GREEN ENERGY DEVELOPMENT AND TECHNOLOGY TRANSFER IN CHINA AND INDIA

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Abstract

Climate change has recently become a hot topic of debate for academia, politics and business due to its serious impacts on environmental, socio-economic conditions and human well-being. Reducing CO_2 emissions as a way to mitigate climate change has been a focus since the Kyoto Protocol came into effect. Most of the efforts, however, have been for the Clean Development Mechanism (CDM), and green energy development and technology transfers have emerged to take the leading roles in recent years.

The two biggest CO_2 emitters, China and India (after China and USA), have made progress to maintain their leading role in developing and transferring green energy. This study aims to analyses green energy development and technology transfers in these two countries, and makes conclusions on some experiences for other developing countries to consider as they shift to low carbon societies. The study shows that besides good policy, market-based instruments and management skills, the development of green energy requires scientific and international cooperation and green technology transfers. Technology transfers can be implemented through bilateral agreements, international commitments and market-based mechanisms.

Keywords: climate change, green energy, technology transfers, developing countries

1. Introduction

Many scientific studies have confirmed that climate change (CC) is occurring, caused mostly by human beings and their institutions (UNEP, 2010; WB, 2010; Hansen, 2009; Harmeling, 2009; WWF, 2008; IPCC, 2007; 2001; Dasgupta et al., 2007;

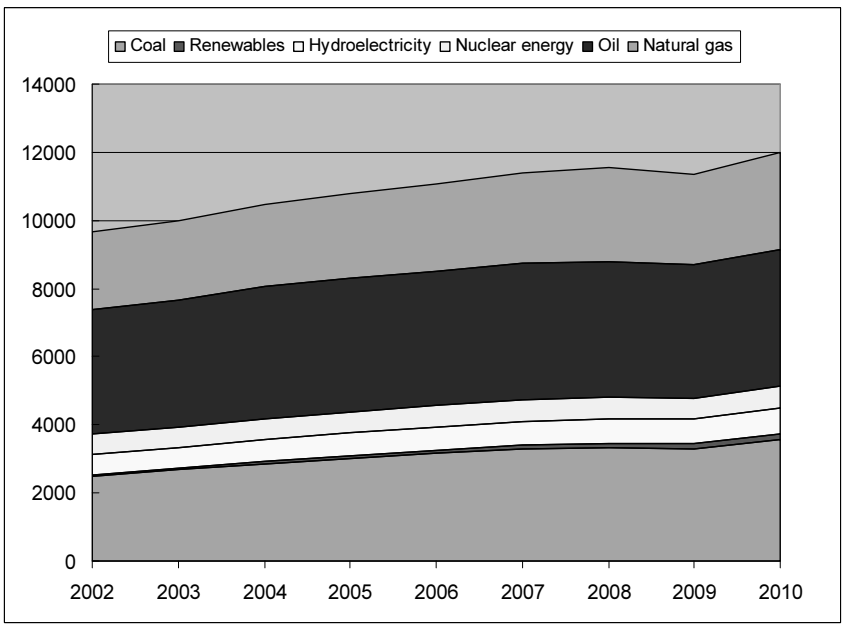
UNDP, 2007). CC has many negative effects, including greater frequency of heat waves, increased intensity of storms, floods and droughts, rising sea levels, a more rapid spread of disease, and loss of biodiversity (IPCC, 2001). Negative impacts of CC on human beings are already occurring, such as serious storms, hurricanes, floods, droughts, and the rise of sea levels. The CC has firstly afflicted poor and vulnerable people in developing countries, and then reversed the development of the entire planet.

The relationship between CO_2 emissions and CC or global warming is strong (UNEP, 2010; WB, 2010; Hansen, 2009; Harmeling, 2009; WWF, 2008; IPCC, 2007; 2001; Dasgupta et al., 2007; UNDP, 2007).

The world will face significant problems if the global temperature increases to 2ºC, so many efforts have been made to ensure that this will not happen. The reduction of energy use and green energy development have been taken the leading roles in addressing the increase of CO_2 emissions in recent years, because energy consumption is a leading factor that has most contributed to CO_2 emissions and global warming. A study by Kim and Worrell (2001) indicated that:

"In most countries the increased (or decreased) production was the main contributor to changes in CO_2 emissions, while energy-efficiency was the main factor reducing emission intensities of steel production in almost all countries."

