systems), or to avoid the introduction of enhanced features that would increase the costs of the meters. At least one industry actor said that its exit from the Eskom market had been partly influenced by frequent changes in the product specification.

Strategic Leader Technology Management Capabilities: The rapid maturing of the PPM technology was in large part enabled by Eskom's ability to execute radical changes in its technology management style through the various stages of the technology cycle: Eskom's strategy boiled down to heavy involvement in the early stages, a push for standardisation, and thereafter reliance on the market mechanism. Needless to say, not every major organisation in an economy will have the organisational skills and resources to execute such a complex strategy over a considerable period of time. Key enabling factors for Eskom included: a) the availability of complex organisational capabilities for strategic technology management across multiple phases of a technology (including knowing how to exit); b) the *financial* resources to provide a sufficiently large incentive at the early stages (the procurement pre-commitment); and c) a credible commitment to *dis*engage from active leadership and technology control when the market mechanism was strong enough.

Coordinating Scarce Domestic Innovative Capabilities Across Sectors: Eskom's strategic alliance initiative was built in the context of a *shortage* of technological capabilities. While compared to other African states, South Africa's innovation system is significantly more developed, the economy's innovative capabilities were focused around several sectors and strategic actors in military procurement, mining and energy, and some areas of manufacturing such as the automotive industry (Fine & Rustomjee, 1996) (OECD, 2007). The capabilities used in the PPM alliance were a combination of capabilities across energy systems, electronics and IT. Many of the companies and individual inventors participating in the alliance had been developers and manufacturers of electronics for the military industry: another advanced and innovative buyer in the South African context. At later stages in the industry's development, the pre-paid metering payment infrastructure was combined with mobile telephony, resulting in innovations in payment systems. So the role of the strategic alliance leader included the identification of capabilities outside its traditional supplier network, and the coordination of 'convergence' across fields, with foreign expertise brought into several areas (such as in the development of some of the advanced encryption aspects of the STS algorithm).

Private Vs. Public Sector Strategic Leader: The ESKOM case study demonstrates the potential role for a para-statal organisation as a strategic leader in a developing country context. In different economies regulatory considerations or historical experience may limit the extent to which parastatals or other state institutions can play such a role. However as the Nokia – Symbian case shows, in a developed country context, a leading multinational may also play such a leadership role, where technology diffusion and innovation within a more-or-less open technology standard brings benefits through a more diverse innovation eco system. It may be that public sector considerations can be served through such initiatives too, possibly in a public-private partnership around particular technology chains.

Possible Parallels with Low-Carbon Energy Technologies: The factors identified above can be used to develop thinking about how strategic leader-based technology development strategies can be designed or influenced in a way that can increase co-operative uses of IPRs. The table below shows some initial thoughts around this area. Further research is needed to develop more specific recommendations for specific low-carbon energy technologies.

Table 3: Key Factors in Pre-Paid Metering Industry: Parallels to Low-Carbon Energy

Key Factors: Pre-Paid Metering Industry	Parallels to Low-Carbon Energy Technologies
Industry leader IP ownership	IP ownership by industry leaders can be used to build incentives toward co-operative uses of IPRs. In key developed economies such as government research agencies and parastatal organisations may own key IPRs in an industry. These may be pooled and contributed toward technology development initiatives: forming the basis of patent pools.
Keeping standards relevant	The adoption of standards around smart meters, smartgrids, wind turbine interfaces or wave power components needs to be balanced with evolving user and technology needs. Technology standard bodies were shown as an important body to intermediate between user needs and technology developers. Industry associations may be another such channel.
Technology standards impact on value chain diversification	Value chain diversification may be particularly important around complex technology systems, such as wind turbines. The deployment of wind in a massive scale in an ever increasing diversity of environments leads to requirements around sensing equipment, grid integration, wind farm optimisation with predictive software, and so on. Ensuring inter-operability between the different wind energy chain technology components can allow increased innovation and experimentation, as well as building of economies of scale.
Disproportionate role of 'simple' standards	Simple technology interfaces such as plug-in modules for turbines/blades, or uniform communication platforms may be critical for increased competition across wind energy platforms: increasing buyer power vis-a-vis key suppliers.
When to push for a standard	The point at which the costs of running multiple standards are higher than the benefits of doing so is when standardisation becomes necessary. Many of the issues identified here are likely to be of relevance to other situations where several innovators are engaged in systemic innovation, and where the emergence of multiple standards is possible. For instance in wind offshore and carbon capture there are multiple pilot studies running concurrently. At what point should we push for standards?
Market power as enabler for standards adoption	At the early stages of a technology's deployment (such as CST, offshore wind, wave and tidal energy) large scale buyers have a disproportionate impact on the technology specifications. There may be scope for building international cooperation between utility service providers in different economies, to ensure common standards requirements are put to technology suppliers. At the very least, developed economy utilities providers (as buyers of renewable energy) should communicate between each other and with developing country utilities on purchasing technical requirements around standards.
Co-ordinating scarce domestic innovative capabilities and convergence of capabilities across sectors	The scale of ambition of such projects may be limited by the scarcity of domestic innovative capabilities in most developing economies. Technology development activities may be focused around key areas of adaptation of technology to local conditions. Engagement with key players in other

