Paper No. 3:

Framework for improving the diffusion and implementation of environmentally sound technologies and know-how under the UNFCCC: perspectives from the Asia-Pacific region

Editor's note: Please note that the views expressed in this paper are those of the authors and
do not necessarily reflect the position of the UNFCCC secretariat

Contact information:

Tata Energy Research Institute
Darbari Seth Block
Habitat Place, Lodi Road
New Delhi
110 003
India
Tel.(91-11)460-1550 or 462-2246

Fax.(91-11)462-1770 or 463-2609

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List of Abbreviations

AIJ	Activities implemented jointly
CDM	Clean development mechanism
CFCs	Chlorofloro carbons
CFL	Compact fluorescent lamp
CGLP	China green lights program
CNG	Compressed natural gas
CSD	Commission on sustainable development
EHV	Extra high voltage
EST	Environmentally sound technology
EST-ADC	Environmentally sound technologies - adoption and diffusion center
FCCC	Framework convention on climate change, Secretariat
FDI	Foreign direct investment
G77	Group 77
GDP	Gross domestic product
GEF	Global environment facility
GHGs	Greenhouse gases
GTZ	Gesellschaft für Technische Zusammenarbeit
HIDECOR	Human and institutional development project for ecological refrigeration
HVDC	High voltage direct current
IGCC	Integrated coal gasification combined cycle
IPRs	Intellectual property rights
ITP	Integrated technology program
JI	Joint implementation
NEDO	New energy and industrial technology development organization
NGO	Non-governmental organization
ODA	Overseas development administration
OECD	Organization for economic cooperation and development
R&D	Research and development
SDC	Swiss agency for development and cooperation
SIDS	Small island developing states
SME	Small and medium scale enterprise
TCDRI	Tianjin cement industry design and research institute
UN	United nations
UNEP	United nations environment program
UNEP-SPV	United nations environment program - special purpose vehicle
UNFCCC	United nations framework convention on climate change
UNCTAD	United nations conference on trade and development
VSBK	Vertical shaft brick kiln
WEG	Wing electric generator
WTO	World trade organization

1.0 Executive summary

The Asia and Pacific Islands region is both a significant contributor of GHGs and a major potential victim of its consequences, namely global warming and climate change. The Asian region accounted for about 5070 million tonnes of CO_2 emission in 1997, which was 22% of the world's total CO_2 emissions. (IEA, 1999). As the economies of the countries in this region grow, so will be the emissions of GHG from the region. Environmentally sound technologies (ESTs), which include both mitigation and adaptation technologies, can enable these countries to achieve sustainable economic growth in a climate-friendly manner.

There are large differences among the countries in the region in the level of socio-economic development achieved and in their experience in successful technology transfer and building indigenous technological capacity. This has wide implications for the transfer of ESTs in the context of climate change, as some countries will have a stronger path dependency to manage the transfer and diffusion of ESTs than others. Since climate change is not a priority for most developing countries in the Asia-Pacific Islands region, it is important that strategies for implementation and diffusion of ESTs are in tandem with their developmental priorities. Another challenge faced by most countries in the region is to bring together and involve a diversity of central and state government ministries and departments, local administrative set-ups, regional organizations, NGOs (non-governmental organizations), and public- and private-sector organizations in each country to a common agenda.

The environmental concerns of this region are not new and there have been some successful cases of transfer of ESTs to this region. Some countries have prioritized their actions in the context of climate change to some extent. However, there is a need to develop an integrated program endorsed by the national governments and the donor agencies to transfer ESTs and to promote for widespread adoption and diffusion of these technologies.

The main issue related to technology transfer within the context of the UNFCCC (United Nation Framework Convention on Climate Change) is to provide a direction to the technological cooperation between the developing and the developed countries that will lead to a wider adoption of ESTs by the developing countries. In the above context, this paper discusses a participative approach towards the adoption and diffusion of ESTs in the countries of this region under the UNFCCC. The outcome of various steps defined in the framework is the development of an ITP (Integrated Technology Program) at the national level. The approach towards the formulation of an ITP is based on establishing a national dialogue on climate change issues, country responses, and technological needs among the major stakeholders like policy-makers, public and private enterprises, regional organizations, R&D institutions and NGOs.

The programs for the implementation of ESTs and information dissemination will necessarily have to be very country-specific, and a broad-brush approach can only defeat the very purpose for which such programs need to be devised. However, national governments need to play a leading role in institutionalizing the climate change debate into the national agenda through necessary changes in the organization structures and policy framework. Thus the major steps proposed in the framework as follows:

- Identification of country priorities for mitigation and adaptation to target technology transfer and know-how to those ESTs that are most appropriate for the developmental objectives.
- Detailed study/investigation of the present technological status and needs of the identified priority sectors, the available technological options and various barriers to the adoption and diffusion of ESTs.
- Assessment of different technological options to filter out a few technologies from the list of possible options.
- Formulation of an ITP for adoption and diffusion of ESTs incorporating technology sources and enabling policies to promote the same.

The first three steps can be referred to as ‘scoping activities’ towards the development of an ITP. Since the role of the private sector in the transfer of ESTs is likely to increase in the future, it is important for each country to ensure participation of this sector and of other national stakeholders in the entire planning process. Countries can consult international experts (from the UN bodies, World Bank, etc.) in the ‘scoping activities’.

In order to maintain a focus on the issue of climate change at the national level, it is proposed that the governments create a ‘climate change unit’ or any other equivalent body under the concerned Ministry (e.g. Ministry of Environment/Energy). It is this Unit that will coordinate all the activities leading to the formulation of an ITP. For development and execution of the ITP, a national autonomous body (e.g.: Environmentally Sound Technologies - Adoption and Diffusion Centre (EST-ADC)) should be established under the concerned ministry. This will help in speedy implementation of programs/projects and result in better coordination with various stakeholders. Besides enabling the transfer of ESTs, the ITP will focus on specific barriers related to information dissemination, development of institutional and technological capacity, and other possible hindrances, leading to long-term development of markets for ESTs in these countries.

The multilateral/bilateral support under the charter of the UNFCCC should take into account the identified country priorities and the national ITP. On the part of the developed country governments, it is essential that the public and private sector

participation is encouraged by providing tax incentives, promoting special technology missions, export promotions, etc.

It is proposed that financial support for the scoping activities should come from multilateral funds (e.g. the GEF), whereas the operation of EST-ADCs be funded jointly by the multilateral fund and the respective host country government. Commercial funding, AIJ, CDM, bilateral grants, multilateral grants, equity and UNEP-SPVs (special purpose vehicles) can finance the projects developed under the ITP. UNEP-SPV is an innovative financing mechanism proposed in the framework in which a semi-commercial fund is created under the United Nations Environment Program to buy sector-specific technologies (having a high adoption potential in the developing countries) from the developed countries and making them available to enterprises in the developing countries. The semi-commercial fund should be formed with contributions from several multilateral and bilateral donor agencies.

Under the ITP, the EST-ADCs will also assess the success or failure of various projects/initiatives and will report the same to the FCCC Secretariat. This will enable the countries to modify their programs/projects incrementally and will allow the UNFCCC to assess and suggest modification to various international initiatives.

2.0 Regional Context

The Asia- Pacific region is a significant contributor to and major potential victim of, global warming and greenhouse gas effects. The Asian region accounted for about 5070 Mt of CO_2 emission, which is 22% of the world's total CO_2 emissions, in 1997 [IEA, 1999]. Emissions of some of the countries in the Asia region is given in **table 1**. The pattern of economic change is leading to a significant increase in use of fossil fuels. The total primary energy supply from the region, and hence the corresponding emissions are estimated to rise to 26.1% of the world's consumption by 2010 and to 30.5% by 2020 [IEA, 1999]. Since use of fossil fuels will continue to be the major source of energy, strategies such as adoption of clean fuel technology and improvements in efficiency of utilization will be essential.

Table 1. GDP and CO_2 emissions of different countries in Asia region for 1997

Country	GDP (billion 90 US$)	CO_2 Emissions (mt of CO_2)	CO_2/GDP (Kg CO_2/90 US$)
Bangladesh	30.14	20.91	0.69
Brunei	3.92	5.12	1.31
People's Rep. Of China	814.33	3120.62	3.83
Chinese Taipei	256.81	189.41	0.74
Hongkong, China	107.14	41.33	0.39
India	445.92	880.71	1.98
Indonesia	188.68	256.52	1.36
Japan	3343.73	1172.64	0.35
Korea	411.00	422.11	1.03
DPR of Korea	-	77.80	-
Malaysia	75.96	123.71	1.63
Myanmar	35.21	6.94	0.20
Nepal	4.97	1.85	0.37
Pakistan	52.06	89.45	1.72
Philippines	54.91	68.74	1.25
Singapore	65.15	72.86	1.12
Sri Lanka	11.53	8.48	0.74
Thailand	135.20	175.36	1.30
Vietnam	11.42	48.37	4.23

Source: IEA, 1999

The rise in sea level would have a disastrous impact on the Pacific Island countries and other low-lying coastal developing countries like Bangladesh. A number of studies have been carried out to study the economic and social implications of sea level rise for various countries. For example it has been indicated that a 1-meter sea level rise would inundate considerable areas of deltaic plains of Bangladesh and 80% of the land area of Marshall Islands [Watson et al, 1996].

There is also a wide disparity in socio-economic environment of the countries in this region. Some countries like Japan, South Korea and Taiwan are at a much higher level of industrial and economic development compared to other countries in the region. Some countries like India are in a transition phase of their economic liberalization. The social development priorities among countries in this region are

also widely different. For example in countries like India and Bangladesh, poverty alleviation is a major issue along with the much-needed economic growth. The countries also differ in terms of their past experience of technology transfer and the level of institutional capabilities developed. South Korea and Taiwan for example have been very successful in their attempts to transfer industrial technologies and developing innovative capabilities over time. India on the other hand had a mixed experience of successful technology transfer and it diffusion.

The framework discussed here takes into consideration this wide socio-economic disparity between countries in this region and their varied needs. The role of respective country governments in the region has been emphasized in the framework to address the country specific issues. A limited and focused number of specific case studies providing examples of the terms of technology transfer, drawing on practical experiences of programs and projects to respond to priority needs (terms of transfer of technologies, role of key stakeholders, evaluation mechanism for assessing program successes and failures) have been included in the paper.

The paper collects and synthesizes information on a possible framework for improving the diffusion and implementation of ESTs and elaborates possible steps and options to implement such a framework. The criteria for effective and sustainable technology transfer like identification of technology needs, information on and access to technology, economic and social development potential, market potential and penetration, long term capacity development, dissemination strategies, and adaptability of technology to local conditions have been discussed. Other elements of a framework to facilitate technology transfer like coordination of donors response, mechanisms to monitor and report technology transfer activities, promote exchange of information among parties have also been addressed.

3.0 Defining Environmentally Sound Technologies and technology transfer

For the purposes of this paper, Environmentally Sound Technologies (ESTs) are interpreted broadly to include the technologies and measures useful for mitigation of and/or adaptation to climate change.

> *" Climate relevant technologies are interpreted as environmentally sound and economically viable technologies and know-how conducive to mitigating emissions of greenhouse gases and adapting to climate change. The term "technologies and know-how" encompasses 'soft technologies' and 'hard technologies'. Examples of 'soft' technologies include capacity building, information networks, training and research, while examples of 'hard' technologies include equipment and products to control, reduce or prevent anthropogenic emissions of greenhouse gases in the*

energy, transportation, forestry, agriculture, industry and waste management sectors, to enhance removals by sinks, and to facilitate adaptation (FCCC, 1996).”

In this paper, ESTs imply both mitigation and adaptation technologies. Mitigation technologies include technologies which help slow down climate change by reducing the emissions of greenhouse gases (GHGs). Although the Kyoto Protocol enlists six gases, the major ones are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Adaptation technologies deal with effect of climate change and include technologies like changes in agricultural practices, coastal zone management and other "climate safe" measures. Currently a variety of technologies are developed and successfully used (like dikes, levees, floodwalls, seawalls, periodic beach nourishment, dune restoration and creation, mangrove plantations, etc) for coastal adaptations that are related to the adaptation of impacts due to climatic changes. But, they have to be implemented in a broader integrated coastal zone management framework that recognizes immediate and long-term needs.

In the context of climate change, technology transfer has a special relevance. Technology transfer is a process to make technologies proven to be climate relevant in certain countries available to other countries and to facilitate their effective implementation and dissemination in recipient countries. The size of the financial payment made by the buyer depends on the nature of the legal system protecting these technologies in the advanced country of origin, the monopoly or oligopoly position of the technology seller, the nature of technology (advanced and relatively recent or mature or simple) and the bargaining power of the technology buyers (Stewart, 1990).

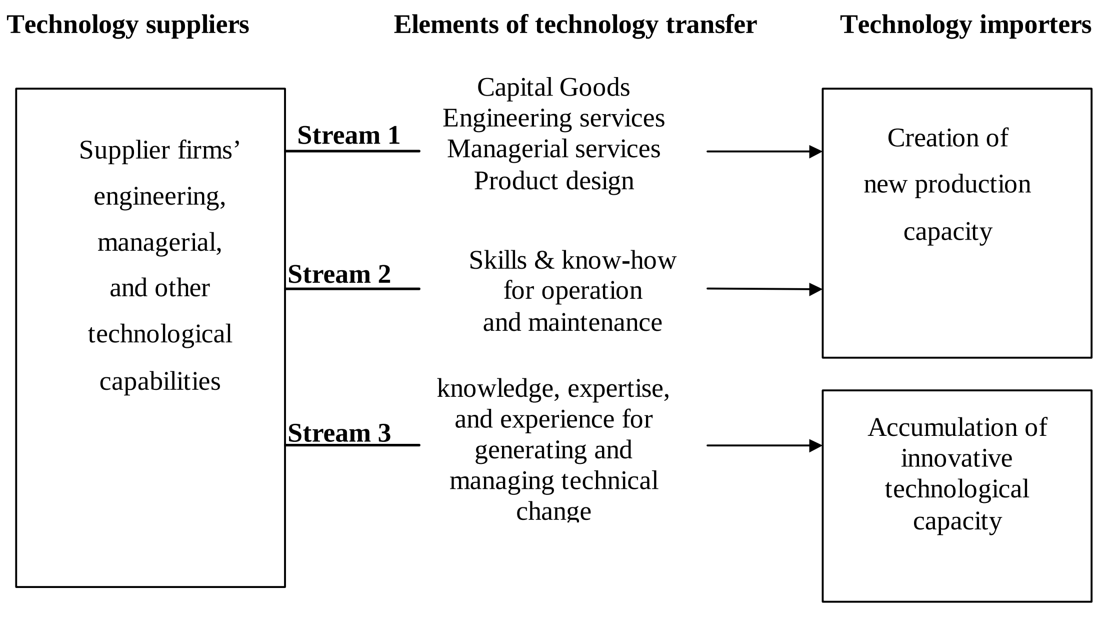

Figure 1. Technology transfer process (adapted from: Scott-Kemmis, & Bell, 1988)

The generation of new environmentally sound technology (ESTs) usually takes place in the industrially advanced countries. With the environmental issues reaching the global forum and due to several international agreements there is an increasing pressure on the countries of the world to reduce the emissions of GHGs. New technological options using environment friendly technologies offer a potential for the mitigation of the greenhouse gases through adoption of such technologies in existing facilities and their use in the upcoming projects. However because of the concentration of ESTs with few firms/countries in a particular part of the world (developed countries) there is a strong need to transfer these technologies to other countries.

Technology transfer is a highly variable process and the nature and contents of the transfer may vary widely. As shown in **figure 1**, the process of technology transfer can be divided in three main categories.

- Transfer of scientific and engineering material and equipments to improve the existing technological capabilities of the recipient country.
- Transfer of knowledge and competence necessary to operate and maintain the technologies transferred.
- Transfer of knowledge, competence and experience to simulate, create and lead technology change and development in the recipient country.