Energy, however, is a vital resource for economic development and the demand for energy will dramatically increase to meet the needs of global and national economic growth and the prosperity of people (Fig.1). In the era of rapid industrial development and expansion, land was not as important as Adam Smith considered, like a "mother"; but energy could be considered as a "mother", which combined with "labor" to make "the wealth of nations" (Adam Smith, 1776). Meanwhile, energy resources are limited and have sharply decreased in volume. Therefore, to achieve sustainable development, we need not only to efficiently reduce energy use but also to find new energy resources to cope with the rapid global growing demand for development. By summarizing the green energy development of current state-of-the-art knowledge and technology, Li (2011) also concluded that energy security has been on top of national agendas around the world. He suggested that the development of energy strategies, policies, and technologies to ensure energy security is imperative and green energy is the choice for sustainable development (Li, 2011).



Source: BP, 2011

Fig.1: World energy consumption (million tonnes oil equivalent)

Green energy resources are promising; but there are a number of challenges for achievement, especially for developing countries. The global economy is still too dependent on non-renewable energy resources, and green energy accounts for a very small portion of total energy use: 19% of total energy consumption (REN21, 2011: 15). However, investments in green/renewable energy have significantly increased in recent years (Fig.2), indicating a potential "paradigm shift" in economic development models and environmental governance. The energy report of WWF (2011), in collaboration with ECOFYS and OMA, even suggested a challenging target: up to 100% renewable energy in use by the year 2050. To achieve this challenging goal, there will be a tough price to pay from now, especially for developing countries.

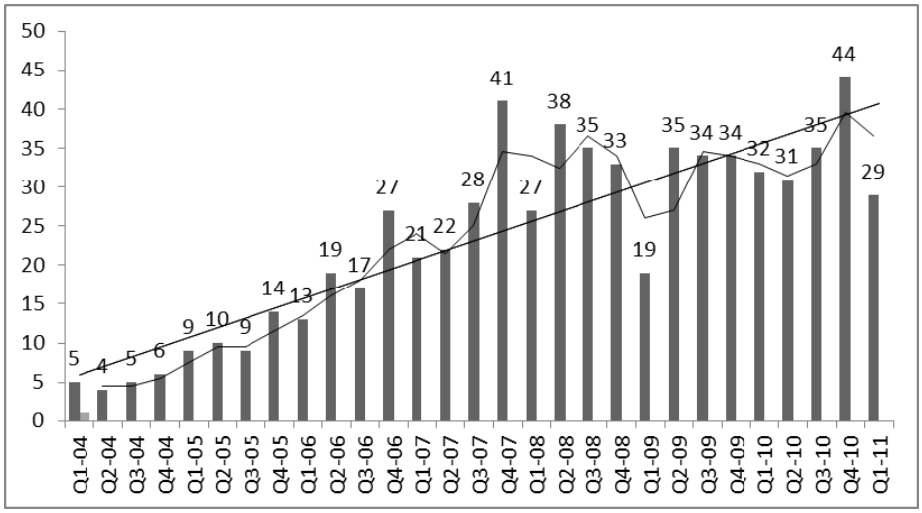


Fig.2: Global financial new investment in renewable energy quarterly trend, Q1/2004-Q1/2011, $ billion (Source: UNEP, 2011)

Green energy development also requires the development and transfer of green energy technology. Dincer and Rosen (2011: 20) summarized that "green energy and technologies are expected to play a key role in sustainable energy and global stability scenarios". Green technology innovation is important and many models for development have been proposed (Dincer and Rosen, 2011; Gielen and Taylor, 2006; Icerman and Morgan, 1984; Lund, 2010; Sagar, 2004). Transferring green energy to developing countries has been a primary global concern as the development of green energy incurs large investment costs. Gaast et al. (2009) suggested using the Clean Development Mechanism (CDM) as a way of transferring green technology to developing countries.

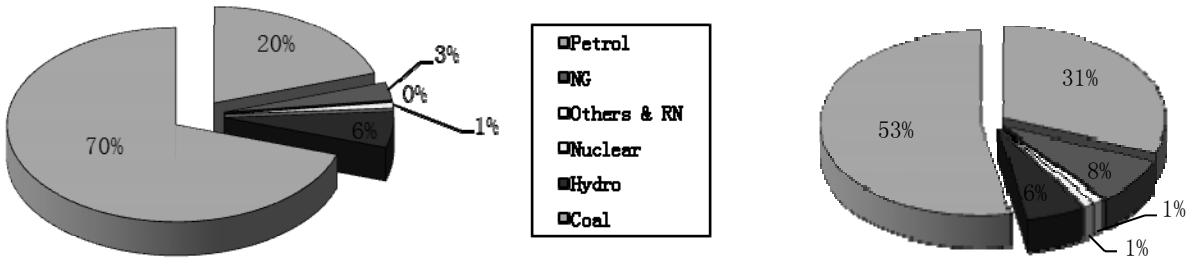
In this paper, we will focus on discussing green energy development technology transfer as a mechanism for developing countries to prepare and step forward to green energy use. The paper firstly provides background information on the urgent need to develop green energy. The second section presents the historical figures of energy use globally and green energy development in the cases of China and India, with focus on how green technology has been transferred to these countries for green energy development. Section 3 discusses how green technology could be transferred to developing countries for green energy development through bilateral agreements, international commitments and market-based mechanisms. The conclusion section proposes some mechanisms for transferring green technology to developing countries based on the real experiences of China and India.

