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CAPACITY-BUILDING IN THE DEVELOPMENT AND TRANSFER OF TECHNOLOGIES

Technical paper*

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CONTENTS

I. INTRODUCTION

A. Mandate

1. The Conference of Parties (COP), by its decision 4/CP.7, adopted the framework for meaningful and effective actions to enhance the implementation of Article 4.5 of the Convention contained in the annex to that decision (FCCC/CP/2001/13/Add.1). The framework covers five key themes and areas for action: technology needs and needs assessments; technology information; enabling environments; capacity-building; and mechanisms for technology transfer.

2. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its sixteenth session, adopted the programme of work of the Expert Group on Technology Transfer (EGTT) for the biennium 2002–2003. The EGTT programme of work provides for a specific area of activity relating to capacity-building for the development and transfer of environmentally sound technologies (ESTs) and know-how. The SBSTA, at its seventeenth session, requested the secretariat to prepare a technical paper on capacity-building for technology transfer for consideration by the EGTT.

3. The SBSTA, at its eighteenth session, took note of the intention of the EGTT and the secretariat to continue their work on a technical paper on capacity-building for development and transfer of technologies, and to make it available for consideration by the SBSTA at its nineteenth session. It also recognized that this document could provide important and useful information relating to the implementation of the frameworks annexed to decisions 2/CP.7 and 3/CP.7 and to the comprehensive review of the implementation of the capacity-building framework by the Conference of the Parties (COP) at its ninth session.

B. Background and scope of the paper

4. This technical paper was prepared on the basis of the terms of reference recommended by the EGTT. Its focus is on capacity-building for technology transfer under Article 4.5 of the Convention and as defined in the technology framework. It was also guided by the principles and approaches identified in the frameworks for capacity-building (decisions 2/CP.7 and 3/CP.7).

5. The paper draws largely from the capacity-building literature and the information generated during the discussions on development and transfer of technology within the Convention process. This literature includes the information from the reports of the regional workshops[1] organized under the consultative process on technology transfer (decision 4/CP.4), the Intergovernmental Panel on Climate Change (IPCC) *Special Report on Methodological and Technological Issues in Technology Transfer*, the IPCC Third Assessment Report (IPCC TAR), and relevant reports from the Global Environment Facility (GEF) and its implementing agencies. Other sources of significance are the recent national communications from Annex I and non-Annex I Parties.

6. Additional inputs were received from recent regional workshops on technology needs assessments and technology information where country experiences and capacity-building needs were exchanged. In response to the programme of work of the EGTT, these workshops were organized by the Climate Technology Initiative (CTI), the United Nations Development Programme (UNDP) and the United Nations Environment Programme (UNEP) in cooperation with the UNFCCC secretariat and the EGTT.

7. The general objective of this technical paper is to outline experiences, lessons learned, success stories and challenges in building the capacity of developing country Parties, and Parties with economies

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1 The reports of the three regional workshops are contained in documents FCCC/SBSTA/1999/11, FCCC/SBSTA/2000/INF.2 and FCCC/SBSTA/2000/INF.6

in transition, in the development and transfer of technology, and is meant to provide background information to the EGTT and the SBSTA.

8. This paper has the following goals:

(a) To give an overview of experiences by different international organizations and institutions of on-going capacity-building activities;

(b) To summarize lessons learnt from capacity-building activities to identify gaps and overlaps in their implementation;

(c) To identify priority actions in capacity-building for technology transfer in the context of the UNFCCC process;

(d) To present some conclusions and suggest possible steps that may be taken on this subject.

9. Capacity-building is a broad term and is interpreted differently by different groups, making summary of the available literature a challenging exercise. This is particularly so because few experts looking at capacity-building have done so with the intention of examining its role in enhancing technology transfer. Of the information available, much is anecdotal and not particularly well substantiated. Despite these challenges, the secretariat, under the guidance of the EGTT, has attempted to capture the main ideas and experiences of those experts who have looked at capacity-building and technology transfer efforts, and to interpret these in the context of the UNFCCC and decision 4/CP.7.

II. CONCEPTS AND ISSUES IN CAPACITY-BUILDING FOR DEVELOPMENT AND TRANSFER OF TECHNOLOGIES

A. References to capacity-building for technology transfer in multilateral forums

10. Achieving the ultimate objective of the Convention, as stated in Article 2, will require technological innovation and the rapid and widespread transfer and implementation of environmentally sound technologies (ESTs), both for mitigating the effects of greenhouse gas emissions and for adapting to climate change (IPCC, 2000). Technology development and transfer is more than the installation of hardware, but also covers the ‘software’ (knowledge) to make technology work. Transferring experience, knowledge, skills and practices is ‘capacity-building’. Probably the most important experience gained in recent decades in technology transfer is that there are numerous barriers to the diffusion of ESTs and that comprehensive programmes are generally required to integrate capacity-building, access to information and an enabling environment of policy measures into a mechanism for diffusion of technology.

11. “Horizontal technology transfer” refers to technology transactions between parties of similar technological status, whereas “vertical technology transfer” occurs between parties of different technological status. The latter is of more interest to this technical paper as it directly relates to Article 4.5 of the Convention. However, in reality horizontal technology transfer occurs among developing countries, referred to as ‘South–South cooperation’.

12. Technology transfer results from actions taken by various stakeholders. Key stakeholders are governments, technology suppliers, developers, buyers and users (research centres, private and state firms as well as individuals), financiers (donors, investors, commercial and development banks), information providers (international organizations) and intermediaries (NGOs, media, consumer groups, associations) (IPCC, 2000). Although technology can be transferred directly between public agencies,

between private-sector firms and between private partners and government,[2] increasingly technology flow depends on the interaction and coordination of multiple stakeholders.

13. The rate of transfer is affected by 'barriers' in society that impede transfer, and 'actions' taken by the stakeholders involved that induce more rapid adoption of ESTs. Barriers are institutional, political, technological, economic, informational, financial and cultural factors that inhibit technology development and transfer (IPCC, 2000; Martinot and McDoom, 2000; see also FCCC/TP/1998/1 and FCCC/TP/2003/2).

14. A reference to actions on facilitating technology transfer is made in chapter 34 of Agenda 21, including information networks, government policies, institutional support for developing new technologies, international cooperation, collaborative research and development and long-term collaborative arrangement for foreign direct investment and joint ventures. The IPCC (2000) distinguishes three major groups of actions to enhance technology transfer: capacity-building, an enabling environment and mechanisms for technology transfer. Successful technology transfer requires adequate human, organizational and information assessment and monitoring capacity. The report recognizes that governments are major actors for taking actions that make technology transfer more effective by setting the broad policy framework. They have a variety of policy tools to create an enabling environment.[3] In addition, the report stresses the importance of other stakeholders in taking actions to address the technology transfer barriers. It calls for national systems of innovation that integrate the capacity-building and policy actions of the various stakeholders into a mechanism for EST transfer. Bilateral and multilateral donor aid form international mechanisms to enhance technology transfer.

15. In terms of dynamics, the transfer of EST may be understood as a process encompassing various steps. IPCC (2000) identifies technology transfer as a five-stage process involving assessment, agreement, implementation, evaluation and adjustment, and replication. Van Berkel (1997) identifies the following steps: creating awareness of the need for ESTs and involving stakeholders; assessment of technology options and assessment of capacity for the absorption and/or adoption of technology; and implementation of technology transfer (actions to acquire and operate the technology as well as policy measures and capacity-building actions to remove barriers). In this framework, capacity-building for technology transfer can itself be viewed as a process involving various steps: assessment of current capacity and identification of gaps in the institutional, technological, human resources and government capacity; short-listing and prioritizing the opportunities for capacity-building; implementation of the capacity-building programme;[4] and monitoring and evaluation.

16. Reflecting the fact that capacity-building for technology transfer takes on different forms, intensity, and duration depending upon the particular situation being addressed within a country or region, it is not surprising that there is no uniform definition or model that emerges from literature. Therefore an attempt to define such a conceptual framework in provided in the next section.

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[2] There are several pathways through which stakeholders can to transfer technology, such as direct purchase, licensing, franchising, direct investment, sales of turn-key plants, joint ventures, subcontracting, cooperative research arrangements, exchange of personnel, education and training, and open literature (IPCC, 2000).