While technology transfer operation traditionally concentrated on the first two categories, in recent years, there has been an increasing focus on the third category that would encourage the development of technological capabilities of the recipient country.

Building innovative technological capacity in the country is important to achieve sustainable growth. For developing required technological capacity to be able to generate technology in long run, a conscious complimentary investment is required in developing institutional as well as R&D capabilities apart from making a conducive policy environment for such investments. The investments in capacity building are highly sensitive to the incentive environment, the cost of the investment, and the availability of the investible resources (apart from the finance, these are access to skills, technical information and support, and interactions with related firms) (Lall, 1996). The roles of host and donor country and multilateral organizations are increasingly becoming important to enable successful and meaningful transfer of ESTs. For example, the role played by the multilateral bodies (i.e. World Bank, UNEP) was important in facilitating technology transfer for non-ozone depleting substances under the Montreal Protocol. Under the protocol a multilateral fund was created with the contribution of donor countries to undertake projects in the developing countries. The multilateral organizations (World Bank, UNEP) helped in

project identification and making the projects in a standardized format for obtaining funds under the protocol. With regard to the ESTs, the policies of the donor and host country governments can create an incentive environment for successful transfer of ESTs and encourage the development of ‘know-why’ capabilities (**figure 1**: stream 3) in the country. The multilateral organizations (e.g. under the charter of UN, World Bank, etc.) can play a crucial role in the negotiation process between the host and the donor country governments and funding various projects through multilateral funds.

In the context of technology transfer, it is worthwhile discussing here about the publicly and privately held ESTs. It is expected that the role of private sector will become increasingly important in the future for the transfer of ESTs and thus the primary role of governments is to work in tandem with in-country businesses to overcome barriers to attracting investment in priority areas.

Some countries argue that the technology rests with the private sector, so it is difficult for governments to do anything. Many pacific island countries argue that this may be the situation for some technologies but there is still a role for governments, in encouraging technology transfer (SPREP, 1998). The issue of publicly owned technology transfer has its inter-governmental basis for action both in Agenda 21 and the program for further implementation of Agenda 21 adopted in June 1997 (Chung, 1999). Both in the developed and developing countries a significant percentage of R&D funds come from public sources. According to Organization for Economic Cooperation and Development (OECD), in 1993 up to 40% of national R&D spending within many of its member states was publicly funded (Chung, 1999). Among the developing countries, 66.9% of total national spending for R&D in Brazil, and 68.5% in Thailand comes from public funds (details for developing countries may be found in UNESCO, World Science Report 1996, Paris) (Chung, 1999). At the sectoral level a number of developed countries are specifically earmarking R&D expenditures for sustainable development and environmental protection (for quantified figures refer Chung, 1999). Thus there is a significant potential for the transfer of publicly held ESTs through inter-governmental agreements.

Technology transfer process also brings into picture the issue of IPRs. The IPRs ensure that the developers of technology have an exclusive right over it and can appropriate commercial returns for selling the technology to someone else. The issues related to IPRs are becoming important for both privately and publicly held technologies. With regard to the ESTs, transfer of technology at fair and most favorable terms has been highlighted in all discussions and debates on sustainable development. The Rio Declaration of 1992 as well as most of the multilateral environmental agreements emphasizes the need for such technology transfer

(Submission to WTO by India, 1999). The barriers related to IPRs are discussed in the next section.

4.0 Current issues and experiences of technology transfer

4.1 Overview

While technology transfer encompasses all sectors of economy, there are some features unique to the area of climate change. Transfer of ESTs would encompass all countries and a wide range of technological options for mitigation/adaptation. The uniqueness of such an effort is that the benefits will accrue not only to the participating countries but also to the entire global population.

Governments of some East Asian countries (e.g. South Korea, Taiwan, Singapore) have played a constructive role in managing the transfer of technology for enabling the long-term capacity building in these countries. This is evident in the form of various incentives (export orientation, tax incentives, etc.), development of human capital, technical information and support services, finances and the technology policy (constructive intervention) in these countries (Lall, 1996). These countries have a strong path dependency (by the virtues of their previous investment and policies for successful development of technological capability) that can enable them to develop technological capacity for the adoption and diffusion of the ESTs. The existing national systems of innovation in these countries can be efficiently used for furthering the objectives of the adoption and assimilation of the ESTs. These countries had used various modes of technology transfer (like technology licensing, foreign direct investment (FDI), import of capital goods, etc) for acquiring the technologies from other countries and building indigenous technological capacity. For example, Republic of Korea used capital-goods imports, technology licensing and other technology transfer agreements as predominant modes to acquire industrial technology. In Korea, a good institutional set-up, incentive structure, and technology policy initiatives complemented the technology transfer process to develop strong technological capabilities (Lall, 1996). The national development plans of Korea, Indonesia and Thailand provided adequate government budget allocations for institutional development needed for the transfer of technology (FCCC, 1998a). In other Asian and the Pacific Island countries the efforts to develop the technological capacity did not have similar results as in the case of some East Asian countries. This among other factors is attributed to the lack of sound government policies and inadequate institutional structure to foster accumulation of technological capabilities.

Many countries in Asia and Pacific Island region have initiated policy measures to facilitate the transfer of technology in the context of climate change. In Thailand and Republic of Korea, environmental and energy conservation laws and regulations have

been established and periodically revised to reflect the environmental needs of each country (FCCC, 1998a). For example there are a number of laws and regulations in Thailand for facilitating transfer of technology by providing incentives for foreign and local investments for ESTs (FCCC, 1998a). The Korean and Indonesian governments are also taking measures for enabling technology transfer and capacity building for the ESTs. For example, in Indonesia the prioritized actions have been identified for technology transfer in energy supply, energy demand, transportation and forestry. The planning and priority setting process was initiated by the national government and was reported to be on-going in a study conducted by IVAM Environmental Research, Netherlands (van Berkel et al, 1998). The prioritized actions included promotion of renewable energy, integrated coal gasification combined cycle (IGCC) technology, ethanol fuelled vehicle technology, etc. (IVAM-country fact sheets, 1999). Industrially advanced countries in the region like Japan, Republic of Korea, Hong Kong and Singapore also have a set of prioritized action streamlined for the transfer of ESTs from other countries (IVAM-country fact sheets, 1999). It is not necessary that the host country governments must necessarily initiate the planning and priority setting process, in Kiribati for example a research institute was co-initiator of the process.

There are examples of enabling activities in India, China and other Asian countries but on a lesser scale. In India, for example, a Technology Development Board has been established in 1996 to facilitate the development of new technologies and the assimilation and adaptation of imported technologies, by providing catalytic support to industries and R&D institutions to work in partnership. China has initiated efforts to identify and prioritize actions for transfer of technology for the ESTs in different sectors of the economy. The sectors in which the prioritized actions are identified for technology transfer are energy supply, energy demand, transportation, forestry, agriculture, industry, waste management, infrastructure and coastal zone management. For example in the mitigation and adaptation technologies the prioritized actions include: i) development of new and renewable energy sources; ii) high efficiency thermal power generation; iii) upgradation of existing power plants; iv) use of cleaner coal technologies such as IGCC, pulverized fluidized bed combustion (PFBC), and coal bed methane, and v) efficient transmission technologies (IVAM-country fact sheets, 1999). The Pacific Islands Climate Change Assistance Project (PICCAP), which utilizes funding from GEF (UN, 1997a) for capacity building on climate change abatement and adaptation measures is expected to complement the national environment strategies of most Small Island Developing States (SIDS) in the Pacific region. The Maldives has undertaken national vulnerability assessment and has come out with a list of adaptation options. The work on developing specific policies or

strategies for climate change and integrated coastal management will be critically important for the island states.

4.2 Barriers

The barriers to the adoption and dissemination of ESTs are very country specific. Major barriers can be categorised under the following groups:

4.2.1 Information gap

One of the essential elements of the process of technology transfer is the provision of support services to user enterprises to facilitate evaluation of technological options in the context of their own requirements (TERI, 1997). Many Asian countries do not have the necessary infrastructure for studying and evaluating the diversity of the available technological options that might suit their needs. There is an urgent need to develop an effective information support system and institutional infrastructure to facilitate selection of appropriate technologies. Within SIDS, sources of information on sea-level rise tend to be dispersed with different institutions tending to use widely different methods of assessments. There is a need for better coordination of information on available and appropriate technologies that could benefit the small island states (SPREP, 1998). The Pacific Island countries have pressed for the development and enhancement of technologies that countries themselves could implement, which were both climate friendly and affordable, particularly in the fields of coastal zone and adaptation technologies (SPREP, 1998). From the experience of executing a few projects in the country, Pakistan has highlighted a few barriers related to the lack of awareness/information and lack of skilled manpower (IVAM-country fact sheets, 1999).

4.2.2 Financial barriers

The Korean experience with climate-relevant technology transfer has highlighted the non-availability of financial means as a main barrier to the technology transfer (IVAM - country fact sheets, 1999). The above barrier was identified for the projects with national subsidy/soft loan scheme. For some of the East Asian economies, like the Republic of Korea, Thailand, and Indonesia, the current financial crises will be a major barrier to the transfer of ESTs for some time, especially owing to their lack of foreign exchange for purchase of ESTs from abroad (FCCC, 1998a). The cost of adaptation measures like new construction to protect shorelines against future sea-level rise, will amount to costs well beyond the economies of most of the Pacific Island countries.

4.2.3 Lack of in-country capacity

Technology transfer is not a one-time phenomenon. It is necessary to have institutions that could be involved with studies/research on the adaptation and absorption of

imported technology. The experience of many less developed countries suggests that little can be expected from technology transfer in the absence of an institutional capacity to indigenize it. Lack of local capacity also results in the transferred technology seldom reaching the designed operational efficiency and often deteriorating significantly over the life of the equipment. This brings to focus the *need for local capacity building* to effectively manage the technological change. This could be facilitated by policies, which insist that foreign technology/investments inflows should be accompanied by adequate training of local staff.

For example, till now the Pacific Islands region has limited capacity to develop or implement their own coastal zone management strategies. Although such support from international bodies and other countries have been forthcoming, there is a need for in-country capacity building among the oceanic islands to face these challenges in the longer term. An Indonesian project for Renewable Energy Supply System funded under the AIJ identified the lack of local managerial skills as the main barrier in the technology transfer process. With regard to the transfer of environmentally sound technologies to SMEs in Thailand, few of the barriers were lack of strong institutional structure to support technology transfer, the inability of the current bureaucratic mechanism to respond to private sector's demand in transferring ESTs systematically and low absorbing capacity of Thai manpower as a result of low quality and quantity skilled engineers (NRC, 1999).

4.2.4 Policy inadequacies

Government policies on investment, taxation and environment play a significant role in determining where investment is to be made. Many countries in SouthEast Asia that have made extraordinary progress in the last two decades had the right policy instruments (tax incentives, selective promotion, export orientation, etc.) to ensure development and promotion of technology. On the flip side, for example, lack of manpower and organization capability to comprehend the implications of proposed technology transfer have been barriers to comprehensive policy directives in Bangladesh [Omar & Hossain, 1994]. Formulation of policies on technology transfer in several developing countries have remained limited to declaration of intent, due to lack of institutional arrangements for their implementation. In Thailand, even though the official small and medium scale enterprise (SMEs) supporting programs have been launched recently, resource allocation and priorities are not well managed and cannot sponsor SMEs' requirements efficiently as a consequence (NRC, 1999). Another example of policy inadequacies is in the case of bagasse based cogeneration in India. The promotion of cogeneration is very much dependent upon the regulatory regime and tariff structure of the electricity generation and distribution authorities. For example, bagasse-based cogeneration did not get a boost in some states in India (Maharashtra, Uttar Pradesh) due to unfavorable cogeneration policies. *The key to*

unlocking the cogeneration potential, is to have policies in place that make competitive electricity prices available to the producers for the electricity they can make available to the grid.

In the absence of a comprehensive technology-based development policy, it becomes difficult for funding agencies to identify the technological goals of a developing country. There is a need for development plans to be sustainable and to ensure that impacts of climate change (e.g. sea level rise in Pacific Islands) are taken into account. The UNFCCC and the other bilateral and multilateral donor agencies can play a significant role to assist some developing countries in the formulation of technology-based development policy in the context of climate change. National academic and research institutions can also contribute towards this effort. Such a participative approach is discussed in much greater detail in the proposed framework discussed later.

Actions to address the challenges posed by climate change have helped some of the Pacific island countries to set-up high level bodies, such as government departments, to guide and coordinate development policies and measures, and to function as a catalyst for action. Most SIDSs have begun to enact specific legislation to enable them to comply with the provisions of various regional and international agreements, including the use of environmental impact assessments.

Another issue of importance is regarding policy measures in the developed countries regarding the transfer of ESTs. The developed countries should have in place policy measures (e.g. tax incentives, special technology missions, etc.) for encouraging the transfer of ESTs (both publicly and privately held) to developing countries.

4.2.5 Appropriateness of the transferred technology

The technologies that are developed in the industrialized countries are most often designed to respond to the local requirements (in terms of fuel quality, ambient conditions, degree of automation, etc.). It might be inappropriate for the host countries to directly import and use the technologies from the countries that have developed it. The transferred technologies need to be adapted to the host country environment for its successful operation and further dissemination. An example of a case where a technology was imported without adapting it to the local environment is given in **box 1**.

Box 1. Technology transfer program of data buoys

This case study stresses the need for adaptation of a foreign technology to local conditions.

To collect ocean parameters in Indian seas and improve the weather and ocean state prediction system, a technology transfer program of data buoys was initiated between Norway and India in 1997. An agreement was signed to supply, install and maintain fifteen moored data buoys. Twelve buoys have been deployed in Indian seas so far, both in deep and shallow waters, to measure wind speed, wind direction, atmospheric pressure, air

temperature, conductivity, sea surface temperature, current speed, current direction and wave parameters. The buoys carry sensors to measure water quality parameters. All the sensors that collect met-ocean data function well in Indian seas. But, inspite of the best manpower provided, the water quality sensors tested in labs in Europe did not function effectively in the tropical waters of Arabian Sea and Bay of Bengal due to effects of biofouling.

There are also cases of pilferage of these expensive ocean buoys even in the high seas. The suppliers have not thought about these before deployment, and hence not supplied any tracking system to find interference from people working in the high seas.

Source: National Institute of Ocean Technology, Chennai, India

In a number of South Asian countries, the scale of production facilities is much smaller. For such units, knocked-down technological packages are rarely possible. For example, the average size of a paper mill in India is 15,000 tonnes per year compared to 300,000 tonnes per year in Europe and North America (Chemical Weekly, 1998). Therefore it is difficult to directly adopt many ESTs being adopted in pulp mills in Scandinavian countries in paper industry in South Asia.

4.2.6 Intellectual property right (IPR)

Technologies, particularly commercial technologies, are generally held by companies either as proprietary information or as formal IPRs. Holders of the patents to these technologies that are usually transnational companies can refuse to grant permission to other companies even if they are willing to pay market prices or else the technologies may be made available at high prices (due to the monopoly enjoyed by the patent holders). Presently, specific legal and administrative restrictions are not a barrier to the transfer of publicly held technologies (Chung, 1999). However, in the future the issue of IPRs is expected to gain momentum also for the transfer of publicly funded technologies and research. Inter-governmental agreements and various international negotiations (e.g. can be facilitated by the UNFCCC) under the wider WTO regime can play an important to allow access to such ESTs.

Weak IPR regimes in the host countries might discourage the foreign firms to invest in these countries. The insecurity that the transferred technology may be copied or replicated in the host country might lead to refusal by the firms in developed countries to transfer ESTs. It is important for the countries to strengthen their IPR regimes in order to encourage transfer of ESTs of both public and private origins.

