Finding the social, economic and technological barriers and opportunities in the developing countries for designing the technology transfer and innovation regime in climate change[12]

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1 Introduction

Technology transfer and innovation is a central issue in climate change negotiations. The parties agreed to establish the "technology mechanism" in the Copenhagen Accord. The Expert Group on Technology (EGTT) is working to produce a recommendation on the institutional design. However, no concrete proposals are put forward yet partly due to the lack of understanding of the issue, partly due to the lack of research demonstrating the unique technological and financial opportunities and obstacles that exist in the developing parts of the world.

This paper addresses social, economic and technological issues and barriers in the developing countries for designing the technology transfer and innovation regime in climate change. The author reviews previous research on the subject and identifies social, economic and technological issues and barriers that need to be incorporated in designing the technology transfer and innovation regime. One issue relates to the fact that there are different social expectations for technology transfer and innovation. Some countries are willing to invite "technology transfer" and successfully adopt technologies in operation, while some countries tend to focus on "technology innovation". One needs to incorporate the different social expectations and needs to design multilateral projects and programs to diffuse or develop technologies to reduce greenhouse gas emissions. Another issue to discuss is different concepts and levels of technology transfer. In some cases, technology transfers are not successful in the operational phase of the technologies due to social, economic and technologies barriers.

This paper also suggests issues to consider in designing a multilateral framework to encourage technology innovation and transfer to reduce greenhouse gas emissions. One issue relates to the fact that there are different stages in the technological development (demonstration, deployment, diffusion, and commercial stages). The paper argues that different institutional designs are necessary for each stage of technological development. For example, economic policy instruments such as the Clean Development Mechanism (CDM) and emissions trading may be effective to encourage technologies at the diffusion and commercial stages, while the empowerment of the network of the research groups are needed to encourage technologies at the demonstration and deployment stages. The conclusion of this paper stresses that beyond barriers, there are also large business opportunities in bringing leapfrogging technologies.

2 Literature review: barriers in technology innovation and transfer identified through previous studies

This section provides a brief review of previous and ongoing studies addressing obstacles in technology innovation and transfer. As stated above, the EGTT is working to produce a recommendation on the

[1] This research is supported by the Environment Research and Technology Development Fund (S-6-3) of the Ministry of the Environment, Japan. The author wishes to express his gratitude for the support.

[2] Earlier version of this paper was presented at the 2nd Global Conference on Environmental Governance and Democracy on Strengthening Institutions to Address Climate Change and Advance a Global Economy on September 17th, 2010.

institutional design of technology mechanism. In 2009, it submitted several reports to the subsidiary bodies of the Conference of the Parties "for the long-term perspective beyond 2012, including sectoral approaches, to facilitate the development, deployment, diffusion and transfer of technologies" (Expert Group on Technology Transfer 2009, 7). The reports provide the current trend and the data of technology innovation and transfer as well as several conceptual frameworks and models to understand the issues.

In fact, there are several research initiatives that identify barriers in each stage of technological development. Some of them also attempt to address policies and measures that may effectively overcome the barriers. The following sections summarize the results of three studies conducted by research organizations including University of Sussex, Ecologic Institute, and International Institute for Industrial Environmental Economics (IIIEE).

2.1 University of Sussex Energy Group's study

The Energy Group at the University of Sussex published several reports investigating barriers in technology transfer of low carbon energy technologies (Ockwell et. al. 2009). In one of the reports, they demonstrated their view that "developing recommendations of how collaborative research, development, demonstration and deployment (RDD&D) initiatives between developed and developing countries might contribute to technology transfer". They also stated "there is no one policy fits all solution to facilitating low carbon technology transfer. Relevant policy interventions vary according to the nature of the development and the political and economic characteristics of both supplier and recipient technology, its stage of commercial countries." This point is consistent with the discussion presented in EGTT's report mentioned earlier in this paper.

The research conducted by the University of Sussex included five case studies in India including 1) wind power, 2) solar PV, 3) hybrid vehicles, 4) energy efficiency in small and medium sized enterprises (SMEs), and 5) integrated gasification combined cycle (IGCC) for power generation. As a result, they came up with several obstacles that they observed in technology innovation and transfer in India. Following are some of the obstacles:

1. Intellectual property rights (IPRs): Insufficient protection of IPRs can be a deterrent to international firms transferring technologies.
2. Political stability: Political instability in some countries might act as a deterrent to foreign investors, particularly where new commercial technologies are concerned.
3. Enabling business environment: As well as political stability, there is also a linked need to focus on creating an enabling economic, social and business environment to encourage technology transfer.
4. Infrastructure: National governments have an important role to play in ensuring that the appropriate infrastructure is in place to foster technological development.
5. Access to finance: For some smaller scale financing issues, there may be a role for national government intervention.
6. High costs of new technologies: Many low carbon technologies are new or still being developed and therefore entail higher costs for acquiring and/or using/operating them.
7. Need for private sector involvement: Government intervention in technology transfer must recognize the central role that private investors play in the transfer process.
8. Information barriers: Poor knowledge of available technologies and financing opportunities reduces demand for new technologies.