[3] Barriers and policy tools for creating an enabling environment according to 10 dimensions: national systems of innovation; social infrastructure and participatory approach; human and institutional capacities; macroeconomic policy frameworks; sustainable markets; national legal institutions; codes, standards and certification; equity considerations; rights to productive resources; and research and technology development.

[4] This may include a number of activities, such as public consultations and forums, seminars and workshops, training in courses and learning-by-doing experiences, case studies, action plans, pilot activities and strengthening of networks and information exchange mechanisms.

B. Conceptual framework for capacity-building for technology transfer

17. The framework for meaningful and effective actions to enhance implementation of Article 4.5 of the Convention, contained in decision 4/CP.7 (FCCC/CP/2001/13/Add.1), lists the following key themes and areas in technology development and transfer: technology needs and needs assessment; technology information; enabling environment; capacity-building; and mechanisms for technology transfer.

18. This technical paper follows the Article 4.5 framework, which defines capacity-building as a process which seeks to build, develop, strengthen, enhance and improve existing scientific and technical skills, capabilities and institutions in non-Annex II Parties, and enable them to access, adapt, manage and develop environmentally sound technologies. The purpose of capacity-building under this framework is to strengthen the capacities of Parties not included in Annex II, particularly developing country Parties, to promote the widespread dissemination, application and development of environmentally sound technologies and know-how, to enable them to implement the provisions of the Convention (FCCC/CP/2001/13, Add.1, decision 4/CP.7).

19. Following the IPCC analysis, this paper distinguishes three categories: human capacity, institutional capacity and information capacity. Lack of capacity and capabilities of the stakeholders involved acts as a major barrier to the transfer and implementation of climate-friendly technologies. Table 1 gives a list of capacity gaps and capacity-building actions as mentioned in by the IPCC (2000) and other sources.

20. The enabling environment component is defined in the same framework as government actions, such as fair trade policies, removal of technical, legal and administrative barriers to technology transfer, sound economic policy, and regulatory frameworks and transparency, all of which create an environment conducive to private and public sector technology transfer. This paper therefore focuses on capacity-building in the more narrow sense of human and institutional capacities; on issues regarding capacity-building at the systemic level[5] (creating an enabling environment) useful information can be drawn from document FCCC/TP/2003/2. Relevant information can also be drawn from the ongoing activities on the other components of the technology transfer framework, such as technology needs assessment, technology information and mechanisms for technology transfer.

21. It should be noted that the table 1 provides a generic list. Large differences exist among developing countries and countries with economies in transition in existing capacity and capacity development needs. Many studies stress that all countries have indigenous capacity and expertise available (academia, companies, government agencies, NGOs, etc.). The country-driven assessment of existing capacities and the identification of gaps where capacity-building activities can be targeted is a critical step, intimately linked with the assessment of technology needs.

22. Numerous capacity-building actions have been or are being carried out in developing countries to support technology transfer directly or indirectly. Multilateral and bilateral donors have provided support to capacity-building and technology transfer activities. Chapter III discusses in more detail the experiences and lessons learned in donor-supported capacity-building efforts for technology transfer. These lessons learned provide valuable insights on gaps and overlaps in capacity-building. The chapter ends by highlighting some opportunities in international cooperation to address these gaps and overlaps.

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[5] In the literature, capacity-building is often discussed at the level at which stakeholders are situated in society. Thus, capacity can be built at the individual level (technology users, consumers), institutional level (company, organization), and national level (association, government). The national level can be referred to as 'systemic level', the level at which an overall policy framework is provided (UNDP, 2002). To these levels, the regional and international level (multinationals, international organizations) can be added.

Table 1. Elements in capacity-building for technology development and transfer

Capacity-building category	Gaps in existing capacities (as barriers to technology transfer)	Possible capacity-building actions in technology transfer
Human capacity (individual level)	• Insufficient expertise and availability of local skills and craftsmanship • Lack of experience with the acquisition and management of ESTs and technology transfer projects	• **Provision of opportunities for training in the use of ESTs in demonstration projects**; **training and enhancement of skills in adoption, adaptation, installation, and operation and maintenance of ESTs** • **Training in project development and management**; development of skills in business management, innovative funding and technology negotiations
Institutional capacity (organizational level)	• Weak relevant organizations and organizational rigidities; ineffective mobilization of R&D capability; lack of R&D and technology development facilities • Lack of resources within government institutions and capability to regulate or promote technologies • Weak institutional framework (mandates leave gaps or overlap); lack of joint stakeholder networking and planning • Poor coordination among donors and within the country	• **Strengthening the capacities of technology transfer institutions and relevant organizations; strengthening of the capability in research, development and innovation** • Building capacity of regulatory agencies to provide necessary laws and regulatory framework (including the **development of standards and regulation to promote the use and transfer of ESTs**) • Strengthening of the ability to network and cooperate between stakeholders and encourage participatory approaches to involve stakeholders • Improved coordination in donor aid at the recipient country level and between donor agencies
Information capacity	• Insufficient understanding of existing capacity and technology needs and inability to identify appropriate technology; lack of capacity for climate change adaptation (most capacity is geared towards mitigation) • Lack of (access to) data and information concerning available technological options and financial information; preferences and biases of consumer and technology users; low levels of awareness; cultural and language gaps • Cooperation and networking within regions is lacking	• **Skills development in technology needs assessment; building capacity to assess and formulate plans for adaptation; strengthen capacity for systematic observation on climate change** • **Enhancement of the awareness and knowledge of ESTs among institutions** (and individuals)**; improvement of knowledge on energy efficiency and the utilization of renewable energy technologies** • Information management and dissemination systems and linking them with regional or international networks; **promote South–South collaboration**

Source: Modified from IPCC (2000) and FCCC/CP/2001/13/Add.1, decision 4/CP.7.
Note: The text in bold in the right column refers to the list of “scope of needs and areas for capacity-building for the transfer of ESTs” of decision 4/CP.7.

III. EXPERIENCES IN CAPACITY-BUILDING FOR TECHNOLOGY TRANSFER AND DEVELOPMENT

A. Introduction

23. International cooperation has supported numerous technology transfer projects, but there is little literature on the results of these projects and what experience is available is largely anecdotal. Thus, there is little information on the success and failure factors in these projects. Barriers to technology transfer as well as capacity actions and policy measures have only been generically treated in literature. Recently, some organizations have put efforts in evaluating and documenting lessons learned in the areas of capacity-building and technology transfer, but none is devoted exclusively to capacity-building for technology transfer. This is less a shortcoming and more a reflection of the reality that capacity-building is an integral part of the process of technology transfer, not a stand-alone activity. It is the aim of this section to derive hints on new opportunities and directions to enhance international cooperation in capacity-building for technology transfer. A summary of the recent relevant evaluation work in this area is presented in section B, including:

(a) Capacity Development Initiative (CDI) and Second Overall Performance Study (OPS2) of the GEF;

(b) *Technology Without Border*, *Case Studies of Successful Technology Transfer*, a joint study by the International Energy Agency (IEA), CTI and UNEP;

(c) *Developing Countries and Technology Cooperation*, an industrial capacity-building and technology transfer study by the United Nations Industrial Development Organization (UNIDO) and World Business Council for Sustainable Development (WBCSD) and *Taxonomy on Country Experiences in Technology Transfer and Case Study Collection on Technology Transfers* by the Working Group on Trade and Transfer of Technology of the World Trade Organization (WTO)

(d) *'Who Needs to Implement the Kyoto Protocol?'*, a capacity-building needs assessment study, jointly undertaken by the Consortium for North–South Dialogue on Climate Change (NSD) and the United Nations Institute for Training and Research (UNITAR).

(e) Lessons learned from regional workshops held under the EGTT programme of work

(f) Examples of information contained in national communications from Parties included in Annex II to the Convention (FCCC/SBI/2003/7/Add.1).

B. Available information on lessons learned on capacity-building for the development and transfer of technologies

24. To highlight the salient points of the above-mentioned works, summary tables of lessons learnt from those reports are presented in this section, illustrated by selected case studies as examples.