2. Green Energy Development

2.1. Energy demand for development

Global energy consumption has sharply increased since the Industrial Revolution. The annual Statistical Review of World Energy for 2011 just released by BP (2011) focused on the unexpected strong growth in global energy consumption in the year 2010 (Fig.1). Overall, the review points out that global energy consumption growth was 5.6%, the highest rate since 1973, and share of renewable energy slightly increased above average but still accounted for a very limited portion on record. Figure 3 shows the energy structure of China and India. It is evident that green energy accounts for just a small portion of total energy consumption (Ye, 2010).

The review shows an upward line, except for a slight drop in 2009 due to the economic recession. We do expect that economic recession will reduce energy consumption. Therefore, besides reducing energy use, investments in renewable or green energy have dramatically increased since 2004 (Fig.2).

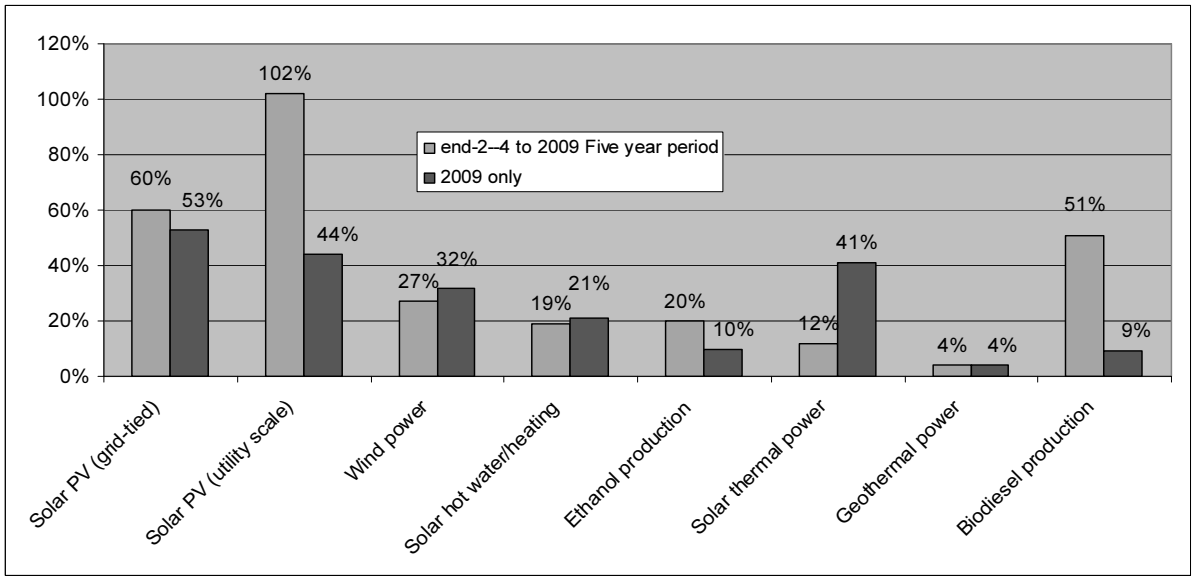


China India

Source: BP Statistical Review of World Energy 2009 (NG stands for Natural gas, RN stands for renewable energy)

Fig.3: Energy structure of China and India (2008)

The need to develop renewable energy has grown rapidly and financial investment in this sector has sharply increased to meet that need. As a result, renewable energy capacity and the use of this new energy have significantly increased in recent years (Fig.4).



Source: REN21, 2011 (PV stands for Photovoltaic cells)

Fig.4: Average annual growth rates of renewable energy capacity, end-2004 to 2009

To develop renewable energy, financial investment is important. However, there is much more required: human capital, political commitment and technology transferring, for instance. Therefore, it is very tough for developing countries to develop green energy without sufficient support from developed countries as China and India have the highest CO_2 emissions of all developing countries. Most recently, the governments of these two countries are attaching great importance to the development of green energy. They have made progress to maintain their leading role in developing and transferring green energy. Thus, this study aims at analyzing green energy development and technology transfers in these two countries.