	sectors may provide access to capabilities.
Private vs. Public Sector Leader	Public-sector leaders may be most effective in areas where public sector purchasing power is playing a key role, and where a technology is still maturing, and where publicly owned utilities are final users. Some areas could be energy storage systems, smart grid and smart meter installations. Where public sector capabilities (or mandate) do not allow such engagement, there may be scope for public-private partnerships, or including technology leadership in the mandate of regulated privatised utilities.

5.2 Driving Factors for Co-operative IP Practices

There are many factors that may make the adoption of cross-licensing and technology standards more or less likely. Table 4 shows some factors that we identified through the case study research. Increasing patent complexity and repeat and costly litigation between key players can demonstrate the case to management of the patent litigation risks with an existing system. In areas where high levels of patent activity have created a complex patent environment, companies may spend an increasing amount of resources on R&D for 'invent-around' competitors' patents around essential product features, while also increasing resource expenditure on patent counsel to manage the risk of infringement. An industry cross-licensing agreement, or a patent pool established by key participants can resolve this complexity: in exchange for a royalty fee, companies will be able to build on existing technologies, allowing them to focus on new features rather than invent-around.

Another contributing factor may be an accelerating product life cycle. Patents have an economic life of up to 20 years, yet in many industries the product life cycle is substantially shorter. So while a drug discovery company whose product has 20 years of economic life has the time to engage in a 2-3 year patent litigation cases, for companies with a faster product life cycle there is the risk that patent litigation may keep them out of the game, even if they subsequently win. Increased heterogeneity of user types can lead to increased demand for product customisation around user features: for instance mobile phone design, but also increasingly in medical devices. In such cases, an agreed technology standard can increase the total market size, as companies find it more economical to focus on niche market innovation, while 'essential IP' owners find their technology deployed in areas they themselves could not have entered on their own.

Table 4 lists a number of other contributing factors that can be used to determine the 'cross-licensing readiness' an of a technology system, or to identify the location where such readiness is highest.

Table 4: Key Industry Indicators for Industry-readiness for Co-operative IPR

Key Indicators	Industry Examples
Increasing patent complexity & Litigation trends	Increasing number of cross-references between companies' patent portfolios, suggesting complex and overlapping claims of novelty, and the potential for costly patent infringement lawsuits
Increasing speed of product life cycle	R&D investment in vertically integrated systems is too high – need for sharing of IPRs
	Product life cycle becomes shorter than the patent lifespan: sometimes product lines are changed even *before* a patent has been granted (due to patent office examination time lags)

Increased heterogeneity of client/user types	Increasingly complex combinations of product technology requirements, user capabilities and needs, and operator requirements lead to increasing number of 'optimal types' of products that cannot be served by any single company
Fragmentation of market by geography and local conditions	Global spread of a technology standard allows access of large number of market niches; complex combination of service providers/ manufacturers/ users/ value added service providers serving unique and dispersed market niches
Increased complexity of technology platforms	Rapid speed of development and user demand leading to increasing complexity Equipment manufacturing increasingly done by 3rd parties Use of value-added services increasing system complexity
Increasing user autonomy and user innovation	Increasing technology configuration choices, niche types, and combinations between products/services open 'space' for an intermediaries between manufacturers and final users
Major external threat: big player from another industry entering your space	In mobile telephony the entry of Microsoft, Apple and Google in different times of the telecoms industry evolution led to increased technology sharing
Major markets identified, but cannot be reached under current business model	A key driver behind ETSI and GSM standard: to allow *national* EU market leaders to expand internationally into other developed *and developing* markets