1. CDI and OPS2 of the GEF

25. The GEF funds projects and programmes that are designed to benefit the global environment. As the financial mechanism for the UNFCCC, GEF receives guidance from the COP on policy, programme priorities, and eligibility criteria relating to the Convention. GEF grants support projects relating to biodiversity, climate change, international waters, land degradation, the ozone layer, and persistent organic pollutants. The GEF's implementing agencies play key roles in managing GEF projects on the ground. Through them, the GEF has quickly amassed a diverse project portfolio serving the developing world, Eastern Europe, and the Russian Federation – more than 140 countries altogether.

26. Climate change projects are designed to reduce the risks of global climate change while providing energy for sustainable development. GEF climate change projects are organized into four areas:[6] removing barriers to energy efficiency and energy conservation; promoting the adoption of renewable energy by removing barriers and reducing implementation costs; reducing the long-term costs of low-greenhouse-gas-emitting energy technologies; and supporting the development of sustainable transport. As of June 2003, GEF has committed approximately US$ 1.6 billion in grants for climate change projects (out of a total of US$ 4.4 billion allocated to all focal areas). It has leveraged more than US$ 9 billion in co-financing climate change projects (GEF, 2003). Thus, the GEF is a key multilateral institution for transfer of ESTs.

27. The GEF Council requested a review of GEF operations, which was carried out in 2001 and referred to as Second Study of GEF Overall Performance (OPS2). The work focused on the achievement of the GEF operational policies and programmes, programme results and initial impacts, as well as modalities of the GEF support and its overall strategy (see, for example, Martinot and McDoom, 2000; GEF, 2002).

28. Strategic capacity development issues have been addressed by the work of the CDI. The CDI carried out an assessment covering country needs for four developing regions, priorities of small island states and capacity needs and development under the GEF and other multilateral and bilateral donors (GEF–UNDP, 2000).

29. These GEF evaluations both address the two key themes of this technical paper, namely technology transfer and capacity-building. Most of the GEF's climate change projects are directed, at least in part, towards increasing the understanding, awareness, diffusion, and adaptation of environmentally friendly technology and towards promoting domestic manufacturing appropriate to client countries. In some cases, the technology has been locally adapted, and manufacturing capacities have been established or given additional support. In other cases, local manufacturers may produce items locally although other parts continue to be imported.

30. Most GEF projects have a component on building capacity at the individual level (through training of local individuals in financial, technical and regulatory skills), organizational level (development of capacities in private sector firms and financiers, support to public agencies to formulate regulatory frameworks) and on information capacity (consumer and policy-maker awareness).

31. Table 2 provides a summary of the many main findings and lessons learned (as they relate to capacity-building and technology transfer) of the OPS2 programme evaluation and the capacity assessment of the CDI.[7]

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[6] GEF mitigation projects have included solar PV and solar hot water supply, grid-connected renewable energy (wind, small hydro, biomass, geothermal, solar thermal), energy-efficient products (lighting, boilers, refrigerators, chillers), energy-efficient processes in industry, energy-efficient building codes, district heating energy and fuel switching and production/recovery.

[7] Apart from the capacity-building needs assessment, the second phase of CDI involved the development of a strategy for GEF action on capacity-building (GEF, 2001). The main goal of the action plan is to provide more opportunities to access GEF resources for capacity-building, by enhanced attention to capacity-building in GEF regular projects; targeted capacity-building within the focal areas; initial self-assessment of capacity needs; and programme of critical capacity-building needs (for LDCs and SIDS). The third element has been approved by the GEF Council and was launched in September 2001 as the National Capacity Self Assessments.

Table 2. Lessons learned from GEF–CDI and OPS2 reports

Category	Lessons learned in capacity-building actions for technology transfer
Human capacity (individual level)	• Training programmes have provided technical, business, managerial, financial, regulatory and legal skills needed for successful technology transfer. However, a proper balance needs to be established between capacity-building at the various levels (individual, institutional, systemic), but due to the short-term nature of most projects the emphasis is often on enhancing individual skills and institutional competencies. • Training and expertise development should take place preferably in national or (sub)-regional institutions rather than in industrialized countries
Institutional capacity (organizational level)	• Transfer of hardware and know-how is often more difficult than project proponents anticipate (e.g., problems in negotiations on intellectual property and technology licensing; high transaction cost of many ESTs; difficulties in financial closure of the projects). This calls for flexibility in the project design during implementation and early monitoring and evaluation, giving more attention to the assessment of project risks. In addition, the project design must include a detailed assessment of capacity needs and involve the main stakeholders. Capacity development efforts should be national priorities rather then donor-driven; • Creating appropriate regulatory frameworks (e.g., technology standards, labelling and building codes) and a favourable investment climate (e.g., smart subsidies, tariff setting and innovative financing) are essential elements in supporting market development of ESTs • Demonstration of viable business models (private, public and/or private–public) is key to achieving project sustainability and often more important than the 'demonstration of technology' component in many projects. This should be adequately reflected in capacity-building actions by government and NGOs, not only at the national but also at the local level. Substantial implementation experience is still needed before success of business and market transformation models and their post-project sustainability can be evaluated. • There is a strong need to enhance coordination between various capacity development and technology transfer efforts by various stakeholders in a country.
Information capacity	• Lessons learned and good practices are emerging (from the GEF portfolio) but need to be better incorporated into project designs and disseminated within and outside the GEF. In particular, the non-environmental benefits of GEF projects (health, poverty alleviation, sanitation, etc.) need further assessment. A framework with indicators is needed to be able to monitor and evaluate project outputs, indirect impacts and long-term impacts. • These centres should actively promote information dissemination among the various stakeholders. Information centres can provide information on markets, business opportunities, and energy resource assessments, and for evaluating technological options and understanding implementation requirements. Awareness campaigns have indirectly (positively) influenced actions and investment decisions, by putting the technology on the agenda

Sources: The list has been compiled from various GEF publications; see Birner and Martinot (2002), GEF (2000), GEF-UNDP (2000), GEF (2001), GEF (2002), Martinot and McDoom (2000), Martinot, Ramankutty and Rittner (2000).

Case study 1: UNDP/GEF project on solar water heaters in Morocco[8]

32. A UNDP/GEF project in Morocco, started in 2000 and currently under implementation, aims at installing 80,000 m^2 of solar water collectors. GEF support is helping to put this technology on the agenda, giving credence to ongoing research, development and commercialization of this technology. The project is training government agencies and private firms to promote, assess and install solar hot water systems. The project builds capacity in the government for developing a regulatory framework of norms, standards, certification and labelling and associated enforcement mechanisms as well as

[8] Morocco Market Development for Solar Water Heaters; adapted from Martinot and McDoom (2000).

reviewing policy (reduction in value added tax and import duties). The project is introducing assemblers and manufacturers to these standards and specifications, and training architects and engineers to apply them to facilitate compliance. The project conducts training workshops on preparing business plans for bankable solar water heating projects and provides information on best practices and equipment available internationally. Beneficiaries of the solar hot water systems will be private-sector and public-sector establishments, such as hotels, schools, mosques, sports centres and apartment buildings.

Lessons learned

33. Human capacity: One lesson, already learned in the project's early stages, is that training has been essential to this programme by providing the basic technical, business, regulatory, managerial, business and legal skills to private–sector individuals and policy makers. These skills form the basis for successfully purchasing, promoting, regulating, financing and commercializing solar water heating technology in the latter stage of the project.

34. Information: Awareness among the public is enhanced by information dissemination through media campaigns and visibly placing demonstration projects in public facilities. Other awareness building activities aim at government policy makers and at opinion leaders in the business and architect/engineering communities. The project takes public sector representatives on study tours in the Mediterranean and holds national workshops to develop public–private partnerships. Such activities have lent credibility to the technology, created fresh interest in the technology's application and positively affected the further implementation of the project.

Case study 2: UNDP and World Bank/GEF biomass power generation in Brazil[9]

35. Three successive GEF-supported projects have helped to prepare the way for the commercialisation of efficient new biomass power technology in Brazil. Two projects involve the technical demonstration of gasification of woodchips from plantations and demonstration of its commercial viability. The other project involves the use of residues in sugar cane processing (bagasse and field trash) in high-efficiency gas turbines to generate electric power. The sugar cane project revealed that field wastes could be successfully gasified, resulting in almost double the available fuel supply and making possible year-round power generation. Both demonstration projects resolved most of the technology and systems integration issues, including developing and testing equipment to use biomass fuels and engineering design of a commercial demonstration plant. Feasibility studies have shown that the biomass-based technologies compare favourably with hydropower resources in terms of cost and resourced potential.