As the list indicates, they addressed several barriers that relate to the capacity of the firms on the side of the developing countries. They stressed in their report that "recipient firms must take a strategic approach to acquiring knowledge and expertise as part of the technology transfer process." They also maintained "improving firms' capacity to absorb new technologies is essential to enabling firms to take full advantage of new low carbon technologies". According to them, IPRs is an important issue for the developed countries' side to consider further technology transfer to the developing countries. They suggested formulating an international collaboration program along each technological development stage to discuss the IPR issues in the multilateral form.

2.2 Ecologic Institute's study

The Ecologic Institute published a report titled as "The Current Proposals on the Transfer of Climate Technology in the International Climate Negotiations: An Assessment" (Gerstetter and Marcellino 2009). The report addressed the following barriers for technology innovation and transfer:

1. Lack of funding: Developing countries have stressed the need for additional financial and other resources to be provided by developed countries for technological support geared towards adaptation and mitigation measures.
2. Market barriers: Some market barriers will exist even with price signals from robust carbon markets, meaning the private sector will under-invest.
3. Enabling regulatory environment: Some developing countries need assistance to develop enabling environments of regulations, policies, and institutions. Lack of enabling policies, investment stability, and institutional support were three barriers to technology transfer experienced under the Montreal Protocol.

It is noteworthy that lack of funding and lack of enabling environment were also identified as a barrier through the research conducted by the University of Sussex. In fact, these are commonly identified as a barrier among researchers and business managers in the developing countries.

As for lack of funding, the report maintained that "public funds should be used for fundamental research and development and demonstration. The literature indicated that public investments in the initial stages of R&D encourage subsequent private investment in the later stages of development. Public procurement directed toward emerging climate friendly technologies can create markets and foster technology pull". This is an important point to note since public policy intervention is often the only way to encourage technologies in the early development stages.

In addition, the report pointed out "substantial mitigation options with negative cost at today's energy prices have been identified empirically, though myriad barriers, especially for building efficiency, restrict investment. Studies have suggested that even a carbon price of US$ 40/ton could not overcome these barriers". It further maintained that "market-based mechanisms must be complemented by other measures that address underfunded stages of the technology cycle and cover all countries." This seems to indicate that the market-based approaches such as CDM and emissions trading are not sufficient enough to encourage technology transfer to reduce GHG emissions.

Interestingly, as for IPRs, the report addressed a different view from other studies introduced earlier. It argued "empirical research indicates that intellectual property is not currently a major obstacle to the transfer of climate technologies to developing countries. Research has found that in many cases non-patent protected technologies are available. In particular, relevant technologies are not protected by patents in the majority of developing countries."

2.3 IIIEE's study

The IIIEE at Lund University in Sweden released a report titled as "Advancing technology transfer for climate change mitigation: Considerations for technology orientated agreements promoting energy efficiency and carbon capture and storage (CCS)" (Dalhammar et. al. 2009). While the study focused on two technologies, namely, CCS and energy efficiency improvement in the building sector, it drew lessons that may be applicable to innovating and transferring other technologies.

Through the study on CCS, they developed a view that "given current policy and market conditions, carbon markets appear marginal or inadequate for sole support of CCS applications to economic viability. There appears to be a need for additional support". Through a study on energy efficiency improvement in the building sector, they came to a conclusion that "the CDM has proven to be a largely inappropriate mechanism for addressing the building sector, and only a few building projects have been initiated under its auspices. For the most part, the economic benefits from CDM projects cannot justify the transaction costs associated with project management, dealing with CDM methodologies, and required monitoring programs." They stressed in the report that "while CDM, GEF and other funding mechanisms can help funding important catalyst projects, they cannot in their current forms deliver technology transfer at the pace required." As seen above, the Ecologic Institute also addressed this point in its paper.

As other studies (illustrated above), IIIEE's report pointed out that the creation of enabling environment of the developing countries is the most important element in encouraging technology transfer. The authors of the report are not positive about CDM in this aspect as well. They stated that "the capacity-building potential of CDM and GEF projects are probably quite limited."

3 Issues and barriers to consider: social, economic, and technological

Section 2 briefly reviewed previous and ongoing studies addressing the obstacles for technology innovation and transfer. The author is aware that there are other research initiatives exploring an institutional design to encourage technology innovation and transfer. For example, a study conducted by Carbon Trust suggests establishing "Low Carbon Technology Innovation and Diffusion Centers" (Carbon Trust. 2008). Another example is a paper published by Fei et.al. from Kennedy School at Harvard University titled as "Possible Development of a Technology Clean Development Mechanism in a Post-2012 Regime" (Fei et.al. 2008). This paper proposed reforming CDM to make it more effective in diffusing technologies to reduce GHG emissions in the developing countries.