2.2. Green energy development in China and India

Over the past few years, investment in renewable energy has grown rapidly, mostly in China, Brazil and India due to venture capital (VC) invested in solar power, wind power and bioenergy. China absorbed 9% of total global renewable investment in 2006 mainly to develop its wind power, methane and dust burying, while India followed closely as the largest purchaser of overseas renewable energy companies, although the total investment it absorbed fell just behind China (NDRC, China, 2006).

(A) Solar energy and wind energy policies

In recent years, the annual growth rate of the global photovoltaic (PV) industry was maintained at 40%. European markets in Germany, Spain, Greece and France are the most important growth points of the global solar industry. In Asian markets, the governments of China, Japan and South Korea have been offering subsidies to develop energy (Pei, 2009).

China has launched *Renewable Energy Law* and *Mid-Long Term Development Plan for Renewable Energy,* which have set clear targets for renewable energy development. The consumption of renewable energy in China has risen from 7.5% in 2004 to around 10% in 2010, and will reach 15% by 2020. India has a special ministry for renewable energy, to set special policies and development plans for renewable energy. The government pays all efforts to boost development and employment for renewable energy. As a result, it now has the greatest application of wind power and solar power in the world, and its total installed wind power capacity ranks number 4 in the world.

At India's 11th new energy and renewable energy conference, it established a five-year plan for its new strategic energy development goal from 2008 to 2012: by 2012 renewable energy such as solar photovoltaic power generation will account for 10% of electricity demand in India. In India, there are more than 19 solar photovoltaic cell manufacturing plants currently in production. According to the original plan, from 2002 to 2007 renewable energy should have been 3075 MW electricity interconnection, however the actual figure was more than 6,000 MW in 2006. This large increase was due to the rapid growth of wind power in India. Moreover, regarding wind power, the installed capacity for wind power was 4430 MW in India, which ranks number one in Asia. And wind power capacity is expected to increase more than 10,000 megawatts by 2012 (New Delhi Renewable Energy, 2009). From the draft plan of National Solar Development acquired by The Times, India is aiming for solar power capability of 20 gigawatts by 2020 and 100 gigawatts by 2030, compared to the global capability of 14 gigawatts at present, which is really an ambitious target.

At present, solar water heaters and photovoltaic power of China are an important part of the global market. In July 2009, the Chinese government announced a plan to stimulate the field of solar energy and the photovoltaic power generation industry, and it began to increase financial support for efforts made on grid-connected photovoltaic power generation projects, based on the PV system and its supporting transmission and distribution projects totaling 50% of investment grants (Christoph Steitz and Leonora Walet, 2009). According to some experts, large-scale construction of solar photovoltaic power plant currently costs about 25,000 yuan per kilowatt. Using the same calculation, in 2020, China's photovoltaic power generation investment will rise to at least $ 25 billion yuan and average annual investment will reach at least 20.8 billion yuan. However, there are still some issues today. For example, the development goals of PV are set too low, the level of production technology is low, there is excessive construction of low-level redundant factories and the technology and equipment is old and lacking advanced manufacturing support (Jin, 2009).

(B) Management of green energy

In India, there is a new integrated management department for green energy and it is responsible for all matters for effective management of the new energy. In contrast, China's new energy management is covered by the establishment of the NDRC's energy bureau. It does not include the initiative in energy prices, as energy prices are still decided by the NDRC. Directly reporting to the State Council, the NDRC was led by the ministries to participate in such high-level coordination work - the National Energy Commission is responsible for coordinating tasks (Liu, 2006, Pei, 2009). This mechanism is clearly operating under the Bureau of Energy, including new items and large energy operating costs, and is not conducive to management responsibility for issues regarding effective energy, nor is it conducive to various kinds of comprehensive coordination between energy uses.

(C) Green energy laws and regulations

The Indian government is increasing subsidies to support green energy. As of April 2008, the Indian government provides subsidies of 62.5 million U.S. dollars for a 1 MW network of wind energy, and 37.5 million for a 1 MW small hydro network (2008, http://www.86ne.com/Solar/200804/Solar_119288.html). As the prices of different energy differ, the India government encourages businesses to use wind and small hydro power generation.