Lessons learned

36. Institutional capacity: The projects were started in the early nineties when interest in using biomass as fuel was not high in Brazil. Multilateral support in the form of GEF grants was essential to mobilise and engage the major stakeholders (utilities, such as CHESF, the sugar cane industry, universities and government agencies).

37. Information: One important indirect impact of the projects has been the interest raised among stakeholders elsewhere in the world through information dissemination. This stresses the importance of international information dissemination in putting new technologies on the agenda and in giving credence to expansion of R&D and commercialization programmes

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[9] Brazil Biomass Integrated Gasification/Gas Turbine – Project I (UNDP/GEF) approved in 1992; Brazil Biomass Power Generation: Sugar Cane Bagasse and Trash – Project II (UNDP/GEF) approved in 1996; and Brazil Biomass Power Commercial Demonstration – Project III (World Bank/GEF) approved in 1997; adapted from Martinot and McDoom (2000).

38. In addition to the previous case studies, information can de drawn from a number of GEF projects on renewable energy resource assessment and assessment methodologies. Examples are projects in China, Peru (solar resource measurements and databases), Mauritania (wind energy atlas), Indonesia, Latvia, Lithuania, Estonia (hydro and geothermal resources) and Sri Lanka (wind, small hydro and biomass resources). In addition, the GEF supports regional and global renewable energy resource assessment programmes, such as the World Bank/GEF Wind Energy Resource Atlas of South East Asia and the UNEP/GEF Solar and Wind Energy Resource Assessment (SWERA). These projects stress the importance of having access to existing resource assessments and resource assessment tools and techniques (including training and assistance in using these tools) to overcome the barrier of uncertainty on availability and applicability of renewable energy sources, such as solar and wind.

2. *Technology Without Border, Case Studies of Successful Technology Transfer.* Joint study by International Energy Agency, CTI and UNEP

39. The joint IEA–UNEP–CTI publication presents case studies of successful transfer of climate-friendly technology and practices and presents lessons learned. It mentions building skills, sharing information and assessing technology needs as a main group of actions to create a favourable environment for the transfer of ESTs, alongside engaging the private sector (by creating a sound business environment and providing incentives), using development assistance more effectively (improved coordination) and developing innovative financing (to pool resources and share risks). A summary of lessons learned relating to capacity development for technology transfer is given in table 3.

Case study 3: Energy efficiency and information centres

40. Between 1990 and 1994, six energy-efficiency centres were created in Bulgaria, China, Czech Republic, Poland, Russia and Ukraine as part of capacity-building processes to enable government and the emerging private sector to adjust to a more market-based economy.[10] The centres are the Bulgarian Centre for Energy Efficiency (EnEffect), Beijing, Energy Efficiency Centre (BECon), Czech Republic Centre for Energy Efficiency (SEVEn), Polish Foundation for Energy Efficiency (FEWE), Russian Centre for Energy Efficiency (CENEf), and the Ukraine Agency for Rational Energy Use and Ecology (ARENA-ECO).

41. The activities of these centres were to promote energy-efficient products, techniques and services. The centres have been supporting the preparation and financing of major projects and have stimulated investment in market transformation activities. They also have had a pronounced role in shaping energy-efficiency policy in their countries by drafting legislation on demand-side management, standards and labelling and energy conservation. By radio and television campaigns, the centres have helped raise public awareness. A review in 1999 indicated that the centres' activities have resulted in cost savings equivalent to 20 times the cost of setting them up. Most of the centres have become financially self-sufficient.

Lessons learned

42. Information: When considering business opportunities, investors require independent information (such as market analysis, energy data and energy-efficient equipment profiles) as well as expertise to provide technical assistance (training in energy management techniques and setting up demonstration projects). The centres have been instrumental in public awareness raising by spreading general energy-efficiency information by means of the media and targeted information to the private sector by means of newsletters and their web sites. Many centres plan to expand their efforts to the

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[10] These centres were established with the technical support of the Pacific Northwest Laboratory with financial resources provided by the United States Environmental Protection Agency (USEPA), United States Agency for International Development (USAID) and private foundations; adapted from IEA (2001).

regional level. Thus, technological skills and techniques on energy efficiency gained in their countries will be replicated to other countries.

Table 3. Lessons learned from the IEA-UNEP-CTI report

Category	**Lessons learned in capacity-building actions for technology transfer**
Human capacity (individual level)	• Training of servicing personnel to deal with new technology is often essential. Using host country firms builds local skills and allows these firms eventually to undertake their own projects
Institutional capacity (organizational level)	• Financial institutions may lack the ability or experience to assume cost and risk in renewable energy and efficiency projects. Capacity can be built by working with local banks on soft financing or loan guarantees and tailoring these to local conditions and type of technology • Demonstration plants and projects are important by functioning as a testing ground and to build confidence. They also provide information on the appropriateness of the technology from the users point of view and on necessary modifications. For more mature technologies, shifting from capital investment to knowledge investment often yields a more effective use of money. Here, staff need to be trained on possible technology delivery and business models. • Competitive energy markets can encourage sustainable energy development, but may not be effective if environmental benefits are not given adequate consideration (for example, reducing advantages of fossil-fuel technologies or by giving incentives to renewables). A specific capacity-building need is for training of government officials on appropriate legal and regulatory frameworks and policy measures. • Public–private partnerships can work in sustainable energy, if governments create the right environment for private investment. Bundling small projects and collective purchasing can reduce transaction and investment cost. • Well-coordinated regional and international cooperation among governments, donors and private companies can avoid duplication and help disseminate lessons learned.
Information capacity	• A transparent and strategic technology needs assessment can deliver huge benefits in determining appropriate technology and help governments target priority areas • Information centres (e.g., energy-efficiency centres) can meet the need of investors for unbiased information on business opportunities, market analysis and relevant data, especially when going hand-in-hand with workforce training. The media play an important role in consumer information and awareness. Apart from formal information dissemination, information conveyed informally (mouth-to-mouth) can be very influential in stimulating demand. • Linking technology suppliers with potential buyers in information clearing houses and networking can help overcome the information barrier. In fact, strong partnerships between industry in developed and recipient countries can be key element of success in technology transfer.

Source: IEA (2001). The case studies in IEA (2001) are:

- Ecofrig Hydrocarbon Refrigerator, India
- District heating, Baltic countries
- Energy efficiency centres in transition economies
- PV dissemination, Kenya
- Technology needs assessment Philippines (TCAPP)
- Grid-connected cogeneration, El Salvador
- Wind farm development, Honduras
- Demand-side management, Ukraine
- Energy-saving lamps programme, Poland (PELP)
- Networking and EC–ASEAN cogeneration
- Solar cookers, South Africa
- Prodeem, Brazil (off-grid rural electrification)
- Energy efficiency fund, Hungary
- World Bank/GEF IREDA project (renewable energy agency)

Case study 4: The EC–ASEAN COGEN programme

43. The European Commission–Association of South East Asian Nations (ASEAN) COGEN Programme was a partnership programme between the industrial sectors of the ASEAN and European suppliers of cogeneration equipment (IEA, 2001). The programme involves two components, a 'business line' and a demonstration component. The 'business line' gave information to potential suppliers of technology about the opportunities in cogeneration in the ASEAN region and guidance about various governments' investment rules and incentive programmes. The programme's second component provided financial and technical assistance to cogeneration developers in setting up demonstration projects. A review of the project indicated that 14 biomass cogeneration in ASEAN countries have been supported, with environmental benefits in terms of savings on fuel oil and electricity purchases and avoided rice-husk disposal, and economic benefits in terms of income generation and trained staff.

Lessons learned

44. Institutional capacity: Successful demonstration projects raised investor confidence in biomass-based cogeneration technology and helped push through regulatory reform, allowing small private operators to produce and sell grid-connected electricity.

45. Information: The COGEN programme linked potential buyers and sellers of cogeneration technology through a network of national teams, the COGEN secretariat and European consultants Linking technology suppliers (in Europe) with potential buyers (in the ASEAN region) helped overcome information barriers and stimulated the transfer and adoption of ESTs. International cooperation worked as a catalyst stimulating this process.