Many of these studies indicate that dynamics of technology innovation and technology may require new approach to analyze. In particular, there have to be an attention to different expectations for technology transfer and innovation among the developing countries. Some countries are willing to invite "technology transfer" and successfully adopt technologies in operation, while some countries tend to focus on "technology innovation". While many companies in China tend to be open for investment into the latest technologies to import from the developed countries, India, for example, seems to eager to develop its own technologies even if they do not guarantee the best performance of their kind. In fact, some companies and the governments in the EU and the US being aware of such differences, they began to work enthusiastically opening an "innovation center" in cooperation with their local partners in India for example.

Another dynamics to observe is the increasing trends for the "south and south" cooperation in technology innovation and transfer. Indeed, many local companies in the developing countries already have a capacity to develop renewable and energy efficiency improvement technologies on their own and import

them to other developing countries. An example is wind power generation in India. There are already wind turbine manufacturing companies in India to set up wind farms especially in the South of India. These firms are eager to sell their local technologies to neighboring countries including Sri Lanka and Bangladesh. The traditional model of technology transfer from the developed to the developing countries may be becoming an old paradigm. How to capture the South and South dynamics is a subject to consider in designing an international institution for technology innovation and transfer.

As indicated in Section 2, lack of enabling environment in the developing countries is still a major barrier for technology innovation and transfer. According to the report published by the Ecologic Institute, lack of enabling policies, investment stability, and institutional support were three barriers to technology transfer experienced under the Montreal Protocol. In addition, the author of this paper points out that more attentions should be heeded to the barriers after technology is innovated or transferred. For example, the case studies that the author is conducting in Thailand uncovered that there have been failures in the operation of biomass/biogas power generation projects due to the lack of know-how in maintenance and training of local employees. The scope of possible barriers for technology innovation and transfer should be more holistically examined perhaps by emphasizing more on increasing local capacity in technology innovation and transfer.

4 Designing a multilateral framework to encourage technology innovation and transfer to reduce greenhouse gas emissions

Literature review indicated that different institutional designs are necessary for each stage of technological development. Policies and measures should be tailored to each technological development stage. The author of this paper emphasizes that economic policy instruments such as CDM and emissions trading may be effective to encourage technologies at the diffusion and commercial stages, while the scaling-up of the public funding and the empowerment of the network of the research groups are needed to encourage technologies at the demonstration and deployment stages. The author suggests mapping each technology together with effective policies and measures for each technology on the scale of the development stages is the first step to overview the interaction between technologies and effective policies and measures.

There should be a question about the effectiveness of the existing market-based instruments including CDM in technology innovation and transfer. As the study by the IIIEE explicitly indicated, there should be a question about the effectiveness of the existing market-based instruments including CDM in technology innovation and transfer. While some CDM activities are leading to diffusion of renewable energy projects in the developing countries (for example, wind power projects in India and biogas projects in Thailand), the magnitude of technology diffusion through CDM is too small to reduce GHG emissions in the large scale in the future. Though technology transfer is not a condition for the project to be a CDM activity, there was an expectation among policymakers earlier that CDM could facilitate more renewable or energy efficiency improvement technologies that could not have been introduced without it in the developing countries. With this respect, there seem to be gap between CDM in theory and CDM in practice.

5 Conclusion

In conclusion, the author wishes to add three more perspectives. Firstly, while the existing research focus on the analysis of obstacles, research to address the opportunities side is lacking so far. Indeed, there is a great deal of research looking into the potentials of GHG emissions reductions by calculating their

marginal cost to do so. Needless to say, the marginal cost in the developing countries tend to be lower than the develop countries. However, there is a lack of research examining the financial return from investment or more generally, business opportunities in the developing countries. There may be a return in technology transfer and innovation that may easily overcome the barriers discussed in this paper. The point of this argument resembles the argument in business management study to find cases of business models in the base of the pyramid.

Secondly, in order to accelerate technology innovation and transfer, the joint efforts between the public and private sectors are inevitable. As the study conducted by the University of Sussex indicated, especially in the early stage of technological development, the public sector both in the developed and developing countries has a clear role in financing R&D initiatives and building networks across the public and private sectors. At the later stage of technological development, however, the private sector has the key role in bringing a larger scale of finance and providing technologies for the projects in the developing countries. The author stresses that the private companies are the ones developing technologies and introducing them to the developing markets.

Finally, it is necessary for the finance community and the technology community to work together to study and decide which technologies to finance in what financial arrangements. At this moment, the finance community including investment banks, multilateral agencies and venture capitalists is engineering new financial schemes to implement projects in the developing countries. Their efforts are not necessarily informed among technology innovators and manufactures both in the developed and developing countries.

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