In China, a series of green energy laws and regulations have been enacted, such as the 'power law' in the December 28, 1995, the 'Renewable Energy Law' in February 28, 2005 and the 'Energy Act' in October 28, 2007. In August 2000, the State Economic and Trade Resources Conservation and Comprehensive Utilization Department constructed the '2000 to 2015, new energy and renewable energy development plan points'. In June 11, 2007, the State Council considered and adopted the 'long-term development plan for renewable energy'. In March 18, 2008, the National Development and Reform Commission adopted the 'Renewable Energy Development 'Eleventh Five-Year 'plan' (Pei, 2009) . The promulgation of these laws and regulations

for China's new energy development form a legal perspective to provide standards and protection, but the market support measures are still not perfect. For instance, investment, financing, technical standards, foreign trade, government procurement, tax incentives and other aspects of the package of measures are not perfect. An effective technical innovation service system, which is a service for the development of new energy demand such as information, personnel, capital, technology, management consulting companies, has not yet been established. The specific measures need to be refined for the area of operation of new energy, which they do not support, including such as PV electricity price subsidy rules and other measures. . The new energy will undoubtedly weaken the enforcement of laws and regulations.

(D) Scientific and technological effort policy

Requirements for a low carbon economy and clean energy are increasing, making the whole world focus on the development and application of new energy. 'China's Energy Development Report 2009' indicated that for energy consumption in China, 69% of primary energy comes from coal and more than 80% of the capacity of power generation is from thermal power. This is not sustainable energy and energy shortage has become one of the bottlenecks of China's economic development. To this end, attention is turned to the development of new energy industries, which will be a new economic growth point and a new area of strategic high ground in international competition (Hu, 2009). The U.S. administration's new energy policy has four pillars: energy efficiency, new energy development, climate change, and 'smart grid' development. According to the U.S. administration's new energy policy, China's government has been aware that these practices should also be combined with China's national conditions, carefully studying and learning. First, priority is given to key projects in new energy technology research and reform of the existing system of energy research, and efforts are made to develop technology in major new energy projects, which made significant research breakthroughs. Second, in response to climate change positive progress has been made quickly, enhancing China's potential power. This is better for energy conservation and new energy development to achieve greater technological progress. Third is the development of the 'smart grid'. A variety of energy sources, mainly through the power supply, are in the process of realization and the 'smart grid' is developed as a 'green industrial revolution'. This is significant not only for energy saving; it can also greatly improve the safety factor of the national grid, and may bring digital technology to a higher level (Xu, 2009).

In August 2006, India's Planning Commission drafted a 'comprehensive energy policy report,' India's 'Tenth Five-Year (2007 ~ 2012) Plan' to develop energy policy guidelines. It clearly indicates green energy technologies to improve the efficiency of energy production and use, to ultimately solve their own energy security issues and achieve energy independence. The Report points this out by encouraging closer moves to commercialization and setting a clear schedule for the development of new energy technologies, including solar energy technologies, bio-fuel technologies, nuclear energy utilization technology, hybrid vehicle technology, high-energy battery technology, and gas hydrate technology. The Report also states that the National Energy Fund should provide financial support to solve technical issues and national investment in India should be established (Pei, 2009).

(E) Policy regarding international cooperation for green energy

Strengthening green energy cooperation is significant for reducing carbon dioxide emissions, reducing greenhouse gas emissions and achieving sustainable economic development. In 2009, China's Huaneng Group and America's Duke Energy signed a cooperation memorandum in Beijing, which is a plan to jointly develop a variety of renewable energy and clean energy technologies to improve the response to climate change. The core objective of the the two countries' memorandum is to use the most advanced and efficient existing energy technologies including carbon capture and storage and clean coal technology, as well as coal gasification technology to reduce carbon dioxide and other greenhouse gas emissions.

In 2008, the Federal Government of India announced that relevant ministriesin India and Israel will collaborate to develop renewable energy technologies. Areas of cooperation are water resources, the development of space technology, bioenergy and nanotechnolog (http://www.inen.com/newenergy/html/newenergy1023102350178962.html).

Based on the above discussion, by comparing green energy development in China and India, we can offer the following recommendations for emerging countries.

1) It is very important to accelerate the development of solar energy and wind energy, especially the PV industry;

2) It is the central government that should undertake the overall management of energy policies, for better guidance and coordination;

3) Detailed construction of new energy laws and regulations is a necessity. In the meantime, it is necessary to establish market support measures;

4) Some science and technology research efforts will be required, such as “smart grid” and others;

5) It is important to enhance international cooperation to ensure the safety of new energy and obtain support from other emerging countries, namely investment, financing and mechanisms to avoid possible trade protectionism.