Source: Interviews of industry experts

To illustrate how such an approach might work in practice, we have developed a simplified example focused around the wind energy industry. The following analysis applies the concept of key indicators to measure the readiness/need for patent pool and industry standard body to the wind energy sector. A mark of 5 suggests a high readiness for co-operative IPR solutions

Table 5: Diagnosing the Industry-Readiness for Cross-licensing – Illustrative example for Wind Energy

Key Indicators	Wind Energy Standard Readiness (1-5)
Increasing patent complexity & Litigation trends	**3:** Several high-profile patent litigation cases since 2006: Enercon vs. Vestas; GE vs. Mitsubishi
Increasing speed of product life cycle	**4:** Turbine power has roughly doubled in the last 5 years; rotor diameter in offshore applications may be double the size of onshore
Increased heterogeneity of client/user types	**3:** increasing differences between operator types in terms of geography, purchasing power, micro-wind conditions, and off-grid vs. On-grid
Fragmentation of market by geography and local conditions	**4:** highly heterogeneous conditions in terms of regulatory environment; big differences between operational environment in onshore vs. Offshore; but also between micro-wind and mainstream wind
Increased complexity of technology platforms	**4:** increased use of software for optimization, operation in extreme environments, use of composite materials, etc.

Increasing user autonomy (vis-à-vis distributor)	**2**: little user innovation – platforms used as intended; possible move to independence through a retrofit/2nd hand turbines market
Major external threat: big player from another industry entering the space	**2:** many potential entrants, but little chance of paradigm shifters; possibly long-term move to vertical-axis offshore platforms
Major markets identified, but cannot be reached under current business model	**5:** enormous potential for global wind power: it would increase the industry size by multiples; relatively high installation and maintenance costs and lack of storage capacity limit deployment; potential breakthroughs would be through radical de-costing and in power storage

As this illustrative example for wind turbines suggests, the likelihood or need for a cross-licensing agreement, a patent pool or a standard may vary between the different of the technology system. For instance, standardisation around communications protocols may ensure that 3rd party software monitoring systems can be implemented across turbines manufactured by other companies, while standardisation of 'plug-in' component of turbines and rotors could allow 3rd party transmission systems to be fit across all turbines. Needless to say the analysis is **not intended** as a definitive statement, but just as an illustrative example. However, it would be possible to scale up such an approach to develop an analysis across a number of low-carbon energy technology systems and sub-systems, by engaging a broader range of industry stakeholders – including from makers which have not yet been accessed under current business models.

6. Co-operative IPR Practices from a Public Perspective

No doubt many co-operative IPR arrangements already exist in the low-carbon energy space. Nevertheless, we are at the early stages of a new wave of innovation around more sophisticated control devices, materials, and altogether novel forms of energy service provision. In this environment, it is important to consider likely locations where competing standards and hold-ups may occur, as well as ways in which the adoption and diffusion of standards can be accelerated. This experience brings us back to the question that motivated the paper: Is there a case for public policy for actively supporting the formation of co-operative standard bodies, cross-licensing agreements and/or patent pools? This question has two components relating to the overall level of technology innovation, adoption and diffusion in developing countries.

First, is there a case for public support for co-operative IPR arrangements to enhance the speed of low carbon innovation? From a public perspective there are many reasons why a more open and co-operative usage of IPRs may be preferable to a closed system. As economies adopt a technology they commit to a specific supply chain. As they do so, parts of the chain may be owned by key industrial actors/suppliers. Commitment to vertically/fully owned supply chains may lead to technology lock-in into inferior technologies, or provide suppliers with higher pricing power. Proprietary standards may prevent the emergence of a diverse supplier base, and limit economies of scale. A combination of patent ownership and proprietary technology standards may also enhance pricing power: especially in LDCs where strategic negotiating power is low.

Vertically owned supply chains may prevent the emergence of economies of scale and lower prices. Proprietary technologies may lead to duplication of efforts between competitors and a concentration of efforts on patent litigation and invent-around instead of genuine innovation in a system. Respectively, the adoption of open technology standards can contribute to decreased risk of litigation (and therefore lower business uncertainty), savings from duplication of R&D effort/building on others' mistakes, decreased barriers to entry for newcomers, specialisation and value chain diversification, and unexpected and novel uses of technology. Common standards can also facilitate the building of increased user feature diversity and niche application of a technology. Finally, if there is a standards war rather than joint development of a standard, the users of the 'losing' standard will also have to incur switching costs to technologies using a 'winning standard'.

