Addressing a portfolio of effective policy measures and financial mechanisms to encourage technology innovation and transfer of clean energy technologies in the Asia-Pacific region

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Abstract

In the recent climate change negotiation, technology transfer as well as financial mechanism has become a central issue. In Cancun, the parties agreed to organize the Technology Executive Committee (TEC) and the Climate Technology Centre and Network (CTCN). The developed countries have committed to provide $100 billion yearly to assist the developing countries in mitigation and adaptation. While the scheme of the Fund is currently under discussion at the Transitional Committee for the design of the Green Climate Fund, it is essential to re-evaluate effectiveness of existing policy measures in order to consider a new institutional framework to make renewable and energy efficiency improvement technologies available in the developing countries.

This paper addresses a portfolio of effective policy measures to encourage technology innovation and transfer of clean energy technologies from the developed to the developing countries. Before examining policy measures, it illustrates several stages of technological development ranging from demonstration, deployment, diffusion, to commercialization, often referred as RDD&D chain as a basis for considering what policy and institutional arrangements are necessary. Then, it briefly describes barriers that hamper innovation and transfer of technologies in the developing countries along the RDD&D chain including technological, financial, and institutional barriers.

The paper recognizes that different policy measures need to be designed for each stage of technological development. For example, at the early stage of development, both national and international support for research and development (R&D) efforts is critical. Public support for building R&D centers and research network is needed to encourage technology innovation. At the later stage of technological development, on the other hand, the economic policy instruments such as Clean Development Mechanism (CDM), bilateral crediting mechanism and program-based crediting mechanism can be an effective scheme mechanism to encourage technology transfer to the developing countries. The paper summarizes effective policy options for each stage of technological development.

The paper also briefly discusses effective financial mechanisms for each stage of technological development. In the early stage, Technology funding mechanisms for the developing country participants in R&D is necessary. In addition, financial mechanisms to provide strong incentives for clean energy incubators, venture capitalists, and entrepreneurs are needed to mitigate their business risk and encourage their participation at the deployment stage. Various clean energy finance and carbon finance vehicles some

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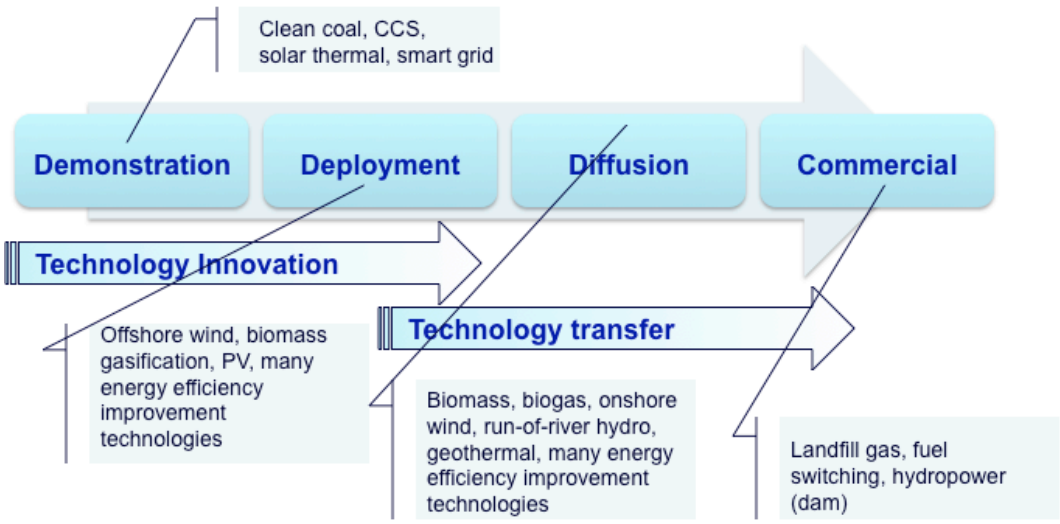
of which are already established by multilateral financial institutions are effective to introduce technologies at the diffusion stage.