3. Technology transfer for green growth

3.1. Bilateral relationships or international agreements for technology transfer

Technology transfer is an important means by which developing countries may gain access to technologies that are new to them. Trends in the regulations introduced to encourage trade liberalization also have implications for access by developing countries to foreign technologies.

Technology transfer is usually a basis for technical innovation and often has after-effects in the form of innovation diffusion (Andrzej, 2005). Technology transfer can be defined as the inflow of technical knowledge to the market where it is sold and bought (Andrzej, 2005). In the Andrzej argument, technology transfer flows from one place to another where it could be bought or sold (product). According to Andrzej, technology transfer exists in the following main forms;

- Sales/purchase of the results of R & D work
- Turnover of licenses, patents. Utility models, know-how
- Sales/purchase of production techniques, means of automation etc
- Technological advisory/consulting
- Technical staff training
- Exchange of technological information. Andrzej went further to simplify technology transfer into;
    1) Embodied technology transfer (ie the flow of knowledge embodied in new products, materials, tools, machines and similar equipment), and
    2) Disembodied technology transfer (ie other forms of flow of technical knowledge).

Below are some methods of technology transfer.

(A) Foreign Direct Investment (FDI)

FDI has been a channel for technology transfer approved by many authors because of its direct impact on economic development and the low cost of transfer. However, the selection of the method used to channel technology depends on the country’s market size, market growth, the threat of imitation, and IPR.

For developing countries to acquire technology through FDI there needs to be an abundance of skilled and semi-skilled workers and also strong IPR protection to attract investors. These will increase the level of tacit knowledge (know-how) absorption.

(B) Joint Ventures

Joint ventures typically involve less risk than strategic alliances, acquisitions or financing subsidiaries, and tend to be more common, as skills, attributes and resources are sought through mutual business objectives (Czinkota et al, 1994). Through joint ventures, companies can pursue common business-related aims, use harmonizing technology or research techniques, increase capital and bargaining power, extend the risk of scale; and surmount entry barriers by gaining market share and therefore power (Boyett and Boyett, 2001).

(C) Licensing Agreements

A license is a contract that authorizes the use or exploitation of the subject matter of the license for a specified purpose and period of time with all other rights maintained by the owner of the technology (Thomas, 1998). Thomas also argued that companies wishing to expand into the international arena are finding that licensing or transferring their technology provides a low risk and is a highly profitable alternative to direct exports, establishing a foreign branch, subsidiary or joint venture.

(D) Implementation of IP Strategy

Intellectual property (IP) is a factor apart from infrastructure, trade, location, investment in-flow, policy, culture, etc .that affects technology transfer to developing countries. Developing countries should strengthen their IP policy to attract foreign investment. Developed countries will be willing to set up manufacturing and R&D facilities in countries with strong IPR.

At the international level, technology transfer is becoming increasingly drawn into political negotiations between developed

and developing countries, particularly those involving international agreements on trade and environment-related issues. Provisions on technology transfer, for example, play an important role in several multilateral agreements, such as the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) of the World Trade Organization (WTO), UNCTAD (United Nation Conference Trade and Development) and the United Nations Framework Convention on Climate Change (UNFCCC), as well as in regional and bilateral agreements.

Policies adopted by developed countries for stimulating the transfer of technologies to developing countries are also becoming increasingly relevant. This is because international policies on trade and environment issues often require such countries to create incentives for the transfer of technologies to developing countries.

For example in November 2009, President Barack Obama and President Hu Jintao announced seven new U.S. - China clean energy initiatives during their Beijing summit. In doing so, the leaders of the world's two largest energy producers and consumers affirmed the importance of the transition to a clean and low-carbon economy - and the vast opportunities for citizens of both countries in that transition. The following joint initiatives were announced; (1) U.S-China Clean Energy Research Center. (2) Electric Vehicles Initiative. (3) Energy Efficiency Action Plan. (4) Renewable Energy Partnership. (5) 21st Century Coal. (6) Shale Gas Resource Initiative. (7) Energy Cooperation Program.