4.2.7 Lack of initiatives to transfer public technologies

As the debate of technology transfer centers mostly on the important role of private sector, the role of government in the development and transfer of technology received relatively low attention (Chung, 1999). Since a significant amount of R&D is publicly funded in developed and developing countries there is a need for proactive role by the developed and developing country governments to enable the transfer of ESTs. As highlighted in main finding of the feasibility study on "The role of publicly funded

research and publicly owned technologies in the transfer and diffusion of environmentally sound technologies" (undertaken in 1997 by the UNCTAD in cooperation with the UNEP and the DESA/United Nations, CSD Secretariat) (Chung, 1999):
"… there is a clear gap between the public R&D community and development cooperation community in coordinating the transfer of publicly funded technologies to developing countries. There is a need to improve the linkage between the 2 communities in order to facilitate the transfer of publicly funded R&D results to developing countries. (Chung, 1999)"

Bilateral agreements between the governments, tax incentives, tariff reductions, joint technology development programs (under the charter of the UNFCCC) to promote research collaboration between countries can promote the transfer of the publicly held technologies. The benefits can be in the form of adoption and diffusion of ESTs and the development of indigenous technological capacities in the host countries.

An elaborate discussion about addressing these barriers is given in the framework.

5.0 Key elements of a framework under the Convention

The proposed framework takes into consideration the key issues in the transfer, adoption and diffusion ESTs for the countries in the Asia and Pacific Island region. Various issues discussed in the framework relate to the identification of country needs, present technological status and technology needs, assessment of various technological options, and development of an integrated technology program. The framework discusses various key elements pertaining to private sector participation, issues of IPRs, information dissemination, role of the UNFCCC and other multilateral organizations, and the role of governments in the transfer and diffusion of ESTs. The proposed framework takes into consideration the issues raised in the submissions to the FCCC Secretariat by the Parties belonging to this region, mainly by G77/China and Japan (FCCC, 1998b; FCCC, 1998d; FCCC, 1999).

6.0 Proposed framework

6.1 Overview

The potential of clean technology transfer to combine economic growth with the protection of the environment in developing countries was recognized in Agenda 21, arising out of the Rio Summit in 1992. The Agenda contains two programs which promote the transfer of cleaner technologies: first, through the encouragement of inter-firm co-operation with government support to transfer technologies which generate less waste and increase recycling; and second, through a program on responsible enterpreneurship, encouraging self regulation, environmental research and

development, worldwide corporate standards and partnership schemes to improve access to clean technology [Skea, 1994].

Any framework for the adoption and dissemination of the ESTs must address these issues for sustainable technology transfer. For the technology transfer to be sustainable the technologies for mitigation and adaptation should preferably complement the developmental needs of the countries in this region. Hence identification of country priorities for transfer and development of ESTs is essential for developing an integrated technology program. Once the priority sector (s) of the country is (are) decided by the government, an understanding of the present technological status and technology needs of these sectors is required, to ensure the right match between available technologies and country specific situations. A holistic assessment of various technological options in the sector along with identification of market potential would ensure selection of appropriate technologies in line with the existing country capabilities.

Development of country specific integrated technology programs is required for promotion and diffusion of ESTs. The integrated program should address major elements that will facilitate technology transfer like macro-level policy initiatives, institutional capacity building, information dissemination, legal framework etc. A system to assess the effectiveness of the above programs on an on-going basis and to provide feedback, needs to be developed so that the necessary modifications could be made to improve the EST transfer process.

Central to the whole approach is the promotion of international and regional cooperation among parties and emphasizing the role of multilateral/bilateral donor agencies to promote the transfer of ESTs under the Convention.

The steps involved in development of the proposed framework are shown in **figure 2**. As shown in the figure, the first three steps relate to ‘scoping acitivities’ leading to the formulation of an "Integrated Technology Program (ITP)". **Figure 3** outlines the proposed institutions and their activities as are discussed later on in the framework.

6.2 Identification of country priorities for mitigation and adaptation

The FCCC recognizes six sectors as crucial for mitigation of emissions of greenhouse gases and adaptation to climate change, i.e., energy; transportation; agricultural; forestry; industry; and waste management sectors. The comparative importance of these sectors regarding mitigation of emissions of greenhouse gases and adaptation to climate change depends on a number of national factors, such as socio-economic considerations, factors related to natural resources and the environment, technological infrastructure and demographic as well as cultural factors (van Berkel et al, 1996; IVAM, 1998).

Technology can be a dominant force in combating the detrimental effects of the GHG emissions. However, it is worth mentioning here that technology is always woven in the social and economic fabric of a country. Therefore, any technological innovation should take into account socio-economic parameters for wide spread adoption. For example, in many countries in the region (Vietnam, India, Bangladesh etc.) traditional sources (biomass based) play a very important role in the energy systems and contribute significantly to the total carbon emissions. Hence it might not be of much relevance for a country like Vietnam (where CO_2 emissions from biomass constituted 74.5% of the total CO_2 emissions in 1992) to adopt a high-cost clean technology for replacement of fossil fuels. In this case the mitigation benefits (besides improving indoor air quality) achieved through improving the cooking stoves in the rural population and/or providing alternative fuels to cook and heat might be more relevant than the ones that can be achieved in the latter case. A sector-wise analysis of GHG emissions shows that the industrial and residential sectors contribute the major share of GHG emissions in the Republic of Korea while in both Indonesia and Thailand it is the transport and power generation sectors that contribute the major share of such emissions (FCCC, 1998a). Thus it is imperative that each country must define its own priorities for the mitigation and adaptation in the context of climate change. The priority list must strive to strike a balance between the international concerns regarding climate change and socio-economic development agenda of the country.

Specifying the country priorities must be the responsibility of the respective country governments. To help identify the priority areas, a "Climate Change Unit" should be established under the concerned Ministry or an existing institution having requisite experience and expertise. This Unit, along with the help of a steering committee (formed by drawing experts from different sectors), will identify the critical issues for discussion in a roundtable (**figure 4**). For a meaningful discussion, the members of the steering committee must have the necessary background information about the present situation with regard to the GHG emissions, development agenda of the government and the international issues/agreements on climate change. Several tools can be used for acquiring the background information. For example, national databases of GHG emissions will be useful for this purpose. Wherever there is limited information on present status regarding GHG emissions, a fresh assessment of the prevailing situation with regard to mitigation and adaptation issues might be carried out (with or without the support from the multilateral agencies).

To ensure that the country priorities are in line with the overall national policies for development, some sort of projections or scenarios must be made about the future economic growth. A thorough review of the available plans and strategies should be done to focus on the implications of the projected trends and desired developments for

the level of emissions of greenhouse gases by sources and the level of containment of greenhouse gases by sinks.

The discussion in the roundtable should have representation from various national stakeholders (**figure 4**). To ensure that there is adequate representation from the business sector and the industry, various industry/business associations or any other equivalent national body representing the businesses must be involved in the prioritization process. The countries can involve international experts in the discussion that have previous experience of working in this area (e.g. experts from World Bank, UNEP, or existing TCAPP program of the U.S.).

The final outcome should be a well-informed and well-represented list of country priorities in different sectors for further action. The prioritization exercise must distinctly highlight the important issues in different sectors of the economy (**table 2**). For example, under the Philippines TCAPP effort selected priorities included the increased use of renewable energy in rural areas to address their primary goal of poverty alleviation (NREL, 1999).

Table 2 Identified country priorities in the context of climate change (an example)

Sectors	**Priority areas**
Energy	• Power generation • Renewable energy • End use energy efficiency
Transportation	• Adoption of cleaner fuels • Public transport system • New technology in the vehicles
Industry	• Clean production technologies • End of the pipe treatment for industrial wastes
Rural development	• Provision of alternate fuels for cooking and heating
Forestry	• Increase the rate of afforestation

Setting a long list of country priorities may result in a diffused focus and lack of effort to achieve the desired results as compared to a situation where concerted efforts are devoted to a few areas (and technologies) having highest potential and significance. *Also the priorities set by the countries should not be a mere wish list with no practical relevance*. Hence it would be prudent to have a comprehensive and short list of country priority areas.

Having identified the priorities, all the countries in the region must report their priorities to the Secretariat. To maintain a regional focus a separate regional sub-committee can be set up to compile the database regarding the identified country priorities. Identification of country priorities and its availability with a central nodal agency (like the UNFCCC) would help in coordination of donor responses. Co-ordination of donor response under the umbrella of country priorities outlined by the host governments is key to minimizing overlap, discouraging donor competition, and assuring complementarity of assistance roles of the key stakeholders and promoting institutional capacity building of the priority sectors. Once the country priorities are already set and agreed upon by various stakeholders, no additional resources from the bilateral technology cooperation efforts (like TCAPP of U.S.(NREL, 1999): though the TCAPP program had to take such proactive steps as the country priorities were not set beforehand) would need to be spent for this purpose.

6.3 Present technological status and technology needs

There would be a number of ESTs available within each of the available priority areas. In order to establish the present technological status in the country vis-a-vis the technology needs, various sectoral committees might be established under the Climate Change Unit to promote an intra-sectoral dialogue (**figure 5**). The sectoral committees will include representatives from government and various stakeholder groups like relevant institutions, NGOs, business organizations and other representatives from the sector (**figure 6**). In this discussion the representation from the foreign technology suppliers or international experts and donor agencies will be useful in identification of the possible technology options. A UN body (like the UNFCCC) should play the role of the mediator to bring together the donor agencies and international technical experts (a consortium) for this discussion. Wherever there is limited in-country capacity to identify the technology needs, a world nodal body (under the charter of the UN) might render the required help to do so and for further assessment of the technological options (next step).

Adequate representation for the business/industrial sectors is important to take into account their specific needs. Since the private sector participation is expected to be important in the transfer of ESTs, their active participation in the whole process (leading to the development of Integrated Technology Program) is very crucial for achieving success in the adoption and diffusion of ESTs.

The objective is to identify the present technological status in different prioritized sectors and determine all technically feasible options for mitigation and adaptation. For example, for the energy sector in China and India, where coal is the dominant source of energy, the broad technological options can be using new and efficient technology for power generation (CFBCs, CCGTs, coal gasification, etc.), advanced

technology for power transmission (HVDC, EHV) etc. For countries in the Pacific Island region, several coastal adaptation technologies like creation of embankments, mangrove plantations, relocation, etc. might be useful. The technologies identified at this stage in a particular prioritized sector can be very diverse and in many cases a mix of the various technologies/measures that are available would get shortlisted (**box 2**).

Box 2. Options for reducing emissions in transport sector

For addressing the problem of vehicular emissions the technological option can be very diverse. For a city like Bangkok, which is facing a grave problem because of pollution due to vehicular emission, the technological options can be:

- Adoption of cleaner fuels (e.g. CNG, propane)
- Improvement in the vehicle technology to reduce the emissions.
- Better management of traffic by improved city planning (construction of by-passes, flyovers, etc)
- Provision of an efficient public transport system.

It can be said that the output of the discussion at this stage should be in the form of a 'Technology Report' for identified priority areas. These reports will give the required background information for further assessment at the next stage.

6.4 Assessment of various technological options

After the initial identification of technological needs in different priority areas, an assessment of all the technological options for their technical and market feasibility must be carried out. The objective is to filter out a few technologies from a long list of technological options identified in the previous step. Again the sectoral committees under the Climate Change Unit with additional representation from various financial institutions should be at the helm of the affairs. Special country missions can be created under the Secretariat to help in assessment of various technological options identified in the 'Technology Reports' made by different countries. The international representation (a consortium of technical experts) will help in determining whether the technological options are feasible for the host country environments and can also provide a preliminary assessment of barriers from the 'supply side' in the transfer of ESTs. The technology assessment should be carried out taking into consideration various factors like present level of technological capacity in the country, technology gap, skill requirements for the use/adoption of technology, initial cost of the technology, etc. The inputs from the 'Technology Reports', in the form of present technological status in the country with respect to the ESTs, will be useful in performing a technological assessment of the identified technology needs. Since development of technological capacity is a slow and gradual

process, the technologies identified for adoption and diffusion should build upon the present level of technological activities in the countries. This does not mean that the countries cannot aim for adoption and diffusion of technologically advanced ESTs. The existence of strong institutional capacities (technical, human, financial etc.) in a country might enable it to undertake technological leap frogging for the adoption and diffusion of ESTs (as already demonstrated by some countries in the East Asia for industrial technologies). This however must be supported by strong policy initiatives from the government creating an enabling environment. For countries that have underdeveloped technological capacity and limited human and institutional resources, it will be inappropriate to transfer a complex technology for mitigation of GHGs and adaptation.

A socio-economic analysis will help in identifying the potential benefits of the technology to the society and the economy **(figure 7)**. For example, the social benefits of a solar photovoltaic project (through improving the quality of life in the rural population) may overshadow the economic benefits from any similar competing project(s) in the sector. It is possible that some of the projects might be economically unattractive but might have attractive social benefits. In such cases a careful examination must be carried out to determine the economic sustainability of the program in the longer term. For example, the adoption of solar photovoltaics might be uneconomical in the short-term but it might be economically viable in the long run when the volumes increase and the markets evolve. The technologies identified for their socio-economic relevance must be tested for their market potential to determine their sustainability over a period of time.

The technologies must be segregated as per their anticipated market potential into the categories of high market potential, moderate market potential, and low market potential. In order to enable decision making at this stage, it might be required to carry out preliminary market survey or sector studies for the shortlisted technology options. Technological options having high market potential are most promising for adoption and diffusion. Such options are economically viable as it is and can be adopted in different prioritized sectors for wide spread adoption. The ESTs having moderate market potential are those needing some external reinforcement (may be financial or institutional support) for enabling adoption and diffusion. With respect to the ESTs having high and moderate market potential it is important to identify the barriers to technology transfer and adoption. The above market surveys and sector studies can be used to identify and collect information about the barriers (financial, training, information, lack of skills, etc.) and views of the user groups. For example, the main barriers for the adoption of the Coal Gasification Technology can be the unavailability of technology from local sources and lack of required skills for the operation and maintenance. The improved efficiency of the new technology may

make it a financially viable project but still it cannot be adopted in the sector(s) due to the above barriers. At this stage the countries should give adequate focus on the options with high and moderate market potential.

An example of selection of ESTs out of various available technological options is highlighted in the case-study of cogeneration in cement plants. (**box 3**)

Box 3. Environmentally Sound Technology: different perceptions

This case study highlights differences in country priorities towards ESTs taking the example of adoption of cogeneration in cement industry. It also brings out the importance of proper technology assessment by developing countries taking into account the local factors like the existing technology base, capital cost and the needs of the country *vis-a-vis* the available technologies from various technology suppliers.

Cogeneration of power utilizing waste heat is an attractive proposition for energy conservation. The high temperature exhaust gases from the preheater tower and hot air from the grate cooler are utilized for power generation. This is especially attractive for cement plants located in electricity deficit areas. Generally 1 ton of cement production requires 110 kWh of electricity. Heat recovery power plants have been reported to recover approximately 30 kWh of electricity per tonne of cement produced. This means that cement plants can self generate nearly 30 % of their electrical needs thereby reducing their dependence on the grid or diesel generator sets.

A large number of Japanese cement plants have established cogeneration plants. One of the major factors contributing to this trend is the relatively high electricity prices in Japan. Many Japanese companies have developed a rich experience of designing, installing and commissioning waste heat power generation plants. For example Mitsubishi Mining and Cement Co. Ltd. introduced a waste heat recovery system in their Kanda cement plant way back in 1983, which resulted in a power generation capacity of 23 MW. This capacity was the largest waste heat recovery systems in Japan at that time. The Japanese machinery manufacturers have also supplied this technology to cement plants in others Asian countries like South Korea, Taiwan etc. In fact, law in Taiwan requires power generation from exhaust gases when new plants are built.

In contrast to the Japanese cement industry, the perception of the European technology suppliers has been totally different. The cement technology suppliers in these regions have focussed their activities in the past on the direct cement producing process by improving the energy efficiency of the preheater, kiln, cooler, burner etc. Waste heat utilisation for electricity generation was not considered an energy saving option from the viewpoint of clinker burning. For example it is argued that by installing 5- and 6- stage preheaters, the waste gas losses behind the cyclone preheater can be reduced considerably. Moreover, since these gases are utilized for combined grinding and drying of incoming raw material, the available waste heat is fully utilized concerning energy saving. However some attempts are now being made in a few cement plants in Europe to install cogeneration systems with the assistance of European Commission under its THERMIE Program.