3. *Developing Countries and Technology Cooperation*, an industrial capacity-building and technology transfer study by UNIDO and WBCSD and *Taxonomy on Country Experiences in Technology Transfer and Case Study Collection on Technology Transfer* WGTTT of the WTO

46. The WTO Working Group on Trade and Transfer of Technology (WGTTT), established in 2002, has drafted some documents that give an overview of how technology is transferred to and diffused within countries (WTO, 2002a) and of country experiences with technology transfer (WTO, 2002b). The studies give an overview of policy instruments that provide market support and adequate incentives, create an enabling regulatory environment, establish infrastructure and directly organize government programmes.

47. A joint UNIDO–WBCSD study provides an analysis of technology cooperation from the perspective of 10 member companies of WBCSD (UNIDO–WBCSD, 2002). From the 10 case studies, several key recommendations are provided to the business audience and policy makers on technology cooperation and strengthening the capacity of developing countries.

48. A summary of the key findings of both the WTO–WGTTT and UNIDO–WBCSD regarding capacity development for technology transfer studies is provided in table 4.

Table 4. Lessons learned from WTO and UNIDO–WBCSD reports

Category	Lessons learned in capacity-building for technology transfer
Human capacity (individual level)	• Capacity-building efforts in technology transfer are more effective if methods and training are adapted to local conditions and the knowledge and skills level of the trainees. Developing trainers will contribute to success and post-project sustainability. • Training of the domestic labour force is important, but in some countries mechanisms should be devised to retain the capacity to avoid a brain drain (e.g., by introducing wage flexibility or repatriation grants, or by offering incentives and venture capital to start technology firms). • Depending on the type of project, training should not only focus on technical staff, but also take into account the users of technology (consumers, communities). Effective communication is essential at all stages (this includes sensitivity to language barriers and cultural differences)
Institutional capacity (organizational level)	• Universities and other educational institutions should adapt their curricula and R&D programmes more to the needs of industry and multinational companies • Support is needed here by government spending (or incentives, such as tax deductions) to provide the necessary infrastructure developments (e.g., industrial parks and industry incubators) as well as capacity-building (e.g., industrially geared technical education, R&D activity for technology adaptation to the domestic market, fostering international cooperation in R&D); • Government should provide conditions for setting up a competitive market, a regulatory environment (quality standards) and provide incentives to attract foreign investment and new technology • Donors' support can encourage technology transfer partnerships by fostering links between research centres and industry and by providing mediation between finance providers and domestic investors (venture capital) • Greater interaction must be created between ODA, government spending and FDI, e.g. by using a portion of ODA to reduce risks (by building local technical capacity, better governance and administration)
Information capacity	• Technology needs assessments should precede the implementation of specific technologies • Information clearing houses can play an important role in providing information on technologies and advisory services as well as in organizing promotion campaigns • Clearing houses and business incubators can encourage interactions between domestic and foreign firms (backward and forward links in the production chain) and promote business alliances (joint ventures, licensing, subcontracting) with foreign companies.

Sources: WTO (2000b) and UNIDO-WBCSD (2002)

Notes:

The case studies analysed in the WTO document were:

- New-generation refrigerators, India
- Diffusion of wind technology, India
- Coal power plants, China
- Alternative technology to CFC solvents, Mexico
- Cooperative R&D on concrete armouring for the coast, South Africa
- South–South technology transfer
- Indian pharmaceutical sector
- Wind power systems, Inner Mongolia
- Government support to Intel suppliers, Costa Rica
- Automotive industry, South Africa
- Technology services, Mauritius
- Technology parks and incubators, Korea
- Technology transfer policy, China
- Building a technology transfer infrastructure, United Kingdom

The 10 case studies of the UNIDO–WBCSD analysis:

- Municipal solar infrastructure project, Philippines (BP Solar)
- Entrepreneur development programme, Morocco (Suez Lydec)
- Duijangyan Cement Co. construction projects, China (Lafarge)
- Landfill site methane recovery projects, China (CH2M Hill)
- Supply chain management, Kenya (SC Johnson)
- Integrated crop management, Brazil and Guatemala (Bayer)
- Natural fibre project, South Africa (DaimlerChrysler)
- Joint venture RMC ready-mix cement, India (RMC)
- Alumar plant, Brazil (Alcoa)
- Coca-Cola entrepreneur development programme, South Africa

Case study 5: BP Solar Municipal solar infrastructure project, Philippines

49. In the Philippines, BP Solar undertook the Municipal Solar Infrastructure Project (MSIP), in conjunction with the Philippine and Australian Governments, aiming at providing solar energy equipment to expand and upgrade basic facilities in remote un-electrified communities. The project was started in 1997 and was completed in May 2001 at a cost of about US$ 27 million (UNIDO–WBSCD, 2002). MSIP involved the provision of solar energy equipment, but being seen as a development rather than a solar technology project, the project implicitly included other infrastructure needed to deliver the energy services, such as lighting facilities, vaccine fridges, school equipment and water pumps. Apart from hardware installation, the ‘social preparation and community phase’ is considered as a crucial step in the project. This phase consisted of social preparation (needs assessment and evaluation of current infrastructure), training (community development officers and technical training of municipal operatives and engineers) and community development (organization of water, health and school committees) as part the major components of this project. In total 1,145 solar systems were installed in 435 villages (barangays).

Lessons learned

50. Human capacity: A key element to ensure sustainability was training. More than 2,000 community members were trained, including ‘training of trainers’, on governance aspects (community organization, fee collection and revenue raising) as well as technical aspects (maintenance and local repairs). Advanced training was also provided to the universities to enable them to fully dismantle, repair and reassemble the components.

51. Institutional capacity: Assessment of development and technology needs has to be the starting point for any community EST project. For the project to be successful, the community has to be involved and committed. Community ownership was further enhanced by building incentives to perform in the project (e.g., paying a fee for maintenance of the solar equipment). In addition, it specifically included revenue generation activities, such as night lighting for fishing boats, growing cash crops, animal breeding and handicrafts. A key element in ensuring post-project follow-up has been the delegation of project management to local stakeholders.

Case study 6: Lafarge Dujiangyan Cement Company, China

52. The French company Lafarge entered a joint venture agreement with the Dujiangyan Building Materials Corporation, under which a new cement plant was constructed in Chengdu, using the more efficient dry process technology. Finance has been provided by the International Finance Corporation (IFC). More then 80 per cent of the plant’s production equipment was sourced locally and local firms were subcontracted for construction. The plant is now in operation and has a production capacity of 1.4 million tonnes of high-quality cement per year.

Lessons learned

53. Human capacity: Intensive training programmes were carried out to ensure that all personnel were adequately informed and equipped with appropriate skills in manufacturing, installation and project management. Best practices were transferred, in particular those relating to safety and environmental practices. High sensitivity to cultural differences and varying business styles has been a key element to gain good working relations with the local partner and subcontractors and in getting support from the government. Quality translation and interpretation has been a success factor in attaining good communications.

54. Institutional capacity: The project has shown that last-generation technology can be successfully transferred by large international companies, provided the partners have financial strength, and can

provide the necessary technical support, based on extensive technical and local experience, and operational support guided by a strong management team and well-developed procedures.

Case study 7: Wind power systems in Inner Mongolia, China[11]

55. In the early 1980s, the Government of the Inner Mongolia region of China initiated a programme to spread local production and dissemination of stand-alone wind-electric systems among its rural herding population. The technology transfer has centred on local adaptation of a foreign product (in this case, wind turbines from Sweden), resulting from collaboration with the Swedish company and the Chinese plant in Shangdu. The Swedish design had to be adapted to the low wind-speed regime in Inner Mongolia.

Lessons learned

56. Institutional capacity: The key element of success has been the intensive cooperation between the stakeholders involved, i.e., local Government, private sector, technology users and research institutes. A New Energy Office (NEO) was set up by the Government to bring together the various ministries involved (planning, finance and agriculture), universities, research institutes, private sector and local herdsmen. Maintenance and quality control were coordinated in a network of R&D, production, distribution and service organizations, and service centres were set up in 60 of Inner Mongolia's 88 counties.

4. *Who Needs to Implement the Kyoto Protocol?*, a capacity-building needs assessment study, jointly undertaken by NSD and UNITAR.