1. Stages of technological development: The RDD&D chain

Traditionally, innovating a new technology and transferring an existing technology from the developed countries to the developing countries were discussed in a separate policy or business forum. Since technology innovation and transfer was not a central issue in the United Nations Framework Convention on Climate Change (UNFCCC) negotiation until now, there was a lack of communications between the experts working on the future technologies such as clean coal, carbon capture and storage (CCS), solar thermal and the experts working on the transferrable technologies such as wind power, solar photovoltaic (PV), and mini-hydro. Recently, however, innovation and transfer of technologies are being discussed as part of the same flow of technological development. The reports submitted to the UNFCCC uses the RDD&D chain (Research & Development, Demonstration, Deployment, Diffusion, and Commercial maturity) to indicate the flow from innovation to transfer of technologies (UNFCCC, 2009a, UNFCCC, 2009b, UNFCCC2009c). The chain consists of several stages of technological development. Figure 1 shows the stages of technological development with several examples of technologies for each stage:[2]

Figure 1: Stages of technological development and examples of technologies for each stage[3]



[2] The original version of this figure is contained in UNFCCC (2009b). The author modified the figure by simplifying the stages of technological development from six stages to four stages and adding several sample of technologies along the chain.

[3] This figure should be treated only as a conceptual flow of technological development. The actual mapping of the technologies depends upon various conditions of a country or region. It is also noted that the stages are not as clearly separated in reality as shown in the figure.

The paper recognizes that different policy measures need to be designed for each stage of technological development. Section 3 summarizes effective policy options for each stage of technological development.

2. Understanding barriers in technology innovation and transfer along technological development

There are a variety of barriers in innovation and transfer of clean energy technologies in the developing countries. Typical barriers are associated with the fact that there are difficulties in raising capital to introduce clean energy technologies. Other common barriers are a lack of regulatory support or incentive programs for the investment into clean energy technologies. When the return from investment into a clean energy project is lower than other investment opportunities, a regulatory support such as the feed-in-tariff program is crucial in improving investment conditions. A lack of information about available technologies is also commonly observed in the diffusion stage of technological development.

There are extensive research initiatives that have attempted to identify barriers in the diffusion stage. The research is typically conducted based on the case study approach (Dalhammar et. al. 2009, Gerstetter and Marcellino 2009, Haselip et. al. 2011, Ockwell et. al. 2007, Ockwell et. al. 2009). An example is a study conducted by University of Sussex on barriers in diffusing Light Emitting Diode (LED) in India. The research identified several barriers including 1) limited size of the market, 2) lack of skills and know-how, 3) high production cost of LED chip manufacturing, 4) high procurement cost of equipment and raw materials, 5) high costs associated with intellectual property rights (IPRs) and 6) lack of policy intervention (Ockwell et. al. 2007, Ockwell et. al. 2009). Another example is a study by UNEP Risø Centre on Energy, Climate and Sustainable Development on barriers for implementation of bioenergy projects in India. The barriers for the projects include 1) lack of consistency in quality of biomass as fuel, 2) lack of interests among financial institutions into the projects, 3) lack of information about the technology, 4) lack of social interests into the projects, and lack of adequate training and capacity building program, and 5) lack of policy support for the projects (Haselip et. al. 2011).

The author is currently summarizing the results of those case studies conducted by several research initiatives. Tentative results of the work indicate that these barriers can be broadly classified into three areas including technological, financial and institutional as presented in Figure 2:[4]

[4] There are previous research initiatives that attempt to classify barriers. See, for example, Painuly, 2001 and Painuly and Fenhann, 2002.

Figure 2: Technological, financial, and institutional barriers

Technological barriers	Financial barriers	Institutional barriers
• Lack of absorbing new technologies in general. • Limited access to the international technology market. Poor knowledge of available technologies in the market. • Lack of appropriate infrastructure. • Lack of local knowledge and expertise for imported technologies. Lack of skills and know-how for operation and maintenance.	• Lack of funding for R&D. • Lack of funding (debt and equity) for project implementation. • High investment costs. • Higher O&M costs in the developing countries. • Lack of private sector involvement. • Lack of enabling business environment. • Poor knowledge of financing opportunities among project participants.	• Lack of awareness and lack of access to regulatory information. • Lack of policy and incentive programs to promote clean energies. • Lack of middle or long-term goals to promote clean energy. • Lack of enabling regulatory environment. • Insufficient protection of intellectual property rights. • Political instability. • Lack of social acceptance and support for clean energy.