It is also interesting to note that a large number of plants in China have also successfully adopted waste heat recovery plants for power generation. This achievement owes mainly to the Tianjin Cement Industry Design and Research Institute (TCDRI), one of the 15 national institutions devoted to building materials in China. Till 1998, TCDRI had commissioned 12 cogeneration plants and another 6 plants under commissioning or design stage. The diffusion of this technology in China can be attributed to the national policy of giving thrust to indigenous development of a particular technology so as to enhance the institutional capabilities. On the other hand, not much progress has been made in Indian cement industry to install these cogeneration plants. The plants have remained either totally dependent on the national grid or have set up captive power plants to ensure that the critical equipment continue running during power shut down period. The major reason is that the rates of return from cogeneration projects are lower than other competing investment options available to the cement companies in India. In a period of high demand, the companies tend to invest in

increasing their production capacities as it yields higher returns. These two cases really demonstrate the influence of local market conditions on country priorities for ESTs.

Source: Sethi, 1999.

The assessed technological options identified by each country in the region must be reported to the FCCC Secretariat. Such a centralized information with the Secretariat will enable further development of country specific programs for enabling the adoption and diffusion of the ESTs.

6.5 Development of an integrated technology program (ITP) for adoption and diffusion

Technology transfer and its successful adoption and diffusion require careful planning and implementation. To enable the speedy implementation of projects and better coordination with various stakeholders, an autonomous body (e.g. an Environmentally Sound Technology-Adoption and Diffusion Center: EST-ADC) under the concerned Ministry could be set-up at the country level. The proposed body should draw some members from the previous committees and the Climate Change Unit to maintain continuity and to ensure that the learning acquired in the process is not lost. The members in this autonomous body must consist of experts drawn from various prioritized sectors, policy makers, representatives from academia and various institutions. The main objectives of the EST-ADCs can be (**figure 8**):

- identifying various sources of ESTs,
- recommending policy framework to the government to create an enabling environment for adoption and diffusion of the ESTs,
- formulating a blueprint for capacity building in different sectors,
- creating an information dissemination framework,
- develop projects for funding and coordinate with the FCCC Secretariat (project specific and crosscutting for all the objectives of the EST-ADCs), and
- assessment of various programs/projects and financial mechanisms.

One of the main outcomes of the ITP, besides facilitating technology transfer would be long-term market development for the ESTs. For the Pacific Island states it might be appropriate to join hands to form a collective forum for development of an integrated technology program. This is mainly because each individual island state might not have the required resources, expertise and capacity to formulate and undertake such programs individually. Various countries should be able to draw upon the expertise available from the world nodal bodies (UNEP, UNFCCC, etc.) for the creation and working of the proposed EST-ADCs. As a precursor to this, the states may need several rounds of negotiating meetings in which the consensus can be reached about the common issues and a uniform plan of action. Close coordination

with the FCCC Secretariat in the development of ITPs is important to ensure coordination of efforts in the regional and international context. The coordination required with the Secretariat in carrying out different objectives of the EST-ADCs is discussed below where different functions are described in detail.

The relationship of the EST-ADC (and hence the ITP) with the UNFCCC is shown in the **figure 9**. Under the national ITP specific projects should be created (regarding technology transfer, information dissemination, building institutional capacity etc.) to meet the various objectives outlined above. The EST-ADCs should propose the projects to the UNFCCC for support (financial, mediation, advisory etc.), report the activities and various barriers and provide feedback on the technology transfer projects (Thus in a sense the UNFCCC should adopt the national ITPs). The UNFCCC should provide financial support for the functioning of EST-ADCs and the projects proposed under the ITP, provide expert advice to the EST-ADCs, help in technology transfer negotiations, provide information about technology sources and technology transfer programs in other countries in this region. EST-ADC shall be responsible for implementing various projects (through sectoral agencies) under the ITP and recommending policy measures to the government to facilitate adoption and diffusion of ESTs.

Various functions required for the successful adoption and diffusion of the ESTs are given below.

6.5.1 Identify EST sources for technology transfer

As a first step to effectuate adoption and diffusion of EST, it is imperative to identify various sources of technology. Since there can be more than one technology supplier from various countries (mostly developed countries) for a given EST, an evaluation of their products is required for decision making by the users. Various other factors that are important for technology selection by the user are: the previous experience of technology transfer with the supplier, reliability of the technology, level of sophistication and contents of the technology transfer. A well-informed buyer of technology will be in a better position to negotiate the terms of technology transfer and avoid any chances of technology dumping. Such an information will also allow the analysis of the ownership pattern (public/private) of available technologies and thus help in formulating adequate policies in this regard. While in most cases, technology transfer involves firms from the North transferring expertise to firms from the South, there are several examples of South-South initiatives, especially in the Asia-Pacific region. The example of Vertical Shaft Brick Kilns (VSBK) (**box 4)** demonstrates how North-based institutions can provide the resources to implement South-based technological innovations.

Box 4. Development and dissemination of energy-efficient small scale brick making technology

The development and dissemination of Vertical Shaft Brick Kiln (VSBK) technology, is a typical example of a South-South technology transfer, which has been promoted through financial and technical assistance of North based institutions.

Vertical Shaft Brick Kiln (VSBK) technology originated in China in 1950s. In 1980s, Chinese Government supported further development and dissemination of the technology. Today it is a popular technology for small-scale production of bricks in rural China. Energy Research Institute, Henan, China estimates that about 40,000-60,000 VSBKs are operating in China - in the provinces of Henan, Anhui, Fujian, Hubei and Zhejiang.

The kiln has a number of advantages compared to traditional brick kilns (such as clamps, scove, down draught, Bull's trench kilns etc.) used in developing countries: energy consumption is about 30-70% less, faster firing process, greater production flexibility, less space requirement, suitable for round the year operation, modular construction, lower stack emissions etc.

VSBK has made its entry in a number of south Asian countries such as India, Nepal, Pakistan, Bangladesh and Afghanistan. Agencies such as Gesellschaft für Technische Zusammenarbeit (GTZ), Overseas Development Administration (ODA), and Swiss Agency for Development and Cooperation (SDC) are involved in the demonstration and dissemination projects in these countries. The first testing of VSBK outside China was done in Nepal in 1991. GTZ of Germany started a 'development project' in Peshawar (Pakistan) with technical assistance from a Chinese team in 1993. Later on, a prototype demonstration of VSBK was done at Peshawar during March-June 1996, with finance from ODA. A six-shaft VSBK was demonstrated in Afghanistan in 1995 under VSBK-GTZ project. Perhaps the most comprehensive VSBK demonstration, development and dissemination program is currently under way in India. The program is supported by SDC and involves participation of local industry, leading Indian NGOs and Indian, Chinese and European technical experts. Since 1996, five VSBK pilot plants have been constructed and demonstrated successfully in different regions of India to suit different types of soil, fuel and climatic conditions. The program has resulted in several improvements in the VSBK technology and a broad-based dissemination program is planned in the year 2000.

Source: TERI, New Delhi

The preliminary information about technology sources must be available from a nodal international institution (like the UNFCCC). With the available database of technology needs reported by countries in the region to the Secretariat, the UNFCCC should prepare a comprehensive list of technology suppliers (both from the developed and developing countries) to match the perceived technology needs of the countries. The technology database should include the technologies available from both the developed and developing countries. The national EST-ADCs can thus draw upon the information available with the nodal international institution for identifying the sources of technologies and their communication to various stakeholders.

The information database should be made available to the users through the information dissemination networks. This is discussed in more detail in the subsequent sections.

6.5.2 Information dissemination framework

One of the essential elements of the technology transfer process is the provision of support services to user enterprises to facilitate evaluation of technological options in

the context of their own requirements (TERI, 1997). Ironically, this is also one of the main barriers in adoption and diffusion of the ESTs in the Asian countries (IVAM, 1998). The need for information dissemination was also highlighted in the submission made by G77/China to the FCCC Secretariat (FCCC, 1998d). One of the major objectives of the proposed national autonomous body (EST-ADC) should be to prepare innovative projects for disseminating information about the ESTs to various national stakeholders and user groups.

The EST-ADC can be the national nodal agency for gathering information from external and internal sources to enable dissemination of information. It can provide centralized information regarding the government policies in the context of ESTs, information about various technological options, donor information, and possible financing options for the ESTs (**figure 10**). Other information deemed important for the dissemination of information may be included under the charter of the proposed center. In many Asian countries the large industry is mostly well organized and well informed about the technological option available for the ESTs. Thus the major objective of the center will be to prioritize the dissemination of information to those sectors of the economy, which do not have access to such information. A background study may be required in some countries in this region to determine the structure and the modus operandi for the dissemination of information. The EST-ADCs of the countries in this region should report their information dissemination needs along with the proposed activity plan (proposed projects) to the Secretariat. This will enable the FCCC to coordinate, prioritize and possibly mobilize necessary resources (financial, technical expertise and institutional support). For large and diverse countries, like China and India, it might be prudent to create some kind of a system through which the information can be disseminated to different regions within the country. Similarly, smaller countries can pool in their resources and create regional networks for information dissemination. These will allow better dissemination of information in the regions of these countries. For coordination purposes these regional centers must be linked to the national center (a national node).

For disseminating information about the ESTs in the unorganized sectors, various innovative tools can be used. In small-scale industry the information dissemination strategy can be to contact the producers through associations, regional fairs (e.g. furniture fairs) etc. Extensive use of media (television, radio, newspapers etc.) can be used to disseminate information in these unorganized sectors. Mass media could also be a vehicle to reach out to the rural and urban masses to raise their level of awareness about environmental concerns and adoption of ESTs. Such an initiative might lead to several community based local development program. An example of such an initiative for the city of Benxi in China is presented as a case study in **box 5**.

Box 5. Role of local bodies in implementation of environmentally sound technologies

The city of Benxi, in the eastern mountainous region of Liaoning province of China is an important industrial raw material base and has a population of over one and a half million. The city was faced with acute pollution problems in the late 1970s. The levels of pollution were so high that the city, which was once known for its scenic beauty, was often enveloped in smog and came to be known as a "city invisible from satellites". In order to improve the situation of city, the Benxi Municipal Government, in 1989, took up the onerous task of implementing a seven-year plan for environmental rehabilitation. Since then, the environmental quality of the area has improved considerably.

The city administration concentrated on environmental control in 20 pollution intensive enterprises in highly polluting metallurgical, building materials, coal mining and chemical industries. A 32.8 square kilometer smoke control area was demarcated. District heating, waste heat recovery and usage of gas was actively promoted in the household sector and a public campaign to set up clean factories was launched. The city also launched an 'industrial restructuring' strategy to promote concerted development of economy, society and the environment. Environmental considerations have been incorporated as key factors in Benxi's urban planning. Preference has been given to deployment of emerging technologies in the electronics, telecommunications, biotechnology, pharmaceutical and chemical industries. Benxi has invited domestic experts to train personnel and actively seeks international cooperation in this regard on a continuous basis. The city has now embarked on an ambitious plan by launching China's first local Agenda 21. The cities achievements have received wide recognition and representatives of the city were invited to attend habitat II. In the words of resident representative UNDP China "the sustainable development initiative in Benxi is moving forward very fast. We have seen a committed and energetic Municipal Government as well as some innovative activities. Benxi's sustainable development is very promising."

Source: Li, 1997

The international exchange of information among the countries in this region can be useful for policy making and formulating innovative strategies for the diffusion of ESTs. In order to facilitate the exchange of information between the countries, the EST-ADC from different countries must provide information about all the initiatives to a world nodal agency (e.g. an agency under the charter of the UNFCCC). This nodal agency should collate information from the EST-ADCs of different countries and disseminate the information in the form of new letters/ publications among the member countries. This nodal agency can organize annual conference to facilitate interaction of stakeholders and policy makers from different countries. This will lead to sharing of experiences and lessons between countries in the region.

The donor agencies must coordinate their actions in consultation with the FCCC Secretariat and the national EST-ADCs so that coherence is maintained in the efforts of different donors and the chances of wasteful duplication of efforts are minimized. The FCCC Secretariat can also encourage the private sector firms (the owners of the ESTs) to engage in information dissemination about their technologies (through focused seminars, conferences etc.) by highlighting potential for such technologies in the host countries.

The proposed centers in different countries can be connected to each other through IT network. This will enable efficient and fast transfer of information between countries.

Each of the national centers could even host its own web page, where information about its activities, technology transfer case studies, and information about on-going and completed projects of the country will be available.

6.5.3 Policy framework

Government policies on investment, taxation and environment play a significant role in determining the areas/sectors where the investment is made. Many countries in SouthEast Asia that have made extraordinary progress in the last two decades had the right policy instruments to ensure development and promotion of technology.

The objective of the policy initiatives should be to create an enabling environment for adoption and dissemination of the ESTs, while simultaneously addressing specific barriers in their transfer. Both the issues must be addressed simultaneously in the policy making process to effect in a coherent outcome. For example, it will be pointless to promote solar photovoltaics through macro policy measures (relaxation of import duties, encouraging adaptive R&D, etc.) when the market barriers (in the form of uninformed masses and high first initial costs are one of the big barriers) prohibit their wide dissemination. With regard to implementation strategies, there are no universal norms, instead, an integrated policy considering the characteristics of technologies and target groups addressed is needed. Though policymaking is the job of respective governments, but the EST-ADCs can consult the FCCC Secretariat for recommending innovative policy measures for enabling the adoption and diffusion of ESTs. Thus for the policymaking process the Secretariat can assume the role of an advisor to the EST-ADCs.

Joint technology development programs **-** Initiation of joint technology development programs for sectors where there is no appropriate technology available can be another effective measure to mitigate the GHG emissions. Once such technologies are successfully developed and demonstrated in the pilot projects they can be replicated in the other units. The EST-ADCs can play an important role in identification of the demonstration projects for joint technology development. The UNFCCC can play a crucial role in the facilitating inter-governmental partnerships and bringing the international technical experts together in such a program. Since the development costs of such projects are usually high, the funding should be provided by the donor countries under the FCCC (refer Article 4.5) and/or multilateral funds. The technologies developed in this process can be kept in the public domain for wide scale replication.

This approach is more appropriate for the small-scale industries that use locally fabricated age-old technologies for economic activities. For example, in the Indian foundry sector an improved energy efficient technology has been adopted as a demonstration project (Dugar et al, 1999). After the success of this project, it is

entering into a diffusion phase where the other foundry owners are ready to adopt this technology. The development of such technology with international assistance must take into consideration the twin objectives of reducing the greenhouse gas emissions and keeping the cost of technology economically attractive for wide spread adoption. Role of local consultants (NGOs, R&D institutes, etc.) and engineering contractors is of prime importance here, since the development of technological capacity takes place in a network of users, technology consultants and engineering firms. Pacific Island states can also plan to take-up similar innovative joint programs for adaptation with bilateral/multilateral assistance.

Command and control and market based mechanisms - The host country governments can use several command and control measures to promote the use of ESTs in different sectors of the economy. However the use of command and control measures alone in the form of stricter emission norms, penalization etc. do not offer a sustainable path for mitigation of GHGs. India's approach to environment management has been characterized as overly dependent on the command and control regime. For example, emission standards for small-scale foundries in India were implemented when no off-the-shelf solutions at a reasonable investment were available to the local foundries. This proved to be counter productive resulting in closure of many units that did not have access to the required technology or the mitigation technologies were too expensive for them to afford. In many cases, indiscriminate use of command and control measures may also lead to wide spread public backlash.

Over the years increasing emphasis is being given to market-based instruments, mainly pollution taxes, fees and tradable permits, either to supplement or a substitute for conventional command and control instruments. Market based mechanisms can be cost effective, minimizing the aggregate cost of achieving an environmental target, and can provide dynamic incentives for the adoption and diffusion of better technologies.