On the other hand, the Japan International Cooperation Agency (JICA) signed Japanese ODA loan agreements with the Government of India to provide six loans of up to a total of 132.646 billion yen. The government of India has set "faster and inclusive growth" as a goal, aiming to increase the size of the overall economic pie (faster growth) while ensuring that everyone will be able to enjoy benefits of inclusive growth. To accomplish these goals, major impediments must be resolved for improving infrastructure, such as power, transportation, and communications. The 11th Five Year Plan (the government's current development plan being implemented from fiscal 2007 to 2011) calls for 40 trillion yen (USD 500 billion) in infrastructure investment, while the 12th Five Year Plan (for fiscal 2012 to 2016) calls for more than 80 trillion yen (USD 1 trillion) in investment, through domestic and foreign funding and procurement, reliable implementation, and the resolution of critical issues for development. The features of the Japanese ODA loans are outlined as follows: (1) Improve the investment climate by increasing power supply. (2) Leverage Japanese experience to support the introduction of new and renewable energy as well as energy-saving projects. (3) Support growth with benefits for all.

3.2. Market-based instruments for green energy technology transfer

The combination of market-based instruments such as tradable permits, green certificates, and eco-taxes can contribute significantly to green energy technology transfer, as they are a cost-effective way of protecting and improving the environment (2011, Wooders). They provide incentives to firms and consumers to opt for greener production or products, and it is crucial to make good use of them because green energy is expected to play a key role in the future global energy supply. The market instruments for green technology transfer aim to lead the environmental and health costs of economic activities to market-based pricing. Secondly they set a price for the use of natural resources such as air, water and soil (2007, Dimas, Kovács). Gradually, the spectrum of policy and market instruments has broadened, recognizing that there is no single universal policy tool that can provide solutions to all problems. Below are presented different market instruments for green technology promotion for developing countries (see table 1):

Market mechanisms in country-specific cases for promoting green energies show that in India, the Renewable Energy Certificate (REC) is prominent and China is an interesting case of a market-driven shift towards green energies. The shift towards the usage of green energies in these two countries has some significant differences. Chinese targets for green energy adoption seem to work efficiently, and currently 10% of overall energy consumption is already from clean energy sources. China can be characterized as a country with strong state control/ power and therefore the targets set are efficient. China has introduced several efficient subsidy systems (Pei, 2009). Nevertheless in Indian case different measures must be taken. The instruments used in India for green technology are for example the five year plan for strategic green energy development. By 2012 India hopes to reach their goal of 10% for photovoltaic power generation for overall electricity production. The shift towards green energies is to a great extent influenced by culture and thus we see different methods being introduced in these countries.

In India historically, actual power generation capacity additions in the conventional power sector have been falling significantly short of government targets. For the renewable energy sector, the opposite has been true, and there has been a tendency towards exceeding the targets set in the five-year plans. This is largely due to the booming wind power sector. Given that renewable energy was about 2% of the energy mix in 1995, this growth is a significant achievement even in comparison with most developed countries. This was mainly spurred by a range of regulatory and policy support measures for renewable energy development that were introduced through legislation and market-based instruments over the past decade (Global Wind

Table.1 Subsidies/loans/grants/fiscal measures

RD&D	Financial measurés	Non-financial measures
	- Fixed government RD&D subsidies - Grants for demonstration, development, testfacilities, etc. - Zero (or low) interest loans	
Investments		
	- Fixed government investment subsidies - Bidding system for investment subsidies/grants - Subsidies for switching to renewable energy production or for the replacement of old renewable energy installations - Zero (or low) interest loans - Tax advantages for renewable energy investments - Tax advantages for (interest on) loans for green energy investments	- Negotiated agreements between producers and government
Production		
	- Feed-in tariffs at a fixed level set by the authorities - Bidding system for feed-in tariffs necessary to operate profitably - Tax advantages for income generated by renewable energy	-Quota obligations for production
Consumption		
	- Tax advantages for the consumption of renewable energy	- Quota obligations for consumption

Table combined by the authors Research, Development and Demonstration (RD&D)

Energy Council, 2011)

In 2010, the Indian government recognized the role that green energy can play in reducing dependence on fossil fuels and fighting climate change. Therefore India introduced a tax of Rs.50 (up to USD1.0) on every metric ton of coal produced or imported into India. This money is used to contribute to a new Clean Energy Fund. In addition, the Ministry of New and Renewable Energy (MNRE) announced its intention to establish a Green Bank by leveraging the Rs 25 billion (EUR 400 million / USD 500 million) expected to be raised through the national Clean Energy Fund annually (Reuters, 2011). The new entity would likely work in tandem with the Indian Renewable Energy Development Agency (IREDA), a government-owned non-banking financial company (ABPS, 2009).