Second, is there a case for public support for standard bodies and patent pools to enhance the adoption and diffusion of low-carbon technologies in developing countries? To answer this question, we have to explore the channels through which developing countries may benefit from such co-operative IPR arrangements with industry. We have identified several such channels:

(i) Facilitating the entry of developing country suppliers or manufacturers, by providing easy(ier) and cheap(er) access to key technologies, as well as access to North markets compatible with existing IPR norms. In the example of ETSI and Symbian Alliance, developing country suppliers such as Huawei have been able to rapidly gain a leading market position, and sell into developed economy markets: as well as engage with leading global corporations in R&D and production collaborations In the semi-conductors industry South Korean corporations (at the time a non-OECD economy) were able to enter the North American market while avoiding patent-based litigation with leading US players.

(ii) Increasing economies of scale decrease product costs, thus helping developing countries as *consumers*. Mobile telephones have become widely spread in developing economies. The drastic cost reductions have been possible through the value chain diversification, specialisation of different actors in specific value chain niches, as well as higher customization (including for developing world user needs). Likewise, the pre-paid meters developed by the Eskom alliance provided a cheap and high-tech import-substitute.

(iii) Providing cheaper IPR sharing mechanisms for South-South technology co-operation and diffusion. The pre-paid meters developed under the Eskom alliance were first exported to other developing country markets: in Southern Africa, Latin America and Asia. The STS Association provided a relatively cheap certification and compatibility mechanisms for other developing country manufacturers. Their design for local conditions provided more appropriate features for developing country environments.

(iv) Ensuring adaptation of key low-carbon energy technologies where developed economy multinationals may not do so. The characteristics of the technology that are required to meet climatic conditions and capabilities of domestic manufacturers and maintenance engineers in many developing countries differ from developed countries. This points to the need to adopt the technology to local circumstances. Often multi-national firms would not have the local capacity, or very high costs of operating in local markets and are therefore not in a position to pursue these activities. Patent pools or standard bodies allow third parties to adopt and diffuse new technologies in local markets. Otherwise new entrants run a significant risk of infringement of patents by incumbent companies and are put at the risk of delays and licence agreements at unfavourable conditions. In principle one might expect that international firms that do not have the capacity to enter such markets themselves should also support such patent pools and public standard bodies. After all, they offer the prospect of some revenues. However, as these are likely to be small and are therefore of limited strategic interest, it is not clear whether they would be subordinate to the IP strategy in markets and towards competitors in developed countries.

This suggests that where leading firms in a sector initiate IP sharing agreements or public access to industry standards, this also addresses the basic IP requirement to facilitate technology adoption and diffusion in developing countries. However, where such initiative is not present, this is not only likely to be of disadvantage for the global technology development, but might be of particular concern for developing countries. Public intervention to facilitate cooperative IP arrangements might offer benefits under such circumstances.

The discussion of our two case studies points to a second development: Cooperative IP arrangements do not necessary avoid IP disputes, but offer processes that are often quicker and cheaper in addressing these conflicts. However, much of the success of this conflict resolution depends on the interest of powerful members to find a solution, and e.g. avoid a trade conflict between EU and USA. Would such conflict resolution strategies work if (i) the 'cooperation' is not entirely self motivated, but rather imposed by public policy intervention and (ii) if one of the conflict parties is a smaller developing country, or firm active in such a country.

We have not explored these questions with industry participants, but assume that if the answer to either of these questions is no, then the governance structure of currently existing industry standard bodies or patent sharing pools would not be suitable to facilitate technology cooperation with developing countries. Instead a stronger representation of the interest of public policy in global use of low-carbon technologies would have to be ensured through appropriate governance structures of such patent pools or industry standard bodies.

7. Conclusion: Engaging with Industry – Targeting Co-operative IPR Agreement Efforts

The discussion thus far has shown ways in which industry co-operative IP sharing agreements can accelerate technology diffusion, stimulate innovation and help access a larger portion of the market for a technology. The ESKOM and STS Association example also showed how the public sector can successfully stimulate and manage the maturing of a new technology by focusing on early push for standards, transferring IPRs to a standards management body, and disengaging when a market is mature enough. Yet cross-licensing and technology standards may be slow to emerge, even when the conditions are ripe. Even if industry players are willing to participate in a co-operative IPR agreement, there may be co-ordination failures and institutional barriers for doing so. There may also be a substantial time-lag factor between when the conditions for a co-operative IPR arrangement emerge, and when industry players adopt such mechanisms. There may therefore be a case for public sector engagement with industry players to identify areas where co-operative IPR arrangements may be appropriate, and seeking ways to accelerate their emergence.