Private sector participation - The private sector has an important role to play in the development and promotion of ESTs. Governments can play a leading role in creating a conducive environment for private sector participation by encouraging financial sector reforms (e.g. capital markets, insurance, banking etc) which would lead to greater private investments. Removal of bureaucratic approval procedures and improved transparency in decision making will certainly encourage private sector investments for ESTs. Another way of encouraging private sector investments in ESTs is by providing support to banks and other financial institutions to advice firms on technology choices and to design innovative credit instruments for economically feasible ESTs that often need high capital investments. A typical example of

promotion of private sector participation by the government is the wind energy program in India **(box 6).**

For the private sector firms, the technology transfer takes place at the firm level and thus the success/failure of the technology transfer projects will largely depend on the organizational capacity of the firms to manage the process. The government policies can help in development of the organizational capacity of the firms in the private sector. Various initiatives like training programs, workshops, specialized courses etc. about the available technological and financial options can help in upgrading the organizational capacity of the firms. For encouraging the development of operational and adaptation capabilities the firms should be encouraged to build the clauses of skill developments and training in the technology transfer agreements.

Another important factor for sustainable adoption of the ESTs is to encourage private sector innovation in this field. Both the direction and the vigor of innovative activities of a firm are strongly influenced by the national systems of innovation in which a firm is embedded. A few of the main factors that influence the rate and direction of technological innovation are the main national institutions (e.g. universities, R&D institutes, firms), their *competencies*, and the national market *incentives and pressures* to which the firms respond (Tidd et al, 1997).

Box 6. Wind energy program in India -Success story of private sector involvement

The case study on large scale, grid-connected, wind energy program in India provides a successful example of private sector participation.

The installed wind based power generation capacity in India is over 900 MW, with most of the capacity additions being in the private sector. Private sector involvement received a boost due to favorable policies of the government since 1993. There was rationalization of customs and excise duties, exemption/minimal environmental and forestry clearance, and simplification of procedures and clearances for land procurement for wind power projects. Concessional loans were provided for private sector wind farms by the government and other multilateral and bilateral sources. The different state electricity boards formulated policies for wheeling/banking/purchase of power from wind power plants. The concept of wind power estates was introduced with joint participation of government and private sector, to encourage private investment for ownership of one or more WEG machines. The idea was that the joint venture company would undertake land acquisition/leasing, development of infrastructure and grid facilities, secure necessary clearances, installation and operation and maintenance of wind turbines on behalf of investors. This would reduce the gestation period and reduce costs of small investors.

Presently over 1800 MW of wind energy is at various stages of planning. About 21 Indian companies have tie-ups with foreign companies (largely wind turbine manufacturers from Europe) for joint ventures/licensed production of Wind Electric Generators (WEG) in India. Except for few components like blades, special bearings and gears, the wind turbine industry is sourcing components locally. Wind turbines are being exported to other countries in the region like Sri Lanka and Indonesia.

Source: ETSU, 1998

Public technologies - The donor and host country governments can play a significant role in facilitating the transfer of publicly funded ESTs. For example, the donor

country governments can provide incentive environment for the local organizations engaged in publicly funded R&D to market their technologies to firms/institutions in the developing countries. The bilateral government agreements for technical collaboration in this regard can help the host countries to build technological capacity by fostering linkages between the R&D institutes/universities. The host country government must provide adequate incentive environment, in the form of strengthened IPR regimes, copyrights, etc., to encourage the flow of publicly funded R&D results and technologies. Transfer and diffusion of clean coal technologies from Japan to China is a very good case exemplifying the proactive role played by NEDO of Japan and the host country government (NEDO, 1999). The above initiative by NEDO, focuses on the research for the application of environment-friendly coal utilization systems, model projects (demonstration projects) and technology transfer projects (NEDO, 1999).

Public procurement policy - Another area where the policy initiatives can aid the diffusion and implementation of the ESTs is through public procurement. Policy initiatives that encourage the procurement of the ESTs by the public sector and other government owned organizations might lead to development of the domestic market (demand) for the product. The government bodies (municipal corporations, state governments, public sector undertakings, etc.) should propose such projects to the EST-ADCs which can be funded partially by the government and/or bilateral/multilateral grants. For example, the public procurement policy for lighting can promote the use of energy efficient lighting (e.g. compact fluorescent lamps - CFLs) in the commercial buildings and the public sector enterprises. Similarly, the public procurement for energy efficient and environment friendly transport systems can aid in the adoption of such technologies in the country. An example of government initiative to promote an EST is highlighted through the Chinese Green Lights Program **(box 7).**

Box 7. The China Green Lights Program: a bold initiative

The China Green Lights Program (CGLP) is a major energy conservation initiative of the Government of China, which complies with the principle of coordinated growth of economy while protecting the environment. It is supported by UNDP and carried out by State Economic and Trade Commission of China. The CGLP is consistent with the national energy policy that gives importance to energy conservation activities. The program is listed as a major energy conservation project in China's Ninth Five-Year plan ending in 2000. During this period, 300 million compact fluorescent lamps (CFLs), thin tube fluorescent lamps and other high efficiency illumination products will enable savings of 22 billion kilowatt-hours of electricity. It is expected this project would create a market driven demand for high efficiency lighting devices that would follow the rules of certification and labeling. The main contents of the CGLP are:

- Education and information dissemination, to increase public awareness of the importance of reducing electricity consumption and of the economic and environmental significance of CGLP
- Macro-regulation to formulate relevant policies for conserving electricity in lighting

- A certification and labeling plan to increase equipment quality, establish brand image, and develop a quality certification and labeling systems to assure production of quality products.
- Pilot and demonstration plan e.g. replacement and retrofit of lighting systems of a large hotel and commercial complex.
- Finance plans to raise the level or increase sale of high quality equipment by investments in technology development
- To expand international exchanges and support collaboration plans for implementation of the CGLP. The program solicits advanced technology and welcomes participation of foreign manufacturers in the lighting equipment market.

Source: Dadi & Hong, 1997

Legal framework - A sound legal framework is important for building investor confidence and enhancing user compliance. Technology, particularly commercial technology, is generally held by companies either as proprietary information or as formal Intellectual Property Rights (IPRs). The host countries should ensure adequate protection of the IPRs to encourage international trade and free flow of technology among nations. For example, separate laws in Korea protect patents, trademarks, industrial designs, trade secrets, copyrights and computer programmers. Enforcement of IPR laws ensures that the economic returns from a proprietary technology of a firm can be appropriated. Since the issue of IPRs is also becoming important for the publicly held technologies, it is important that the developing countries disseminate information about the importance of IPRs and its implications to the universities/R&D institutes besides the public/private sector business enterprises. On the part of the developed countries, it is important to ensure that ESTs are made available to the developing countries at favorable terms to help them achieve sustainable development.

Where legal institutions are weak or not developed, as is the case in many developing countries, instruments that rely on legal action for enforcement are unlikely to be effective. Examples include command and control regulations such as effluent standards or mandated technology that provides for fines, prosecution, closure, and imprisonment in case of non- compliance (UNEP, 1994). In such a situation it is also difficult to enforce a legal liability system. Thus the developing country governments must strengthen the legal institutions (by giving special powers, initiating anti-corruption drives etc.) in order to create an enabling environment for adoption and diffusion of ESTs.

6.5.4 Framework for developing institutional capacity

The institutional capacity building issues are varied for different countries and there can be no generic structure for an institutional set-up. Since the institutions evolve over a period time and are embedded in the social and economic set-up of a country, thus a synergy between the social and economic issues and the objectives of these institutions is very important to enable an equitable and sustainable economic growth.

The operation of these institutions must be coherent with the charter of the priorities and the objectives defined by the government.

The end users of ESTs technology do not operate in isolation. They operate, in many industries, in a dense network of formal and informal relationships with suppliers, customers, competitors, consultants, research and educational institutions (Lall, 1996). The efforts to develop technological capability must focus on interventions (by regulating these linkages and externalities) that will have cross cutting effect on the adoption of these technologies by various users. This will help various actors in the network to deal with each other, to gain access to expensive ('lumpy') information and facilities, and to create information, skills and standards that all firms need but no individual actor will generate (Lall, 1996). For the expensive and complicated ESTs it is important that the network model is adopted for building the capacity in the country. This will avoid any duplication of effort on the part of the firms and will allow better diffusion of the ESTs. Since a lot of inputs for capacity building must come from the donor countries, the issue of coordinated donor approach is very important. The donor countries and bilateral/multilateral agencies must focus on coherent agenda to help develop the requisite capacity in the host country for sustainable development. An example of a successful partnership between governments of three countries to build capacity of private firms and research institutions is the Ecofrig project in India (**box 8**).

Box 8. Ecofrig project: a unique cooperative effort

This case study highlights the importance of 'human endowed capacity building' and 'access to information' as the two most important aspects which must be addressed in any technology transfer processes leading to the adoption of environmentally sound technologies (ESTs) in developing countries. These two major initiatives have been made possible in the Ecofrig project through unique cooperative efforts by the Governments of Switzerland, Germany and India on one hand and the private industry partners in India, Germany and Italy on the other. Apart from the three research institutes from India, namely, Indian Institute of Technology, New Delhi, National Chemical Laboratory, Pune and Tata Energy Research Institute, New Delhi who are the research partners in the project, key inputs are also being provided by a number of other organizations like INFRAS, GTZ, etc. This project can serve as a model case for improving technology transfer under the FCCC.

Ecofrig project basically aims to develop the capacity of the Indian domestic and commercial refrigeration industry in making informed technology choices in their efforts towards adopting environment friendly technologies. The project had its origin in 1992 with an exploratory visit by INFRAS – a leading consultancy organization in Switzerland (sponsored by Swiss Agency for Development and Cooperation), to study the use of hydrocarbon (HC) fluids as refrigerants and insulation foam-blowing agents in the Indian refrigeration industry. This was followed by visits of the Indian industry to Europe to get first hand knowledge on the various aspects of hydrocarbon technology, which was just being established as a popular technology choice by the major refrigerator manufacturers in Germany and other European countries. Regular interaction with the European counterparts removed the initial skepticism that the Indian industry had on the use of HCs on a commercial scale.

The Ecofrig project can be considered to be divided in two phases. The phase I, which extended from September 92 to March 96, consisted of the initial exploratory activities and the setting up of the two pilot plants based on cyclopentane as a blowing agent at two refrigerator manufacturing facilities in India. The plant and machinery were imported from Italy

and Germany and the installation was completed as per German safety norms. The experience gained by the industry in the operation of these two pilot plants, particularly in relation to the safety aspects, has been helpful in acquiring the know-how needed for application of cyclopentane foaming technology on a commercial scale. The phase II of the project, which is presently underway, consists of adaptive research, pilot production and information dissemination for compressor design using R 600a. It also includes know-how transfer from a German refrigerator manufacturer to two Indian refrigerator manufacturers in appliance engineering aspects for safe design of domestic refrigerators. It is expected that the project would, by the end of its duration, have built capacities in the participating Indian industry partners in adoption of cyclopentane based foaming technology and in adaptive research in compressors/ appliances based on HCs. It would also lead to the institutionalization of technical, engineering and managerial capabilities, which are expected to help in technology absorption and diffusion on a continuous basis in the participating industry partners. As a parallel exercise, INFRAS in association with the existing ECOFRIG partners has launched a pilot phase of another initiative called HIDECOR (Human and Institutional Development Project for Ecological Refrigeration), which relates to training and imparting of requisite skills to the informal sector personal in the refrigeration sector. The main phase of HIDECOR would address the issue of capacity building as an ongoing and continuous exercise and would involve active cooperation of the existing industry partners and the Governments of India, Switzerland and Germany.

Source: *TERI (1997): Capacity building for technology transfer in the context of climate change. Tata Energy Research Institute, New Delhi*

The institutional capacity must be developed or adapted to enable the assimilation of technology in the country resulting in capacity building. This will ensure that the technology transfer does not become a one-off event without having a replicative and trickle-down effect on the economy. It is evident from the discussion about the barriers in this paper that a proper institutional set-up is lacking in many countries of the Asia and the Pacific Islands region. **Figure 11** shows the kind of institutional set-up required for enabling efficient transfer of technology and capacity building. The host country governments must develop the capabilities of these institutions simultaneously and promote a mutual interaction between them thereby helping in development of efficient national systems of innovation in the country. The development of the institutional capacity must thrive to maintain a link with the technology suppliers, possible user groups and the donor agencies.

The amount of effort and investment that is required for developing requisite institutional capacity might vary for different countries in this region. As mentioned elsewhere in this paper the institutional set-up in some of the East Asian country is well developed and efficient. Many of these countries have efficiently used a proper institutional set-up to herald a path of high economic growth in the past few decades (FCCC, 1998a; Lall, 1996). Thus for these countries the main issue is to add a few more institutions/regulatory bodies and to adapt the existing institutions to meet the required ends. These countries can draw upon their previous experience of regulating the technology transfer and successful assimilation of the transferred technology (as in the case of Korea, Taiwan and Singapore). For example, in the future the Korean Government has plans to set up a technology promotion fund to help develop some

core technologies as well as to expand the Korea Technology Financial Corporation (FCCC, 1998a; Lee and Kim, 1994).

The capabilities of the financial institutions (belonging to the public or private sector) must be developed to devise innovative financing mechanisms for funding the ESTs projects. Several financial instruments such as revolving funds, green funds relocation incentives and subsidized interest or soft loans might be used by the local financial institutions to fund various EST projects. There is a need to develop the capacity of the financial institutions to appraise projects not only from the point of view of financial returns, but also in terms of the environmental and social benefits. A case study of innovative financing mechanism adopted for providing loans to rural population by Grameen Bank of Bangladesh is given in **box 9.**

Box 9. Innovative financing mechanisms: catering to the rural sector

Bangladesh's Grameen Bank has become widely known for successfully providing microcredit to the rural poor. Beginning in 1974, when US $ 27 was lent to 42 villagers, by 1998 over 2.3 million Bangladeshi's in over 37,000 villages had borrowed from it. Over this period, the bank has cumulatively loaned more than US $ 2 billion, and repayment has been almost 100%. The average loan is about US $ 60 and over 90% of the borrowers have been landless rural women.

In 1996, Grameen Bank initiated a programme to provide credit for renewable energy systems to serve those areas without access to electricity through a non-profit rural energy company, Grameen Shakti. It is providing loans to install solar energy systems in village households. It has also begun to develop international partnerships with companies that provide appropriate technology. Grameen Shakti expects that 100 000 photovoltaic systems will be in operation in Bangladesh rural homes by the year 2000. The Bank has plans to offer small loans for other renewable energy applications like biogas plants as well. There are other similar initiatives of innovative financing like the World Bank/GEF-supported Indonesia Solar Home Systems Project where micro-credits have been provided to enable purchase of solar home systems by rural households and commercial establishments on an installment plan basis.

Source: TERI database

Building local human capacity is essential to developing successful technological capacity in the country and is essential at every stage of the technology transfer process. It is only through investment in the human capacity can the tacit knowledge associated with the technologies and innovations can be transferred to the host firms/institutions in these countries. National universities, technical institutes, industrial training institutes, etc. can play a vital role in training the workforce for new ESTs in different sectors. The capabilities of these institutions must be upgraded. The universities can introduce new curriculum to address the issues for the transfer ESTs and impart the required skills to the students and researchers. Similarly, upgrading training institutes will help in providing trained and skilled manpower for the implementation and operation and maintenance of the ESTs both in the formal and informal sectors. An example of inadequate development of the capacity of the universities and technical institutes can be given in India's ozone-friendly technology

transfer program. The knowledge about the harmful effects of CFCs on stratospheric ozone layers became evident in 1980s. However the syllabus for the industrial training institutes in India on refrigeration and air-conditioning that was updated as recently as 1997 did not cover key aspects related to new ecological refrigeration technologies (CIMI, 1998). Donor country governments and multilateral and bilateral agencies should ensure that training and capacity building programs sponsored by them take into consideration the local needs and conditions of the host countries.