In the very early stage of technological development, technological barriers are dominant until technologies are proven to be feasible. At this stage, public national institutions provide financial resources into R&D mainly, since the future prospects of the technologies are too uncertain for the private sector to invest at this stage. In the later stage of technological development, financial barriers emerge as a major barrier since public funding becomes less available. Private funding is still difficult to bring due to the high risk involved in investment. This stage of technological development is known as the “valley of death” as a metaphor for the gap of financial resources available at this stage of technological development (UNFCCC, 2009b).

In order to design policy measures for technology innovation and transfer, it is necessary to identify barriers more clearly. Policy measures should be designed to overcome identified barriers in each stage of technological development.

3. Portfolio of effective policy measures at each stage of technological development

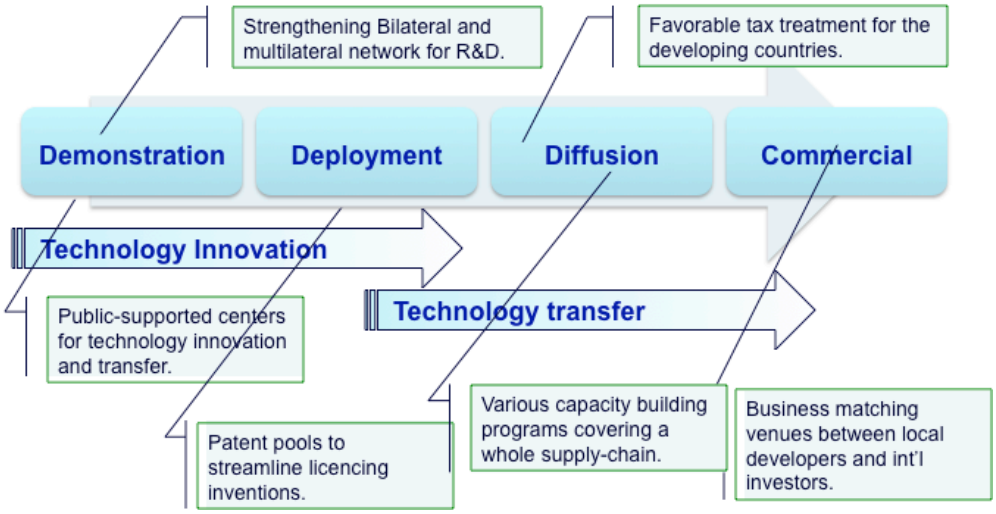
As noted above, innovation and transfer of technologies are being discussed as part of the same flow of technological development in the UNFCCC negotiation. On the other hand, different policy and institutional designs are necessary to promote technologies at each stage of technological development.

In the early stage of technological development, the empowerment of the network of local research groups is needed to encourage technologies, especially with a stronger initiative from the public side. International institutions can partly play an important role by facilitating the network between international and local actors. At the bilateral level, in fact, there have been several initiatives already to build a network among research institutions. For example, there are research agreements between the EU and China as well as between the US and India in clean coal and CCS. Australia and several developing countries have begun to work together under a cooperation called the Global CCS Institute. At the multilateral level, while there have not been remarkable efforts from the public side, there have been several industry-based programs for

several years including the Asia-Pacific Partnership on Clean Development and Climate (concluded in April 2011) as well as specific industry-based programs for technology innovation including the Technology Breakthrough Program in the steel sector, the Cement Sustainability Initiative in the cement sector, and the Carbon Sequestration Leadership Forum in the electricity generation sector.

At the later stage of technological development, the involvement of the private sector including project developers, equity investors and commercial banks becomes essential. It is possible to encourage their participations by facilitating venues for sharing knowledge and providing them with economic incentives to improve investment conditions. For example, the economic policy instruments such as CDM may take an instrumental role in at this stage of technological development, while it is not realistic to regard them as a universal policy instrument for diffusing technologies across all stages of technological development.[5] If they are designed well, a bilateral carbon crediting mechanism as well as an expansion of project-based CDM into a sectoral or program-based mechanism can be also a good policy candidate for technology transfer in the post-Kyoto regime. At the national level, an introduction of a feed-in-tariff program has received a greater attention in the developing countries, while other economic instruments such as subsidy, emissions trading, and renewable energy certificate scheme can be also considered as policy options to attract technology manufacturers and investors from the developed countries.[6]

Figure 3 includes examples of policies and institutions for each stage of technological development:



[5] In author's view, the role of the existing market-based instruments including CDM in technology innovation and transfer is limited to the diffusion or commercial stage of technological development. While some CDM activities are leading to diffusion of renewable energy projects in the developing countries, the magnitude of technology diffusion through CDM is too small to reduce greenhouse gas emissions in a larger scale. Though technology transfer is not a condition for the project to be a CDM activity, there was a higher expectation among policymakers that CDM could facilitate more renewable or energy efficiency improvement technologies that could not have been introduced in the developing countries otherwise.