57. The Consortium for North–South Dialogue and Partnership on Climate Change (NSD) was formed in 1997 to promote North–South technical cooperation and new partnerships in the area of climate change. A joint UNITAR/NSD project assessed capacity-building needs relating to the Kyoto Protocol in 33 developing countries. The GEF CDI (see paragraph 28.) has also assessed capacity needs for countries to meet their obligations under the Convention at the regional level in Africa, Asia, and Latin America and in SIDS.[12]

58. In general, the studies show that capacity-building needs are considerable and require high financial and human resource investments. Regional differences do exist and require different objectives for training. For example, some countries in the group of LDCs need formal training of core skills (which will assist them to have the threshold of labour requirements for effective technology absorption). In addition, they need capacity-building for improved decision-making (workshops for governmental and public sector staff and senior business executives as well as institutional support to strengthen relevant institutions and strengthen rapport between private and public sectors). Other developing countries are likely to focus more on skills development in business promotion, technology acquisition negotiations and networking. Also, they might focus on capacity strengthening in government to set up appropriate legal and policy frameworks and to better coordinate and share information between government agencies at various levels and with NGOs and the private sector. For smaller states (especially the SIDS), regional cooperation in capacity-building and technology transfer is important to achieve 'economics of scale' in terms of human and financial resources. For regions such as Latin America, the Arab States and West Africa, it is important to have regional networks that design didactic materials and databases in non-English languages.

5. Lessons learned from the regional workshop held under the EGTT programme of work

59. In December 2002, an Africa regional workshop on technology needs assessments and technology information was held in Dakar, Senegal, jointly organized by the CTI, UNDP and UNEP in

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11 Adapted from WTO (2002b)

12 Mugabe, et.al, (2000), Zakri, et.al., (2000), Bucher, et.al., (2000), and Binger (2000)

cooperation with the UNFCCC secretariat and the EGTT. From this meeting emerged many key findings that provide further insight into the capacity-building needs and priorities of southern and central Africa.

60. These outcomes included:

(a) Strengthening the information management capacity of institutions that serve as nodes on regional information networks;

(b) Engaging local information users to ensure that information accessible through networks is relevant to them. Information users include trainers, decision makers, entrepreneurs, financial institutions and project developers. These users can be engaged through training and workshops;

(c) Promoting improved information sharing and coordination on climate change and related issues between international organizations and with regional networks;

(d) Supporting a "human network" by involving different institutions that form part of a network in training and capacity-building activities;

61. In October 2003, a workshop on technology needs assessments and technology information for the Caribbean region was held in Port of Spain, Trinidad and Tobago, jointly organized by the CTI and UNDP in cooperation with the UNFCCC secretariat and the EGTT. The main objectives of the workshop were: to discuss regional concerns and priorities in assessing technology needs, including information tools and resources relevant for the Caribbean region; and to discuss a framework to assist countries in conducting comprehensive technology needs assessments, including addressing adaptation issues and concerns.

62. The technology needs assessment process can serve as a valuable tool for identifying capacity-building needs for the successful transfer of technologies and practices. Similar to the lessons learned from other sources, these needs in the Caribbean region include the full range of human, institutional and international capacity-building; in particular it was noted that the identification of key capacity-building and public awareness measures should play a more visible role in the technology needs assessment process.

6. Examples of information contained national communications from Parties included in Annex II to the Convention

63. The section on financial resources and technology transfer contained in most of the third national communications (NC3) of Annex II countries included useful information on their efforts on capacity-building for technology transfer (UNFCCC/SBI/2003/7/Add.1). Nine Parties (Australia, Belgium, Canada, Germany, Japan, Netherlands, Norway, Sweden, United States) included a separate section on capacity-building in their NC3. Other Parties reported capacity-building activities in their bilateral projects,[13] or by providing information with respect to adaptation as requested by the guidelines.

64. The NC3s reflected in general an increase in the share of bilateral projects, particularly in capacity-building. A summary of bilateral financial contributions to activities directed to capacity-building and other vulnerability assessments, which included capacity-building components, as reported by Annex II Parties is contained in document FCCC/SBI/7/Add.1, table 14, page 51.

65. From the analysis of the NC3s the fields of activity which received most of the support were: capacity-building programmes and projects at the national and regional levels relating to vulnerability assessments (agriculture, coastal zone management and forestry); research and application of greenhouse gas mitigation technologies; capacity-building activities relating to the development and implementation

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[13] Details of these projects are compiled in a table available on TT:CLEAR (http://ttclear.unfccc.int).

of clean development mechanism/joint implementation (CDM/JI) projects; joint research and development; improvement of climate data management and monitoring capabilities; preparation of national action plans; training and education; participation of non-Annex II representatives in meetings and workshops; and climate knowledge information systems and networks.

66. In reporting information on examples of selected technology transfer projects, Annex II Parties in some cases highlighted the capacity-building component; in other cases it is possible to derive the component from the project's typology. But in general if it is not indicated clearly it is difficult to single out and evaluate these aspects.

67. NC3s provide for a wide range of information on projects and programmes, but it is still difficult to clearly identify specific capacity-building for technology transfer components in such activities. The availability of additional information in future national communications could not only improve the common understanding of the issue but also provide for positive lessons learned to be replicated in different countries or regions.

C. Summary of lessons learned and priority needs for international cooperation in capacity-building for technology transfer

1. Introduction

68. Section III B above focuses on experiences in capacity-building for the transfer of ESTs, relying on the availability of a number of evaluation and case study collection in literature. This section provides summary conclusions on the lessons learned on gaps and overlaps in capacity-building for technology transfer. It identifies priority actions for international cooperation to address these gaps and overlaps (see table 5).

2. Human resources development

69. Adequate trained labour is essential to the development and transfer of technology. Technology absorption capacity requires considerable domestic technical and managerial staff capable of adopting, operating and managing new technologies. Experiences of some developing countries have shown that there is an interaction between technological capability and economic success, by transforming their economies from labour-intensive to capital intensive economies. Achieving this required threshold will require strategic technical cooperation inputs, especially into the LDCs.

70. One of the major challenges of human capacity-building in developing countries, notably LDCs, is retention of capacities. Options to minimize this problem include introducing wage flexibility, offering incentives (venture capital to start firms or grants) and organizing training as much as possible in developing countries. The latter option also provides the opportunity to relate the training to local conditions and train larger numbers of individuals. If nationally training opportunities are not available, training and expertise development could take place in (sub)-regional institutions.

71. LDCs will continue to need formal 'hardware' training of core skills which will assist them to have the threshold of skilled labour force requirements for effective technology absorption, whereas other developing countries will focus more on 'software' skills in project development and business promotion. Capacity-building efforts are more effective if methods and training are adapted to local conditions and to the knowledge and skills level of the trainees. Formal training programmes do not always ensure practical learning. 'Learning by doing' and other participatory techniques should be characteristic elements in human capacity-building programmes.

72. Due to the short-term nature of many projects, much training is organized in the form of workshops and seminar, often as one-off activities without direct follow-up. They do assist in information exchange, but are limited in terms of long-term effectiveness.

3. Institutional development

73. Building, developing and strengthening capacities in relevant organizations (institution building) is another key factor in the development and transfer of technology. Unfortunately, there is often institutional weakness in responding to new areas such as climate change and ESTs. The term institution building may be misleading; rather than setting up new institutions it is often more appropriate to strengthen existing organizations or institutional structures. The financial burden of setting up new institutions is often a major obstacle and institutions or mechanisms created with donor support in (short-term) projects often lack local ownership and may collapse after funding ceases. On the contrary, existing organizations are embedded in the institutional structure of the country or region.

74. In the case of diffusion of 'new' technologies, demonstration can be important by functioning as a testing ground and to build confidence. In many international cooperation projects, therefore, the component 'demonstration plant or projects' is very visible. However, in the case of 'proven' or 'mature' technologies: the demonstration of viable business models (private, public and/or private–public) is much more important. The GEF experiences, for example, have shown that viable business models (private, public and/or private–public) are key to achieving project sustainability. Different technology delivery and business models need to be explored. Before the success of business and market transformation models and their post-project sustainability can be evaluated, substantial implementation experience is still needed.