In order to achieve successful diffusion and implementation of ESTs it is important that a proper institutional set-up complements the technology transfer efforts. The EST-ADCs should clearly identify the needs for developing the institutional capacity and apprise the UNFCCC about the same. As a lot of inputs for capacity building must come from the Annex 1 countries, thus their commitment in this regard (in the form of making the finances available, providing expert training and necessary counsultancy) is very important. The UNFCCC should ensure that the commitments made by the Annex 1 parties are in line with the perceived needs of the developing countries. Such a synergy is important for any meaningful development of institutional capacity in the host countries. The financing options of such capacity building initiatives are discussed later in this paper. The EST-ADCs should be the main implementing agency for developing the institutional capacity while it can draw upon the expert advise made available by the developed countries under the Convention.

6.5.5 Financing mechanisms: a coordinated approach

The role of financing mechanisms is crucial for addressing the issues of technology transfer and capacity building in the context of climate change. There are several existing mechanisms to promote, facilitate and finance the transfer of, or access to, ESTs and know-how. However, there is a need to fine-tune the existing mechanisms (GEF, AJI/JI, CDM, emissions trading) and other developmental assistances (ODA, multilateral/bilateral grants) to build capacity of the developing countries to respond to the adverse effects of climate change. This is all the more necessary since many countries in the Asia-Pacific region are severely hampered by local factors like low per-capita incomes, low literacy rates, persistent poverty, sluggish economic growth and concerns over food supply and national security.

Global Environment Facility (GEF) which was established in 1990 as the operating entity of the UNFCCC Financial Mechanism, has experience of funding investments and technical assistance programs in several developing countries. However GEF has come under criticism for various reasons. For example, in the GEF mechanism there is a need to change the focus for preparation and execution of some projects (like renewable technologies) from positive local externalities to positive global

externalities. Also, in case of developing countries, more stress should be on assessment of vulnerability and assessment measures rather than on inventory preparation and mitigation assessments. (Srivastava & Soni, 1998). The small island nations of the Pacific region are concerned that the present form of GEF does not take into consideration their special needs. The need to strengthen the consultative process while deciding country priorities has been stressed. GEF should also assist in vulnerability assessments and institutional strengthening of small-states and low-lying coastal developing countries (Ashe, J W, et al, 1999). The GEF facility should be restructured so as to ensure new and additional financial resources on grant and concessional terms, in particular to the developing countries (UN, 1992).

The three major mechanisms adopted at Conference of the Parties (COP-3) are the Joint Implementation (JI), Clean Development Mechanism (CDM) and Emissions Trading (ET). In CDM, unlike the JI mechanism and ET, the transfer of credits could be from countries that do not have abatement commitments. Hence CDM could lead to additional investments for mitigation projects and at the same time assist the developing country Parties in undertaking adaptation measures. However it may be necessary to put a limit on the extent to which Annex I parties can meet their commitments recourse to the flexibility mechanisms (Pachauri, 1998).

The local government has a proactive role to play in identifying the criteria of selection of projects in line with their definition of sustainable development, in ensuring that the projects are host-country driven, and also in endorsing and approving these projects. For generating resources for development purposes and addressing the concerns about transfer of credits for easy abatement options, a tax could be charged by the local governments based on the unit abatement cost of GHG reduction. The proceeds could contribute to development fund established at a national level or feed into the central exchequer.

Proposed financing mechanism

For the framework proposed in this paper the financing needs are expected to be met by existing multilateral financial mechanisms, bilateral funding, the host country governments and some new mechanisms proposed here. The sources of funds for various activities proposed in the framework is presented in a time line diagram given in **figure 12**. As shown in the figure, the ‘scoping for the ITP’ includes three activities: (i) identification of the country priorities for mitigation and adaptation; (ii) present technological status and technology needs; and (iii) assessment of various technological options. As shown in the time line and as discussed in the framework these activities must follow each other sequentially leading to the development of an ITP. It is proposed that the scoping activities for the ITP be funded by the GEF. The allocation of funds must be done separately for every country in the region and funds

are granted to the countries in a staged manner after successful completion of preceding activity. This will help in overcoming some of the criticisms of the GEF mentioned above. The special needs of various countries in the region (like carrying out comprehensive national surveys; a fresh assessment of the prevailing situation etc. as mentioned earlier in the framework) for completing the "scoping activities" might also be funded on a case to case basis.

The completion of the scoping activities will lead to the development of an ITP. As discussed before the conceptualization and implementation of the ITP will be carried out by a national focal point i.e. EST-ADC. The establishment and functioning of the EST-ADCs should be funded partially by the GEF and the respective host country governments. In the case where a regional EST-ADC is set-up, as might be in the case of small island states, the participating governments should pool in the funds. For various projects proposed by the EST-ADCs, regarding the transfer of ESTs, capacity building and information dissemination, different funding mechanisms can be used (e.g. multilateral/bilateral funds, AIJ, Commercial, Equity, CDM, etc.). The multilateral and bilateral funds can be used for the promotion of programs like joint technology development, training, information dissemination etc. These activities have high costs but have a wide impact on the adoption and diffusion of the ESTs in the countries. The commercial route can be promoted for those projects that are financially viable for adoption and diffusion. The UNFCCC can play an important role of mediator in such cases by facilitating the negotiation process between the parties to the proposed project. A number of projects can be funded through mechanism like CDM and AIJ.

A new innovative financing mechanism proposed here for funding the projects is through creation of UNEP-Special Purpose Vehicle (SPV). A semi-commercial body should be created under the UNEP and should be funded through multilateral and bilateral funds. The objective of the body should be to devise various SPVs for aiding the procurement of ESTs from the advanced countries and making them available to the developing countries (Annex 2) for adoption and diffusion. Through this mechanism several technologies can be sourced from the developed countries and brought in the public domain thereby reducing the barriers associated with accessibility to technologies. The SPVs should take a sectoral approach towards the procurement of technologies. The information made available under the ITPs of various countries can be used for shortlisting the technologies that need to be sourced for the prioritized sectors and have a large potential for adoption and diffusion in the developing countries of this region.

7.0 Assessing the effectiveness of the programs/projects on an ongoing basis and providing feedback for modifications

It is reasonable to assume that financial flows like, FDI, ODA and other multilateral and bilateral assistance promote diffusion and transfer of technologies and know-how. An analysis of the period 1990-96 reveals that financial flows to developing countries have shown an increase of 186%. Although official development finance has decreased by 27% over the period, there has been an increase in private flows. Within the private flows, the indirect link between FDI and transfer of technology makes these flows important to environment-related issues and climate change. However it is difficult to analyze the investment pattern of FDI by climate relevant sectors, as its distribution in developing countries is not well documented, and the statistics on transfer of ESTs and their impact on GHGs is difficult to determine (FCCC, 1997). Hence to get an insight into transfer of ESTs and know-how, there is need for better documentation of financial flows. For example, a separate category may be defined for FDI related to transfer of climate friendly technologies and know-how. Besides helping in quantifying the transfer of ESTs, it would also help the government to selectively promote investments in this area.

To measure the effectiveness of various programs/projects on an ongoing basis there is a need for periodic assessment. This would help to identify the most effective options and policies in different situations so that modifications could be made in the proposed integrated technology program. Assessment of the programs can be through national surveys and sector specific studies. Apart from estimating the impact of the programs on GHG emissions, the surveys can help in a better understanding of the dynamics of the capacity building issues. Since the overall national capacity for adoption and diffusion of the ESTs is an intertwined network of the individual capacities developed by firms, institutions, associations, R&D institutes and other actors, the surveys/studies should try to understand the linkages between different actors besides assessing their individual capacities. For large countries like China and India where conducting a large number of national surveys/studies can be very expensive and time consuming, regional or sector-specific surveys could be undertaken. The feedback from these surveys would be useful for making incremental corrections in the technology transfer process and various policy initiatives to promote the ESTs.

The above assessment process will also provide feedback on the effectiveness of various multilateral and bilateral mechanisms used for different projects. Thus necessary modifications can be made in such mechanisms under the Convention to deliver the required end results.

The national focal points (the EST-ADCs) should be responsible for carrying out the assessment of the projects on an ongoing basis. The feedback should be provided to

the FCCC Secretariat so that modifications can be incorporated in future projects that will be proposed by various Parties.

8.0 Conclusions

Effective diffusion and implementation of ESTs is essential for stabilization of global climate change. The main technology transfer issue within the context of the United Nations Framework Convention on Climate Change (UNFCCC) is to provide a direction to the technology cooperation between enterprises in developing and industrialized countries that lead to greater adoption of ESTs in the developing countries. Since climate change is not a priority for most developing countries in the Asia-Pacific region, it is important that strategies for implementation and diffusion of climate relevant technologies reinforce their developmental priorities. Another challenge faced by most of the countries in the region is to bring together and involve the diversity of central and state government ministries and departments, local administrative set-ups, regional organizations, NGOs, public and private sector organizations in each country in a common agenda. This paper has attempted to provide a framework and to suggest strategies to enhance transfer and diffusion of ESTs in the Asia and the Pacific Island region, keeping in view the specific regional barriers.

In the light of these challenges, this framework proposes an elaborate participatory process to initiate and enhance the transfer of climate relevant technologies. This approach is based on establishing a national dialogue on climate change issues, country responses and technological needs among the major stakeholders like policy makers, public and private enterprises, regional organizations, R & D institutions and NGOs. The programs for implementation of ESTs and information dissemination will necessarily have to be very country-specific, and a broad-brush approach can only defeat the very purpose for which such programs need to be devised. However the country governments need to play a leading role in institutionalizing the climate change debate into the national agenda through necessary changes in the organization structures and policy framework. Thus the major steps proposed in the framework include:

(a) Country priority areas for mitigation and adaptation have to be identified to target technology transfer to those ESTs and know-how that are most appropriate for the developmental objectives

(b) The present technological status and needs of the priority sectors identified have to be studied to identify all the available technological options

(c) Assessment of the different technological options will have to be made to filter out a few technologies from the list of possible options

(d) An integrated technology program for adoption and diffusion incorporating identification of technology sources and enabling policies to promote the same will be helpful.

(e) Need for a formal information dissemination set-up, so that most of the relevant information on climate relevant technologies is available to facilitate decision-making.

Policy initiative by the respective governments of the countries in this region is essential for creating an enabling environment for the transfer of ESTs and its successful adoption and dissemination. Various policy measures to enable the transfer, adoption and diffusion of ESTs can be: providing investment incentives, public procurement, use of command and control measures, promoting market based instruments etc. Joint projects between countries would facilitate dissemination of mitigation technologies and knowledge and lead to local capacity building. The effort for technology transfer of the ESTs must focus on capacity building efforts in the country. Development of institutional capacity must focus on developing capacity in the financial, technical, R&D, education, and other areas.

The paper was an attempt to examine the important issues in the area of technology transfer and information dissemination of ESTs for the countries of Asia and the Pacific Islands region. Since most of the countries in the region have limited experience in the transfer of ESTs and financing thereof, there is a greater need for a more detailed analysis of country policies and specific projects for an enhanced understanding of the barriers to transferring and disseminating ESTs and know-how. The opportunities to facilitate this process through a coordinated effort that involves the respective governments, private sector, R&D institutions, NGOs, and multilateral and bilateral institutions need to be studied in greater detail.

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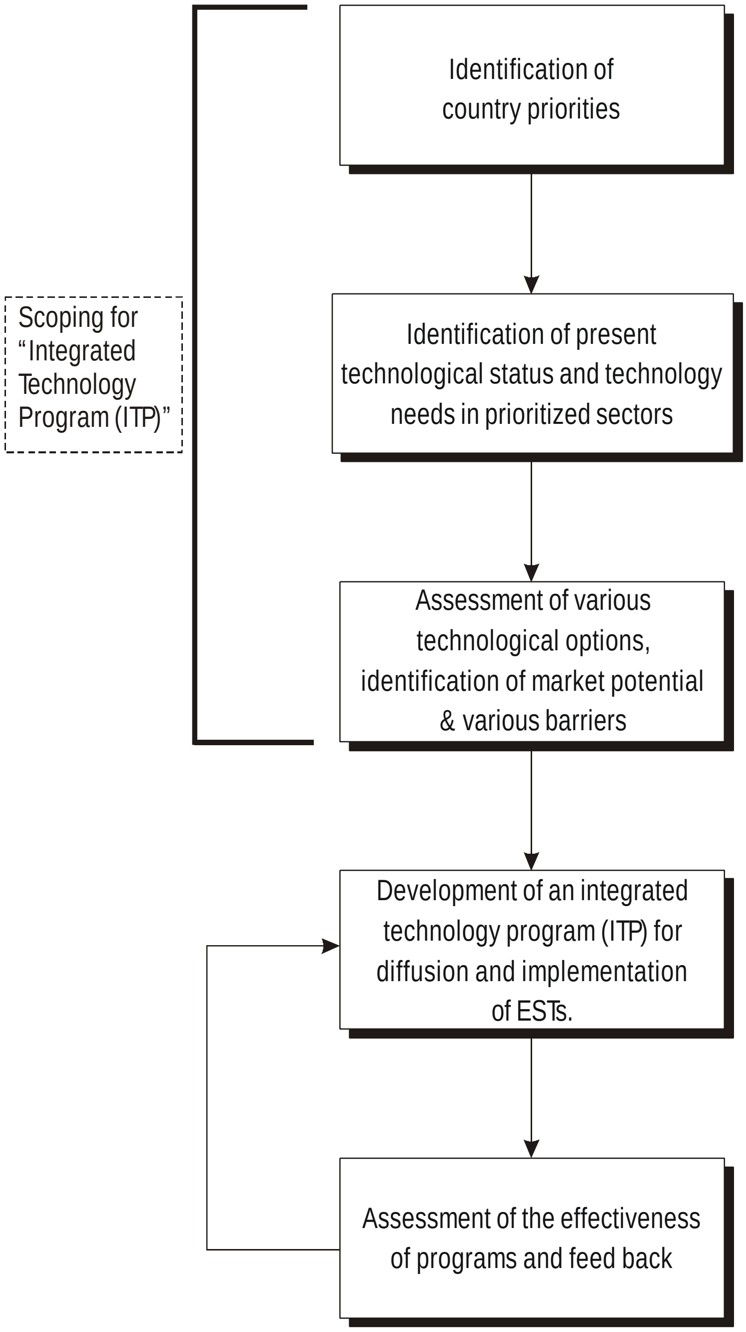