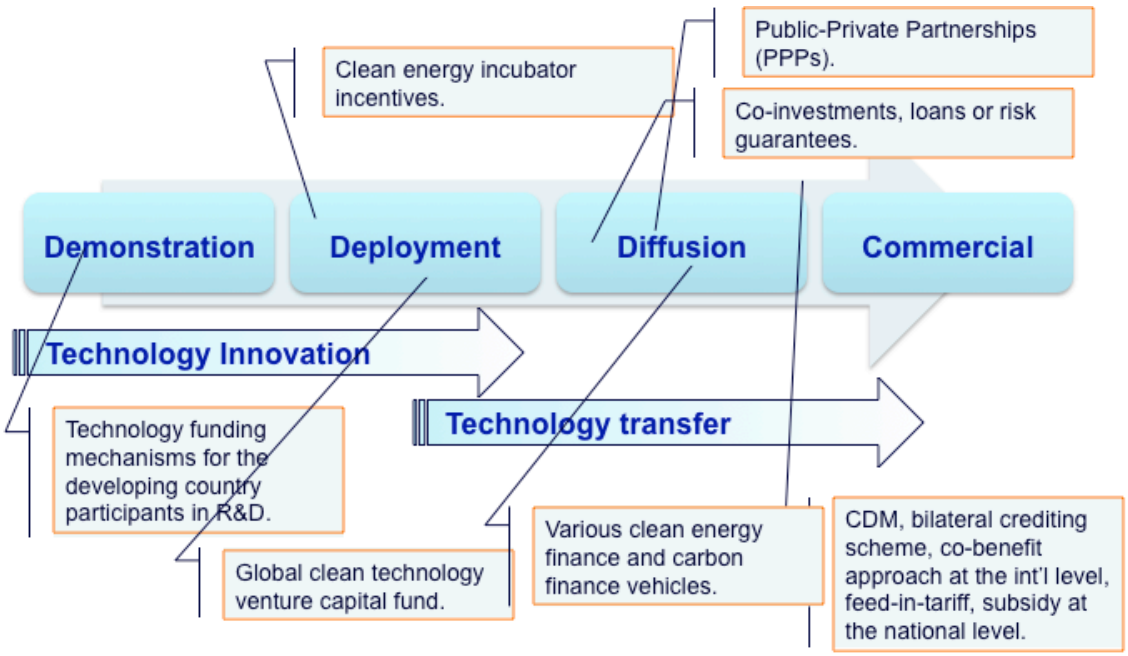
[6] The author is currently mapping different technologies, together with effective policies and institutions for each technology on the flow of technological development.

4. Effective financial mechanisms at each stage of technological development

This section briefly discusses effective financial mechanisms for each stage of technological development. In the early stage, Technology funding mechanisms for the developing country participants in R&D is necessary. In addition, financial mechanisms to provide strong incentives for clean energy incubators, venture capitalists, and entrepreneurs are needed to mitigate their business risk and encourage their participation at the deployment stage. However, as stated above, at the deployment stage, private funding is still difficult to bring due to the high risk involved in investment as illustrated as the "valley of death". The roles of public national institutions providing financial resources into R&D are still essential at this stage of technological development.

At the diffusion stage, various clean energy finance and carbon finance vehicles some of which are already established by multilateral financial institutions are effective to introduce technologies at the diffusion stage. At the international level, the economic policy instruments such as CDM, bilateral crediting scheme and co-benefit approach may take an instrumental role in at this stage. At the national level, economic incentives such as a feed-in-tariff program is proven to be an effective policy option in several countries to diffuse technologies at this level. The schemes such as co-investments and loans or risk guarantees may help to reduce risk associated with investment from the private sector.

Figure 4 illustrate these examples of financial mechanisms for each stage of technological development:



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