75. New and renewable energy technologies often have high transaction and initial capital investment cost. In many developing countries, financial institutions may lack the ability or experience to assume cost and risk in such projects. International cooperation can support capacity-building in financial institutions (commercial banks, micro-credit organizations) by developing innovative financing mechanisms (that are tailored to local conditions and user needs). In addition, international cooperation can support networks that provide mediation between finance providers and seekers.

76. International assistance can provide capacity-building support to national governments to build a macroeconomic framework appropriate to national circumstances. Competitive energy markets can encourage the development and transfer of clean technologies (energy efficiency, renewables), but may not be effective if environmental benefits are not given adequate consideration (i.e., reducing advantages of fossil-fuel technologies). In this respect, appropriate legal and regulatory frameworks are needed for transfer and diffusion of new/adapted technologies. Elements in such frameworks may include technology standards, labelling and building codes, fiscal incentives (reducing fiscal technology import and export barriers, tax exemptions) and credit assistance (guarantees for risk, preferential loan rate, subsidies for start-up).

77. Transfer of know-how is often more difficult than project proponents anticipate, due to difficulties in negotiations on intellectual property and technology licensing as well as in the financial closure of projects. There is a need to carefully consider the pathways of technology transfer (turn-key investment, build–operate–transfer, build–own–operate–transfer or joint venture) and realistically appraise costs. Technology transfer negotiations can be facilitated by encouraging interactions between domestic and foreign firms and the promotion of technological partnerships, business alliances and networking between firms in developed countries and in developing countries. Partnerships require a long-term commitment with the objective to share knowledge, enhance technological capabilities and foster innovation as well as to share risk and cost. LCDs, especially, may not have such expertise, and here international cooperation can play a supportive role by facilitating the transfer of ESTs.

78. The increasing competitiveness in the global economy requires increased knowledge, innovation, management and technological capabilities. Expertise of a multi-disciplinary nature is needed to cope with the knowledge-based activities now prevailing in the international technology transactions. This requires changes in both financial and human resources that few institutions in developing countries can

afford. Setting up collaborative links between R&D institutions, universities and private companies from developed countries and developing countries could be one solution to cope with this challenge. Networks are a group of institutions or associations with the aim of enhancing capacity to conduct joint research, to improve training and education, to improve market access and to exchange information on technology, investment opportunities and successful case studies. Experience has shown that such partnerships and networks are mostly in developed countries. International cooperation can be instrumental in promoting networks between developed countries and developing countries.

79. Some international cooperation projects are not fully coordinated within larger development priorities, are donor-driven and have restrictions e.g. tied-aid. The development of mutually advantageous and sustained partnerships is often crucial to the development of appropriate policy and legal frameworks. At the national level, greater synergies must be created between ODA, government spending and foreign direct investment. There is also a need to enhance coordination between various capacity development efforts in a country between and among bilateral and multilateral donors.

4. Information capacity

80. The important role of information and awareness creation in the development and transfer of technology has been discussed in several parts of this technical paper. In fact, extensive information is already in the public domain, providing useful information on technologies, costs and environmental parameters (for example, the list in annex I). However, the usefulness of web-based information clearing houses for technology transfer is often limited, as they do not include the specific technical data (local and external) that will facilitate technology selection, development and use in a particular recipient country context. Mostly they contain information to promote technology sales rather than provide independent assessment of technology and technology providers. Information on investment opportunities in developing countries is also scarce and this impedes effective involvement of the private sector.

81. As most information clearing houses are based in developed countries, there is a need for national and regional information and technology transfer centres that add country and region-specific data derived from field experiences and local circumstances. Such centres could provide services, such as information exchange, public awareness, training and seminars, technology databases, marketing and promotion, demonstration projects, and act as facilitators in technology transfer networking. The centres and their databases should be linked with other centres and international databases in both South and North as part of global or regional technology information and transfer networks, making maximum use of electronic technology.

82. Coordination among donors is crucial to ensure optimum benefits to the recipients. Lessons and good practices on technology transfer and international cooperation in capacity-building are emerging through project descriptions and case studies. These can give valuable information, but such reporting is often ad hoc, sketchy and focusing on the project’s outputs rather than on its impacts on society. Publicly available evaluations, such as the GEF’s overall programme and project evaluation studies, are still rare. Consequently, there is a tendency to redo projects, and lessons learned are not taken into account into the design of new projects.

Table 5. Opportunities in international cooperation to support capacity-building for technology transfer

Category	Opportunities in international cooperation
Human capacity (individual level)	• Training and expertise development should preferably take place in national or (sub)-regional institutions rather than in industrialized countries. Sometimes measures need to be taken to retain trained human resources. • To have more impact, courses should shift from one-off events without follow-up to training within a longer-term framework
Institutional capacity (organizational level)	• Strengthening existing organizations or institutional structures is usually preferred over setting up new ones (which may collapse if they lack ownership and donor support is withdrawn). • Financial institutions need capacity-building on the design of innovative financing products for ‘higher-risk’ ESTs (soft financing or loan guarantees, tailored to local conditions) • Government institutions need capacity-building support in formulating sound legal and regulatory frameworks (standards, labelling and fiscal incentives) and enabling environment (competitive markets, giving adequate consideration to environmental externalities) • Transfer of EST (turn-key investment, build–operate–transfer, build–own–operate–transfer, joint venture, clean development mechanism) can be facilitated by linking technology suppliers with potential buyers and fostering partnerships between national and foreign firms and financing institutions • For ‘new’ technologies, pilot plants or projects can be important to get investor’s confidence, but for ‘mature’ technology, demonstration of viable business models (private, public and/or private–public) is more important than hardware demonstration. However, substantial implementation experience is still needed before success of business and market transformation models and their post-project sustainability can be evaluated. • Capacity development efforts should be based on national priorities rather than be donor-driven. Donors need to play a softer role in project design and implementation (micro) and focus more on facilitation and supporting processes in a longer-term approach (macro). There is need to enhance coordination between various capacity development efforts in a country between and among bilateral and multilateral donors and greater cooperation should be created between ODA, government spending and FDI.
Information capacity	• Lessons learned are emerging from technology transfer, but need to be better incorporated in the design of new projects by international exchange of info (project fact files, demonstration, best and worst practices) • Revised or new reporting mechanisms and indicators for capacity-building are needed for longer-term monitoring and evaluation of effectiveness of technology transfer and internationally supported capacity-building • International cooperation should support North–South, South–South and regional cooperation and networking between R&D institutions, companies or branch associations, and also support strengthening of national (or regional) information centres and clearing houses and support their regional and global-level networking

Note: This table is based on the ‘lessons learned’ tables 2–5. More explanation is given in the main text.

83. Coordination among donors is crucial to ensure optimum benefits to the recipients. Lessons and good practices on technology transfer and international cooperation in capacity-building are emerging through project descriptions and case studies. These can give valuable information, but such reporting is often ad hoc, sketchy and focusing on the project’s outputs rather than on its impacts on society. Publicly available evaluations, such as the GEF’s overall programme and project evaluation studies, are still rare. Consequently, there is a tendency to redo projects, and lessons learned are not taken into account into the design of new projects.

84. One priority in international cooperation is the need for independent mechanisms at country and inter-agency levels to evaluate and report on project outcomes and impacts. The information thus generated (lessons learned in terms of good and bad practices) would allow building on prior work, avoiding overlap and duplication of capacity-building efforts in the development and transfer of technology.

85. Another priority is analytical work to develop a common set of indicators to establish the effectiveness of capacity-building and technology transfer programmes. These determinants are necessary for countries to be able to report on their projects, their effectiveness and impacts. The UNFCCC could be instrumental to this process, by including specific information on performance of capacity-building in the development and transfer of technology in the Parties' national communications. In particular, there is a need for Annex II Parties to clearly identify the capacity-building activities supported in their technology transfer sections, and for the recipient countries to report not only a list of projects, but also on their progress and results.

IV. SUMMARY OF MAJOR CONCLUSIONS

A. Conclusions

86. Capacity-building is a long-term, continuous and complex process that requires the active cooperation of all involved stakeholders. In particular, in capacity-building for the development and transfer of ESTs to mitigate or to adapt to climate change, an extra effort is required. Development and transfer of appropriate ESTs to developing countries can help them in achieving both global environmental goals, i.e., addressing climate change problems, and sustainable development goals. However, developing countries need basic capacity to assess, analyse and prioritize technologies based on their own needs and development priorities and then adapt these technologies to specific local conditions.