In keeping with the recommendations of the National Action Plan on Climate Change (NAPCC), the MNRE and the Central Electricity Regulatory Commission (CERC) have evolved a framework for implementation of the Renewable Energy Certificate (REC) Mechanism for India. Renewable Energy Certificate - the Clean Energy Program will implement this market-based instrument to promote the usage of clean energy technology by providing a production subsidy to electricity generated from renewable sources, thereby also promoting renewable energy development (Global Wind Energy Council, 2010).

The REC system is useful because it will push renewable energy development further in the coming years. Under EA 2003, the SERCs set targets for distribution companies to purchase a certain percentage of their total power requirement from renewable energy sources (Narendra, 2007). The target is known as the Renewable Purchase Obligation (RPO).

In comparison, we can say that Chinese green technology transfer market has not been driven by market instruments as much as it has been forced to innovate by market mechanisms. There are policy instruments available to address every dimension of the value chain, including research and development, equipment manufacturing, design and installation, financing, power generation, transmission and distribution and end use. These instruments can be applied to technology, financing, grid parity, integration and behavior. Policies are useful in the Chinese case; nevertheless the demand for innovation has remained high in China and thus IP and IP rights have not played such a significant role in promoting technology transfer as they should have, in the same way as some other instruments.

Thus we can see that although we are discussing a developing country in transition like China and another developing country like India, there is no single universal policy or market tool that can provide solutions to all problems. There are no simple measures that Indians could adopt from China or vice versa. Every method, tax, policy or whatever instrument is used to promote clean technologies needs to be adapted to the special requirements of the specific country. For developing countries

many factors should be kept in mind and when using market mechanism it is country-specific solutions that will provide the best results (Kemp, 2000).

4. Conclusions

Energy is a vital resource for economic development and the demand for energy will dramatically increase to meet the needs of the global and national economic growth and the prosperity of people. However, most of the energy resources that have been used are non-renewable sources that are limited and also pollute to the global environment more. Therefore, green energy resources are promising; but achievement is very challenging, especially for developing countries. Developing green energy for global environmental protection requires more cooperation and sharing than competition. The most efficient ways for developing countries to develop and use green energy are not only financial support but also the development of human resources development and the transfer of green technology.

Based on the green energy development conditions in China and India, it seems that some policies need to be improved for green energy development in developing countries. This includes the accelerated development of solar energy and wind energy; centralized energy management; detailed construction of new energy laws and regulations; the increase of "smart grids" and other science and technology research efforts; and the strengthening of international cooperation with other developing nations.

To improve the situation in developing nations, the focus should be technology transfer to developing countries.. This will reduce the gap between developed and developing countries. Developing countries should be willing to encourage technology transfer as well as local R&D activities. The transfer of technology is not the only economical solution to developing countries - transfer of R&D is also important. This will empower local R&D entities to achieve further innovation. This paper proposes that such transfers could take place through bilateral agreements, international commitments and market-based mechanisms. Developing countries like Cambodia and Laos should collaborate with other developing countries like China and India for technology transfer, as these countries were once in the same situation and will be willing to negotiate for appropriate technology transfers.

India needs efficient service support maintenance, in other words infrastructure, that favors green technology transfer - efficient market mechanisms. The cost and local adaptability of the technologies remain essential for equally technology transfer and the mass adoption of technologies in India (Sahai, 2005). In the Indian case, the Technology Diffusion Centre needs to act as a hub for clean energy technological information as well as an innovation platform for their diffusion and adoption (MNRE, 2008). As a result of tariff liberalization on green products, countries similar to India may eventually becoming and remain 'technology dependent' if no additional actions for cost-effective technology transfer, development and attached funding are set (Kanoria, 2011). Thus in India it is vital to establish the necessary infrastructure for enforcing market mechanisms and fairly set instruments.

An examination of the situation of market instruments in both countries indicates that in the Chinese case, some clear decisions need to be made at the government level before infrastructure can be fully established. As the Chinese innovation market has been greatly demand-driven, market instruments have played a secondary role (ETS pilot, Energy performance Contracting, Carbon Tax) (Qi Ye, 2011)

There are two possible directions: support of energy generators (a feed-in system) or support of green energy consumers, perhaps through pricing. China would like to pursue a voluntary emissions trading scheme and government tenders for innovation.

In the Indian case we see the successful REC system development, and perhaps here China could learn from India and the USA, by introducing mandatory requirements like quota obligations in the energy generation mix. When discussing quota obligations China should clarify whether they are promoting megawatt-based systems, with subsidies and investment, or megawatt per hour systems. In the Chinese case direct investment incentives could be used to promote green energy transfer, or another option could be taxes and voluntary emissions reduction programs. All these findings need to investigate further and are recommendations for further research.

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