Figure 2: Various stages in the development of the framework

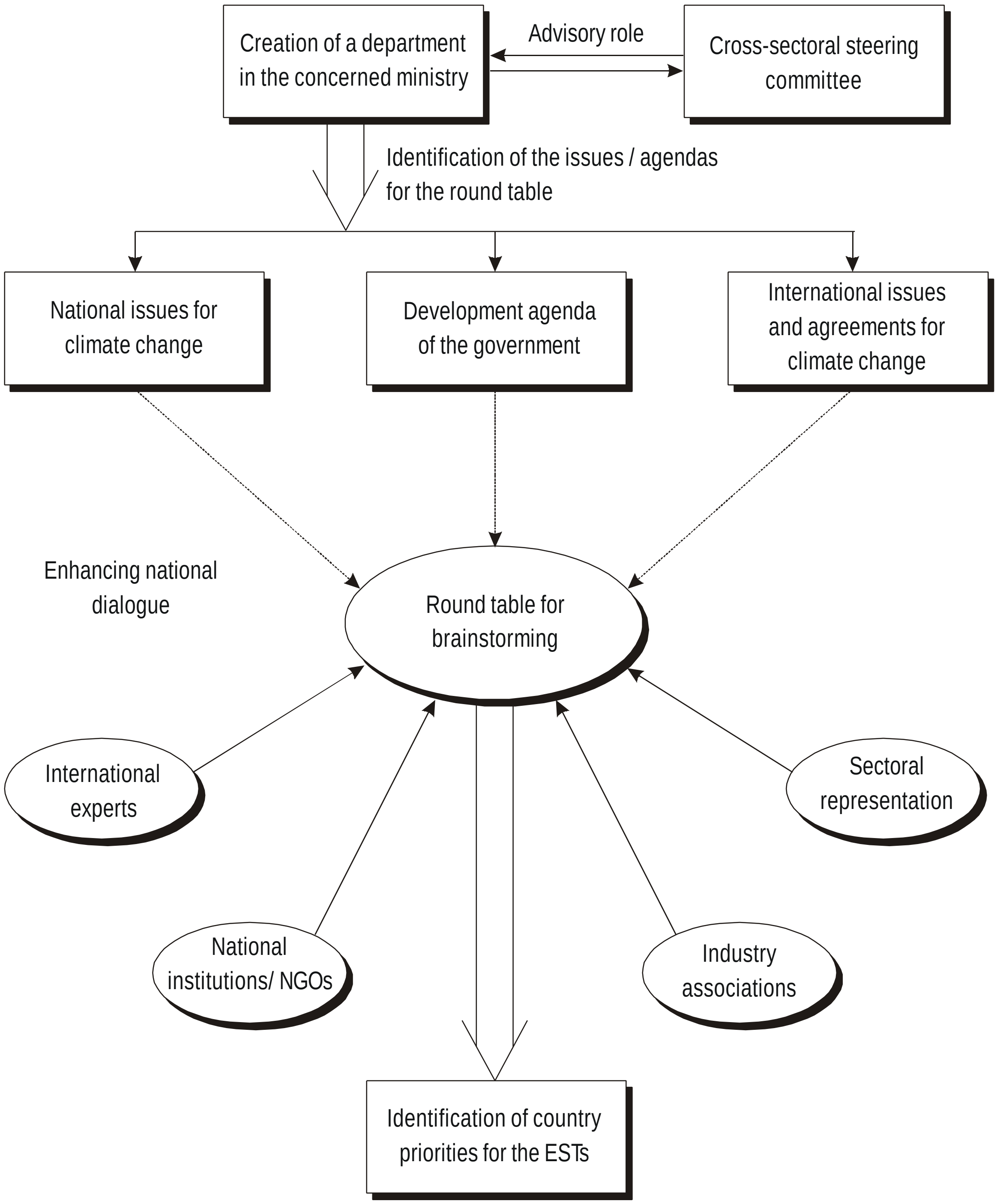


Figure 4: Participatory approach to identifying country priorities

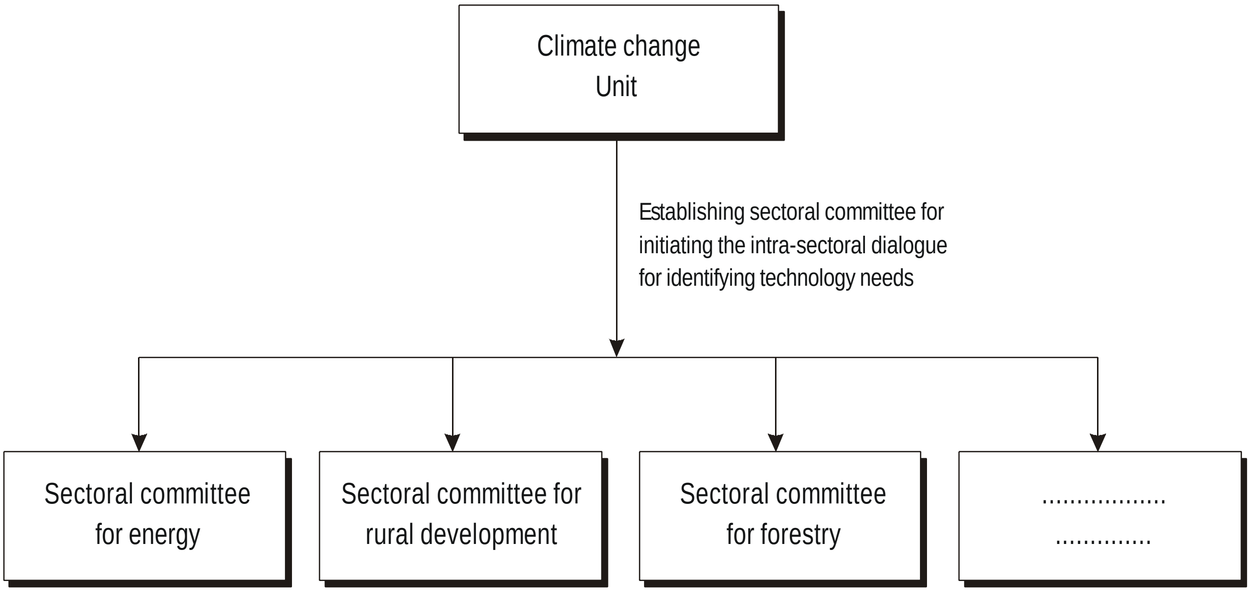


Figure 5: Creating sectoral committees for promoting intra-sectoral dialogue

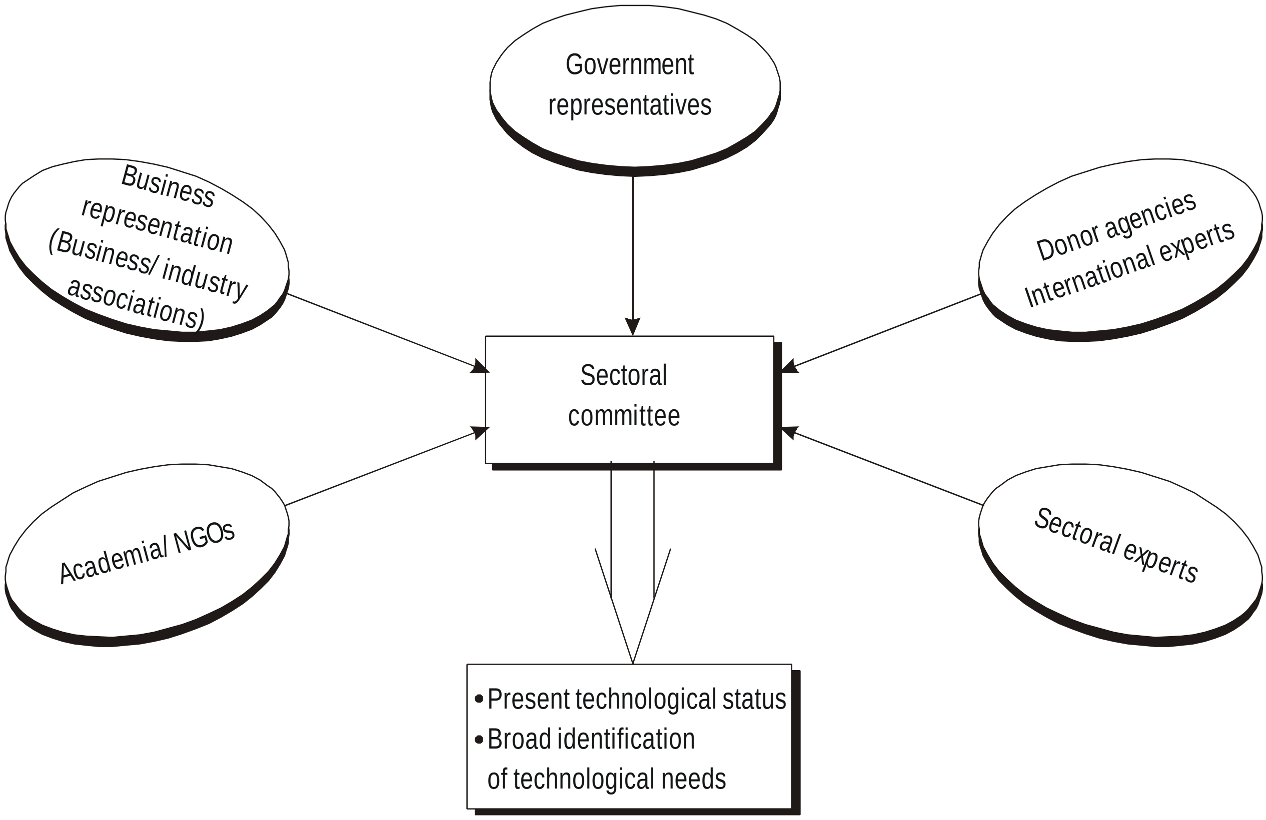


Figure 6: Consultative process for identifying present technological status and technology needs