87. The literature summarized in this technical paper provides for some general remarks:

(a) New technologies require demonstration projects to show their technical and commercial viability. For proven or mature technologies it is more important to demonstrate viable business models and to create an appropriate enabling environment. This distinction should be reflected in the curriculum of training and courses and should therefore include enhancement of legal, regulatory, management, financial and business skills;

(b) Considerable financial, human and institutional resources are needed for capacity-building efforts in developing countries and economies in transition to effectively access the ESTs they need. This is most likely to be forthcoming in the context of mutually advantageous partnerships. However, capacity-building activities in developing countries and countries with economies in transition will vary according to the technological capability of these countries. For example, LDCs may concentrate on technical training and institutional development, whereas other developing countries and countries with economies in transition may focus on technology partnership and networking, and developing business and negotiating skills;

(c) Donor agencies should concentrate on facilitation and support for projects, and cases where they are directly involved in the design and implementation should be structured in a way that the recipients are involved from the beginning and have the possibility to take over;

(d) Lessons learnt from case studies show that more work needs to be done in the specific area of capacity-building for technology transfer. Suitable monitoring and evaluating systems are needed to better assess the effectiveness of capacity-building activities.

B. Possible next steps

88. Suggested steps that can be taken include:

(a) Organization of specific capacity-building technology transfer projects in the areas of:

(i) Technology evaluation and selection to build upon completed technology needs assessments projects;

(ii) Development of institutional frameworks, including regulatory, legal, financial, and managerial, for the adoption of new environmentally sound technologies;

(iii) Development of technical skills in research, development and diffusion of ESTs and of managerial, business and financial skills to advance appropriate business and market development models.

(b) Explore the need to develop a set of criteria/indicators to assess capacity-building activities in technology transfer in developing countries and countries with economies in transition on the basis of multilateral and bilateral experiences, and explore how it could be developed and utilized;

(c) Explore how this issue is dealt within other Conventions;

(d) Request information from Parties on their experiences in capacity-building for the development and transfer of technology;

(e) Analysis of trends (e.g., capacity-building for hardware operation, human resources and institutional capacity building) and gaps and overlaps in the implementation of different capacity-building activities

89. In addition, Parties could be encouraged to:

(a) Include more specific reporting on capacity-building activities in technology transfer in the preparation of their national communications;

(b) Promote and support technology networks and facilitate technology partnerships that complement technology transfer and capacity-building activities;

(c) Promote and support training programmes that cover core science and technology skills and peripheral skills such as business development for developing countries and countries with economies in transition, including evaluation and monitoring skills.

Annex I

Technology information clearing houses and databases

Several existing web-based portals and clearing houses seek to enhance the information flow in technology transfer. Many of their databases contain useful information on environmentally sound technologies (ESTs). A non-exhaustive list is given below:

Alliance to Save Energy (ASE)	ASE undertakes research, educational programmes, and policy advocacy, designs and implements energy-efficiency projects, promotes technology development and deployment, and builds public–private partnerships (in the United States and other countries).	www.ase.org www.ase.org/links.htm (useful links to other web sites and information clearing houses)
Asian and Pacific Centre for Transfer of Technology (APCTT)	APCTT is a United Nations regional institution under the Economic and Social Commission for Asia and the Pacific (ESCAP). It promotes transfer of technology to and from small- and medium-scale enterprises in Asia and the Pacific, and implements development projects funded by international donors.	www.apctt.org Portals: www.technology4sme.com (business matchmaker) www.techmonitor.net/ (technologies) www.business-asia.net/ecoach/ap/index.htm (business guide, technology transfer, case studies)
Asia-Pacific Economic Cooperation (APEC) Virtual Centre for Technology Exchange (APEC-VC)	APEC-VC is research project approved in 1996. The project helps APEC economies, municipalities, corporations and environment-related institutions share, via the Internet, information on environmental technologies.	www.apec-vc.or.jp
Canada’s Natural Resources	Different portals on clean energy, energy efficiency and natural resources	www.nrcan.gc.ca oee.nrcan.gc.ca www.cleanenergy.gc.ca
CleanEnergy	German-based portal providing clean energy company directory, news, links	www.cleanenergy.de www.cleanenergy.de/index2.html (portal)
COGEN Europe	The European Association for the Promotion of Cogeneration has a web page with links to associations and organization as well as operators and suppliers of cogeneration solutions	www.cogen.org/Links.htm
Climate Technology Initiative	Multilateral activity to promote the objective of the UNFCCC by facilitating the more rapid development and adaptation of climate friendly technologies and practices. Currently formed under an implementing agreement of the IEA.	www.climatetech.net
United States Department of Energy (DOE) - Office of Scientific and Technical Information (OSTI)	DOE’s EnergyFiles is a vitual library with links to over 500 websites and databases	www.osti.gov/energyfiles/
Energy Source Guides	A comprehensive online buyer's guide and business directory to more than 7000 renewable energy businesses and organizations worldwide.	energy.sourceguides.com

Enterweb	Enterweb provides sources of information and weblinks on micro, small and medium business in developing and developed countries, finance, international trade and enterprise development	www.enterweb.org
IEA–OECD EETIC (Energy and Environmental Technologies Information Centres) • GREENTIE Greenhouse gas Technology Institute) • Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET)	GREENTIE provides an international directory of suppliers whose technologies help to reduce greenhouse gas emissions. It also provides information on funding and on leading international organizations and IEA programmes on clean energy technologies. CADDET forms an international network that provides information on renewable and energy efficiency applications in projects around the world	www.greentie.org www.caddet.org (energy efficiency) www.caddet-re.org (renewables)
Enviro-Access	Enviro-Access is one of the three *Canadian Environmental Technology Advancement Centres* (CETAC). The two other centres are the Ontario Centre for Environmental Technology Advancement (OCETA) and the Canadian Environmental Technology Advancement Corporation – West (CETAC–West).	www.enviroaccess.ca/eng/index.html www.oceta.on.ca
Environmental Data and Information Exchange (EDIE)	United Kingdom-based EDIE on water, waste and environmental technologies and suppliers	www.edie.net
EnviroNET	Australia's EnviroNET is a directory of Australia's environment industries including databases of environment management expertise, industry applications for environmental technologies, environmental education	www.environet.ea.gov.au
Global Network of Environment & Technology (GNET)	United States-based GNET contains information resources on environmental news, innovative environmental technologies, government environmental technology programmes, contracting opportunities, market assessments, market information, current events.	www.gnet.org
Green Pages	This global environmental directory provides information on a full spectrum of environmental products and services suppliers and institutions from 136 countries, as well as information about organizations, conferences and publications	eco-web.com
Renewable Energy Policy Project (REPP) – Center for Renewable Energy and Sustainable Technology (CREST) – Solstice	REPP, a United States NGO, provides links to documents and databases on renewable energy and energy efficiency	www.crest.org sol.crest.org

RETScreen	The RETScreen International Renewable Energy Decision Support Centre helps to promote the implementation of renewable energy projects by connecting industry, customers and project stakeholders via an Internet-based marketplace. Also RETScreen provides on-line training materials and software on renewable energy technology	www.retscreen.net/ang/13.php (market place) www.retscreen.net
UNFCCC TT:CLEAR	TT:CLEAR is the UNFCCC secretariat's prototype technology information clearing house, providing up-to-date information about technology transfer and allowing direct access to databases, publications and case studies and promoting the exchange of views on different technology transfer issues	ttclear.unfccc.int/ttclear/jsp/
U.S. Climate Technology Gateway	Provides a framework for a range of programmes, projects, resources and actions supported by the United States Government to promote international technology cooperation to address global climate change.	www.usctcgateway.net
Solarbuzz	Provides information on solar energy companies and consultancy and research services	www.solarbuzz.com
UNEP SANet	The *Technology Transfeedr Networks* is a global UNDP/GEF project aimed at connecting key public and private sector stakeholders in technology transfer to recipient countries. Its information management tools is the SANet (SustainableAlternatives.net), which helps businesses overcome technology transfer challenges by offering on-line resources (investment decision tools, case studies, expert directory) and co-financing advice.	www.sustainblealternatives.net

Annex II

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