We identify several elements that could form the basis of building industry engagement in cooperative IPR arrangements:

a) **The final buyers and users are involved in such coalitions:** that may be privatised or publicly-owned utilities, but also in the case of transportation, vehicle fleet owners, transport operators
b) **Critical mass of major industry players are involved:** they would provide a critical mass of relevant 'essential' IPR to any technology standards agreement, and provide an 'umbrella' that would provide some defense to smaller players
c) **Representation of developing country actors:** a key 'carrot' for participation by developed economy private sector is improved and accelerated access to developing economy markets
d) **Publicly-owned IPR is contributed to initiatives**: relevant IPRs owned by Universities, research institutes and government departments can provide a critical mass of IPRs in a cross-licensing agreement or patent pool that would increase the incentives for private sector participation
e) **Fair governance structure focused on market creation:** A key element in ensuring the legitimacy of standards bodies or strategic leaders is a credible commitment to developing independent markets. Short-term interventions can be tolerated (and welcomed) if these are aimed at building an autonomous market, and an exit by public actors from active involvement when there is critical mass in deployment or technology maturity.

While the complexity of such a programme is not trivial, it may benefit from a more practical level of support by industry, as the impact can be quantified and translated into specific medium-term benefits to manufacturers and users.

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Interviews: Pre-Paid Metering Case Study

[1] Former head of the STS Association

[2] Former senior manager at Eskom, leader of the electrification strategy

[3] Senior developer at Syntell

[4] Senior developer at Landis & Gyr [5] Senior manager at Landis & Gyr

[6] Senior manager at Eskom Distribution

[7] Senior developer at TSI

[8] Senior developer at CBI

Interviews: ETSI Case Study and Cross-licensing/Patent Pools Research

[1] Former General Counsel of a Fortune 100 company

[2] CEO of Webgate, Mobile Applications Developer

[3] IP/Telecoms Partner at Eversheds LLP

[4] IP/Telecoms Partner at Taylor Wessig LLP

[5] Senior Executive of IP Capital Group

[6] Former head of IP for Europe, Motorola

[7] Senior executive, Continua Alliance

[8] Head of R&D for Diagnostics, Top 5 Pharma company

Annex 1: Diversity in the Corporate Uses of IPRs

Patents per se do not inhibit or promote technology transfer: they are 'just' property rights with many possible uses. It is the way that businesses and consumers choose to use or not use patents in practice that will have an impact on how technology is deployed and transferred to other market participants. The table illustrates the variety of uses of IPRs across sectors and patent owner types.

It is not patents in themselves that may inhibit technology transfer, but the lack of enabling environments and business practices. From a policy maker perspective it is necessary to understand more about how such enabling environments emerge, and if possible, what role policy makers can play in this (if any).

Table 6: Options for strategic uses of patents

Title	**Detail**
Attract Investment	For technology start-ups IP portfolios can be a strong signal of quality and market potential
Blockage	Patent used to block entry in a market/sale of a product infringing a patent holder's rights
Co-operative Standards Setting	An association of key players in an industry which administers key technology standards on behalf of its members. Typically backed by a patent pool by the contributing parties.
Forced licensing	Litigation/court judgement forces
Industry Cross-licensing	An agreement between major industry participants to cross-license IP portfolios, for free or for royalties
Licensing	Company that owns a technology licenses out its IP, in return for licensing fees
Licensing for production	An OEM who contracts out major part of components manufacturing to a supplier may license the use of a proprietary technology
Open-innovation platform[13]	Many open-innovation models/communities are backed by patents or other IP: which codifies expected behavior/uses of the platform
Patent pooling	Key technology owners pool patents related to a specific technology where mutual patent infringement and holdup risks are high,. The management of royalties is handled by a 3rd party.
University-to-industry technology Transfer	Universities focus on commercialisation of academic research, through direct licensing of a technology or the formation of University spin-offs

[13] See Chesborough (2003) Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Business School Press