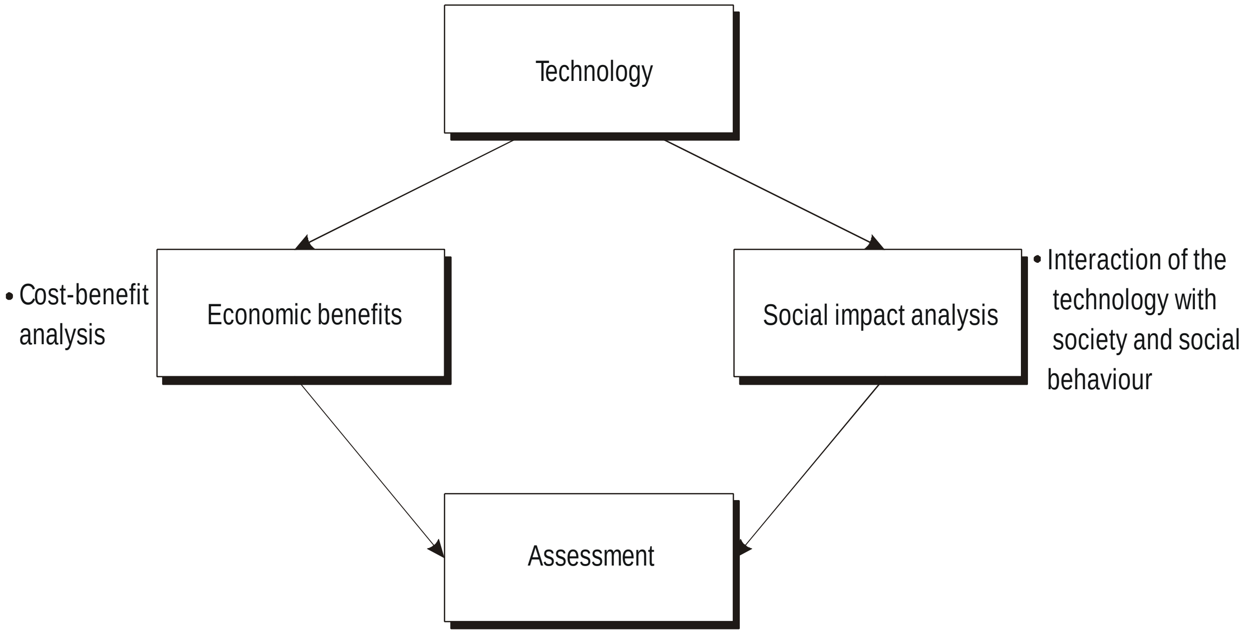


Figure 7: Socio-economic analysis of various technological options

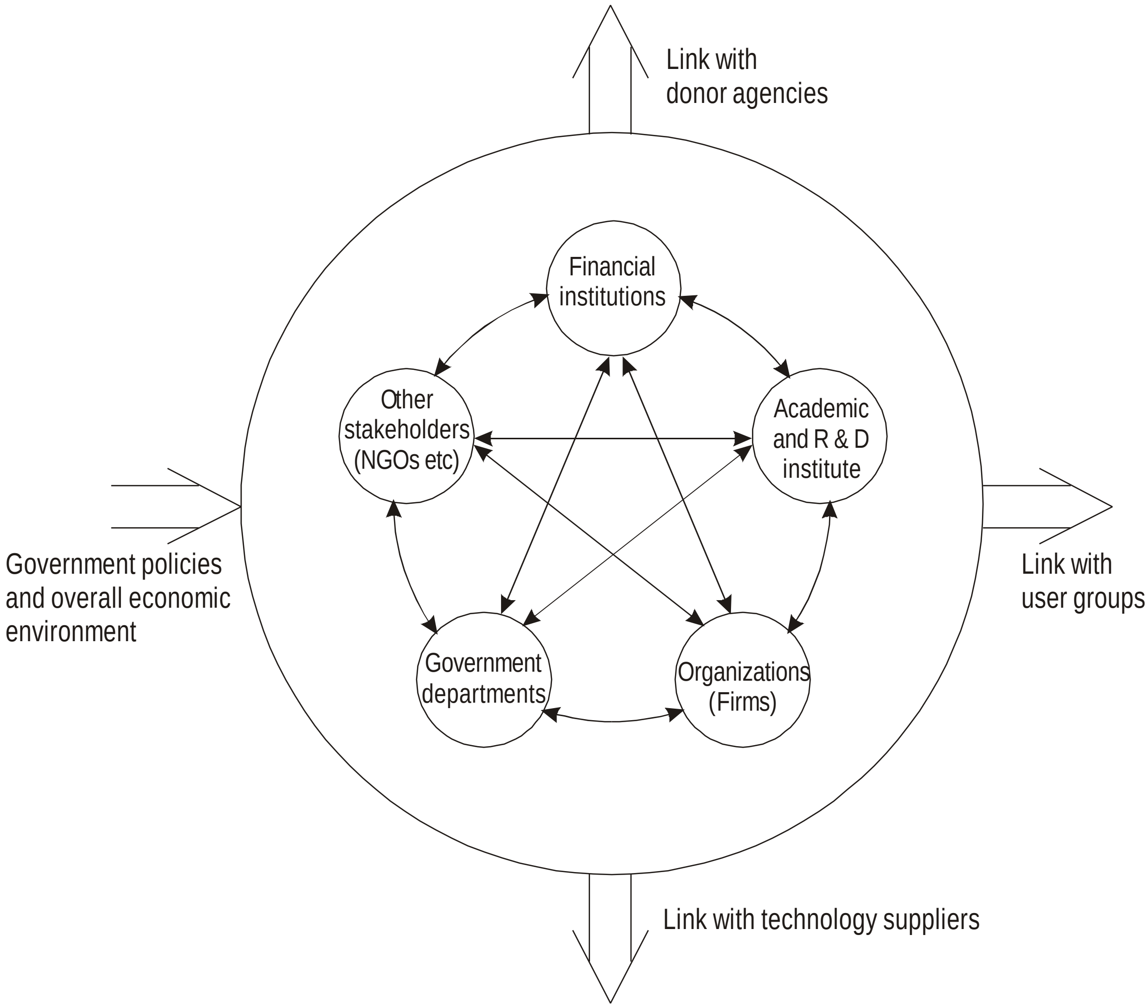


Figure 11: Network model for developing institutional capacity

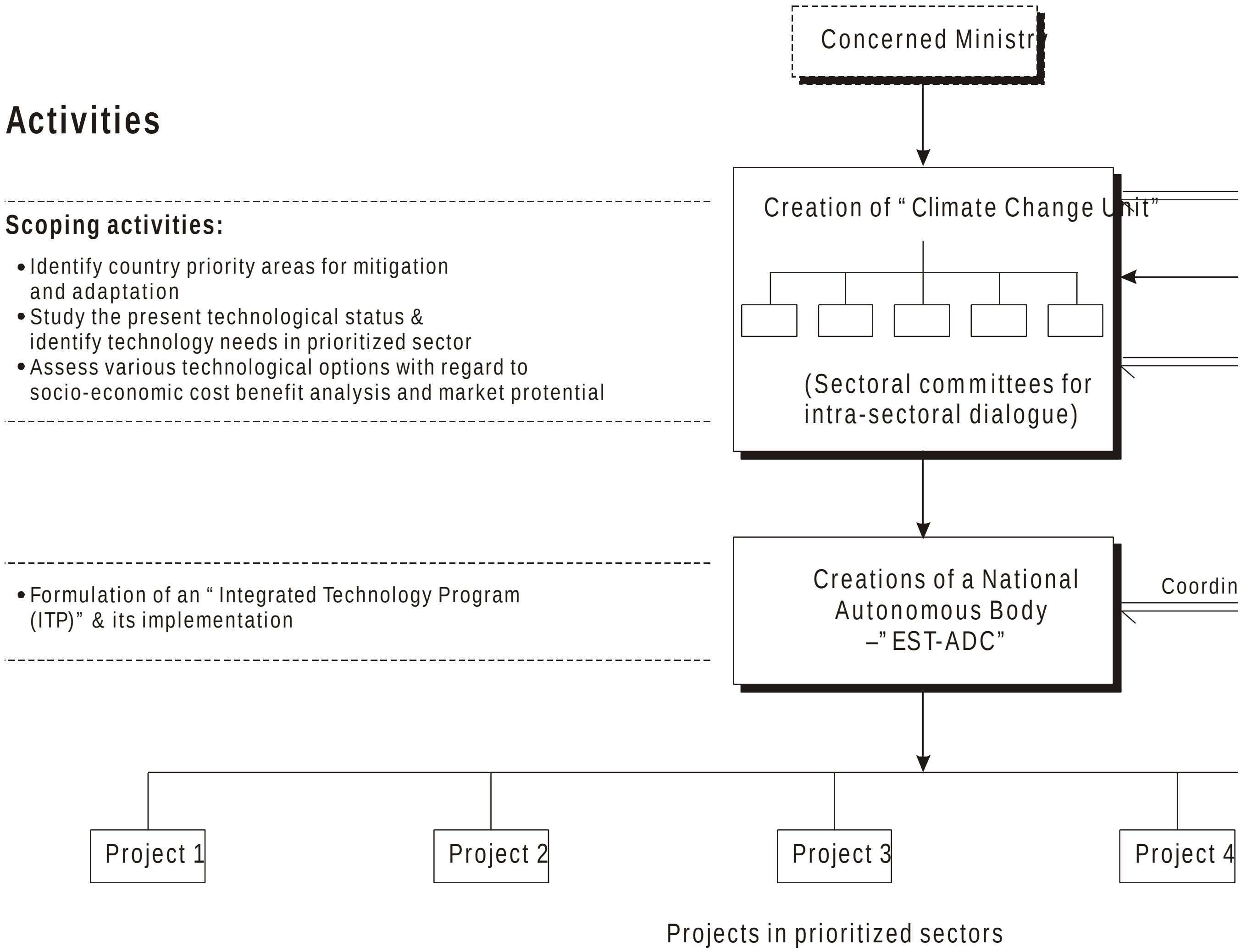


Figure 3: Proposed institutions and their activities

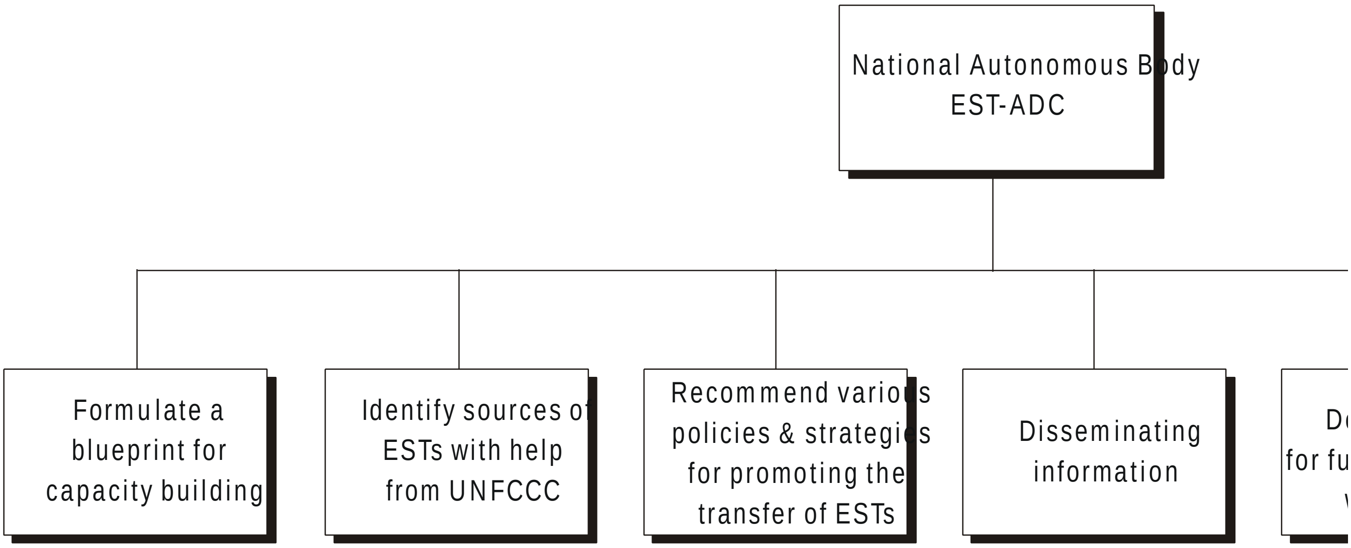


Figure 8: Main objectives of the national autonomous body

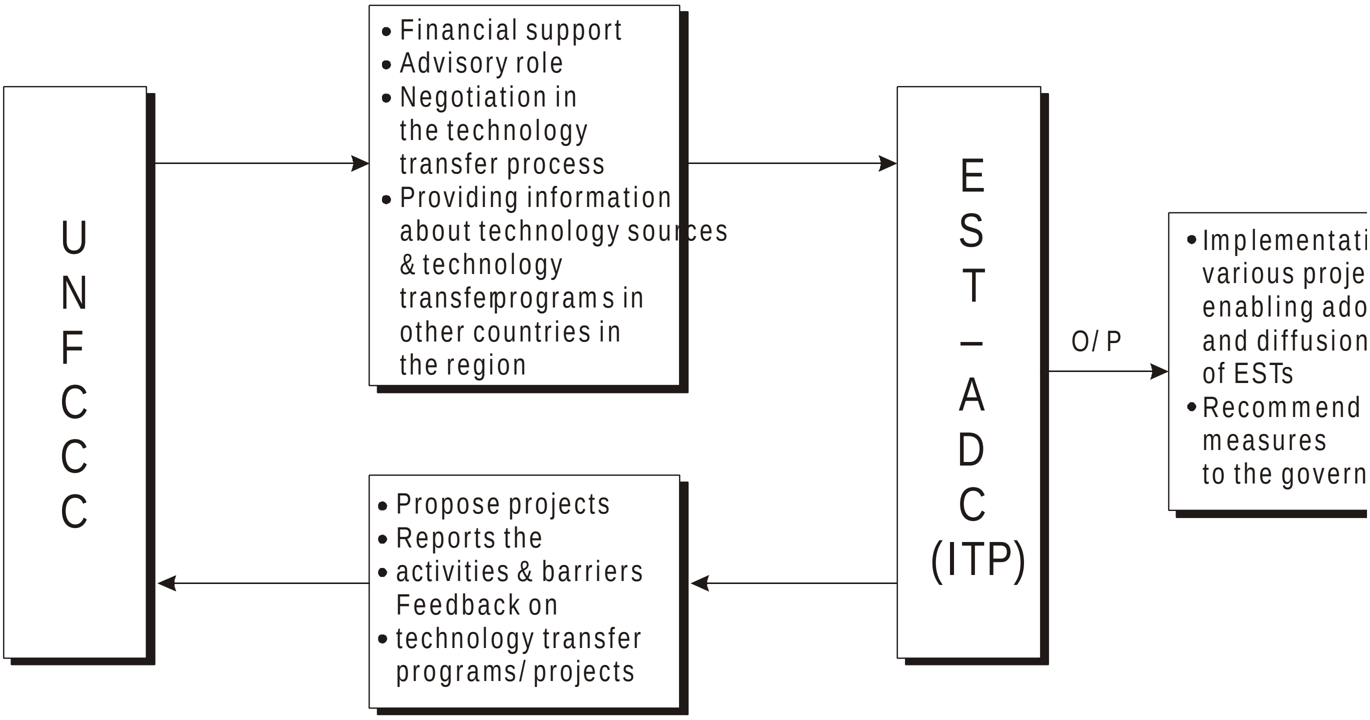


Figure 9: Coordination with UNFCCC

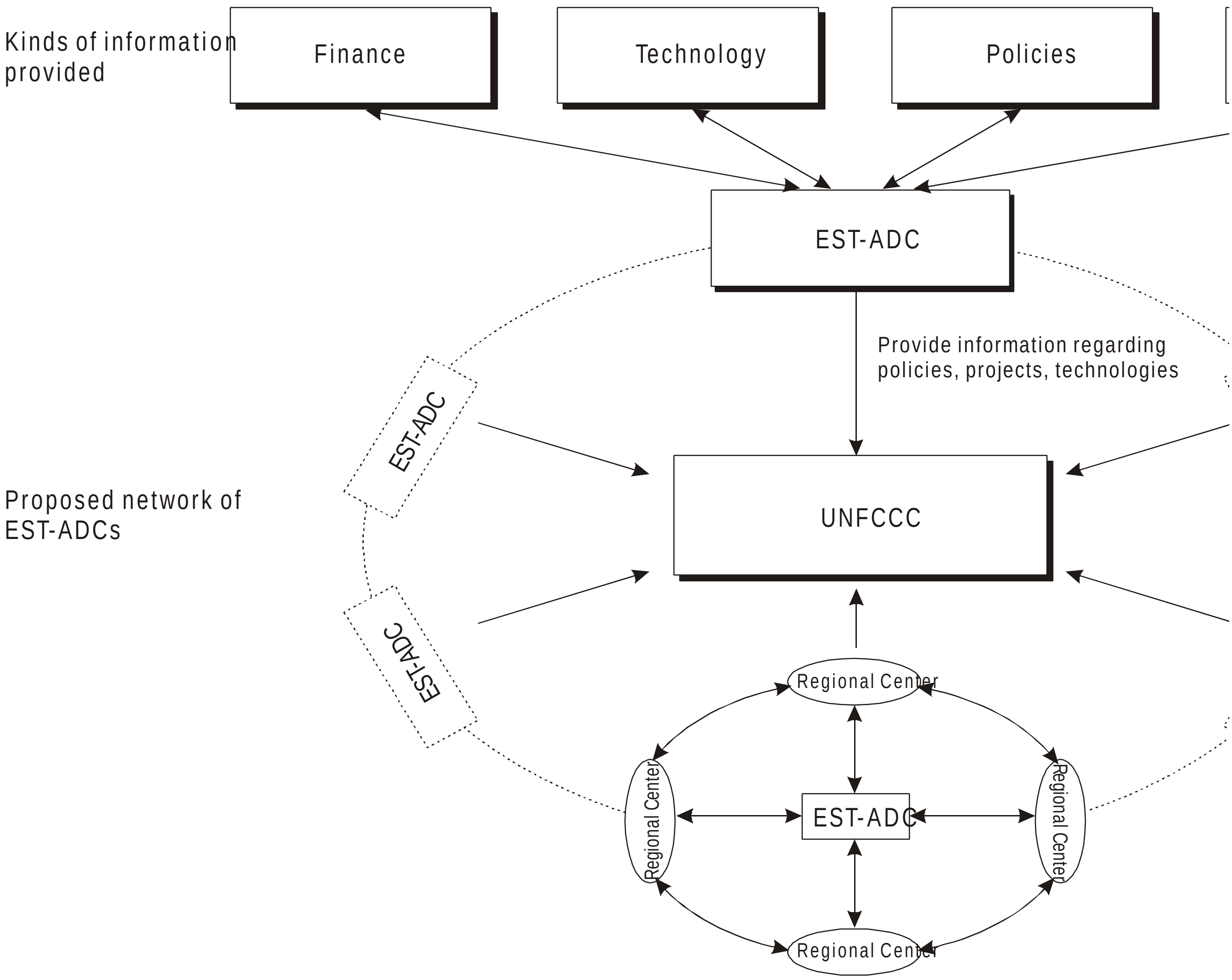
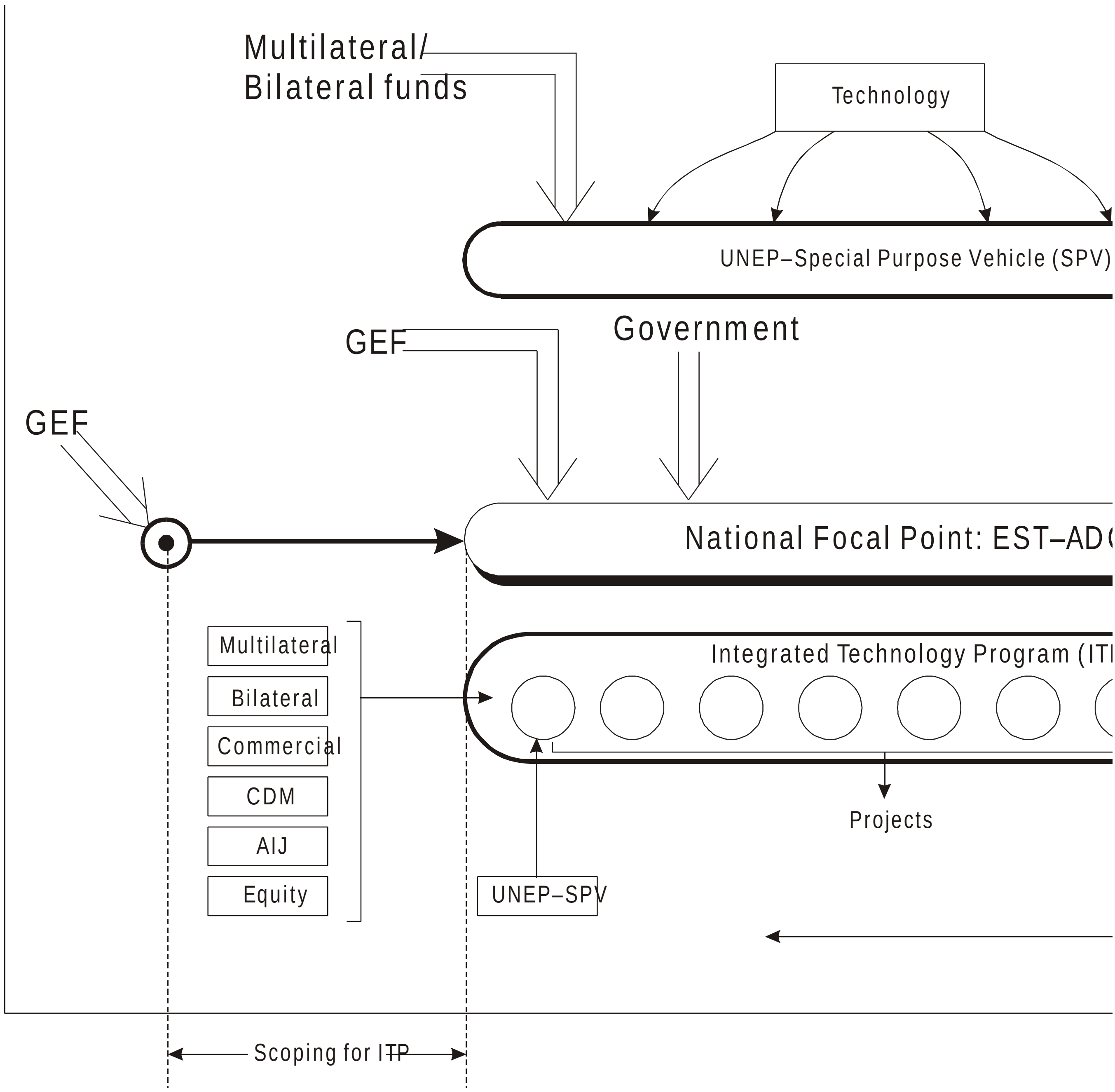


Figure 10: Proposed model for information dissemination and coordination with UNI



Multilateral/
Bilateral funds
Technology
UNEP–Special Purpose Vehicle (SPV)
GEF
Government
GEF
National Focal Point: EST–AD
Multilateral
Bilateral
Commercial
CDM
AIJ
Equity
Integrated Technology Program (IT
Projects
UNEP–SPV
Scoping for ITP